# The Role of Generations, in Rail Vehicle Maintenance

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*Abstract: The economic developments in Europe and the associated increase in mobility demand, as well as the achievement of the climate policy objectives, are indispensable without a transformation of rail transport, which cannot be achieved without the widespread use of digitalization and automation in this transport sector. At the same time, the current labor market situation and the need to replace a dwindling and ageing workforce are key issues for all railway companies to address. In this work, a generational study has been used to identify the characteristics and preferences of the workforce, which can be used as a basis for developing a strategy to make railway companies' jobs more attractive. In this research, data for the population of Hungary and the expected changes in the labor market were investigated and compared. The impact of ongoing and expected rail network developments, digitalization, and automation were investigated, and the number of employees required was determined for the following years. These changes highlight the areas where new competencies should be acquired, due to the changes in employees.*

*Keywords: rail transport; generations; maintenance*

# 1 Introduction

Labor market trends show a growing demand for skilled labor, but the right skills and quantity of workers are not always available to meet this demand. This is particularly true if we focus our analysis on rail transport. As regards the problem itself, several reasons have led to this situation, and analyzing them is a complex task. We can start with the reduction in the number of professionals produced by the education system, one of the reasons is the lack of recruitment opportunities in the rail labor market and, of course, the lack of interest, in this career.

Another important aspect is to look at how we can make the railways attractive and to do this. It is essential to know who we need to make them attractive to. This is not possible without understanding the generations actively involved in the labor market, their characteristics, expectations, means of motivation and learning preferences. In addition, we need to consider current developments in railways, which will impact future labor needs. At the same time, we must not overlook how current rail transport workers will be affected by expected developments.

Rail transport – both passenger and freight – is becoming increasingly important today, as sustainable economic development cannot be achieved without adequate mobility. It is by far the most environmentally friendly mode of transport in terms of its environmental impact. Rail transport must, therefore, be significantly expanded to meet the commitments of the European Green Agreement to reduce $CO_2$ emissions from transport by 90% by 2050. Rail improvements will include the development of the network linking the EU countries, creating new high-speed rail lines, developing related services, and renewing the rolling stock and related maintenance systems.

According to the EU Commission's Sustainable and Smart Mobility Strategy, high-speed rail transport across Europe should double by 2030 and freight transport by 2050 ("Employability in the rail sector in the light of digitization and automation" CER, ETF EDA Rail project summary report).

# 2 Generational Research, Generations and their Characteristics

Before looking at the possibility of attracting generations into the labor market, it is useful to analyze each generation and identify their characteristics and motivations, as this will help us develop an appropriate corporate strategy to recruit and retain them. We are mistaken if we think grouping people according to certain criteria is an initiative of the modern age. This was done much earlier, as the literature mentions generations such as the 'Golden Age' generation or the 'Reformation' or 'Elizabethan' generations associated with different historical phases. So, to deal with generations meaningfully, we need to define the definition of generation. There are several approaches to this in the literature:

> "*A generation is defined as a group of people born in the same era, shaped by the same period, and influenced by the same social markers - in other words, a generation is a group of people of the same age and stage of life, linked by living conditions and technology, events and experiences*" [1]

> "*There are many traits, characteristics or behaviors that we now identify with particular generations and it is worthwhile to acknowledge them, but to*

*regard them as set in stone - as they currently appear in the media and public discourse - is particularly damaging*." [2]

According to Mannheim (1969):

"*…an age group can be considered a generation if it is characterized by a common immanent quality, generational consciousness, and communal traits, and three conditions are necessary for this: common experience; actual orientation towards each other; and common understanding of the situation, attitudes, and forms of action*." [3]

McCrindle and Wolfinger (2010) define a generation as:

"*an array of individuals born in the same era, shaped by the same period, influenced by the same social characteristics, i.e. a group linked by the same life stage, living conditions, technology, events and experiences*" (McCrindle, Wolfinger 2009, cited in Csehné Papp 2017: 125). [4] [5]

Kupperschmidt (2000):

"*An identifiable group whose members share the same period of birth, age, location and significant life events in their critical developmental years*." [6]

It can be seen that the situation is not simple, since the definition itself is not uniform, which shows the complexity of the problem, not to mention the details that lurk beneath the surface. In our research, we used the birth year grouping accepted in Hungary to classify generations, which are summarized in Figure 1:

