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Course of Labor law & New technologies

RAILAND: A THESIS OF MANY DIMENSIONS

About disruptive technologies and the future of Labour in Rail Transportation

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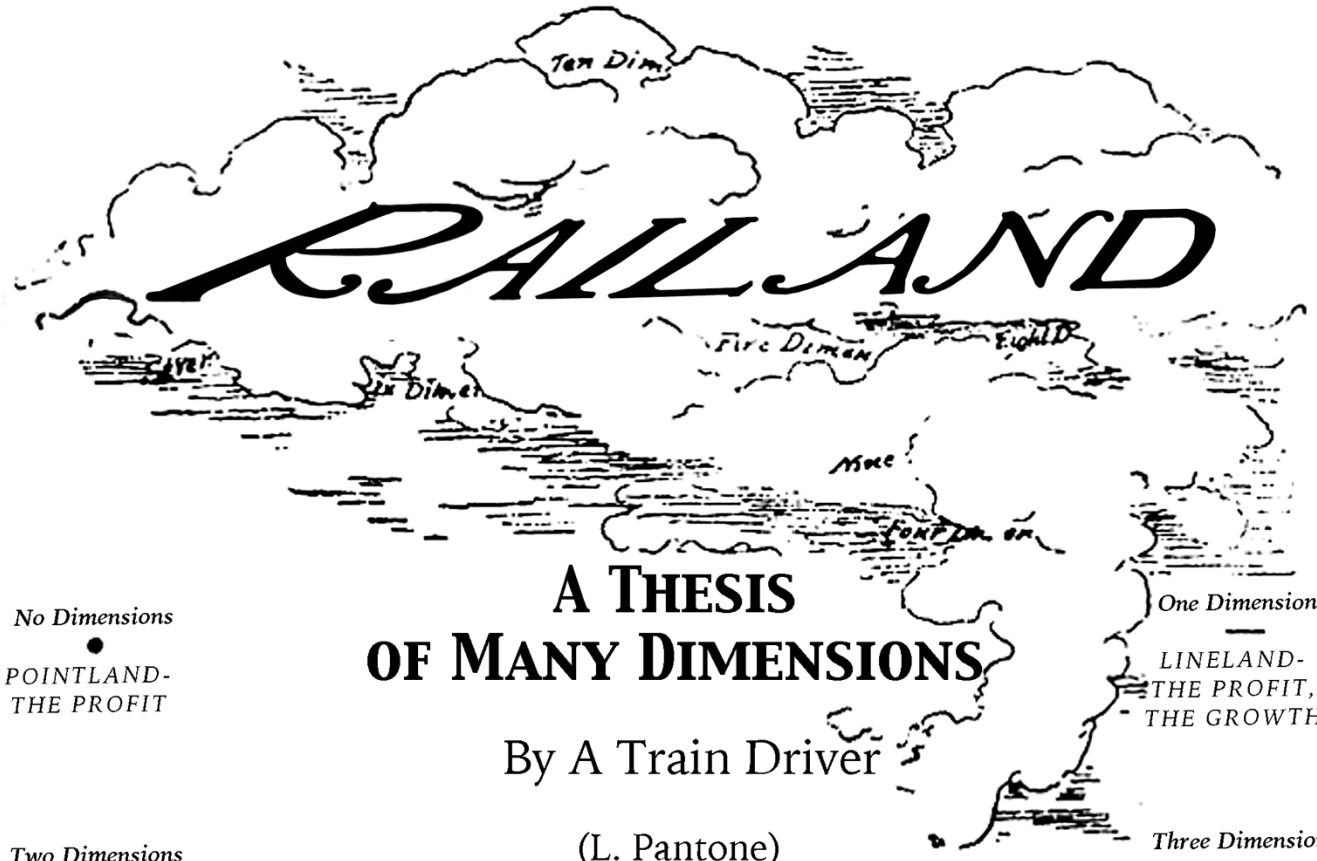
"O day and night, but this is wondrous strange"



A THESIS OF MANY DIMENSIONS

By A Train Driver

(L. Pantone)

No Dimensions

●

POINTLAND-
THE PROFIT

One Dimensions

—

LINELAND-
THE PROFIT,
THE GROWTH

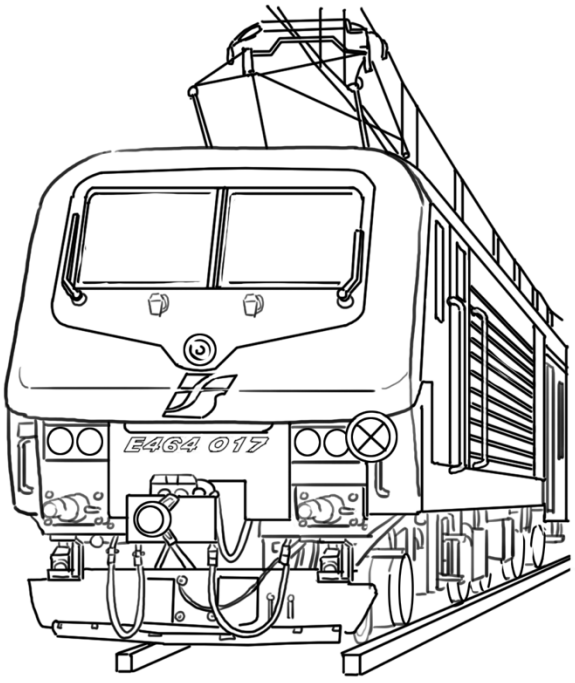
Two Dimensions

□

FLATLAND-
THE PROFIT,
THE GROWTH,
THE PEOPLE

Three Dimensions

SPACELAND-
THE PROFIT,
THE GROWTH,
THE PEOPLE,
THE LABOUR



"And therefore as a stranger give it welcome."

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“To whom has taken my train from the original station,

to whom has got off the train in the middle of the journey,

to whom has jumped on the train in a station in the middle of sadness or joy

to whom has arrived with me until destination and beyond,

Thanks.”

Index

1. Introduction

"Those who thirst for knowledge will never be able to fully satisfy it:
it is a curse of certain men,
but indeed, a blessing of all humanity.
Evviva."
(Prof. Filiberto Brozzetti)

In 1884, the Reverend Edwin Abbott Abbott (for his friends and colleagues, Abbott^2, "Abbott Square") wrote one of his less known books, *Flatland*. When I discovered this amazing pearl in the ocean of forgotten tales, I was sixteen and I read about a book called "The fourth dimension" written by Rudy Rucker: it had really strong references to the story *Flatland,* and I was fascinated by it. At the time, I clearly remember that was impossible to find a copy of *Flatland* in Italian in book shops, and neither online, because only ten years ago the habit to shop online was not so common at all.

After some years, I finally found it and I had the opportunity to read the full integral story and the reasons behind this allegory, sir. Abbott^2 wanted to express his concerns about the English society of that time: he strongly disapproved the classism and the condition of women. The allegory of a flat world (the English society during the Victorian Age) was written in such an original manner that the book was able to avoid censorship. Unfortunately, when the book was published it was not a success, only thirty years later with the advent of another brilliant *Sir*, *Einstein Albert*, the theme of *relativity* and *further dimensions* became mainstream and commonly accepted by public opinion, and the tale of *Flatland* finally knew the fame and success among all the scientific community, to explain the need to think about the world as we see it and as *it could be* if we do not put barriers to our values and beliefs.

Flatland is, after all, a journey: the protagonist (a Square) is a common inhabitant of a Flat World where only two dimensions exist, the Square is a component of the "middle" class (the inhabitants are classified by their number of sides; indeed the less significant are the women, "a line" and the more powerful and prestigious are the priests and governors who are "circles") and he lives an average life, composed by an average work, a wife, children, and a common house. Its life will be tremendously shocked by an unplanned visit by a *supernatural guest: The Sphere!*

The mysterious entity, incapable to be initially understood by the Square, brings our protagonist to other worlds, where even *fewer dimensions* are present in those worlds! At that moment, the Square was ready to discover the universe with *three dimensions*. The Square understood that all its values were put into discussion, that everything it believed was *relative.* The tragedy was just at the beginning: the unexpected prophet suddenly began to question The Sphere about the possibility of the existence of other *worlds with many other dimensions*; the rounded guide got so angry about the too many questions made by the flat figure: - "How dare

you to put in doubt the possibility about the existence of superior *worlds?"* and immediately throwback to *Flatland* our hero.

The Square began to tell its family about what happened that night. Nobody believed him, and in the final instance he was thrown in jail by *The Circles* with the accuse of "heresy about the third dimension". But, in the end, the Circles knew that a millennial revelation would have been made and it could have destroyed the balance of its rigid reign. The Square never apologized for its thoughts, even in the coldest prison of *Flatland.*

As it could be imagined, this thesis has strong references to this book and many others. Since I had not gotten the opportunity to meet a supernatural entity that revealed to me any kind of secret for the whole of humanity, my only way to elevate myself was through *reading* and trying to understand as many things as I can. Unfortunately, this is a joy and at the same time a tragedy; that is why my wish is to write not only a thesis but a proper book that one day I would be able to open and say that in some way I was, right.

In recent years, the future seems to be the latest obsession of everybody. Innovation is moving so fast that now we are seriously putting in doubt several sides of our society and we are challenging the limits of human ethics. Innovations are presented to the average user as "*unavoidable"* (Zuboff, 2018) something that does not respond to any social contract or democratic consent among parts. This mechanism could be largely accepted in some cases, such as the will to use certain software or services, but it cannot be applied to certain core activities of human mankind, such as Labor.

In this thesis, Covid-19 will be seen basically as an accelerator. The spreading of this disease has accelerated some processes that were on the table of the World Economic Forum already in 2016, such as the development of automated labor and the research on what kind of labor would have disappeared in the next decades (Schwab, 2016).

As it could be imagined, the most concerning innovation cited by Schwab in 2016 was the prediction of the spreading of *autonomous vehicles*. In his book, the main topic was focused on cars, but other similar innovations in other fields will be addressed in this thesis.

Changes like this, if not properly addressed, will radically mute the profile of the whole society and individual habits in uncontrolled ways. In this thesis, the attempt to answer the following research questions will be made:

R.Q 1) Are driverless trains going to be a reality in next future?

R.Q 2) How do people and railroad workers view automation—what are their attitudes?

R.Q 3) Is it possible to develop (or propose) EU policies to avoid train drivers' mass dismissals and guide them towards a just transition to a digitalized world?

In the end, I am going to propose several options for something that seems a threat in the Labor market of the Transportation sector.

I hope I have tackled your minds enough to start this journey. Signals are green, the locomotive is ready, everyone is on board. First stop, RAILAND.

2. Of the nature of Railand – Theory and literature review

"Where the logic ends,
the Railway begins"

(Ancient proverb of Italian Rail Workers)

"The train was marching fast through the mountains and little villages, and after a curve, the Train Driver began to brake. It was known that was necessary to reduce the speed some kilometres before! Some moments after, Railand became visible and the big yellow signal who protects the station's safety announced to the Machinist that the first stop was nearby.

Once arrived, the passengers jump off the train and the view was… unexpected. The region was a mosaic of thousands of thousands of micro-systems that were functioning on their own, with just a few of them interconnected, by EU TEN-T corridors. Probably, when in 1804 Sir Richard Trevithick invented the first steam locomotive (Slater, 2010), he could not imagine what would have been the evolution in only 200 years. In the chaos of Railand, there were several regions: Russia, Asia, the Middle East, North America, and Europe. For the aim of this journey, only Europe will be visited." (…)

Figure 1, The hierarchy of Railway system

The European Railway Area is on its own a complex scenario. For many years every member state of the European Union had a different Rail system, differing from one other basically in everything: from the distance between the train tracks to the regulations and procedures established to enact the transportation. Of course, this system has become unsustainable in recent years, that is why the ERA (European Railway Agency) has put in place several "Railway packages" intending to build an efficient "Single European Rail Area"

(DIRECTIVE 2012/34/EU "Establishing a single European railway area", 2012), whereas infrastructures and regulations are standardized, and every rail operator can operate in a free and competitive market in full interoperability. Starting from the 16th of June 2019, the 4th Railway Package was effectively put in place, to permit the "one-stop-shop" process of authorization of new locomotors and a stronger commitment from the ERA to enhance the culture of safety.

These affirmations may seem obvious to an average person, but these policies represent a radical change in the whole sector. Until railway packages, every Nation was a "close system" with few transboundary transportations limited to certain locations. Consequently, the labour market concerning all the professions needed to run the system was stable, even when national railways became private corporations controlled by States.

Furthermore, I would state clearly that the European rail systems and their policies ensure safe transportation (ERA , 2016).

With this being said, it is also true that these political changes bring risks in the short-medium term co-related to the labor market, as it has been seen in civil aviation. Unfortunately, there are two main ways to compete in the market, *cost,* or *differentiation* (Martin, 2015) and it is not quite easy to differentiate a service that uses all the same infrastructure, and its punctuality depends by a marginal part upon the strategic choices of the railway undertaking (For example, in the year 2017 taken in consideration an average year without the Covid impact, the Rail company Trenitalia reached punctuality for the medium-long range trains of 99.1%, on the other hand the company NTV in the same year reached a punctuality for medium-long range trains of 85,4%, where only the 25.4% of overall delays are on behalf of vector's responsibility.[1])

As it could be imagined, the major distortion in the market relies on the cost competition, to ensure the same service at the minor price possible; the principal ways to do so in transportation are:

1) A vector as a *customer of services:* The vector is not anymore, the full owner of any facility, means (trains, vehicles, ships, airplanes), maintenance services, and customer services (ticket desks dematerialized with in-app services). Everything is externalized (outsourced) by the vector who becomes a *hub* where all these products are collected by the vector to provide the final service of transportation. This business model brings more fragmentation to the labour market (Geishecker & Gorg, 2004). Some examples of this business strategy are Ryanair (Polat, 2018). and Flixmobility Group (Flixbus' operator) (Alberto A. Gaggero, 2019)
2) *The new organization of labour*: Vectors that rely on externalized services must have direct employees still. Transportation companies differentiate the personnel into two macro-categories: the operative employees (i.e. drivers, onboard personnel, handling services, maintenance operators, on-field personnel) and non-operative employees (i.e. administrative, human resources, legal department,

[1] Data collected from: "NTV Quality report 2017" and "Relazione sulla qualità dei servizi Trenitalia 2017".

management board). Since non-operative employees have more options to be re-organized in processes and costs (i.g working from home to reduce facilities' cost, automating some operations with digitalized software), the operative employees' costs could be lowered only by 1) reduction of the number of employees (Starr, 2021) 2) Higher number of hours worked daily and strategic re-allocation of shifts to ensure higher workers' productivity, despite the reduction to minimum-standard of physical restoration of personnel (Collewet & Sauermann, 2017).

