Digital Transformation and Social Dialogue in Urban Public Transport in Europe

Final Report

UITP EUROPE

ETF

EVA

wmp consult

With financial support from the European Union

Contents

Imprint

Study

Study in the context of the joint social partners project on "Digitalisation and Social Dialogue in Urban Public Transport in Europe"

Commissioned by the project partners

ETF – European Transport Workers' Federation
Galerie AGORA, Rue du Marche aux Herbes 105, Boite 11
1000 Brussels, Belgium

UITP – International Association of Public Transport
Rue Sainte Marie, 6
1080 BRUXELLES
Belgium

Published by

EVA – Europäische Akademie für umweltorientierten Verkehr gGmbH
Reinhardtstraße 23
10117 Berlin
Germany

Authors

Eckhard Voss /
Dr Katrin Vitols
wmp consult – Wilke Maack GmbH
Schaarsteinwegsbrücke 2
D-20459 Hamburg
Germany

This document was prepared within the framework of the project "Digitalisation and Social Dialogue in Urban Public Transport in Europe". The project received financial support from the European Union under the budget heading "Support of Social Dialogue". The information and views set out in this report reflect those of the authors. The European Commission is not responsible for any use that may be made of the information contained therein.

Preface

AN INCLUSIVE AND PARTICIPATORY SOCIAL DIALOGUE IS KEY FOR PRO-ACTIVELY SHAPING THE DIGITAL TRANSFORMATION IN URBAN PUBLIC TRANSPORT IN EUROPE

These days the EU institutions, the stakeholders and social partners are discussing the GREEN DEAL for Europe and the future European Strategy for Smart and Sustainable Mobility. Collective Urban Public Transport (UPT) is key to achieve Europe's ambitions to fight climate change and realise a carbon neutral Europe until 2050. According to the European Commission, digitalisation is one of the two legs of the future strategy, greening transport is the other.

The European Social Partners in urban public transport, UITP and ETF identified the digital transformation in Urban Public Transport as an emerging topic for the social dialogue already some years ago within the European Social Dialogue Work Program and decided to carry out a joint project called "Digital transformation and social dialogue in Urban Public Transport in Europe".

The digital transformation of the UPT sector is an on-going process and the Covid 19 pandemic even accelerated digitalization and so-called smart working practices. The current developments due to the digital transformation will have both facilitating and disruptive effects on future urban mobility. Digitalisation&automation has an impact on jobs, working conditions, professions and skills. New technologies can create labour, replace labour, intensify labour, change labour, facilitate labour and re-organise labour.

Our objective was to get a better understanding of the technological developments taking place in our sector and their impact on employment, working conditions, professions and skills. We have chosen fours areas for deeper analysis: operations, maintenance, HR Management and work organization as well as customer services including the development of MaaS.

We are convinced that it is of utmost importance that both social partners at all levels contribute to shaping this digital future. This process needs to be managed and planned. We agree that the process must be inclusive and participatory from the very beginning to better anticipate, prepare and manage digital transformation. This process should guarantee a 'just transition' and that 'nobody is left behind'. This is key for a successful digital transformation that benefits all, public transport passengers, employees and companies.

This study is delivering a good overview and background information and is basis for our negotiations of joint recommendations to the social partners and our policy recommendations to political decision makers and competent authorities.

We strongly invite you read the study.

We thank our project partner EVA Academy, the authors from WPM Consult and all European trade union representatives and representatives of UPT companies and associations who actively participated in the project. We also thank the European Commission for the financial support, without which this project would not have taken place.

Susanne Gällhagen
President of the ETF Urban Public Transport Committee

Thomas Avanzata
UITP Senior Director Europe


© AntonioGuillem / istockphoto.com

1. Introduction

This report summarises results of a study that was elaborated to support the joint project of UITP and ETF that started in February 2019. The findings provided in this report are based on desk research and the evaluation of a broad range of information on the digital transformation of urban public transport and the role of social dialogue in this context.

Most of the practice examples described in this report were identified and presented by the two European social partners and their national member organisations, i.e. urban public transport companies and trade union representatives at national level. While the practice examples illustrate that the application of new technologies and digitalisation is a major general trend in urban public transport, they also show that the role of social dialogue in terms of information, consultation, workers participation and collective bargaining differs between countries.