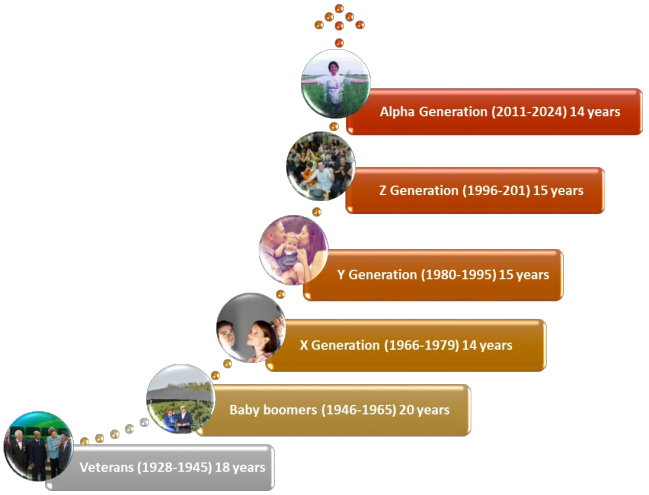


Figure 1
Division of generations by year of birth
(source: own research)

Based on this division, it can be seen that in today's Hungarian society, six generations live side by side. However, if we take into account that from 2025 onwards, the Beta generation will also be present, it can be said that perhaps never in history have so many generations been present in our everyday lives at the same time, which in turn makes our studies in generational research even more complex. Naturally, this paper does not intend to focus on the Beta generation, as there is not yet enough information available to make it possible to study their specific characteristics.

Before describing the specificities of each generation, it is important to note that the classifications determined by the birth dates and intervals in the distribution and the influence of the neighboring period – social, environmental, attitudinal – on those born near the cut-off dates are influential. It is also not possible to say that the characteristics described are uniformly true for everyone within each generation defined since it is not always the case that within each generation, the individual is at a particular stage of life and the influences that have shaped his or her personality. In other words, 2-3 groups within a generation have different characteristics [7] [8].

The general characteristics of each generation can be defined by the "common" experiences, environmental influences, social expectations and individual situations that influenced and shaped the lives of those born in that period as a group. Following this guideline, the characteristics of the six generations mentioned above were summarized [9] [10].

## 2.1 Veterans (1928-1945)

They are also known as the "silent" generation. Almost all of them are retired, although some are still active despite their age. They are part Boomers, part Generation X. They were born before and during World War II, so it was a defining experience for them, which is perhaps why "security" means more to them than anything else. Their experiences – hunger and scarcity – make it important for them to have, to have, to have, to have reserves - money and food essential for this generation. Dictatorial and semi-dictatorial regimes have played a decisive role in their lives. A sense of duty and faith in the institutional system is important for them. In terms of media use, the written press has played an important role, followed by radio and then television, and digital platforms are used only to a lesser extent, and they are even averse to them and, therefore, distrustful of them. Family is important to them; their relationships are dominated by hierarchy, and they trust only those in their immediate environment. [1]

## 2.2 Baby Boomers (1946-1966)

Born after the Second World War, their lives were marked by economic recovery, reconstruction and a new beginning. After the war, this generation experienced a surge in population growth. Some of this generation have retired but are still in the labor market today. One of the characteristics of their lives is optimism, competitiveness, responsibility and individualism. They value hard work and loyalty. They are typically parents of Generation X and Y. As a result of demographic measures, this period is characterized by a large increase in the number of births, which is reflected in the size of the generation. They are brought up in a hierarchical system, with rank and prestige defining characteristics. They played an important role in shaping the social structure, and the role of the family was prominent for them. They are long-term planners, characterized by lifelong work, loyalty, commitment and respect for experience. The explosion of technology started during their adulthood - they were still taking traditional photos, but they had to learn to use Polaroid and digital imaging and digital platforms. Computing reached them at an older age, but they encountered it in the workplace before they retired. Personal contact is important to them, but some have also moved into the on-line world. [1] [4]

## 2.3 Generation X (1966-1979)

They are known as "Digital Immigrants", having grown up in an era of rapid technological development. Typically, they were children in the socialist era and came of age in Hungary during regime change. This generation bridges traditional and modern values - they play an important role between past and future generations. They do not unquestioningly believe in everything. They have questions. They do not accept something "just because it was how it used to be". They have experienced that everyone in the family worked – mum, dad – and often took care of themselves daily. They are hungry for information and will get it as soon as possible. They are career-driven, outspoken and outspoken, sometimes labelled 'pushy' by other generations. They value time for work and study, but the time for me – they find it difficult to find a balance – is crucial. Individual responsibility is high on their list of values, and they speak their mind. Their media consumption is characterized by reading newspapers, watching TV and listening to the radio, but they are also keen to use on-line channels. They form the backbone of the labor market and are important players in economic life, which burdens them considerably. The framework is important to them, but so is their desire to work freely and flexibly. Telephone, email, and face-to-face meetings are not far from their minds - they see no point in endless meetings, and efficiency is crucial. They prefer to work individually because it allows them to show themselves and move up the ladder. [4] [10]