3) *Reduction of labor cost*: In the final instance, the market liberalization if not properly addressed brings some distortion in salaries among transportation personnel providing the same service in different EU member states [2]. Since technical requirements have been harmonized, contracts and salaries still present big differences in guarantees and economic revenues. On the other hand, in the EU the debate around the "minimum guaranteed salary" seems not to reach any result, and its implementation does not seem the most optimal choice to reduce *social dumping* throughout EU territory (Fabozzi, Il Salario minimo, 2021) .

   Actually, the "minimum guaranteed salary" still differs State by State (i.g in Ireland is 1700 euros, in Bulgary 332 euros[3]) and not every State has centralized policies (retribution decided by hard law) on this theme (i.e Italy) whereas the minimum salary relies on collective bargaining between Employers and Union trades (the creation of Collective agreements with salaries classified by workers' function). All these factors concours to possible abuses by vectors who especially operate on boundaries between states where the minimum salary is lower.

These are the main threats in the short-medium term for the transportation labor market.

Besides that, it is time to move our focus to one of the most vital places in "Railand", the Italian neighborhood (the railroad area). Full of history and innovations in the sector, Italy was one of the first States to build a public railway on the 3rd October of 1839 (Carlo Ciccarelli A. G., 2021) and the first Rail System to foster the modern system ERTMS (European Rail Traffic Management System) born in 1999 that nowadays is the major driver to permit interoperability between high-speed lines in different nations[4].

2.1 The Italian Railway

The bigger rail operator in Italy has been since its foundation in 1905, the *Ferrovie dello Stato* group. Since then, FS has been a driver for Italian social and economic development and innovation. Already in 1927 was opened the first direct rail line from the station Napoli Mergellina to Rome (Carlo Ciccarelli C. M., 2020). After almost one century in 2009 the High-Speed network was completed and trains were able to transport passengers (and sometime after, goods) at a speed of 300 km/h. The bigger financial transformation happened in 1992, since FS Group was a statal entity and in that year became a private entity with State's participation.

[2] European Transport Federation, (2012). "The development of the low cost model in European civil aviation industry"
[3] Source: Openpolis' elaboration on Eurostat data
[4] ERTMS Foundation, "Factsheet #4" (https://www.ertms.net/wp-content/uploads/2021/06/4.-ERTMS-in-Italy_SIRTI.pdf)

Following the public disclosures of *Ferrovie dello Stato Group* regarding the financial statement for 2020, it is possible to confirm that its distributed value is 9.6 billion of euro, with a 7% growth compared to 2019.[5] Overall, the FS contribution to the Italian national gross domestic product (GDP) is 2.4% and the overall personnel in force (direct and indirect) are 260.000 people. *Ferrovie dello Stato* has been assessed as the first group for technical investments onto the Italian territory: in 2020 the amount was 9 billion euro, almost 5% more referred to 2019. Regarding the operative revenues for 2020 are 10.8 billion of euros (with a reduction of 1.7 billion euros due to covid). Furthermore, the FS group pursues the engagement towards sustainable activities and the reduction of the negative impact on the environment, like the will to reduce GHG emissions, the investment of 990 million euros in ESG, and the emission of 2.3 billion euros in Green Bonds. Finally, sustainability is pursued also towards the evaluation (environmental and social performances) of third parties as suppliers.

2.2 History of supportive technologies involved in Italian rail operations

Besides FS Corporate's strategies and transformations, it is important to have a step back and look at the several technological improvements (and the exponential curve of changes' speed) over the last twenty years. All these actions and expenses have been made to reach the ultimate objective of the concretization of the "Single European Rail Area" and the digitalization of rail transportation.

In "ancient times" fewer trains were operating on the rail, and they were separated one from each other with the manual control of the stationmaster, who was in charge to communicate (via an ancient version of the telephone) the status of rail traffic only to the stationmaster of the next and previous station. All the activities related to the train conduction itself were in total control of the train driver(s) and they had also the duty to operate some heavy-manual operations within the locomotive (e.g putting the right amount of coal into the locomotive's furnace).

Slowly, trains became a little bit more comfortable and efficient, Rail traffic systems had an evolution (like the implementation of more complex and accurate ways to regulate traffic and the evolution of telephonic communications) until another big change in technologies happened in the early 2000. *Ferrovie dello Stato* was a pioneer in implementing the SCMT System (*Sistema Controllo Marcia Treno*)[6] on board and the *Blocco Elettrico automatico a correnti codificate (BACC)*[7] on infrastructure. This system works with the communication via currents on tracks that are able to communicate to onboard instruments some states of signals and eventual anomalies (via antennas, SSB System). SCMT System was revolutionary and permitted the *same safety less human workload.*

[5] Source: Financial statement 2020 of FS Group (https://www.fsitaliane.it/content/dam/fsitaliane/Documents/media/comunicati-stampa/2021/marzo/2021_03_31_CS_FS_ITALIANE_RELAZIONE_FINANZIARIA_2020.pdf)

[6] Rete Ferroviaria Italiana, "Sistema Controllo Marcia Treno SCMT" (https://www.rfi.it/it/Sicurezza-e-tecnologie/tecnologie/ccs/Controllo-Marcia-Treno/Sistema-Controllo-Marcia-Treno--SCMT.html)

[7] Rete Ferroviaria Italiana, "Circuiti di binario" (https://www.rfi.it/it/Sicurezza-e-tecnologie/tecnologie/ccs/tecnologie-di-terra/circuiti-di-binario.html)

Indeed, in 2009, with the new Italian agreement between Trade Unions and Trenitalia, for the first time was allowed to cut the number of *train drivers* on board for passengers trains from two to *one* for normal operations and still two for specific conditions[8].

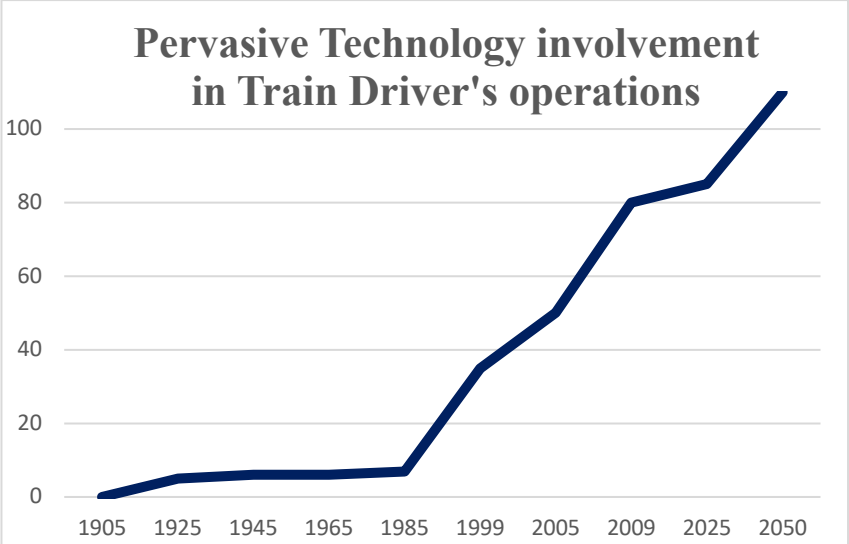

Figure 2, Percentage of technology involvement during Train Drivers' operations over time (years)

2.2 Actual technologies involved in Italian rail operations

Furthermore, in the same period (1999) Italian engineers began to study the ERTMS (European Rail Traffic Management System) system to permit effortless transit of passengers and goods across national boundaries in Europe. The ERTMS was finally implemented in 2009, with the advent of the modern Italian high-speed rail connection from Milan to Rome. Furthermore, this technology is revolutionary, since it disrupts the "old signaling system" to the control of traffic via geo-satellites connected with trains. It permits pervasive instrument controls by the train driver only by the displays on the desk, and a high level of safety even at the maximum speed (300 km/h) (European Railway Agency, 2016). The ERTMS system has been chosen for its interoperability between States and now it has been implemented across Europe to finally enact the Single EU Rail Area. From the labor law standpoint, this technological innovation was one of the reasons to extend the regular working hours per day for onboard personnel from 8 hours to 10 hours[9].

As it could be noticed, the time between one technological disruptive change to the next one is exponentially *decreasing*. With it, also the organization of the labour is changing, from the cut of non-necessary personnel to the extension of actual labor daily hours. In the next chapter, emerging technologies and their social disruptive power will be addressed.

[8] Italian Agreement between Trade Unions and the Railway Undertaking Trenitalia signed on 15th of May 2009. (Annex B)

[9] The modification was applied from recital n.2.6.4, Italian Collective National Agreement for railroad sector (C.C.N.L 2003) to recital n. 2.7 Italian Collective National Agreement for railroad sector (C.C.N.L 2012)

3. Of the Future of Railand – Empirical research

"Everything a man can imagine,
Someone else will be able to realize it"
(Jules Verne)

"(...) Once all the passengers jumped off the train, arrived the time of departure. The train driver asked the train manager to begin the operations to depart. When the train manager showed the green flag, the Machinist gave the last touch to permit the train to move again.
After some time, it was possible to see a huge worksite: the Machinist understood. It was the place where newer technologies were tested and implemented and, suddenly she saw: a train that was moving… with no one in command!
How was possible to even think about that? Years of sacrifices… studies… everything to ensure the safety of others because it is a duty of mine. And they are developing a machine that is going to… substitute me?
The Train driver felt fear. For the future, for her labor: am I safe from unemployment? Will I get a lower salary because I will have less control over the machine? I know that an automated machine, during normal operations, could have better performances than a human[10].

"How can I do private projects for my future in this uncertain scenario?"

The young driver began to think not about if, but when the moment of change would have occurred. (...)"

3.1 Future technologies involved in Rail

One main theme addressed during the MSc Course of Law, Digital Innovation & Sustainability was the implementation of autonomous vehicles. Of course, technological progress does not permit at the moment access to the public to this technology. But, with a broader vision, it is easier to think about faster innovations in this sense to rail transportation (Prashant Singh, 2021), since trains for their characteristics have fewer "degrees of freedom".

[10] ATKINS Report, (2020): "Connectivity, capacity and carbon; re-imagining rail from achieving net zero to covid recovery" and UIC (2014) Automatic train control. Energy efficiency tech- nologies for railways. (http://www.railway-energy.org/static/Auto matic_train_control_79.php.)

Indeed, in 2020 the European Commission has published the *"Sustainable and Smart Mobility Strategy – putting European transport on track for the future"*, where on recitals n.61, 63,64,66, the Commission clearly states the intention to deploy *automated train operations* and *unmanned aircraft*. Moreover, the Milestone towards Smart Mobility n.12 of the strategy states: *By 2030, automated mobility will be deployed on large scale.*[11]

For the aim of this research, interviews with several experts in this sector have been taken since more than one expert has addressed the theme of "social acceptance" of autonomous transportation, data throughout surveys have been collected to further investigate the topic.

Regarding the experts located in Italy, F. Santini (President, Trenord s.r.l. – Head of International Business Development Ferrovie dello Stato Group) and P.Mattera (Consulting & Innovation Manager Knorr-Bremse Rail Systems Italia, Member of Technological Committee DITECFER Consortium) have kindly accepted to answer to my questions. It has been interesting to understand the standpoint of a railway undertaking and a breaking-systems producer (pure technological innovation in its products and services). Both, have denied the possibility of the implementation of autonomous *passenger* trains in the short/medium- term in Italy. However, Knorr-Bremse expert does imagine the use of the autonomous practice of *coupling and decoupling* in the next future, since the firm has deployed the TDS (*Threat Detection Solution*[12]*)* with the *Rail Vision*[13] system, which is capable to detect through sensors obstacles and nearby environment, these instruments have been classified as *support* to operators and not a full replacement of them, especially during the maintenance phase. In the final instance, according to Mr. Mattera's opinion (who has specified to express his opinion following publicly available information), the safety certification process for an autonomous train would take a time frame from 3 years up to 10 years. After the analysis of both interviews, the topic of autonomous trains appears far or not-existent in the Italian railway undertaking panorama, and a high-probable evolution of the sector in Italian located rail-vehicles constructors.

[11] European Commission, "Sustainable and Smart Mobility Strategy – putting European transport on track for the future", (2020)

[12] Knorr-Bremse Rail Systems, Threat Detection Solution informative sheet (https://rail.knorr-bremse.com/media/test_e/6400_publications/6440_product_brochures/tcms/flyer-threat-detection-solution_en.pdf)

[13] Knorr-Bremse Rail Systems, (2020): "Knorr-Bremse and Rail Vision to test obstacle detection systems on Swiss operator SBB Cargo's locomotives" (https://www.knorr-bremse.it/it/press/pressreleases/press_detail_36737.jsp?print=1)

Finally, it is worth mentioning that UIC (International Union of Railways) since 2019 is observing the development of the GSM-R communication system's evolution, called FRMCS (Future Railway Mobile Communication System)[14]. This system according to UIC disclosures, is going to be capable to permit a massive volume of data exchange and "support the new potentials from driverless trains". GSM-R technology is planned to be substituted in 2030 (UIC, Jean-Michel Evanghelou, 2018).