However, the ETF/UITP project strongly was driven by the joint understanding of all partners and stakeholders involved that the digital transformation in urban public transport is not an end in itself but a means to improve the quality and efficiency of public services for customers and a means for improving the working conditions of urban public transport workers. Furthermore, and irrespective of the fact that national and company social dialogue has many different shades the project was driven by the strong belief that social dialogue is important to master the digital transformation process in urban public transport to minimise risks and creates benefits for public transport providers, their employees as well as customers and the public good.

Urban Public Transport and the COVID-19 pandemic

The COVID-19 pandemic has hit the urban public transport in an unpreceded way. Companies throughout Europe were affected with a dramatic slump in revenues due to the widespread lockdown since mid-March. Within just days and weeks since mid-March, passenger numbers dropped by up to 90 percent. Nevertheless, most urban public transport providers maintained a high level or service in order to maintain public transport as a critical infrastructure and a key player of public service.

For employees the crisis has resulted in increased economic, health related and psychological uncertainty. In a moment of emergency and with unprepared companies and workers representatives for this situation public transport workers showed commitment and ensured continuity of the service. Experience increased and new work strains due to additional shifts, frequent changes in staff schedules and rosters and new requirements as regards health and safety as well as security were introduced. It should also be considered that many urban transport employees are amongst the risk groups due to their age.

It is very likely that the "new normality" of urban public transport will look quite different to the pre-crisis situation as regards hygiene and safety requirements, social distancing and emergency prevention. It also is likely that the current crisis will foster digitalisation, i.e. more digital interaction between traffic management and customers as well as communication and collaboration within companies, new features in mobility apps, gathering of passenger data, etc.

Sources: UITP website (https://www.uitp.org/public-transport-and-covid-19), ETF website (https://www.etf-europe.org/activity/covid-19/)

Digitalisation[1] is a major trend in business and everyday life. It refers to the adoption or increase in use of digital or computer technology by a company, industry or country. It is the use of digital technologies to improve processes, lower costs and gain productivity (e.g. operation and maintenance) and to establish new business models providing new revenue, and value-producing opportunities; it is the process of moving to a digital business.

Figure 1: Different stages of digitalisation in urban public transport

Source: wmp, based on United Nations (2014): E-government survey 2014: E-government for the future we want. https://publicadministration.un.org/publications/content/PDFs/UN%20E-Government%20Survey%202014.pdf. See also: Deloitte (2015): Transport in the digital age. Disruptive trends for smart mobility. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/bps/deloitte-uk-transport-digital-age.pdf.

1 According to the Oxford English Dictionary, digitalisation refers to the adoption or increase in use of digital or computer technology by an organisation, industry, country and so on. In other words, it is the use of digital technologies to improve processes, lower costs and gain productivity (e.g. operation and maintenance) and to establish new business models providing new revenue, and value-producing opportunities; it is the process of moving to a digital business. For a comprehensive discussion of the term 'digitalisation', also in contrast to 'digitisation', see: Brennen et. al. (2014): Digitalization and Digitization

As regards digitalisation and the digital transformation of our societies and the economy, we are in the middle of a major change process that shapes all production and service sectors. As highlighted in existing research, digitalisation is related to opportunities and risks regarding its impacts on business models, service quality, employment and working conditions.[2]

Fully integrated and intelligent transport

- multimodal transportation systems and Integrated, intermodal journey planners
- full automation
- cognitive technology: "thinking" vehicles
- self-reparing stock
- generalised open data use,
- pay as you travel
- general use of automated cars communicating with the infrastructure and each other
- cognitive technology
- full integration of transport modes
- dynamic pricing and variable route choices for passengers based on freely-shared, real-time information
- interlocking in the cloud
- algorithms for preventive fault analysis
- asset information systems and and network technology for condition monitoring in maintenance

In the field of urban public transport, digitalisation and digital transformation processes are already in full swing, consisting of the adoption of new digital technologies and processes in all spheres of transport from infrastructure and vehicles to customer relations and the development of new digital-based services and business areas. Digitalisation has potentially a significant effect on employment, skill and competence needs and working conditions.