## 2.4 Generation Y (1980-1995)

They have been called the "millennial" generation, but the term "net generation" or "digital natives" has also appeared. They have been influenced by the explosion of digital technology growing up, often teaching their parents how to use it. They have been the eyes and ears of their parents, occupying a central place in the family, and have thus developed a heightened sense of self-worth and a sense of 'self'. The events of 11 September 2001, the subsequent terrorism and the all-out war against it were a defining event in their lives. This generation is said to 'perhaps never grow up'. They have delayed their studies, moved away from their parents late or moved back home again just after their studies - they are characterized by a tendency to postpone starting a family. They value leisure time, even at the expense of work. They like to work in a team if they can find the flexibility to do so, but they also have high expectations of themselves and their environment and are creative and innovative. They value interactivity in all aspects of their lives, like to discuss everything, and are group-oriented in their learning. Success in the workplace and a sufficiently high salary are their priority, so they will even change jobs if they see it as an opportunity in a new place. Unfortunately, a false self-image often leads to disappointment in the workplace and feeling unappreciated. Mobility is important for them. The phrase "If I had enough money, I would not work anymore" is typical of this generation. The on-line space plays an important role in their lives, but their social relationships are also characterized by face-to-face contact. Feedback on almost everything is paramount to them, preferably immediately. This generation is characterized by divided attention, doing more than one thing at a time - this can be as much as working two jobs—the first generation to be unafraid to ask for help to get on - work, personal life [4] [11].

## 2.5 Generation Z (1996-2010)

They are the "digital natives", living "connected" to the internet at every moment. Typically, they live in the smallest families, with few siblings, and their mothers gave birth to them when they were "older". This generation is also known as the "True Generation" because of their faith and idealistic approach to the world. Because they were born into a constantly changing world, they have no problem experiencing "change". They use the world of the internet in all its forms. They collect and share information. They are constantly in touch with the world, mainly in virtual space. The boundaries between the virtual and the real world are blurred, and they use the technologies they have acquired to stay in touch. It is natural for them to be able to contact anyone, anywhere, anytime. The first generation to grow up in a globalized world, they have been exposed to the same influences regardless of their geographical location - eating the same things, listening to the same things, watching the same events, watching the same films - and throughout

their lives, physical boundaries have increasingly disappeared, giving them a free way to explore the physical world. This is the generation for whom it is unthinkable not to have an internet connection. Visualization is prominent in their lives, and they understand how things work through visual examples rather than through interpretations of texts. Environmental awareness is important to them, and they prefer it to appear among the corporate goals. Social responsibility is important to them and is reflected in their values. They are braver and more proactive than previous generations, and they do not doubt their abilities and skills. If they are not satisfied with something, they move on almost immediately. They do not worry about the new situation. They need to achieve their dreams, and they are prepared to make serious sacrifices to achieve this. Their communication is characterized by immediacy, both outward and in response, and they are less patient. They like teamwork, mainly in the on-line space, but they are also open to working together in person. They are flexible but expect the same from their environment - e.g., where, when and how to work. [5] [10]

### 2.6 Alpha Generation (2011-2024)

This generation is still young and still in the learning phase, surrounded by smart devices, tablets and computers. It is as much a part of their daily lives as traditional games or the outdoor playground. They learn to use digital devices quickly; they are already surfing the internet at a few years old, and as they grow up, on-line communication becomes a priority in their lives so they may have problems with personal contact in adulthood. On-line life and contact can impact their development of appropriate self-esteem, as the constant connection also gives them the opportunity for a constant comparison - real face-to-face contact is overshadowed. They face the challenges of the digital world, such as high levels of addiction, and they already encounter digital bullying. Compared to previous generations, they are even more characterized by shared attention and shared work/tasks, globalization and mobility, resulting in them pursuing their studies in several countries. In their work, it will not be uncommon for them to experience work success by 'migrating' from country to country. Artificial intelligence will play an important role in their lives. Most of all, they envisage a job where they can be their boss [13].

## 3 Generations in the Hungarian Rail Labor Market

A very strange trend was identified in the review of the literature on generational characteristics. In reviewing the characteristics of generations, almost without exception, all authors focus on the differences between generations, whether they are examined from the point of view of comparison, analysis or coexistence at

work [14]. Of course, differences are important, but we must find a common intersection of sets to understand the interrelationships between generations and focus on relationship building. In the next part of this analysis, the characteristics of the generations were summarized, which can be found in Table 1, which the authors made. A detailed analysis has not been carried out in the present research. However, authors would consider it worthwhile to conduct deeper research comparing the generations and their SWOT analysis based on the information summarized in the table - and even extended with additional characteristics - from which we can gain useful information for groups formed in the workplace.