After the investigation of future technologies planned to be implemented in rail, it is possible to affirm that in the future (medium-term) equipped trains with a Grade of Automation (GoA) 4 (equal to Unattended Train Operations, UTO) are going to be a reality (Prashant Singh, 2021). Currently, trains are equipped with a GoA level 2.

In the figure below is possible to better understand the differences between the GoA grades in train operations. Following Europe's Rail Joint Undertaking (a body of the European Union) statement: "Shift2Rail is working on automated train operations (ATO) based on European Rail Traffic Management System (ERTMS) that would allow maximizing the performance of train operations throughout Europe. The first pilot line demonstrations at GoA 4 (grade of automation 4) are planned for 2022." [15] The railway undertaking that has done bigger progress in this innovation is SNCF with the project "Train Autonome" which will already test prototypes in 2023[16].

The Shift2Rail intentions have been strengthened with "*The European Railways' Pledge For a More Attractive, Sustainable, Inclusive and Innovative Mobility*", a memorandum of intentions signed by 33 major EU railway undertakings where they "(…) Pledge to make railways more innovative: (…) Deliver more reliable and productive rail passenger and freight operations in line with customers' expectations and help *overcome interoperability barriers* thanks to innovation and digitalization, through the implementation of: (…) *Automated Train Operations to accommodate more trains on the existing infrastructure*."[17] In the next chapters, the co-related social and labour issues will be addressed with empirical research.

[14] UIC Rail system departement, (2020): "FRMCS and 5G for rail: challenges, achievements and opportunities"

[15] Europe's Rail, (2019) "Innovation in the Spotlight: Towards unattended mainline train operations (ATO GoA 4)"

[16] SNCF official site, (2022) "Train autonome, vers une révolution ferroviaire" (https://www.sncf.com/fr/innovation-developpement/innovation-recherche/trains-autonomes-circuleront-en-2023)

[17] European Rail Joint Undertakings, (2022) "The European Railways' Pledge for a More Attractive, Sustainable, Inclusive and Innovative Mobility "

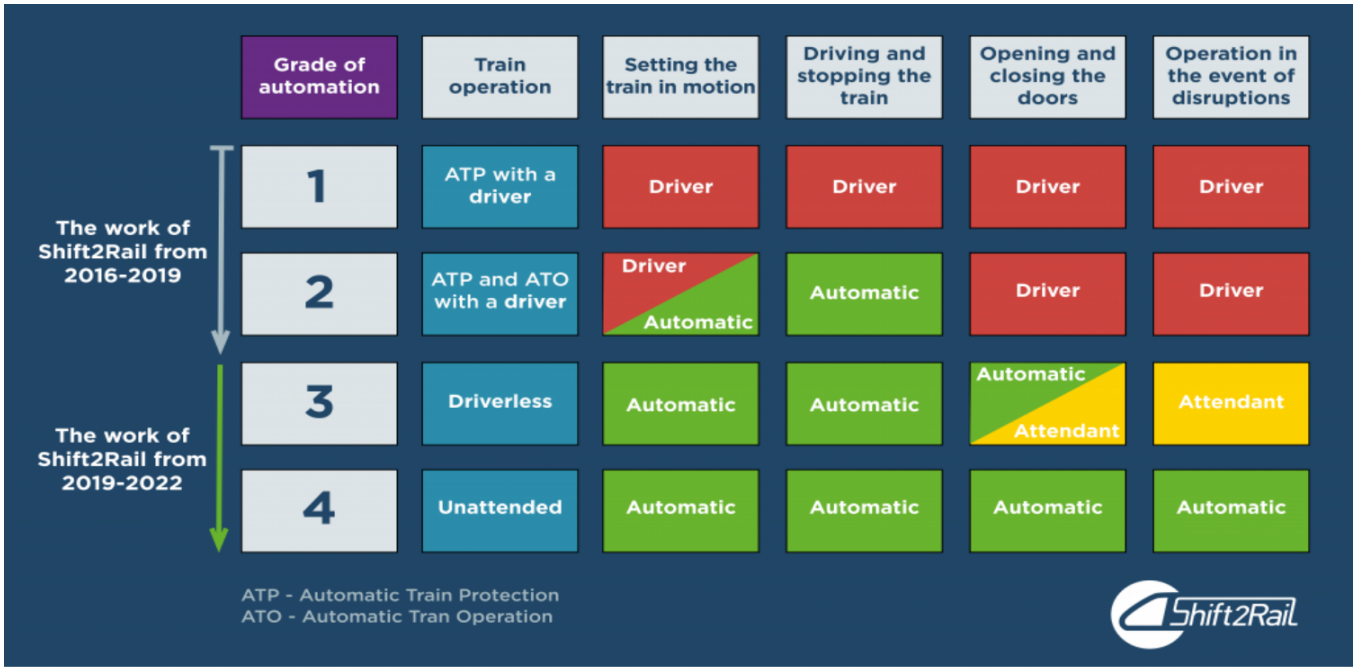

Figure 3, Grade of Automation in train operations, Shift2Rai (2019) "Innovation in the Spotlight: Towards unattended mainline train operations (ATO GoA 4)

Figure 4, Le Train Autonome SNCF (Le voix du nord, 2020)

3.2 Scope of the empirical research

The first aim of this empirical research is to further investigate the opinions and beliefs of rail passengers and workers regarding the theme of the evolution of technologies in the sector. The second scope is to elaborate on specific policy proposals to ensure stability in the European job market.

3.3 Research methodology

As mentioned before, for the aim of this thesis several data have been collected through a survey. The scope of this survey is to investigate further the public opinion about rail transportation and the rail workers' opinion on several topics. The questionnaire has been differentiated following the type of respondent (passenger, worker) and subsequently, the type of operative worker (i.e train driver, train manager, other). The questionnaire has been distributed throughout social media channels and flyers with a QR code on it in several strategic locations where there is a high density of rail workers. To further enlarge the scale of the research, social media channels have been particularly useful to interview rail workers from other States, especially in Europe. Respondents have not disclosed their employers to ensure full honesty and anonymity. Finally, the data are going to be discussed and compared in the next chapters.

3.4 Data collection

In total, 315 people answered the survey: 236 males (74,9%) and 77 females (24.4%) and 2 (0.6%) preferred not to disclose their gender. Regarding the age, 106 people are under 25 years old (33.7%), 170 people are between 25 and 35 years old (54%), 29 people fall into the 36-45 years old (9.2%) and people from 46 years old up to 55 years old are 8 (2,5%), only 2 people are over 56 years old (0.2%).

Speaking about location, the majority of respondents (94%) come from South Europe (i.e Italy, Spain, Greece) but an interesting percentage (5.4%) represents people from North Europe (i.e France, Germany). Only 2 people come from outside the EU, respectively from the Middle East region and Australia. The survey has been distributed from January 2022 and March 2022.

3.4.1 Passengers' data

Regarding the people who have targeted their selves as "Passengers", they are a total amount of 56 where the audience has a high level of education (People who have a Bachelor's degree combined with those who have a Master's degree are 64% of the total). The respondents have declared that almost 82,1% take the train at least once a month.

Speaking about the reasons for their habits, it has been asked why they choose the train as a means of transport: 51,9% have declared that it is "because the train is cheaper than other vectors".

Regarding future habits, 60,7% of passengers would use the train more often in the future and 19,1% less often. A further investigation has revealed that people who are willing to use more often the train are looking for a cheaper mean of transport, since "The use of the car is too expensive" (54,2%) that is going to cause less stress (50% of people) and promote a more sustainable lifestyle (43,8%). This trend has been confirmed from the following question, where it has been asked what the key elements are evaluated when a rail vector is chosen: 82% consider "overall costs" and 29% the "travel time". On the other hand, the main reason to use less often the train relies on the change on working habits (48,6% declare that it is why they "work more often remotely") and the demand for more comfort and flexibility (37.1% declare "The car is more comfortable").
Lastly, it has been asked to explain their feelings if they would have to take a driverless train: the majority (58,9%) would feel "indifferent", followed by 28.6% that would "feel anxiety" and a minor part (7.1%) who would "feel safer". On average, the audience would measure their anxiety level about the possible use of a driverless train from 1 (indifferent) to 10 (really feared) with an overall grade of 4.7/10.
Furthermore, it has been asked if they would be encouraged to use a driverless vector if it could ensure more punctuality and less probability of anomalies like "the accidental station skipping": 57.1% answered "yes" and 42,9% "no".
Finally, 76,4% have declared that would not have the intention to develop a career as a train driver if in future trains will be unmanned.

3.4.2 General Rail workers' data

Concerning the respondents who declared to be rail workers, it is necessary to divide the audience into 3 major sub-groups: 1) Train drivers (50,6% of total, 131 people) 2) Train Managers (29,7% of total, 77 people) 3) Other jobs (19,7% of total, 51 people) (i.e station masters, maintenance, human resources). In general, the gender of respondents well represents the sector[18]: there is a majority of males (199, 76,8% of the total) with a minor part of females (58, 22,39% of the total). The level of education is slightly lower than the "passengers" group with a high percentage of people who has a "high school diploma" (64.5%) followed by a 20% who have a bachelor's degree and an 11.6% who have a master's degree. Only a residual part (1,9%) has a higher education such as an MBA or Ph.D.
Overall, the age combined with the seniority shows a group of people who has less than 25 years old with 5-year seniority (28,9% of total), a group between 26 years old up to 35 years old with 5 years seniority (41,7%) and 6 to 10 years of seniority with the same age (12,4%). The other rail workers are older than 35 years old or have even higher experience in seniority.

[18] European Commission (2014): "Employment, skills and working conditions in transport: Policy summary of interim results ", Figure 4

3.4.3 Train Drivers' section

Train drivers declare high satisfaction in their job, with an average grade of 8.5/10. Nevertheless, it has been asked, "what are the things co-related with the job that put you in a stressful situation?": the majority have stated (it was possible to declare more than one option) to "have difficulties to eat properly or healthy" (69,5%) combined with the overall "difficulty to have a regular life (58,8%). Paradoxically, it has been followed by "Not well organized co-related logistic such as car parkings, bike parkings, not well-organized shifts" (45,8%), and "too many working hours" (36,6%), "not sufficient rest between one shift and another" (37,4%), "Fear to be involved in an accident (17,6%). Only a residual part (14,5%) are stressed by "Too many responsibilities during the duty".

In general Train, Drivers show a discreet grade of fear related to new market competition between EU rail vectors with an average grade of 4,7/10. The main reasons for tension between these workers about an open job market are mainly economic since the 68.8% are afraid that "other rail vectors will offer lower salaries" followed by safety reasons (39.8% of people are afraid that "workers from abroad do not operate with the same safety standards"), uncertainty for labour stability (18.3% is afraid "to lose the job completely") and fear for an unbalanced labour market (12,9% is worried about the "social dumping" phenomena).

Regarding the opinions about ATO (automatic train operations) the 42,7% think it is going to be implemented in the long term (over 20 years), the 36,6% in the middle-term (11-20 years), the 13,7% never, and the 6.9% in the short-term (5-10 years.).

Nevertheless, it has been asked to measure "the psychological acceptance from 1 to 10 if an automated system would ensure you the total avoidance of inconveniences like "The station skipping" and the average grade is 5,9/10. About this topic, it has been asked the opinion about incumbent invasive driving technologies such as ATO or automated breaking: the 52.8% is afraid that "the salary will lower" followed by the 39.4% who "would feel safer", the 25,2% who is "afraid to lose the job totally", the 18,9% who is "happy to have less responsibility", the 7.1% who "is going to change job" and only a 3.1% think that the "salary is going to be higher".

Lastly, it has been asked in their own opinion which strategy could be feasible for union trades to avoid the worst-case scenario: the 57,5% suggests to U.T to "Impose to Railway undertakings higher and homogeneous salaries to train drivers that have to control more sophisticated technologies"; the 38,6% suggests to "Impose to railway undertakings "Duty to "re-skill" to ensure a new job to train drivers with the same salary", the 23,6% would like to "Protect the integrity of the Train drivers' job pushing away the incumbent use of newer technologies" and the 11,8% would not suggest any of this solutions.

3.4.4 Train managers' section

Train managers declare a discreet satisfaction in their job, with an average grade of 7,5/10. Nevertheless, it has been asked "what are the things co-related with the job that put you in a stressful situation" (it was possible to declare more than one option) and the majority have stated to "have difficulties eating properly or healthy" (61%) combined with the overall "difficulty to have a regular life (57,1%). Followed by "too many working hours" (48,1%) and "Difficulties to sleep properly" (46,8%). Even here the co-related logistics seem to be problematic (28,6%) combined with the difficulties to reach the workplace (18.2%). An interesting data has arisen from spontaneous options where 7.8% of respondents have indicated "violent interactions with passengers" as a source of stress-related working activity (verbal and physical).

In general Train, managers show a low grade of fear related to new market competition between EU rail vectors with an average grade of 3,9/10.

It has been asked the opinion about incumbent invasive driving technologies such as ATO or automated breaking: 50,6% are afraid that "the salary will lower" followed by the 36.4% who are "afraid to lose the job totally", the 28,6% "would feel safer" the 10,4% who is "happy to have less responsibility", the 10,4% who "is going to change job" and only a 2.6% think that the salary is going to be higher.