According to a report of UITP[3], digitalisation for urban public transport companies is related to opportunities and challenges as well as characterised by significant disparities between companies and countries (see also figure 1 below): As some companies rethink their business segments in order to take advantage of new opportunities, others are "struggling to keep pace". Besides opportunities to increase efficiency and improve quality, lower costs, improve customer services and open up new services and revenue streams, digitalisation also brings a number of challenges according to UITP. These for example are related to customers' digital abilities, the need to leave nobody behind and avoid digital divides. As digitalisation is about big data, challenges are also related to issues of securing the privacy of personal data of customers as well as workers. As a critical public service, cybersecurity, data control and ownership of urban public transport companies is also a very important issue and might become a challenge.

In relation to the impact of digitalisation on employment and work in urban public transport, opportunities and risks of digitalisation are very evident:

For example, automated driving and operations directly effects the largest staff group in urban public transport, drivers. Though the risk of existing jobs being substituted by machines seems rather low (also against the background of demographic change and significant recruitment problems in some areas), some tasks already today are highly automated having a significant impact on task contents and skills requirements.

Automation may result in less strenuous, monotonous, dirty or dangerous work but it may also result in an increase in work intensity and task overload. At the same time, all job profiles in urban public transport will change significantly with new task and occupa-

2 On opportunities and risks of digitalisation see for example: Fernández-Macías, E. (2018): Automa-tion, digitisation and platforms: Implications for work and employment; Degryse, C. (2016): Digitali-sation of the economy and its impact on the labour markets; ECD (2019): Going Digital. Shaping Policies, Improving Lives; Zuboff, S. (2019): The Age of Surveillance Capitalism.

3 UITP (2017): Digitalisation in Public Transport, Brussels.

tional profiles emerging and become more important. Thus, there is a need to invest in the adjustment of skills and competences. Above that, digitalisation and the rapid change of technologies and digital tools require a constant motivation of workers to learn and for up- and reskilling.

Objectives of the project and the study

Against this background, it is of crucial importance that any digitalisation strategy and the digital transformation process in urban public transport is designed and deployed in a way that involves workers and their interest representation in a pro-active way, as early as possible and in a trustful and transparent manner.

The joint UITP and ETF project is illustrating such an approach. The project has been the first attempt to take stock of gathering good practice examples of joint social partners' practices at company and sector level. Such practices haven been driven by the aim to manage the digital transformation process in a way that is human-centred, i.e. aiming at creating win-win-situations for urban public transport providers and their staff with the strong joint commitment to reinforce the quality of working conditions as one of the conditions for good quality of services.[4] Such an approach contrasts to practices of deploying new digital technologies and automation mainly for cost-reasons.

With the project, the social partners in urban public transport aimed at developing a common strategic approach as regards digitalisation in urban public transport and its future role in urban mobility systems. This approach should also include joint recommendations of ETF and UITP consisting of major principles regarding the introduction of new technologies in the social dialogue.

The research conducted in the context of the project and this report aims to contribute to this joint strategic orientation and approach by delivering empirical evidence on three fields:

- Information about the relevant developments of the digital transformation in the sector in the areas of customer services, operations, maintenance and HR management and work organisation;
- Overview of the expected impact of digital transformation on work, especially on employment, working conditions, tasks and skills and social dialogue;
- Good practice examples of social partners joint practices, initiatives and negotiated solutions to shape the digitalisation process in a way that benefits workers and working conditions and the company.