While Generation X prefers job stability and autonomy, Generation Y workers are particularly interested in continuous professional development. They are also the ones who come up with the most creative ideas - test benches, streamlining maintenance systems - and they like interesting and challenging tasks, but if they cannot find them, they may change jobs. Generation Z is primarily interested in earning money and less in a sense of vocation. They are particularly dynamic regarding short-term tasks but lose interest after several days of looking for a vehicle breakdown. They are more interested in using diagnostic systems than in manual work. They find it difficult to tolerate a hierarchical organizational structure, but they are the ones in the team who, if there is a problem, will pick up the phone and look for a solution. The Alpha generation is still in the learning phase, but there is already a strong sense of a more "me" centricity than the previous generation, which will be reflected in the workplace. They are relying more on AI and interactive technologies than on direct experience.

Suppose we want to look at the world of work and the generational composition of the Hungarian labor market. In that case, we need to be aware of the age and gender distribution of the Hungarian population and the intergenerational distribution of the population. To illustrate this, an age distribution has been drawn up based on Hungarian Central Statistical Office data. In this study, the entire generational classification – all six generations – was considered, while the labor market analyses were carried out for the four relevant groups – baby boomers, generations X, Y and Z.

In the chart showing the age and sex distribution of the Hungarian population, the population over 90 years of age is shown as a total, which is based on statistical data and is irrelevant to the final results of the research. The distribution chart is a visual illustration of the ageing of our society, but in this research, the authors only focused on the labor market and not on its roots.

Table 1
Characteristics of generations

| Generation name | Veterans | Baby boom | X Generation | Y Generation | Z Generation | Alpha Generation |
|---|---|---|---|---|---|---|
| Period of birth | 1928-1945 | 1946-1965 | 1966-1979 | 1980-1995 | 1996-2010 | 2011-2024 |
| Specific name | Silent generation | Prophets | Digital immigrents | Digital natives | Global generation | The "New" silent generation |
| Effects that influenced them | Word War II., economic crisis | Reconstruction and economic revovery after World War II. | Rapid development of technology, regime change, emergence of multinational companies | 11. September 2001, the explosive development of technology | A globalized world, that is constantly and rapidly changing. | Smart devices are part of their lives from birth, COVID 19 pandemic |
| Their fundamental values | Safety in all areas of life | Commitment, loyalty | Desire for freedom, taking risks, work-life balance | Self-centeredness characterizes it | Free expression of oneself, awareness of the environment | Sensivity to changes in the environment, diversity, tolerance |
| Role of rules in their life | Sense of duty, a solid institutional system | Hierarchical system, rank and prestige | Democratic leadership, in which you participate | In addition to specific goals and precise job discription, the system should be flexible | They have a strong social consciousness, they shape the world around them | It is not contetnt knowladge that is important, but the application of knowladge that is most important |
| Form of communication | The significance of the given word | They prefer personal contact | Outspoken and open | The most important thing is interactivity, let's talk about it. | They collect and share informations | The online space has everything they need |
| Community relationship | Family and family relationships are importemt to them | The role of the family and the workplace community is important | Friendship, single lifestyle, alternative relationships | Primary connections to the group | The border between virtual and real space blurs | The virtuál world is primary, personal contact is secondary. |
| Media usage | Newspapers, radio, TV, but they do not prefer the digital platforms | Newspapers, radio, TV, but digital platforms are also use | Newspapers, radio, TV, and the use of online platforms are also emphatic | It is important for them to use the online space and digital platforms in their lives | They can't imagine life without the Internet | Development of addiction, meets digital bullying |
| Impact of changes | One workplace for the rest of your life | They react sensitively to changes | Don't believe anything just because it was like that in the past | Conscious management of changes, making decisions | They don't worry much, they change quickly if needed | Fast information processing, innovative thinking. |
| Motivations | Advancement up the career ladder | Rank, prestige, salary, desire to prove oneself | Varied work, success, feedback, authentic communication | Career, money, success, attention, praise | Self-realization, world-changing work, self-development | They attribute a prominent role to AI |