Lastly, it has been asked in their own opinion which strategy could be feasible for union trades to avoid the worst-case scenario: the 57,1% suggests to U.T to "Impose to railway undertakings "Duty to "re-skill" to ensure a new job to train drivers with the same salary";-the 39% suggests to "Protect the integrity of the Train drivers' job pushing away the incumbent use of newer technologies" and the 10,4% would not suggest any of these solutions.

3.4.5 Other rail workers' section

The survey given to these workers is a hybrid between the one proposed to passengers and the one proposed to train drivers: the scope is to measure and compare their opinions with other workers mentioned above about the same topics.

This group usually takes the train daily (45,1%) or weekly (21.6%), the residual part once a month or more rarely. The reason for these choices relies on the fact that train is "cheaper than other vectors" (50%) "efficient" (48%) and gives overall positive feelings to this group of people (40%) lastly, it promotes a less pollutant habit (28%). Also, this group declares that in the future they are going to use the train more often (51%), 33,3% will not change their mobility habits, and the 15,7% will use the train less. Furthermore, the reasons behind these intentions (use the train more) differ from other groups: the major part (69.8%) would like to have less stress during the transport: "The train is more relaxing than the car" followed by an economic reason "the use of the car is too expansive" (55,8%) and their will to "have a more sustainable lifestyle" (41.9%); only the 32,6% answered because the "train is an efficient mean of transport" and 0% because "the train always arrive on time". People who are going to use less often this vector for the 40,6%

is because they “work more often remotely” and are “more comfortable in their private cars” (37,5%); the 12,5% are afraid “to get infective diseases”.

Moreover, respondents have stated that 60.8% would be “indifferent” if they should take a driverless train: 29,4% would “feel anxious” and 7,8% would “feel safer”. Overall, the grade of anxiety related to the possible use of this kind of unmanned vector is discreet with a grade of 4,5/10 and 54,9% of respondents would be encouraged to use a driverless vector if it could ensure them more punctuality and fewer anomalies such as the “accidental station skipping”.

In general, this group of workers consider firstly “overall costs” (64,7%), secondly “travel time” (51%), thirdly “comfort” and lastly “safety reputation” (25,5%), “status symbol” (13,7%), “innovation” (11,8%) when they have to choose a rail operator instead of another for a trip.

The general work satisfaction is 8/10. The main stress-related reasons for these workers are: the general difficulty in “having a regular life” (39,2%), and “difficulties eating properly or healthy” (37,3%); moreover, several reasons reach the same percentage without being significative such as “too many working hours” (29,4%), “not well organized co-related logistics” (31,4%), “not sufficient resting hours between shifts” (27,5%). Fewer people have chosen “difficulties to reach the workplace” (19,6%), “too many responsibilities during the duty” (21,6%), and “fear to be involved in an accident” (15,7%).

This group shows a low grade of fear in consideration of the single EU rail market with a grade of 4,3/10.

From the automatization standpoint, the 47,1% think that driverless trains will be a reality in the middle term (11-20 years), 33,3% in the long run (over 20 years), the 15,7% in the short term (5-10 years) and only 3,9% never.

Their opinions about the topic differ from other workers: 44,9% would “feel safer” with these new technologies (ATO, automated breaking), 22,4% are afraid to “have a lower salary”, 18,4% are “afraid to lose their job completely” and the same percentage thinks about “changing their duty”; 14,3% would be “happy to have less responsibility” and 12,2% think that the salary is going to be higher.

This group thinks that Union Trades should: “Impose to railway undertakings “Duty to “re-skill” to ensure a new job to train drivers with the same salary” (50%), “Impose to Railway undertakings higher and homogeneous salaries to train drivers that have to control more sophisticated technologies” (37,5%); “Protect the integrity of the Train drivers’ job pushing away the incumbent use of newer technologies” (16,7%) and 18,8% would not suggest any of these strategies.

Finally, these workers would not be interested in a career as a train driver if in the future trains will be unmanned (45,8%), or uncertain (16,7% “maybe”).

3.5 Results

These data show some remarkable aspects of social acceptance of innovations in rail transportation and future mobility habits.

Firstly, the overall price increase in traditional fuels in the period, for example in Italy, from September 2021-March 2022 (From 1,669 €/L to 2,007 €/L[19], +18,83%) had an immediate impact on mobility habits. Moreover, the increase in the cost of transportation is connected with a +4,3% inflation[20] is not reflected in an increase in incomes: that is why in the "passengers" group it is possible to observe a radical division between people who are going to use the train more often (because it is a "cheaper means of transport for individuals") and people who are going to use the train less often because they are not going to use any mean of transport at all (since they are "working more often remotely"[21]). With these projections, probably in near future, we are going to see an exponential increase in the overall public transport demand driven by the need to reduce costs whereas it is possible.

1) *With high probability, there will be an exponential increase in transported passengers by train for growth of need and not in overall railway undertakings increase in performances (i.e Innovation, Status symbol, Sustainability)*[22]

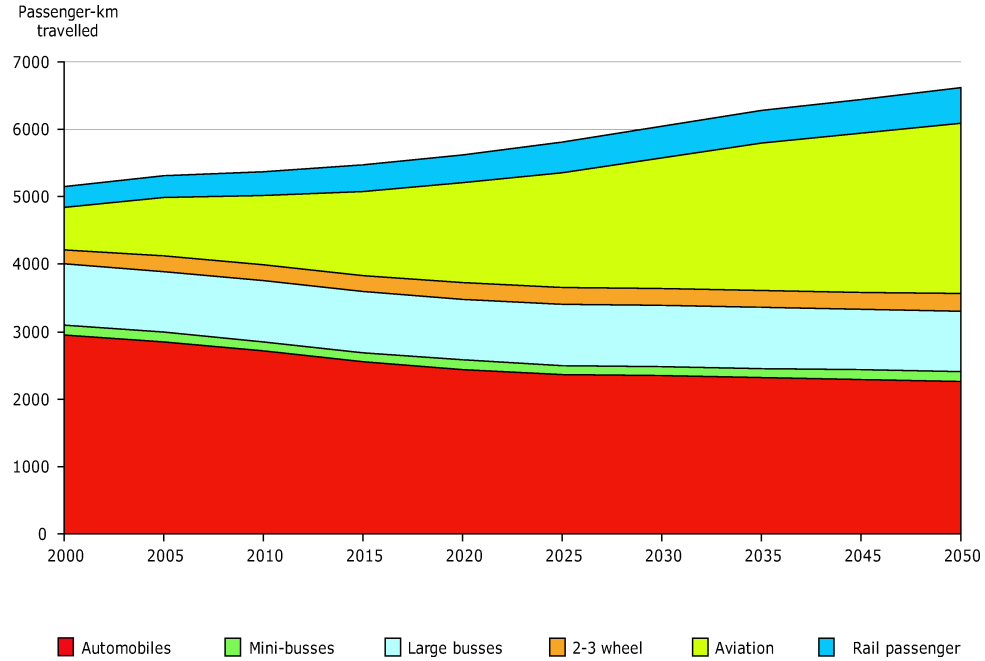

Figure 3, Projections of the passenger transport demand by mode, European Environment Agency (2010)

[19]Italian Ministry of Ecological Transition (2022), "Statistical analysis on energetic resources: Average fuel prices open Data"
[20] Source: ISTAT Data
[21] KPMG report, (2022): "Current trends in remote working"

[22] It is possible to observe in Figure 4 that this statement could be confirmed by a projection made in 2009 by the European Environmental Agency In the report "Passenger transport demand - outlook from WBCSD" (https://www.eea.europa.eu/data-and-maps/indicators/passenger-transport-demand-outlook-from-wbcsd/passenger-transport-demand-outlook-from)

Secondly, about passengers' (customers) acceptance of driverless/unmanned rail vectors, it has been measured that already the majority would be "*indifferent*" about their use of them, moreover, seems to be encouraged if a technological innovation could ensure fewer anomalies such as "the accidental station skipping"

2) *Customers (passengers) seem not to be worried about the idea to use driverless means of transport*[23].

Thirdly, the possible direction of rail transport evolution (unmanned systems) discourages the younger generations from a career as a train driver.

3) *Younger generations are discouraged to embrace a career as a train driver without any clarification on the future labour evolution, even in this period of a chronic shortage of operative personnel*[24] *when it is expected that high-speed EU rail traffic will double by 2030 and triple by 2050*[25]

Regarding the "Rail workers" group, a more complex discussion is needed:
Firstly, the overall work-related satisfaction is the highest for "train drivers" (8,5/10) and the lowest for "train managers" (7,5/10). A further investigation shows that even reasons behind stress work-related slightly differ: for operative train personnel in general the difficulties to have a regular life or a healthy diet seem to be crucial (more than 50% of respondents). An interesting data arises from the difficulty to reach the workplace for train drivers and overall sleep disorders for train managers, who especially have declared spontaneously as a source of stress the physical and verbal violence received during interactions with passengers. The other rail workers do not show a notable cause of stress in respect of others (less than 40%). Recently, in Italy some countermeasures have been put in place such as the *Mobility Manager* institution with the "Decreto Rilancio" (Decree n.34 of 19th May 2020), to oblige private and public companies to implement employees' mobility optimizations measures. Unfortunately, no sanctions or fees have been disclosed by Italian law if these obligations have not been met by the involved actors. Moreover, academic research on sleep disorders and quality of life shows results thus suggest a close relation between greater fatigue and decreased health-related quality of life (Emilie Fortier-Brochu, 2010)

4) *Train drivers show the highest satisfaction about their job, meanwhile, train managers have the lowest. Besides the crucial difficulty to have a regular life and a healthy diet, for train drivers, major causes of stress rely on co-related logistics difficulties, for train managers stress is mainly caused by a*

[23] These conclusions have been reached in other academic studies, such as (Fraszczyk et al., 2015) and (Pakusch & Bossauer, 2017)
[24] International Railway Journal, (2019) "Train driver numbers in Germany rise, but shortage continues"

[25] European Commission (2021), "Action plan to boost long distance and cross-border passenger rail"

decreased life quality; where too many working hours and interactions with people who shows violent behavior are key factors to develop in some cases sleep disorders and general fatigue.

Nevertheless, all the categories of workers show a high level of fear regarding the EU Single Rail market, especially about salary stability. Speaking about innovations such as GoA 4, only train drivers think that GoA 4 would be implemented in the long term, and only operative personnel shows a high fear of a subsequent salary reduction, meanwhile, other rail workers would feel safer on this kind of implementation. Despite these opinions, the general audience not directly involved in train operations employees show a broad consensus and positive attitude toward the use of driverless trains. Indeed, only a residual percentage is convinced that this technology will never be implemented. In addition to that this group shows even a higher level of indifference in respect of normal passengers, whether the train would be driven by someone or not.

5) *Employers in the Railway sector seem to accept the use of driverless vectors and are ready to see them implemented in the middle term.*

Finally, it is time to compare the different opinions regarding the possible Unions' strategy to avoid an unbalanced labour market: train drivers seem to be the ones that prefer to protect their occupation and promote a higher (and homogeneous throughout EU territory) salary due to the more sophisticated skills required to supervise an autonomous train (in the presence or remotely). Meanwhile, the other two groups suggest imposing on railway undertakings the duty to re-skill personnel with the aim to relocate them to other functions with the same salary level. It is worth mentioning that in every group almost 10% do not support any of these two strategies.

6) *Imposing a higher homogeneous salary due to the higher skills required, combined with the oblige to re-skill personnel to avoid collective dismissals, seems to be broadly encouraged by rail workers in future collective bargaining.*

This empirical research would need a greater number of respondents to be more detailed. Considering the total number of rail workers throughout EU territory, around 765,000 people (Eurostat, Labour Force Survey, data 2014), this study wants to be the embryonal phase of further investigations on the labour-related aspect of railway innovations, especially ATO. In the fourth chapter, the labour aspect will be specifically addressed and some proposals to protect the sector from unemployment or income reduction will be studied.

4. Of the Labour in Railand - Discussion

"Things have been, says the legal mind,
and so we are here.
The creative mind says we are here
because things have yet to be."

(H.G. Wells, The Discovery of the Future)

"(...) The driver was not able to think about something else after that. She felt like a robot (fun to say at this point) for several stations:
"The "Work" ... what an interesting word to invent: during the technical high school it was "energy transferred to or from an object via the application of force along with a displacement" [26]".
After school, it became a lot more than "W=fs".
Work, Labour, Job, Qualification, Duty… a lot of words to describe something that means "the creation of something through energy". After all, the protagonist was fascinated by the history and philosophy behind the concept of Labour. She knew that in all her life she was not so special at all: an ordinary employee, an ordinary machinist, an ordinary student. Not excellent nor insufficient. But she knew that in her mediocrity something maybe useful could have been done.
The train was marching, and the locomotive was noisy (as always, when things are functioning well). The machinist began to think about solutions to avoid the worst-case future scenario. After some time, a little smile appeared on her face, and she said:
"Dear 464, thanks for having thought me how to think in silence when around you there is so much noise".
(...)"

4.1 Endogenous and exogenous factors in EU Railway sector

Regarding the quantity of operative personnel involved in rail operations (train drivers, train managers) it is not possible to have direct data. It is possible to extract indirectly a gross number: following the most recent data available (2021) by Eurostat, the total number of transport workers in the EU is 10.8 million[27]. The percentage of "locomotive engine drivers and related workers" is 3%.
With a simple reverse calculation, we have a total (gross) amount of (minimum) ***324.000 workers***.
Despite the little percentage over the total, the automation process of this profession if not properly addressed could exasperate the current state of labour market in the EU and its uncertain future (Wilkinson, 2016),

[26] Britannica, T. Editors of Encyclopaedia (2020, May 12). work. Encyclopedia Britannica.
[27] Eurostat, (2021) "Almost 29 transport workers per 1 000 people in the EU"

without considering other future sectors' automation such as manufacturing, retail, accommodation & food services. (McKinsey&Company, 2020).