4 European Commission (2017): Sectoral Social Dialogue Committee Road Transport, Work programme 2018 – 2019.

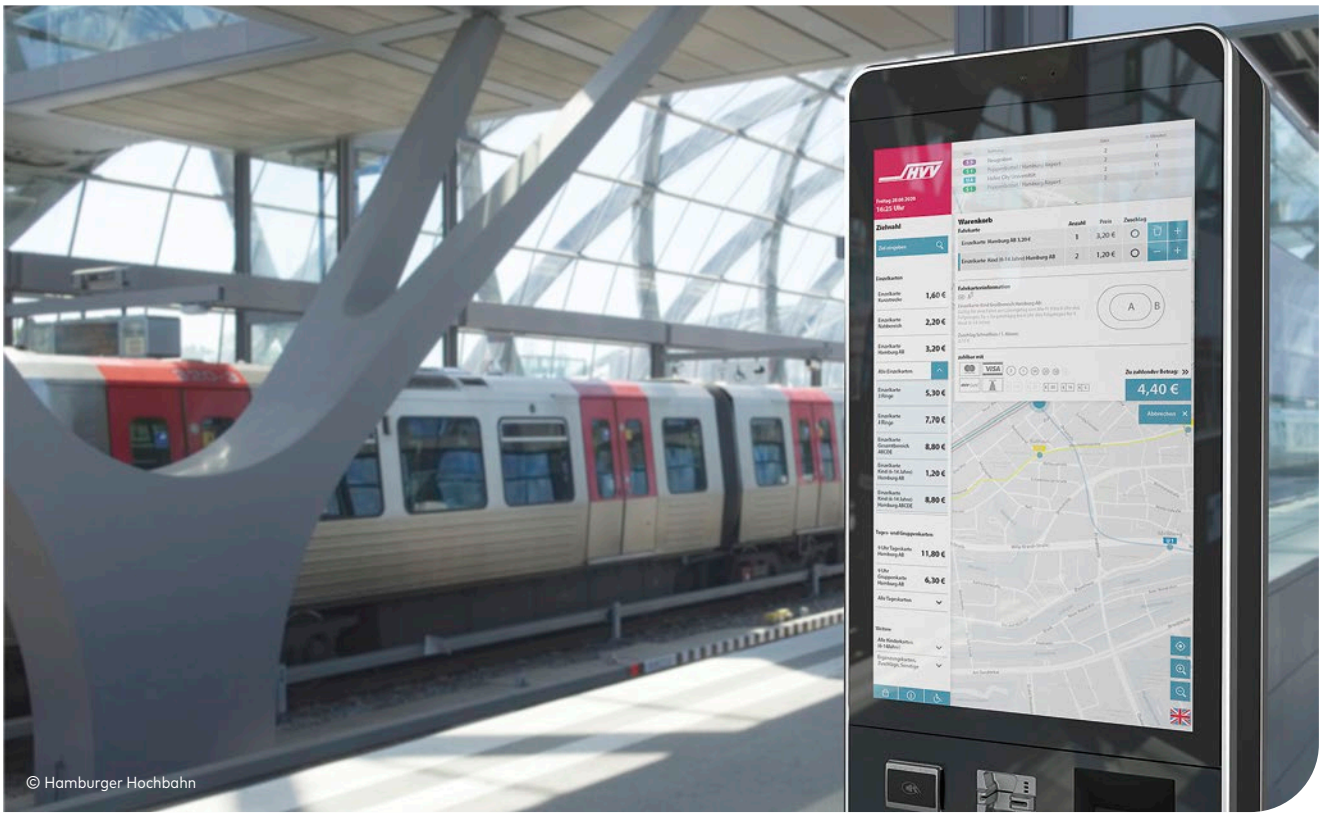
Methodology

Based on a screening of websites and news of urban public transport companies in Europe, an analysis of company and business fair web sites and the examination of trade journals, wmp consult identified around 200 practice examples of digital change from 150 operators in 22 countries. In addition, representatives of companies in 15 countries and trade unions have replied to a questionnaire survey providing insight on digital technologies and innovations causing change in urban public transport as well as their impact on employment, working conditions and task and skills and examples of social dialogue practices. Furthermore, more than 30 in-depth interviews were carried out with company employee and management representatives, trade unions and employer organizations as well as research institutes. The findings are complemented by the results from four workshops held in the framework of the project.[5]

Structure of this report

This report that documents the main results of the study is structured as follows:

Chapter 2 provides an overview of digital change in urban public transport, focussing thereby on the field of operations, maintenance, HR management and work organisation as well as customer services. **Chapter 3** summarises key findings of the project and the study as regards the effects of digitalisation on employment and work. **Chapter 4** presents findings as well as good practice examples of social partners' initiatives and practices of shaping the digital transformation process in urban public transport. The concluding **chapter 5** summarises key finding of the project and highlights major key future challenges the social partners in urban public transport are facing in order to manage and shape the digital change in a successful way, that is as a win-win situation for all involved stakeholders as well as customers.