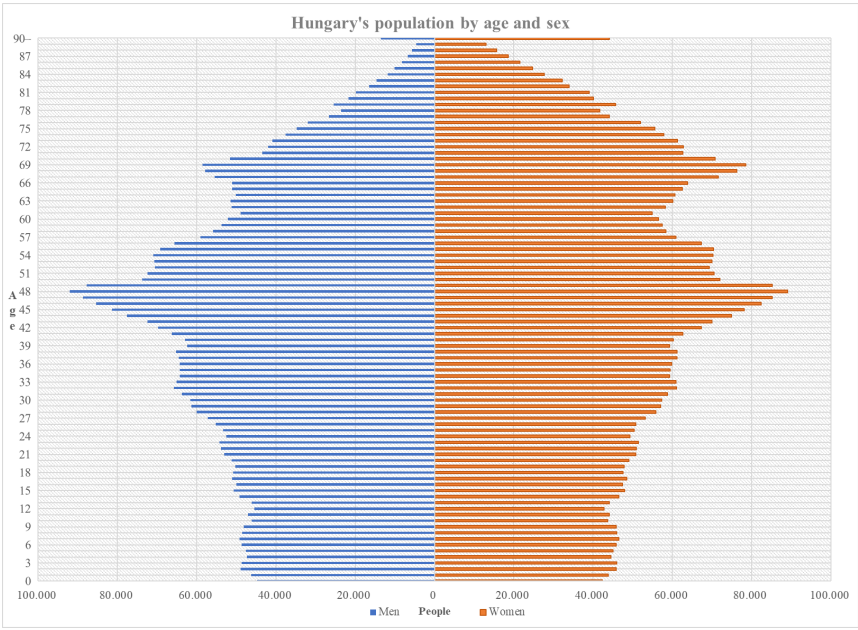


Figure 2
Distribution of Hungary's population by age and sex
(source: own edition)

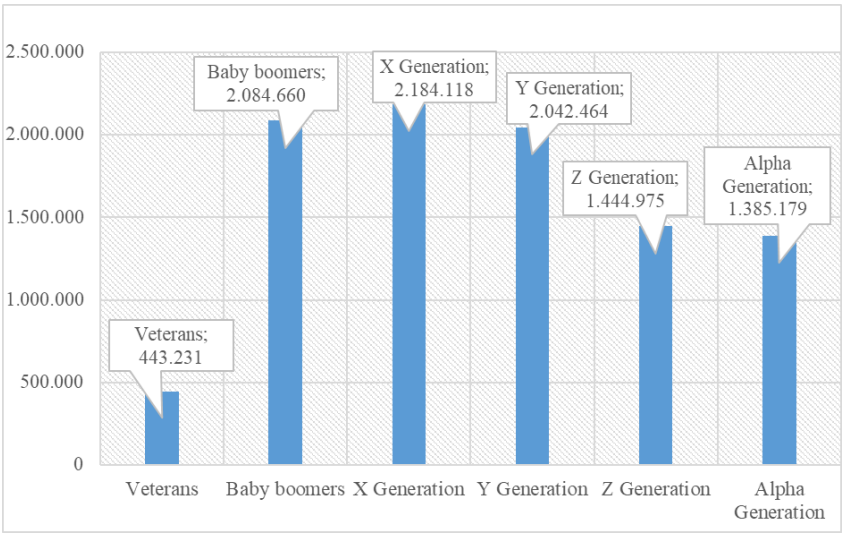


Figure 3
Intergenerational distribution of the Hungarian population
(source: Own compilation based on 2024 data from the HCSO, taking into account the intervals in Figure 1)

The generations active in the domestic labor market are the baby boomers, generations X, Y and Z. In this analysis, authors have excluded that some of the members of the full generation spectrum above continue to participate in the world of work as active workers, even if they are classified as retired based on age. As shown in Figure 2, the backbone of the current active labor force comprises Generations X and Y, followed by Generation Z, which is constantly entering the labor market. The age structure in Figure 1 is worth looking at more closely, especially for the next 10 years.

As a result of this analysis, we have compiled a projection of the number of people expected to exit and enter the labor market over the next 10 years, as shown in Figure 3. As there is no information available on the age at which Generation Z members enter the labor market, the simplification of their entry into the labor market as active workers at the age of 20.5 was considered. In this simplification, Authors considered participation in secondary and tertiary education and ignored the possibility of working under 18. What is clear is that the number of those leaving exceeds the number of expected entrants each year, but what is striking, from the analysis, is that this gap becomes larger between years 5 and 10. This situation poses a major challenge for domestic employers, who must attract potential candidates with the necessary skills from an increasingly shrinking pool of workers and pay particular attention to retaining them, attracting them, and building the necessary commitment.

In the short term, and only temporarily, the re-employment of retired workers – perhaps an increase in the retirement age as a measure to be introduced at the social level – is a solution, but only postpones the problem, it is not a solution.