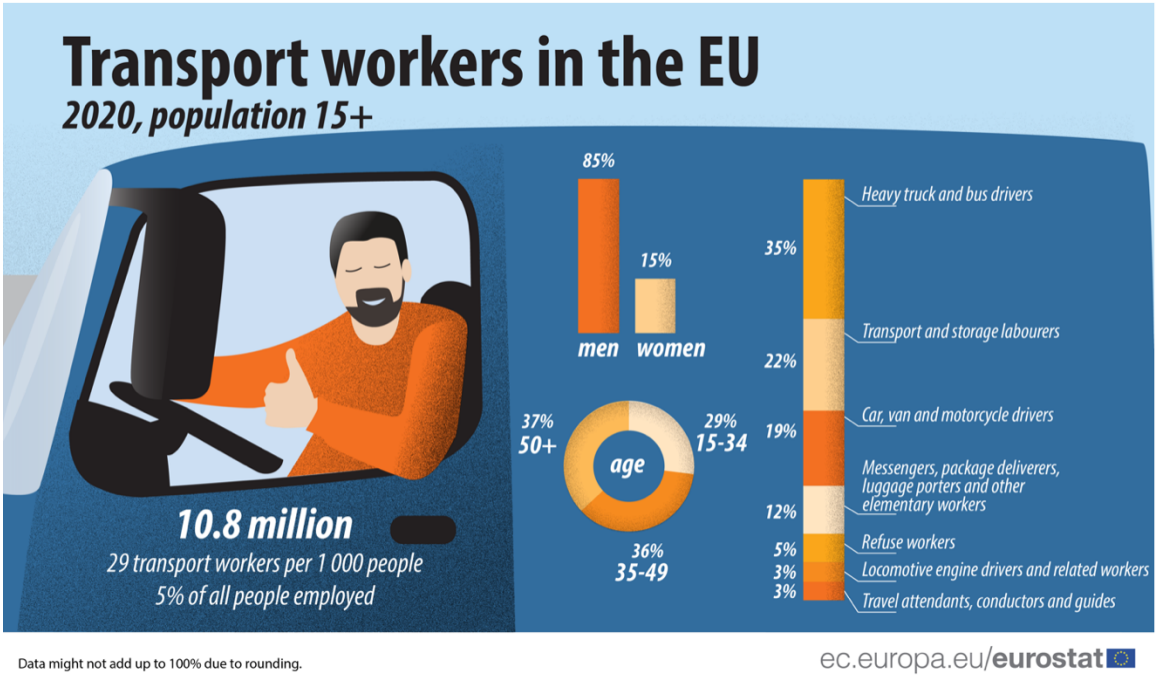

Figure 4 Transport workers in EU, Eurostat, 2021

Related to the previous empirical research, it is possible to affirm that operative railroad workers have a slightly lower average education (High school diploma). On the other hand, we should consider the time interval between present and future automation implementations (almost 10-15 years) that put these workers even at a higher risk, since these factors are interconnected (future age between 40 and 55 years old with lower education) make their re-allocation even more complex in a scenario of increasing reduction of labour force (McKinsey&Company, 2020). Plus, other operational factors such as the chronic shortage of personnel[28], aggravated by an increase in transport demand [29], could function as an accelerator (create urgency) for railway undertakings that want to fill the gap in offer with technological innovations (i.e train conduction automation) (Massimo Bergami, 2021)

Finally, it is necessary to think about possible future solutions for workers with a broader vision: since the railway sector is fully operating in an *open market regime*, it could be feasible to think about *ex Novo* railway undertakings entering the market, that could operate with *driverless technologies* from the beginning (i.e Hyperloop, a hypothetical "AmazonTrain") and conquer market shares from "Statuary railway undertakings"

[28] International Railway Journal, (2019) "Train driver numbers in Germany rise, but shortage continues"
[29] European Commission (2021), "Action plan to boost long distance and cross-border passenger rail"

(maybe with *low fares* and *no-frills).* The Italian company Alitalia s.p.a has thought us that even a "para-national" company is not safe from bankruptcy and mass dismissals [30] in a *concurrency market scenario.*

4.2 The minimum EU salary for train drivers hypothesis (Proposal n.1)

The theme of the "minimum legal salary" goes beyond national State boundaries (Fabozzi, Il Salario minimo, 2021). Even if ILO (International Labour Organization) encourages the efforts of states to develop a common principle for a minimum (legal) salary, that shows a disarticulated position on that, since obstacles imposed by EU norms and national positions are present. (Fabozzi, Il Salario minimo, 2021). In principle, retribution, and salaries (and even mechanisms of salary calculation) fall outside the scope of present EU laws. Indeed, article n.153 on the Treaty of the Functioning of UE (TFUE), clearly states that the EU has no authority over retributions and salaries. The EU permits member States autonomous jurisdiction on this theme, even regarding minimum legal salary (Fabozzi, Il Salario minimo, 2021). Besides that, national organizations, from Union Trades to industrial associations appear against a further EU centralization over this topic since they want to keep a certain grade of independence and authority over this subject. Moreover, the EU's latest territorial enlargements have made salary harmonization even more complex and *social dumping* an instrument to exploit the workforce where the cost is lower (Fabozzi, Il Salario minimo, 2021).

Although the idea of a "minimum legal salary" *erga omnes* seems to be too ambitious and not feasible, it could be possible to think about a sectorial "minimum salary": it is necessary to consider that Union Trades' main concerns rely on the possibility that a "minimum salary" could lead to a general reduction in salary and collective bargaining power. (Fabozzi, Il Salario minimo, 2021).

On the other hand, the national minimum salary does not seem an effective solution: in an open railway EU market, bigger distortions arise in operators based in countries where the average workforce cost is lower, (minimum salary included) do transportation services in other wealthier countries still (e.g., Slovenia based to Italy; Italy based to Luxemburg). Due to transportation activity itself, it could be feasible to think about another kind of solution to ensure transboundary workers a fair wage, or, for workers who are transitioning through an automation process.

It may be interesting to Union Trades (and member States) to think about imposing to transboundary operators the payment to foreign drivers allowances in relation to the country they are operating in and for how many hours:

Example:

A Slovenian-based operator is willing to operate a train with 2 drivers onboard from Slovenia to north Italy. The trip is going to last 0.5 h on Slovenian territory and 5 h on Italian territory.

[30] Concorrenza nel settore del trasporto aereo e dei servizi aeroportuali / Addessi, Angela. - (2017 Nov 09).

The payment should be: 0,5h following the collective Slovenian agreement plus 5 h (e.g. regular pay +driving allowances) following the Italian collective agreement for railway in force.

In synthesis, the idea is to **reach collective agreements to ensure wage based on *work hours* and *places* where *R.U have produced the transport* activity itself**. Regarding **automation**, **salary reduction should not be permitted** in collective agreements for several reasons:

1) *Higher machine complexity:* a semi-autonomous machine requires more complex interaction with it in emergencies or failures. From the basic understanding of *why* some operations are autonomously taken, to *how* to intervene over that, the train driver needs higher education in this sense that is not covered by basic ERA certification requirements (e.g. is not required to know or understand how AI works).
2) *Higher English level required*: it may sound obvious but all procedures in railway are moving towards an invasive use of the English language[31]. Paradoxically, English knowledge is not a requirement for obtaining an EU train driver's license[32]. The result is that many workers are not trained in this sense, and they will need in future more education to fill the gap (higher qualifications).
3) *Risks derived by extreme climate events*: personnel involved in train operations will meet more often extreme climate events. Risks related to the integrity of trains and people will be higher, especially related to the increasing possibility of extreme floods throughout EU territory (Barred, 2011). That is why weather conditions are going to become more challenging than in the past and workers will be put at a higher safety risk. For this reason, it could be interesting to think about ***Climate Risk allowances for workers.***

Figure 5 7th Jan. 2021, TERNI (IT) derailed train due to a landslide caused by bad weather.

[31] Rete Ferroviaria Italiana, 2020 "Overcoming language barriers to achieve a single European railway network" (https://www.rfi.it/en/In-Europe/top-stories/Overcoming-language-barriers-to-achieve-a-single-European-railway-network.html)
[32] DIRECTIVE 2007/59/EC, article 12 and Annex VI.

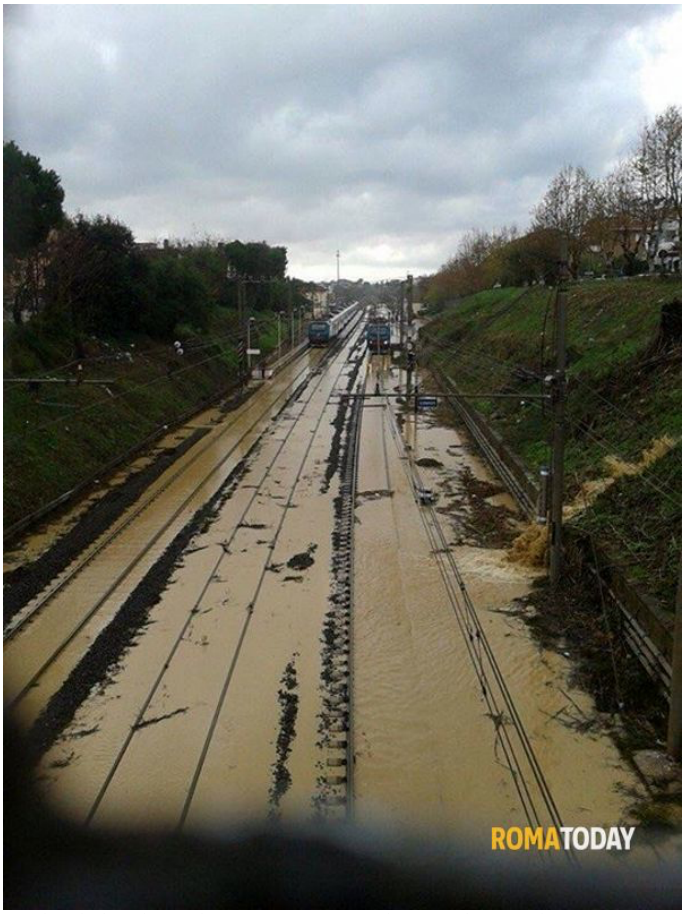

Figure 6 CIVITAVECCHIA (IT), 2014, Flooded railway due to extreme weather conditions. (ROMATODAY)

4) *The untangled responsibility matter*: towards the transition to a driverless train, the train driver is going to become a *conduction supervisor*. Nevertheless, is not clear its role and liability limits: in hybrid conduction, who is responsible for a collision? The train (constructor or the train's owner) or the *supervisor* (that has not stopped manually the train "in time"?) these concerns should be untangled from ERA, to avoid abuses or distortions from employers (such as the idea to register an automated object as a *limited liability company (LLC) per se* to reduce available patrimony for possible damage compensation to third parties, for example, a railway company XYZ registers every train as a *subsidiary per se (i.e. Trainxyz001 L.L.C, Trainxyz002 L.LC…)* with a limited amount of patrimony assigned.

(Kaplan, 2016)). Meanwhile, responsibility for train drivers does not seem to decrease at all: as mentioned in the previous chapter, 17,6% of train drivers have the "fear to be involved in an accident". Following the EU-OSHA report on "Occupational Health & Safety in the Transport Sector- an Overview" (2009) the main cause of Post-traumatic stress disorder (PTSD) among train drivers is the event of the investment of a person (suicides or accidents): even if in Italy being on the railway tracks for people is strictly forbidden by law D.P.R 753/1980, still train drivers are suited in court with the accuse of manslaughter until any proof of innocence arises. The processes usually take many years to be concluded and put workers under high psychological stress. ***ERA, together with EU institutions, should enact amendments to the Directive 2016/798 where train crew should be immune from being***

involved in a trial (or have a beneficial regime to shorten the time of the process), in case of a person's investment, since being on rail tracks for whatever reason is strictly forbidden by law.

5) *Same income, more hours per day option:* academic research articles have shown that human interaction over automated driving systems takes more time than interaction with classic manual driving systems. Furthermore, this time frame gets longer in relation to drivers' condition (i.e. fatigue) and age. The option to ensure the same salary for more minimum worked hours per day (because there is *less workload*) does not appear safe because it increases the risk of fatigue and chronic fatigue (and mental illnesses such as depression) in personnel that must overcome the machine faster as possible (Arefnezhad et al., 2022) (Hiroyuki Kikuchi, 2020).

Lastly, the idea of a minimum sectorial legal salary does not seem the best option to move this profession towards a just transition to driverless trains, but several reasons to protect the actual income have arisen.

4.3 The duty to re-skill hypothesis (Proposal n.2)

Impose to railway undertakings the duty to re-skill personnel more likely to undergo an automation process seems to be an appreciated strategy among railroad workers. Following McKinsey Global Institute: "Less-educated workers, young people, and men are most likely to be displaced by automation. In our analysis, education is significantly correlated with the likelihood of being displaced by automation. In the midpoint automation adoption scenario, people with only secondary education are three times as likely as people with more education to be in roles with high potential for automation". (McKinsey&Company, 2020)

Even though the European Pillar of Social Rights clearly states in Chapter 1 the right for workers to obtain "quality and inclusive education, training and life-long learning in order to maintain and acquire skills that enable them to participate fully in society and manage successfully transitions in the labor market", it still does not specify the basic features of education gained, especially in the automatization scenario. The same reasoning could be applied for recital n.4 of the same Pillar, where "(…) Everyone has the right to transfer social protection and training entitlements during professional transitions. (…)". The employment level is protected without further specifying the need to obtain the necessary training to be employed in jobs that ensure the same level of income.