© Hamburger Hochbahn

5 Workshops with ETF and UITP members took place in Budapest in October 2019 focussing on automation of operations; Paris in November 2019 (maintenance), Barcelona in January 2020 (Human resources) and Vienna in March 2020 (customer services).

© Hamburger Hochbahn

2. Digital change in urban public transport

As highlighted above, a major part of the research carried out in the context of the project consisted of an analysis of relevant developments related to digital change in urban public transport in four key areas: operations, maintenance, human resources management and work organisation as well as customer services.

Based on desk research, interviews with social partners in the sector as well as written contributions and workshop results (presentations of practice examples, working group discussions and other contributions), the research team identified key technologies and drivers of digital change in urban public transport.

These are listed in the figure below and described in more detail in the following sections after a short introduction of artificial intelligence, big data and machine learning that should be regarded as a horizontal key driver of change in all four areas of public transport.

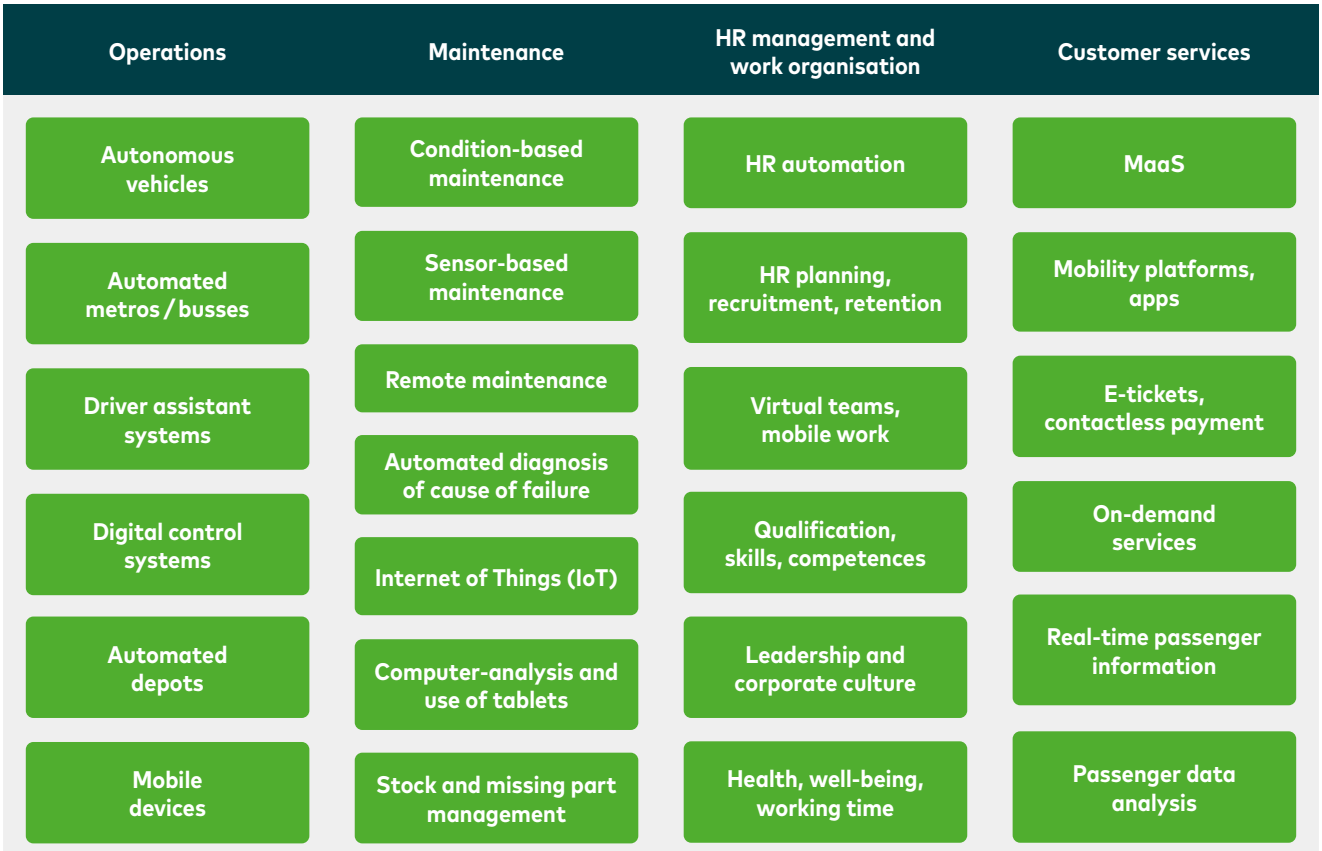


Figure 2: Key technologies and drivers of digitalisation in urban public transport

Source: wmp

Artificial intelligence and its impact on urban public transport

Artificial Intelligence (AI) is an area of computer science that emphasises the creation of intelligent machines that work and react like humans. The use of artificial intelligence is present in all areas of everyday life. Transport is an important field of application and development of AI with examples such as autonomous vehicles that are able to operate without a human driver or assist the driver; unmanned aerial vehicles (flying vehicles capable of operating without a human pilot, known as drones); chatbots (AI systems designed to simulate conversation with human users); and robotic process automation (replicating the actions of a human being by interacting with the user interfaces of other software systems). AI and process automation for example are applied in HR software that supports decision making in the context of screening job applications, selecting employees for promotion or even for firing employees.[6]

A study on AI applications in public transport published at the end of 2018 [7], identified more than a dozen cases of AI application in public transport customer services, operational and engineering processes, safety and security management or in maintenance. Such applications range from digital assistance that support or substitute service staff, chatbots that answer customer queries or staff-support systems in call centres. Using natural language processing and pattern recognition, the AI-driven software analyses customers' queries to call centre agents and automatically displays relevant information on the agents' screen.