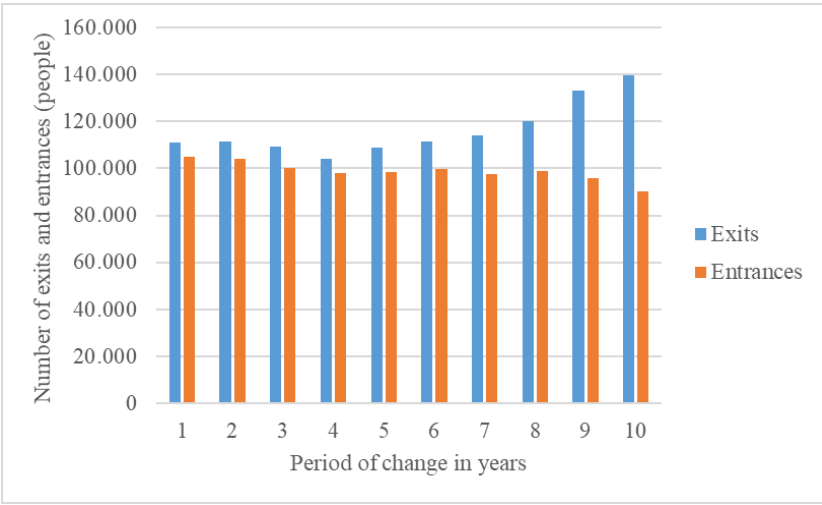


Figure 4

Number of workers leaving and entering the labor market in Hungary over the next 10 years (source: own research based on data from the Hungarian Central Statistical Office, 2024)

If the Hungarian demographic data are taken as a guide for the transport sector and applied to rail transport workers, then in addition to the current labor shortages, further employment problems may arise if an effective and attractive strategy to attract Generation Z is not developed. Based on the authors' experience, the focus should be on attracting the new and active generations. Currently, X and Y. This is particularly important because other market players are also on the hunt for skilled labor, not just us, and in many cases, they want to attract and lure our workers away from us. This is particularly the case for jobs requiring special skills and knowledge or jobs where the number of people in the labor force is low and where a significant investment of time and money is needed to replace them.

To give just a few examples of such jobs in railway practice, they include train drivers, mechanical and electrical engineers, electrical and mechanical mechanics involved in the maintenance of rolling stock, welders and fitters involved in vehicle manufacture, and various traffic controllers. If we also consider that the railway profession is not necessarily one of the most attractive careers, it is all the truer to say that an appropriate labor market strategy is key to attracting the right people.

# 4 Development of the Rail Sector, Digitalization, Automation

Looking at European rail transport globally, it can be said that it is characterized by diversity in many areas, such as the techniques used, technologies, market openness, number of players, degree of state influence, and workforce composition - male-female ratio.

Looking back over the last five years, we can say that rail transport has been significantly affected by the SARS-COVID-19 pandemic, which lasted almost 2 years. In this environment, railway workers had to ensure passengers' safety and the maintenance of rail transport and invest energy in maintaining their health. The closures and mobility restrictions have led to a huge drop in demand while maintaining basic services, and the rail market has faced many new challenges. Also, in the context of the epidemic, the authors' working experience suggests that major steps have been taken in several areas, most notably digitalization, which has introduced elements not previously seen in the general day-to-day practice. In particular, we would highlight the emergence of the possibility of working from home in many jobs, which has made office work much more convenient and mobile. The second major development is the introduction of on-line meetings. This has significantly accelerated the process of signing, authorizing, and authenticating various documents from paper to paper, and it has been done in hours instead of days.

According to the EU reference scenario 2020 (published in July 2021), freight and passenger transport share will increase significantly by 2050. According to the EU reference model, rail passenger transport will increase its share thanks to the expansion of high-speed networks and the development of the comprehensive TEN-T core network. The role and competitiveness of rail transport will likely be further enhanced by the 4th Railway Package, which will shift part of road passenger transport to rail in the long term. Given the current and future challenges, there is no doubt that various areas of the rail sector will – as is already the case today – face serious staffing problems due to the expected increase in output and the expansion of the network.

As shown in Figure 3, there is likely to be a significant outflow from the rail labor market due to retirement, but the lack of sufficient attractiveness to replace it may be a concern. The study confirms that one of the barriers to replacement is the lack of attractiveness of rail transport as a profession for younger generations. There is a consensus among experts that one of the negative factors is the working conditions that rail companies can provide, such as multi-shift working and non-standard working hours, which are a disincentive. This effect is further reinforced by the fact that the wages and other cash and non-cash benefits in the sector are also lower than in other sectors of the economy. To address this problem, railway companies must find a solution to ensure the long-term availability of skilled and competent staff for operations.