The strategy to impose to existent railway undertakings the obligation to give to younger workers economic incentives for their tertiary education and the perspective to a smoother transition would increase the CSR (Corporate social responsibility) towards the future society where R.U are operating.

Laws concerning the sponsored tertiary education topic should be imposed by national and sovra-national norms, such as the obligations regarding the continuous professional workers' education[33].

[33] For example in italy this obligation came from the Legislative Decree n.81/2008 art.37 recital 6.

In this sense, the younger workers (less than 30 years) could be encouraged to begin a worker-student career to obtain a tertiary education and gain the maximum profitability by it, if these kinds of actions are taken in the short term (0-3 years) considering that higher education requires time to be adopted, meanwhile smarter technology time implementation is exponentially decreasing (Tae Wan Kim, Technological Unemployment, Meaning in Life, Purpose of Business, and the Future of Stakeholders, 2019)

The oblige for R.U to offer younger workers free tertiary education could be seen as an "active social safety net" in the view of an automation process.

The costs of free education could be covered with e.g., agreements with major public universities, and direct economic sponsorships to the employee.

Moreover, the workers who are able to obtain higher education are easier to re-locate in duties who require the same train drivers' income, since they have quite experience in the field and a decent theoretical knowledge.

So, other workers (who are not willing or not capable to obtain a higher qualification) are safe from duty disqualification in the future (and possibly lower incomes)? Probably not: according to ILO[34] the main reason for collective dismissals in the EU is "Company internal restructuring" and, in Italy, workers' disqualification is permitted only to "protect from unavoidable mass dismissals" (Fabozzi, Demansionamento e dequalificazione, 2014). These legal instruments put weaker workers at higher dismissal or disqualification risk.

4.4 Barriers in market entrance and obligations to ex-novo fully automated railway undertakings imposed by EU hypothesis (Proposal n.3)

Regarding *ex-novo* smaller railway undertakings, it is proven by academic studies that smaller enterprises are more willing to be more innovative to conquer market shares. (Stringer, 2000).

Hypothetically, a new smaller vector (but it does not mean I could not have big financial resources behind it) enters the market: this vector lawfully uses only driverless trains (because ERA safety requirements permit it) and, to conquer new market shares is capable to operate with low-cost ticket prices and decent service (only on-board customers service). In a full concurrency market, this vector is more likely to succeed since, for the majority, the main passengers' need is *to reach point B from A with a minor possible cost.* The vector's revenue increase is equal to other railway companies' failure (if they are not able to change fast enough to keep the concurrency). Mass dismissals are unavoidable (and lawful, for economic reasons[35]) and specialized onboard personnel (train drivers, train managers) are not able to find another employer since the market is monopolized

[34] International Labour Organization (2016): Report on collective dismissals

[35] In Italian law is called "Licenziamento per giustificato motivo oggettivo, *objective and justified reasons for dismissal*" and it is regulated by Art. 3 of Italian law 604/1966

by a driverless vector. The result is hundreds of highly specialized personnel dismissed and an expense for States who are activating "classic" social safety nets (temporary economic remedies for workers). In Romania, for example, Trade Unions are "postponing" problems related to the "open rail market" with rail service contracts that have a longer duration (i.e., 15 years for regional rail services) between regional territories and Romanian rail undertakings[36], but through this option, there is not a long-term resolution.

To avoid the worst-case scenario and going through a *just transition towards a digitalized world,* it could be interesting **for the EU to impose some kind of "economic barriers" to the market entrance**, such as an **economic penalty for every worker "taken away" with an automated technology or, they oblige to finance or sponsor free tertiary education for a total amount of workers "taken away" from the market with their technologies.**

For example:

Company XYZ wants to enter the market with a total amount of 10 driverless trains per day ("trains" to indicate how many trips point-to-point are made). The operative personnel not employed should be a minimum n.20 (2 workers per train) + 20% (gross workers' substitution index) = 24 workers

Company XYZ, according to EU regulations, should ensure 1) an economic penalty to the member state it wants to be based in calculated in proportion to workers taken off from labour market 2) As a remedy, ensure free higher education to an equal number of workers substituted who are doing the profession which is being automated by XYZ's technology (i.e train drivers, train managers)

4.5 Debate

After the 3 main hypothesis considerations, it is worthy to consider some ethical concerns:

Unavoidability of newer technologies: despite past technological revolutions, people are more willing to accept technological innovations as "unavoidable" (Zuboff, 2018). From a labour standpoint, even the attempt to refuse incoming technologies with legal barriers appears ineffective. It seems that workers at higher automation risk should embrace the "philosophy of change" more than ever and try to overcome it with alternative solutions.

High-intensity jobs: is it fair to permit technology to reduce the number of high-intensity jobs? Besides passion and higher incomes related to the education required, jobs in transport such as onboard personnel, require a working life characterized by non-regular shifts, non-regular or unhealthy food diet, and overall fatigue (the higher incomes are allowances for these kinds of disadvantages). Automation, after all, has been used by

[36] Service contract signed between Alstom and Romanian rail in 2022: (https://www.railtech.com/rolling-stock/2022/03/29/alstom-bags-first-its-romanian-contract-for-passenger-trains/?gdpr=accept)

humans to substitute heavy duties and produce more (McKinsey&Company, 2017). Can we think about a higher quality of life as citizens if every means of transport could be automated? Probably yes.

Re-skill or not to re-skill?: Besides all the possible scenarios, education seems to be the best way to better adapt to future labour changes. To those who are willing to study, higher education should be encouraged to ensure more opportunities. Depending on the location, sponsorships should be given to ensure equal access to studies.

The Unions Trade's role: in this historical period, Union Trades are more needed than ever. By 2020 labour world has seen a radical change regarding its basic concepts: the meaning of "work" "employee", "workplace", "working hours", "holidays", "disconnection", "remote working", and "flexibility" have been put in doubt (Tae Wan Kim, Technological Unemployment, Meaning in Life, Purpose of Business, and the Future of Stakeholders, 2019). U.T need to anticipate future changes to ensure the workers' rights that for many years have been denied before the major social revolutions and strikes. Nowadays, the U.T power seems to be reduced: from the physical disaggregation of workers (aggravated by the remote working conditions to the possible inefficiency of strikes, since in the future raw activities (but still fundamental) will be conducted from automated machines. In this situation, workers may be afflicted by the employer's abuse without any legal protection to defend their selves. U.T should seriously question their selves about what role want to have *towards a just transition to a digitalized world.*

5. Conclusions

"(...) the Last station became visible through the 464's glass, which was slightly dirty after the impact with a mosquito cloud several stations ahead.

The time passed fast, as always. Luckily enough the weather was good, and no anomalies occurred. It was late night and lights were popping through the dark where people were already sleeping. The machinist used to take a moment to enjoy the view around her and contemplate how lucky she was to be there. From the bottom of her heart, she tried to enjoy every day as the last day onboard: no one could have imagined when the day of change could have come.
The thought of a new life puts her in a sense of confusion: her relationship with work was such a love-hate relationship. She hated all the "little", but still stressful things gravitating around the labour; from the anxiety to not hearing the alarm at 3:30 in the night to the fatigue arising some days. On the other hand, once in her cabin, she felt peace in all that noise. There, she was independent, she was relaxed. She loved the fact that thanks to all the rights gained through a strong contract, she had been able to continue autonomously university and pay entirely the necessary expenses, not be afraid to get pregnant, to be serene if a disease or accident would have occurred. After all, she was a female train driver, just 1% among the 7000 train drivers in Italy. She wished that so many workers could have the same guarantees she had. She felt proud about everything she achieved alone. As far as she knew, she thought that it was real love for what she did every day. (...)"

During the MSc Course of Law, Digital Innovation & Sustainability at Luiss University students have been encouraged to conduct empirical research: for sure it is not possible to give a final and defined solution to a problem such as the future automation in labour, but, as far as I am concerned some remarkable proposals that could be useful for further research in legal studies on the future of labour in this sector. The three research questions could be answered as the following:

R.A 1) Is it possible to affirm that EU entities are preparing the ground for the implementation of driverless trains in the middle term (10-15 years).

R.A 2) Passengers seems not to be worried about the idea to use a driverless mean of transport. Employers in the Railway sector seem to accept the use of driverless vectors and are ready to see them implemented in the middle term. Both categories seem to be encouraged in the use of driverless trains if they could ensure lower costs and lower probability of human-factor driven accidents.

R.A 3) *It depends:* The imposition of an EU "minimum legal salary" seems not feasible and a source of disaggregation. Furthermore, several reasons to do not to support future agreements on lower salaries have been demonstrated, such as the matter of responsibility and the adequacy to propose longer daily shifts. The most promising hypothesis seems to be the "duty to re-skill" and the EU imposition of "entrance barriers to the market" to newer vectors. These two strategies interconnected could weaken the "tsunami effect" brought by pervasive automated technology. Of course, in this era the role of stakeholders is fundamental: institutions together with Union trades and railway undertakings must understand that their contribution (a temporary loss in revenue due to worker's education expenses) is going to bring fewer damages in the future from a social standpoint. In general, also workers should be aware of possible future scenarios and the importance of a present sacrifice (the will to begin a worker-student experience) for less dismissal risk in the future. Currently, education is the only individual instrument immediately available to workers, to lower this risk and actively participate in innovation processes, both social and technological.

That is why workers should be encouraged by employers with different types of facilitation (e.g. paid daily permissions, sponsorships).

However, some things are still missing: further research on the topic of detailed data collection on EU workers in the Transport sector is needed. Indeed, a lot of difficulties in data collection have arisen during the research, since different entities such as railway undertakings are not willing to share or show any insightful data.

Moreover, obligations on education sponsorship may appear unfeasible for current law-making processes but attempts at more innovative legislation on the subject could be further studied. On the other hand, there is still not clear how to untangle the matter of workers who are not willing or not capable to obtain higher education: of course, they could be positioned in other similar duties, but with a high probability, they are simply postponing the problem of being without the possibility to gain the same income due to automation in next future. Going even forward, (next 50 years?) the problem of work scarcity will be even more pervasive: could we think about an *erga omnes* retribution such as the Italian *"reddito di cittadinanza"* maybe jointly delivered by States *and* corporations?

In the end, the ERA's mission is "*Railway for a better society"*. How could we be an example for society if train drivers in the first place are going through an *unjust* transition?

For sure, technological innovations are made to make human life easier. Until now, technological innovations have permitted our current well-being and further have to come. Regarding train drivers, there is a high expectancy in automation from the public opinion and a labour law strategy policy must be taken to ensure a heaven transition.

“(…)

For her was hard to imagine a different future, but she had to, because sooner or later she would have been obliged.

Last station arrived. The train gently stopped, and the doors opened. Few people jumped off, and the train manager was happy to close the train and finally get back home. The machinist began the operations to turn off the train for the night.

When the train was finally silent, she stared at it and thought:

“Is it the time to jump off the train forever?”

She did not know yet.

But she was ready to share her ideas with other colleagues, to bring her little contribution to a future that is not written yet.

“After all, I would re-do everything again: because I have always done things that I enjoyed.”

Then, she turned around and walked away to get back home.”

THE END

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Summary

1. Introduction

The Master's degree course in *Law, Digital Innovation & Sustainability* relies upon the inquiry-based model. For this reason, during the course, students have been stimulated with interactive lessons, group projects, and "forced" or "spontaneous" contaminations between each other with different study patterns (especially during the 2nd year). This model has enabled students to continuously find real applications to the theories.

Indeed, the aim of this thesis, called "*Railand: a thesis of many dimensions: About disruptive technologies and the future of Labour in Rail Transportation"* is to tackle the theme of automation in rail transportation and, further investigate how automated trains are perceived by the public. During the thesis, the attempt to answer these three research questions will be made:

R.Q 1) Are driverless trains going to be a reality in next future?
R.Q 2) How do people and railroad workers view automation—what are their attitudes?
R.Q 3) Is it possible to develop (or propose) EU policies to avoid train drivers' mass dismissals and guide them towards a just transition to a digitalized world?

The need to observe the railway scenario on many dimensions (profit, growth, people, labor) came from the fact that transportation itself is not an abstract concept, the sector is tightly linked with the territory, politics, and climate.

As it is possible to read in the full-length thesis, there are many references to the book *Flatland: a romance of many dimensions,* written by Sir. Abbott Abbott (for near friends and colleagues, Sir. Abbott[2]). This tale was written in 1884, during the Victorian Age, where censorship was very tight and books, paints, and any kind of manifestation against the regime were strictly forbidden. The book Flatland has been written in such an original manner that was able to avoid censorship and, at the same time, be able to perfectly draw the society features of that time. Meanwhile, Flatland is also capable to anticipate the main theme of research in physics 30 years earlier: the relativity theme.

Furthermore, the tale is about a journey and the tenacity to "research continuously" without never fulfilling the curiosity that only human being has. That is why the thesis is highly personalized, as a tribute to this wonderful opera.

Regarding the Rail transportation sector, the major difficulty relies on the data availability: unfortunately, there are not many studies in academic literature and, major railway undertakings are not willing to disclose insightful data due to business privacy reasons. Only data arising from EU Agencies reports have been useful for the aim of this research, but they have not been updated in most of the cases since 2010 on average.

For the aim of synthesis, the full-length thesis investigates the past technologies involved in EU Rail, the future technologies that are going to be involved in EU rail, their impact on the labor force (especially train drivers), and how the effect of "technological unemployment" could be reduced.
For this reason, empirical research has been conducted to attempt to gain insightful data on the train automation theme and its perception by the public and railroad workers.