The study describes practice examples such as at the RATP Group where an AI-based process was developed that produces automatic origin-destination surveys and monthly reporting, enabling staff to focus on network planning and congestion management matters supported by advanced information. And in Hangzhou (China), civil servants adopted a control system powered with facial recognition and deep learning technologies that provides real-time traffic recommendations and corrective measures to reduce congestion and optimise responses in case of incidents or disruptions.

According to the study, current AI applications in public transport have not been deployed with the intention to replace existing staff but to *"removing many of the repetitive low-skilled tasks and increasing proficiency in data-driven decision-making"*.[8]

6 According to the U.S. IT Magazine VERGE, in Summer 2019, 300 Amazon employees in Baltimore were dismissed because they did not match productivity targets. Both the productivity targets and the identification of the employees were done by AI. See also: Schildt, H. (2017): Big data and organizational design – the brave new world of algorithmic management and computer augmented transparency.

7 UITP (2019): Artificial Intelligence in Mass Public Transport. UITP Asia Pacific Centre for Transport Excellence (CTE).

8 UITP (2018): The Public Transport Workforce in the Artificial Intelligence Era.

2.1 Digital change in operations

In operations, several important technological developments have been identified. Of great importance are the developments closely linked to artificial intelligence and big data such as in driver assistance systems, automatic and autonomous driving vehicles as well as the related digitalised (traffic) control systems.

Driver assistance systems (also DAS) are used in buses, subways and light rail. The functions of driver assistance systems are manifold. Often safety is at the top of the list of reasons why public transport companies introduce it. Intelligent Speed Adaption (ISA) prevents over-speeding and advanced braking systems improve stopping accuracy at stations. These systems are available in different versions: While informative or advisory Intelligent Speed Adaption gives the driver feedback through a visual or audio signal, a mandatory system of Intelligent Speed Adaption prevents any speeding, for example, by reducing fuel injection or creating upward pressure on the accelerator pedal. Obstacle and collision, blind spot and lane departure warnings are another way to reduce accidents. Seat belt reminders are a common feature in busses. Alcohol ignition interlock systems also fall into the category of driver assistance systems. They are automatic control systems designed to prevent driving with excess alcohol by requiring the driver to blow into an in-vehicle breathalyser before starting the ignition.