The partners involved in the EDA Rail project agree that the move towards digitalization, automation and "smart railways" has the potential to make railways more attractive for both passenger and freight customers and their employees. Digitization and automation can reduce the pressure of a lack of skilled staff in many jobs, partly by increasing efficiency and reducing the need for actual staff on the ground [15].

As we have shown above, it is in the administrative sector that further digitization could make the biggest breakthrough in the shortest time. However, it is not typically in this area that railways have problems with the supply of specialists, but in the executive service. The next segment is ticketing, other commercial activities, and ticket control, where the migration to electronic equipment is progressing rapidly. The pace of development for the employees employed in this area may partly address the issue of retiring staff, but it should not be overlooked that there are many activities/subtasks for which there is no digital solution.

Supervising railway infrastructure and traffic management is also a significant area where dynamic developments are expected [16]. Modernizing the railway tracks, which has already begun in recent years, will lead to upgrading the associated safety equipment and traffic management [17]. Naturally, this will significantly reduce the need for local human resources – switchmen, traffic attendants – but will also create a new staffing requirement for central traffic management and the supervision of the more modern safety equipment. It should

also be noted that the new tasks will place significantly higher employee demands regarding quality and competencies. In addition, the demands placed on workers differ from before, so the psychological strain increases while the physical strain is significantly reduced.

In addition to digitalization, the implementation of railway automation will be a priority in the coming period [18]. All the research and studies on rail development highlight the crucial importance of Automatic Train Operation (ATO) and its impact on the further development of rail transport. Rail transport is particularly well suited to introducing an automated transport system because, on the one hand, the rigid infrastructure design provides sufficient flexibility to handle traffic instead of the more optional routing of road transport [19]. On the other hand, within the transport sector, several systems have already been implemented where elevators are used - urban metro networks and railways connecting airport terminals. Advocates expect rail automation to bring several benefits, such as greater predictability, a significant reduction in delays, increased safety, improved scheduling, and predictability, allowing more trains to pass through the infrastructure, which is currently a bottleneck. Overall, this will provide the necessary backdrop to meet the growing demand for mobility.

From a conventional plant to an automated railway plant, there is a series of steps in which different parts are fully automated, culminating in a fully automated plant. As this system is complex, vehicle and track-side conditions must be fulfilled, and on-line communication between them must be ensured.

This process will gradually change the role of train drivers, and the job, which is still considered a niche occupation, will no longer be needed on these railways in its current form [20]. However, their presence and performance of their duties are still essential for managing traffic today and will remain so for some years. The digitalization of automated rail operations and rail traffic management and supervision directly impacts the planning and execution of maintenance work [21]. With the increasing possibilities and decreasing costs of Internet of Things connectivity, it becomes feasible to connect rolling stock and infrastructure to monitoring systems so that the need for maintenance based on abnormal breakdowns and demand can be identified, predicted and planned [22]. The result is an increase in asset availability and a reduction in unplanned downtime due to breakdowns. In the case of modern rail vehicles, the number and intelligence of on-board diagnostic devices have evolved dynamically over the last 10 years. At the same time, however, vehicle manufacturers and maintainers are not taking advantage of this to the same extent. Vehicle manufacturers strive to achieve as much digitalization as possible for passenger cars, multiple units, and locomotives, but maintenance staff cannot access the information generated. The reasons for this are not analyzed in the research, but there is significant potential for predicting demand-based maintenance and abnormal breakdowns.

In the case of freight transport, an important element of the organization and management of the railway operation is the assembly, marshalling, and dispatching of trains at marshalling yards, as well as the tracking of the train/freight during the journey. This requires considerable human effort and time from the railways, affecting freight trains' regularity.

Digitalization and automation also offer a solution: the Digital Automatic Coupling (DAC). Coupling and uncoupling vehicles are traditionally time-consuming and require much pre-processing. By using DAC as a central traction, buffer and coupling device, not only can the coupling and uncoupling of vehicles be achieved flexibly, but it also offers the possibility to overcome the train load limit of the previous conventional solution – the bolted coupling – allowing longer and heavier trains to run on the network. This will partly meet one of the conditions for achieving the Commission's objective of increasing the share of rail freight. The deployment of the DAC system is not only for the automatic implementation of vehicle coupling because the related improvements will mean the extension of the new functions that will be installed on the vehicles, such as vehicle status sensors, vehicle tracking system elements, devices for identifying wagons and their loads, and a system for ensuring the supply of electricity. Once deployed, the resulting intelligent asset will be an essential foundation for interoperable, efficient, fully digitalized freight operations across Europe and a significant increase in the rail network's capacity.