2. About technologies involved in Rail transportation and literature review

The European Railway Area is on its own a complex scenario. For many years every member state of the European Union had a different Rail system, differing from one other basically in everything: from the distance between the train tracks to the regulations and procedures established to enact the transportation. Of course, this system has become unsustainable in recent years, that is why the ERA (European Railway Agency) has put in place several "Railway packages" intending to build an efficient "Single European Rail Area" (DIRECTIVE 2012/34/EU "Establishing a single European railway area", 2012), whereas infrastructures and regulations are standardized, and every rail operator can operate in a free and competitive market in full interoperability. Starting from the 16th of June 2019, the 4th Railway Package was effectively put in place, to permit the "one-stop-shop" process of authorization of new locomotors and a stronger commitment from the ERA to enhance the culture of safety.
These affirmations may seem obvious to an average person, but these policies represent a radical change in the whole sector. Until railway packages, every Nation was a "close system" with few transboundary transportations limited to certain locations. Consequently, the labor market concerning all the professions needed to run the system was stable, even when national railways became private corporations controlled by States.
Furthermore, I would state clearly that the European rail systems and their policies ensure safe transportation (ERA , 2016).

With this being said, it is also true that these political changes bring risks in the short-medium term co-related to the labor market, as it has been seen in civil aviation. Unfortunately, there are two main ways to compete in the market, *cost,* or *differentiation* (Martin, 2015) and it is not quite easy to differentiate a service that uses all the same infrastructure, and its punctuality depends by a marginal part upon the strategic choices of the railway undertaking (For example, in the year 2017 taken in consideration an average year without the Covid impact, the Rail company Trenitalia reached punctuality for the medium-long range trains of 99.1%, on the

other hand, the company NTV in the same year reached punctuality for medium-long range trains of 85,4%, where only the 25.4% of overall delays are on behalf of vector's responsibility.[37])

As it could be imagined, the major distortion in the market relies on the cost competition, to ensure the same service at the minor price possible; the principal ways to do so in transportation are:

4) A vector as a *customer of services*
5) *The new organization of labor*:
6) *Reduction of labor cost*:

These are the main threats in the short-medium term for the transportation labor market.

It is important to have a step back and look at the **several technological improvements (and the exponential curve of changes' speed**) over the last twenty years. All these actions and expenses have been made to reach the ultimate objective of the concretization of the "Single European Rail Area" and the digitalization of rail transportation.

In "ancient times" fewer trains were operating on the rail, and they were separated one from each other with the manual control of the stationmaster. All the activities related to the train conduction itself were in total control of the train driver(s).

Slowly, trains became more efficient, Rail traffic systems had an evolution (like the implementation of more complex and accurate ways to regulate traffic and the evolution of telephonic communications) until another big change in technologies happened in early 2000. *Ferrovie dello Stato* was a pioneer in implementing the SCMT System (*Sistema Controllo Marcia Treno*)[38] on board and the *Blocco Elettrico automatico a correnti codificate (BACC)*[39] on infrastructure. This system works with the communication via currents on tracks that are able to communicate to onboard instruments some states of signals and eventual anomalies (via antennas, SSB System). SCMT System was revolutionary and permitted the *same safety less human workload.*

Indeed, in 2009, with the new Italian agreement between Trade Unions and Trenitalia, for the first time was allowed **to cut the number of *train drivers* on board from two to *one*** for normal operations on passenger trains and still two for specific conditions[40].

1.1 Actual technologies involved in Italian rail operations

Furthermore, in the same period (1999) Italian engineers began to study the ERTMS (European Rail Traffic Management System) system to permit effortless transit of passengers and goods across national boundaries

[37] Data collected from: "NTV Quality report 2017" and "Relazione sulla qualità dei servizi Trenitalia 2017".
[38] Rete Ferroviaria Italiana, "Sistema Controllo Marcia Treno SCMT" (https://www.rfi.it/it/Sicurezza-e-tecnologie/tecnologie/ccs/Controllo-Marcia-Treno/Sistema-Controllo-Marcia-Treno--SCMT.html)
[39] Rete Ferroviaria Italiana, "Circuiti di binario" (https://www.rfi.it/it/Sicurezza-e-tecnologie/tecnologie/ccs/tecnologie-di-terra/circuiti-di-binario.html)

[40] Italian Agreement between Trade Unions and the Railway Undertaking Trenitalia signed on 15th of May 2009. (Annex B)

in Europe. The ERTMS was finally implemented in 2009, with the advent of the modern Italian high-speed rail connection from Milan to Rome. Furthermore, this technology is revolutionary, since it disrupts the "old signaling system" to the control of traffic via geo-satellites connected with trains. It permits pervasive instrument controls by the train driver only by the displays on the desk, and a high level of safety even at the maximum speed (300 km/h) (European Railway Agency, 2016). The ERTMS system has been chosen for its interoperability between States and now it has been implemented across Europe to finally enact the Single EU Rail Area. From the labor law standpoint, this technological innovation was one of the reasons to extend the regular working hours per day for onboard personnel from 8 hours to 10 hours[41].

As it could be noticed, the time between one technological disruptive change to the next one is exponentially *decreasing*. With it, also the organization of the labor is changing, from the cut of non-necessary personnel to the extension of actual labor daily hours. In the next chapter, emerging technologies and their social disruptive power will be addressed.

3. Empirical research among rail customers and rail workers

One main theme addressed during the MSc Course of Law, Digital Innovation & Sustainability was the implementation of autonomous vehicles. Of course, technological progress does not permit at the moment access to the public to this technology. But, with a broader vision, it is easier to think about faster innovations in this sense to rail transportation (Prashant Singh, 2021), since trains for their characteristics have fewer "degrees of freedom".

For the aim of this research, interviews with several experts in this sector have been taken since more than one expert has addressed the theme of "social acceptance" of autonomous transportation, data throughout surveys have been collected to further investigate the topic.

Regarding future technologies in rail, it is worth mentioning that UIC (International Union of Railways) since 2019 is observing the development of the GSM-R communication system's evolution, called FRMCS (Future Railway Mobile Communication System)[42]. This system according to UIC disclosures, is going to be capable to permit a massive volume of data exchange and "support the new potentials from driverless trains". GSM-R technology is planned to be substituted in 2030 (UIC, Jean-Michel Evanghelou, 2018).

After the investigation of future technologies planned to be implemented in rail, it is possible to affirm that in the future (medium-term) equipped trains with a Grade of Automation (GoA) 4 (equal to Unattended Train Operations, UTO) are going to be a reality (Prashant Singh, 2021). Currently, trains are equipped with a GoA level 2.

[41] The modification was applied from recital n.2.6.4, Italian Collective National Agreement for railroad sector (C.C.N.L 2003) to recital n. 2.7 Italian Collective National Agreement for railroad sector (C.C.N.L 2012)

[42] UIC Rail system departement, (2020): "FRMCS and 5G for rail: challenges, achievements and opportunities"

Following Europe's Rail Joint Undertaking (a body of the European Union) statement: "Shift2Rail is working on automated train operations (ATO) based on European Rail Traffic Management System (ERTMS) that would allow maximizing the performance of train operations throughout Europe. The first pilot line demonstrations at GoA 4 (grade of automation 4) are planned for 2022." [43] The railway undertaking that has done bigger progress in this innovation is SNCF with the project "Train Autonome" which will already test prototypes in 2023[44].

2.1 Scope of the empirical research

The first aim of this empirical research is to further investigate the opinions and beliefs of rail passengers and workers regarding the theme of the evolution of technologies in the sector. The second scope is to elaborate on specific policy proposals to ensure stability in the European job market.

2.2 Research methodology

As mentioned before, for the aim of this thesis several data have been collected through a survey. The scope of this survey is to investigate further the public opinion about rail transportation and the rail workers' opinion on several topics. The questionnaire has been differentiated following the type of respondent (passenger, worker) and subsequently, the type of operative worker (i.e train driver, train manager, other). The questionnaire has been distributed throughout social media channels and flyers with a QR code on it in several strategic locations where there is a high density of rail workers. To further enlarge the scale of the research, social media channels have been particularly useful to interview rail workers from other States, especially in Europe. Respondents have not disclosed their employers to ensure full honesty and anonymity. Finally, the data are going to be discussed and compared in the next chapters.

2.3 Data collection

In total, 315 people answered the survey: 236 males (74,9%) and 77 females (24.4%) and 2 (0.6%) preferred not to disclose their gender. Regarding the age, 106 people are under 25 years old (33.7%), 170 people are between 25 and 35 years old (54%), 29 people fall into the 36-45 years old (9.2%) and people from 46 years old up to 55 years old are 8 (2,5%), only 2 people are over 56 years old (0.2%).

Speaking about location, the majority of respondents (94%) come from South Europe (i.e Italy, Spain, Greece) but an interesting percentage (5.4%) represents people from North Europe (i.e France, Germany). Only 2 people come from outside the EU, respectively from the Middle East region and Australia. The survey has

[43] Europe's Rail, (2019) "Innovation in the Spotlight: Towards unattended mainline train operations (ATO GoA 4)"

[44] SNCF official site, (2022) "Train autonome, vers une révolution ferroviaire" (https://www.sncf.com/fr/innovation-developpement/innovation-recherche/trains-autonomes-circuleront-en-2023)

been distributed from January 2022 and March 2022. For the aim of the summary insightful data are in the full-length thesis.

2.4 Discussion

The gathered data show some remarkable aspects of social acceptance of innovations in rail transportation and future mobility habits.

Firstly, the overall price increase in traditional fuels in the period, for example in Italy, from September 2021-March 2022 (From 1,669 €/L to 2,007 €/L[45], +18,83%) had an immediate impact on mobility habits. Moreover, the increase in the cost of transportation is connected with a +4,3% inflation[46] is not reflected in an increase in incomes: that is why in the "passengers" group it is possible to observe a radical division between people who are going to use the train more often (because it is a "cheaper means of transport for individuals") and people who are going to use the train less often because they are not going to use any mean of transport at all (since they are "working more often remotely"[47]). With these projections, probably in near future, we are going to see an exponential increase in the overall public transport demand driven by the need to reduce costs whereas it is possible.

7) *With high probability, there will be an exponential increase in transported passengers by train for growth of need and not in overall railway undertakings increase in performances (i.e Innovation, Status symbol, Sustainability)*[48]

Secondly, about passengers' (customers) acceptance of driverless/unmanned rail vectors, it has been measured that already the majority would be "*indifferent*" about their use of them, moreover, seems to be encouraged if a technological innovation could ensure fewer anomalies such as "the accidental station skipping"

8) *Customers (passengers) seem not to be worried about the idea to use driverless means of transport*[49].

Thirdly, the possible direction of rail transport evolution (unmanned systems) discourages the younger generations from a career as a train driver.

[45] Italian Ministry of Ecological Transition (2022), "Statistical analysis on energetic resources: Average fuel prices open Data"
[46] Source: ISTAT Data
[47] KPMG report, (2022): "Current trends in remote working"

[48] It is possible to observe in Figure 4 that this statement could be confirmed by a projection made in 2009 by the European Environmental Agency In the report "Passenger transport demand - outlook from WBCSD" (https://www.eea.europa.eu/data-and-maps/indicators/passenger-transport-demand-outlook-from-wbcsd/passenger-transport-demand-outlook-from)

[49] These conclusions have been reached in other academic studies, such as (Fraszczyk et al., 2015) and (Pakusch & Bossauer, 2017)

9) *Younger generations are discouraged to embrace a career as a train driver without any clarification on the future labor evolution, even in this period of a chronic shortage of operative personnel*[50] *when it is expected that high-speed EU rail traffic will double by 2030 and triple by 2050*[51]

Regarding the "Rail workers" group, a more complex discussion is needed:
Firstly, the overall work-related satisfaction is the highest for "train drivers" (8,5/10) and the lowest for "train managers" (7,5/10). A further investigation shows that even reasons behind stress work-related slightly differ: for operative train personnel in general the difficulties to have a regular life or a healthy diet seem to be crucial (more than 50% of respondents). An interesting data arises from the difficulty to reach the workplace for train drivers and overall sleep disorders for train managers, who especially have declared spontaneously as a source of stress the physical and verbal violence received during interactions with passengers. The other rail workers do not show a notable cause of stress in respect of others (less than 40%). Moreover, academic research on sleep disorders and quality of life shows results thus suggest a close relation between greater fatigue and decreased health-related quality of life (Emilie Fortier-Brochu, 2010)

10) *Train drivers show the highest satisfaction about their job, meanwhile, train managers have the lowest. Besides the crucial difficulty to have a regular life and a healthy diet, for train drivers, major causes of stress rely on co-related logistics difficulties, for train managers stress is mainly caused by a decreased life quality; where too many working hours and interactions with people who shows violent behavior are key factors to develop in some cases sleep disorders and general fatigue.*

Nevertheless, all the categories of workers show a high level of fear regarding the EU Single Rail market, especially about salary stability. Speaking about innovations such as GoA 4, only train drivers think that GoA 4 would be implemented in the long term, and only operative personnel shows a high fear of a subsequent salary reduction, meanwhile, other rail workers would feel safer on this kind of implementation. Despite these opinions, the general audience not directly involved in train operations employees show a broad consensus and positive attitude toward the use of driverless trains. Indeed, only a residual percentage is convinced that this technology will never be implemented. In addition to that this group shows even a higher level of indifference in respect of normal passengers, whether the train would be driven by someone or not.

11) *Employers in the Railway sector seem to accept the use of driverless vectors and are ready to see them implemented in the middle term.*

[50] International Railway Journal, (2019) "Train driver numbers in Germany rise, but shortage continues"

[51] European Commission (2021), "Action plan to boost long distance and cross-border passenger rail"

Finally, it is time to compare the different opinions regarding the possible Unions' strategy to avoid an unbalanced labour market: train drivers seem to be the ones that prefer to protect their occupation and promote a higher (and homogeneous throughout EU territory) salary due to the more sophisticated skills required to supervise an autonomous train (in presence or remotely). Meanwhile, the other two groups suggest imposing on railway undertakings the duty to re-skill personnel with the aim to relocate them to other functions with the same salary level. It is worth mentioning that in every group almost 10% do not support any of these two strategies.