The rise of digital technology is leading to a reduction in manual workers and a restructuring of their tasks, especially in lower-level vehicle maintenance. As a result, the process of running diagnostics and subsequent analysis and, on this basis, determining and carrying out maintenance will become the norm in railway practice. Reducing lead times requires that preparatory tasks related to the maintenance of rolling stock are carried out on time, with repaired parts available where the maintenance is to be carried out when the rolling stock arrives. As lower-level maintenance is almost exclusively serviced and mileage increases significantly with the growth in mobility demand, the number of higher-volume maintenance activities requiring almost complete breakdowns will increase. In order to have a fleet of vehicles that is fit for service, for the reasons given above, the staffing requirements will not be reduced, but the structure will change. This is reinforced by the characteristics of the new generations entering the labor market, which is reflected in their focus on their development rather than work. Rather, they are driven by finding a company whose goals match their values. Since they cannot do jobs requiring long-term concentration, they may need more staff to do the job than the previous Generation X and Y staff. The authors did not carry out an in-depth analysis of this.

## Conclusions

In the course of our research, the specificities of the generations showed that it is not possible to treat the generations already working and those about to start working shortly, in a uniform way, as their preferences differ significantly, which

determines how they fit into and are kept in the system - a given company, a group set up to perform a given task. Generation Z's recruitment and employment will have to depart from the methods used in the past. Whereas previously, the traditional methods were tried and tested tools, they are now inappropriate and unattractive to the railways because of the evolving preferences of Generation Z. This means that we can no longer reach them in the usual way, if our channel is not sufficiently attractive.

Another priority is adapting the training process for recruiting Generation Z workers because the usual transfer of knowledge and skills is not working. You cannot use a book and mechanical training if the knowledge transfer in them does not generate interest. Generation Z workers will leave the field if we want to use it. In general, we need to use the achievements of digitalization for training and information transfer facilitated by the digitalization and automation of railway equipment. At the same time, traditional methods of recruitment and hiring should not be abandoned, as the labor market is not only expected to attract Generation Z workers but also potential workers from other generations can be attracted to many of the more open areas of the railway profession, such as traffic management, vehicle maintenance and driving.

If the railway company also emphasizes that it will not simply create a space that meets the needs of the younger generations but will also focus on the employment of two/or more generations in a team, then a reverse process of knowledge transfer can start, which means that members of the older generation can learn how to use modern tools and applications from the those younger.

There is no mature and established system for integrating the characteristics of the generations entering the labor market, technological developments, new technological knowledge and the practice of retaining and transferring knowledge within railway companies. This system must include the elements that make it work, such as the mentoring/tutoring network and the associated motivation system. The Authors consider this an area worth exploring, as applying the results can complete the knowledge transfer framework in practice.

The other important impact on the workforce is the digitalization and automation implemented in the railway plant. Areas of focus include traffic and operations management, wagon and train marshalling tasks related to rail freight, the role of front-line staff due to the reorganization of current sales channels, and automation in back-office tasks, which will also have a significant impact. A reorganization of maintenance tasks – rail infrastructure, rolling stock – is also expected, resulting in a much greater emphasis on preventive, demand-based maintenance, which will significantly reduce the number of abnormal breakdowns. If the processes outlined above – digitalization, automation, network and rolling stock development – are forecast, some of the workers employed in the current system will be faced with the problem of not having the necessary competencies to apply the new technologies.

This will be particularly pronounced in areas where the emphasis has been on the physical performance of work. In these cases, the role of the railway undertaking in retaining the workforce will increase because they will have to be allowed to retrain and acquire new skills. To this end, railway companies need to develop an internal training structure that offers workers retraining/skills acquisition opportunities at the pace of developments such as automation and digitalization.

To summarize the expected direction and effects presented in this work, railway companies are not in an easy position, as future developments will result in the need to attract younger generations to the professions involved in rail transport, into the new environment and ensure an internal training system that retains employees, which is essential for the functioning of the internal labor market.

The Authors aimed to provide an overview of the technological developments in the field of railway vehicle maintenance, their expected impact, and the current and expected future difficulties, in providing skilled personnel, taking into account the impact of the labor market and societal changes. At the same time, the results suggest several unaddressed issues that generate the need for further research to be launched to ensure completeness. Thus, the possibility of setting up a modelling framework that quantifies the changes in competence needs, associated with technological developments considers the relevant generational characteristics and helps the company develop and implement a long-term, dynamic human resources strategy is identified.

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