12) *Imposing a higher homogeneous salary due to the higher skills required, combined with the oblige to re-skill personnel to avoid collective dismissals, seems to be broadly encouraged by rail workers in future collective bargaining.*

This empirical research would need a greater number of respondents to be more detailed. Considering the total number of rail workers throughout EU territory, around 765,000 people (Eurostat, Labour Force Survey, data 2014), this study wants to be the embryonal phase of further investigations on the labour-related aspect of railway innovations, especially ATO. In the fourth chapter, the labour aspect will be specifically addressed and some proposals to protect the sector from unemployment or income reduction will be studied.

4. Discussion and policy proposals

Regarding the quantity of operative personnel involved in rail operations (train drivers, train managers) it is not possible to have direct data. It is possible to extract indirectly a gross number: following the most recent data available (2021) by Eurostat, the total number of transport workers in the EU is 10.8 million[52]. The percentage of "locomotive engine drivers and related workers" is 3%.
With a simple reverse calculation, we have a total (gross) amount of (minimum) ***324.000 workers***.
Despite the little percentage over the total, the automation process of this profession if not properly addressed could exasperate the current state of labour market in the EU and its uncertain future (Wilkinson, 2016), without considering other future sectors' automation such as manufacturing, retail, accommodation & food services. (McKinsey&Company, 2020).

Related to the previous empirical research, it is possible to affirm that operative railroad workers have a slightly lower average education (High school diploma). On the other hand, we should consider the time interval between present and future automation implementations (almost 10-15 years) that put these workers

[52] Eurostat, (2021) "Almost 29 transport workers per 1 000 people in the EU"

even at a higher risk, since these factors are interconnected (future age between 40 and 55 years old with lower education) make their re-allocation even more complex in a scenario of increasing reduction of labour force (McKinsey&Company, 2020). Plus, other operational factors such as the chronic shortage of personnel[53], aggravated by an increase in transport demand [54], could function as an accelerator (create urgency) for railway undertakings that want to fill the gap in offer with technological innovations (i.e train conduction automation) (Massimo Bergami, 2021).

Finally, it is necessary to think about possible future solutions for workers with a broader vision: since the railway sector is fully operating in an *open market regime*, it could be feasible to think about *ex Novo* railway undertakings entering the market, that could operate with *driverless technologies* from the beginning (i.e Hyperloop, a hypothetical "AmazonTrain") and conquer market shares from "Statuary railway undertakings" (maybe with *low fares* and *no-frills).* The Italian company Alitalia s.p.a has thought us that even a "para-national" company is not safe from bankruptcy and mass dismissals [55] in a *concurrency market scenario.*

1) The minimum EU salary for train drivers hypothesis (Proposal n.1)

The theme of the "minimum legal salary" goes beyond national State boundaries (Fabozzi, Il Salario minimo, 2021). Even if ILO (International Labour Organization) encourages the efforts of states to develop a common principle for a minimum (legal) salary, that shows a disarticulated position on that, since obstacles imposed by EU norms and national positions are present. (Fabozzi, Il Salario minimo, 2021). In principle, retribution, and salaries (and even mechanisms of salary calculation) fall outside the scope of present EU laws. Indeed, article n.153 on the Treaty of the Functioning of UE (TFUE), clearly states that the EU has no authority over retributions and salaries. The EU permits member States autonomous jurisdiction on this theme, even regarding minimum legal salary (Fabozzi, Il Salario minimo, 2021). Besides that, national organizations, from Union Trades to industrial associations appear against a further EU centralization over this topic since they want to keep a certain grade of independence and authority over this subject. Moreover, the EU's latest territorial enlargements have made salary harmonization even more complex and *social dumping* an instrument to exploit the workforce where the cost is lower (Fabozzi, Il Salario minimo, 2021).

Although the idea of a "minimum legal salary" *erga omnes* seems to be too ambitious and not feasible, it could be possible to think about a sectorial "minimum salary": it is necessary to consider that Union Trades' main concerns rely on the possibility that a "minimum salary" could lead to a general reduction in salary and collective bargaining power. (Fabozzi, Il Salario minimo, 2021).

On the other hand, the national minimum salary does not seem an effective solution: in an open railway EU market, bigger distortions arise in operators based in countries where the average workforce cost is lower, (minimum salary included) do transportation services in other wealthier countries still (e.g., Slovenia based to

[53] International Railway Journal, (2019) "Train driver numbers in Germany rise, but shortage continues"
[54] European Commission (2021), "Action plan to boost long distance and cross-border passenger rail"
[55] Concorrenza nel settore del trasporto aereo e dei servizi aeroportuali / Addessi, Angela. - (2017 Nov 09).

Italy; Italy based to Luxemburg). Due to transportation activity itself, it could be feasible to think about another kind of solution to ensure transboundary workers a fair wage, or, for workers who are transitioning through an automation process.

It may be interesting to Union Trades (and member States) to think about imposing on transboundary operators the payment to foreign drivers allowances in relation to the country they are operating in and for how many hours.

In synthesis, the idea is to **reach collective agreements to ensure wage based on *work hours* and *places* where *R.U have produced the transport* activity itself**. Regarding **automation**, **salary reduction should not be permitted** in collective agreements for several reasons:

1)Higher machine complexity

2) *Higher English level required*
3) *Risks derived from extreme climate events*
4) *The untangled responsibility matter*.
5) *Same income, more hours per day option.*

Lastly, the idea of a minimum sectorial legal salary does not seem the best option to move this profession towards a just transition to driverless trains, but several reasons to protect the actual income have arisen.

6) The duty to re-skill hypothesis (Proposal n.2)

Impose to railway undertakings the duty to re-skill personnel more likely to undergo an automation process seems to be an appreciated strategy among railroad workers. Following McKinsey Global Institute: "Less-educated workers, young people, and men are most likely to be displaced by automation. In our analysis, education is significantly correlated with the likelihood of being displaced by automation. In the midpoint automation adoption scenario, people with only secondary education are three times as likely as people with more education to be in roles with high potential for automation". (McKinsey&Company, 2020).

Even though the European Pillar of Social Rights clearly states in chapter 1 the right for workers to obtain "quality and inclusive education, training and **life-long learning** in order to maintain and acquire skills that enable them to participate fully in society and manage successfully transitions in the labor market", it still does not specify the basic features of education gained, especially in the automatization scenario. The same reasoning could be applied for recital n.4 of the same Pillar, where "(…) Everyone has the right to transfer social protection and training entitlements during professional transitions. (…)". The employment level is protected without further specifying the need to obtain the necessary training to be employed in jobs that ensure the same level of income.

Laws concerning the sponsored tertiary education topic should be imposed by national and sovra-national norms, such as the obligations regarding the continuous professional workers' education[56].

In this sense, the younger workers (less than 30 years) could be encouraged to begin a worker-student career to obtain a tertiary education and gain the maximum profitability by it, if these kinds of actions are taken in the short term (0-3 years) considering that higher education requires time to be adopted, meanwhile smarter technology time implementation is exponentially decreasing (Tae Wan Kim, Technological Unemployment, Meaning in Life, Purpose of Business, and the Future of Stakeholders, 2019)

The oblige for R.U to offer younger workers free tertiary education could be seen as an "active social safety net" in the view of an automation process.

Moreover, the workers who are able to obtain higher education are easier to re-locate in duties who require the same train drivers' income, since they have quite experience in the field and a decent theoretical knowledge.

So, other workers (who are not willing or not capable to obtain a higher qualification) are safe from duty disqualification in the future (and possibly lower incomes)? Probably not: according to ILO[57] the main reason for collective dismissals in the EU is "Company internal restructuring" and, in Italy, workers' disqualification is permitted only to "protect from unavoidable mass dismissals" (Fabozzi, Demansionamento e dequalificazione, 2014). These legal instruments put weaker workers at higher dismissal or disqualification risk.

7) Barriers in market entrance and obligations to ex-novo fully automated railway undertakings imposed by EU hypothesis (Proposal n.3)

Regarding *ex-novo* smaller railway undertakings, it is proven by academic studies that smaller enterprises are more willing to be more innovative to conquer market shares. (Stringer, 2000).

Hypothetically, a new smaller vector (but it does not mean I could not have big financial resources behind it) enters the market: this vector lawfully uses only driverless trains (because ERA safety requirements permit it) and, to conquer new market shares is capable to operate with low-cost ticket prices and decent service (only on-board customers service). In a full concurrency market, this vector is more likely to succeed since, for the majority, the main passengers' need is *to reach point B from A with a minor possible cost.* The vector's revenue increase is equal to other railway companies' failure (if they are not able to change fast enough to keep the concurrency). Mass dismissals are unavoidable (and lawful, for economic reasons[58]) and specialized onboard personnel (train drivers, train managers) are not able to find another employer since the market is monopolized

[56] For example in italy this obligation came from the Legislative Decree n.81/2008 art.37 recital 6.

[57] International Labour Organization (2016): Report on collective dismissals

[58] In Italian law is called "Licenziamento per giustificato motivo oggettivo, *objective and justified reasons for dismissal*" and it is regulated by Art. 3 of Italian law 604/1966

by a driverless vector. The result is hundreds of highly specialized personnel dismissed and an expense for States who are activating "classic" social safety nets (temporary economic remedies for workers).
To avoid the worst-case scenario and going through a *just transition towards a digitalized world,* it could be interesting **for the EU to impose some kind of "economic barriers" to the market entrance**, such as an **economic penalty for every worker "taken away" with an automated technology or, they oblige to finance or sponsor free tertiary education for a total amount of workers "taken away" from the market with their technologies.**

Debate

After the 3 main hypothesis considerations, it is worthy to consider some ethical concerns:

Unavoidability of newer technologies: despite past technological revolutions, people are more willing to accept technological innovations as "unavoidable" (Zuboff, 2018). From a labour standpoint, even the attempt to refuse incoming technologies with legal barriers appears ineffective.

High-intensity jobs: is it fair to permit technology to reduce the number of high-intensity jobs? Besides passion and higher incomes related to the education required, jobs in transport such as onboard personnel, require a working life characterized by non-regular shifts, non-regular or unhealthy food diet, and overall fatigue (the higher incomes are allowances for these kinds of disadvantages). Automation, after all, has been used by humans to substitute heavy duties and produce more (McKinsey&Company, 2017). Can we think about a higher quality of life as citizens if every means of transport could be automated? Probably yes.

Re-skill or not to re-skill?: Besides all the possible scenarios, education seems to be the best way to better adapt to future labour changes. To those who are willing to study, higher education should be encouraged to ensure more opportunities. Depending on the location, sponsorships should be given to ensure equal access to studies.

The Unions Trade's role: in this historical period, Union Trades are more needed than ever. By 2020 labour world has seen a radical change regarding its basic concepts: the meaning of "work" "employee", "workplace", "working hours", "holidays", "disconnection", "remote working", and "flexibility" have been put in doubt (Tae Wan Kim, Technological Unemployment, Meaning in Life, Purpose of Business, and the Future of Stakeholders, 2019). U.T need to anticipate future changes to ensure the workers' rights that for many years have been denied before the major social revolutions and strikes. Nowadays, the U.T power seems to be reduced: from the physical disaggregation of workers (aggravated by the remote working conditions to the possible inefficiency of strikes, since in the future raw activities (but still fundamental) will be conducted from automated machines. In this situation, workers may be afflicted by the employer's abuse without any legal protection to defend their selves. U.T should seriously question their selves about what role want to have *towards a just transition to a digitalized world.*

5. Conclusions

Surely, it is not possible to give a final and defined solution to a problem such as the future automation in labour, but, as far as I am concerned some remarkable proposals that could be useful for further research in legal studies on the future of labour in this sector. The three research questions could be answered as the following:

R.A 1) Is it possible to affirm that EU entities are preparing the ground for the implementation of driverless trains in the middle term (10-15 years).

R.A 2) Passengers seems not to be worried about the idea to use a driverless mean of transport. Employers in the Railway sector seem to accept the use of driverless vectors and are ready to see them implemented in the middle term. Both categories seem to be encouraged in the use of driverless trains if they could ensure lower costs and lower probability of human-factor driven accidents.

R.A 3) *It depends:* The imposition of an EU "minimum legal salary" seems not feasible and a source of disaggregation. Furthermore, several reasons to do not to support future agreements on lower salaries have been demonstrated, such as the matter of responsibility and the adequacy to propose longer daily shifts. The most promising hypothesis seems to be the "duty to re-skill" and the EU imposition of "entrance barriers to the market" to newer vectors. These two strategies interconnected could weaken the "tsunami effect" brought by pervasive automated technology. Of course, in this era, the role of stakeholders is fundamental: institutions together with Union trades and railway undertakings must understand that their contribution (a temporary loss in revenue due to worker's education expenses) is going to bring fewer damages in the future from a social standpoint. In general, also workers should be aware of possible future scenarios and the importance of a

present sacrifice (the will to begin a worker-student experience) for less dismissal risk in the future. Currently, education is the only individual instrument immediately available to workers, to lower this risk and actively participate in innovation processes, both social and technological.

That is why workers should be encouraged by employers with different types of facilitation (e.g. paid daily permissions, sponsorships).

In the end, the ERA's mission is "*Railway for a better society"*. How could we be an example for society if train drivers in the first place are going through an *unjust* transition?

For sure, technological innovations are made to make human life easier. Until now, technological innovations have permitted our current well-being and further have to come. Regarding train drivers, there is a high expectancy in automation from the public opinion and a labour law strategy policy must be taken to ensure a heaven transition.

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