Driver assistance systems can also be related to ecologically friendly driving supported by a board computer. Acceptance of these systems can be improved with underlying incentive systems. For example, Bogestra (Bochum-Gelsenkirchener Straßenbahnen AG, Germany) has developed a traffic light system for energy-efficient driving, where the driver who drives the most energy-efficiently gets a bonus. The premium system is financed through a reduction in fuel costs due to eco-friendly driving.

However, it was also noted that driver assistance systems must be adapted to the needs of drivers and a special emphasis should be placed on ensuring the efficiency of human machine interface. If not designed properly, a system could confuse drivers instead of supporting them. Furthermore, as these systems collect data on performance, the use of these data should be subject of social dialogue in the company since they have the potential for being used to monitor and discipline drivers.

Practice example: Driver Assistance Systems – Safety by Transport for London

Confronted with the situation that more and more pedestrians, cyclists and other road users use the roads in London, which leads to increasing safety problems, Transport for London (TfL) developed a concept improving the safety of buses for other road users. The underlying concept is the "London's Vision Zero for Buses", which aims at reducing the number of people killed in, or by, London buses to zero by 2030. This concept was followed by a comprehensive Bus Safety Programme, which includes driver assistance systems such as Intelligent Speed Adaptation, automatic braking and audible warning systems as well as measures such as new mirrors and cameras to improve the driver's vision. The programme includes voluntary and mandatory components. For example, with regard to Intelligent Speed Adaption, which has been in operation since 2015, the system cannot be switched off by drivers but automatically reduces speed using a London Digital Speed Limit Map and iBusGPS signal. The "Mobileye" was also developed from the project's innovation fund. It contains the following components: forward collision warning, pedestrian and cyclist collision warning, lane departure warning, following time monitoring and warning as well as a speed limit indicator. The Mobileye has led to a 26% reduction in collisions and 25% reduction in injuries between 2017 and 2018. Advanced Emergency Braking (AEB) is supposed to be mandatory for London Buses starting in 2024.

Source: Presentation by Transport for London (TfL), project workshop Budapest, 03/04 October 2019.

Not necessarily part of a Driver Assistance System, but rather a driver assistance tool, is the provision of **tablets or other mobile devices** for driving personnel. The devices are mainly aimed at enhancing communication and information. They allow drivers to communicate without involving dispatchers or control centres and to be up to date with relevant timetable data and recent changes about routes. Being up to date and well informed thorough these mobile devices is seen as a great advantage by drivers compared with the past. There were cases where passengers in public transport were more quickly and better informed of changes and disruptions, e.g. via company apps, than the drivers themselves. Mobile devices can also include technologies for ticket issuing. Furthermore, these devices can also be used for shift scheduling or holiday applications. Some of these devices may also be used privately whereby the risk exists that boundaries between private and working life are blurring.

Automatic and autonomous driving vehicles are available in the area of **automated metros** and autonomous driving minibuses. Automation of metros refers to the process by which responsibility for the operation management of trains is transferred from the driver to the digital train control system. This covers the operation of the train, starting-up and stopping, closing the doors and dealing with breakdowns and other malfunctions. Depending on which of these processes are performed automatically or by the driver, four levels of automation (Grade of Automation, GoA) can be distinguished. Automated or semi-automated metros have been established in several European cities in various countries, with the oldest lines in Paris dating back more than 20 years.[9] Driverless metro systems are quite common when entirely new lines are being constructed. Converting an existing line to a fully automated line is, however, rather cost-intensive and therefore rare.

There are several advantages of automated metros.[10] There is an increase in transport capacity due to shorter intervals and higher operational flexibility by real-time adaptation to increasing or decreasing passenger volumes. Furthermore, punctuality and safety improve. Cost and energy efficiency also increase as, for example, information about the route (gradients, curves, speed limits) are taken into account in speed calculations. None of the operators participating in this study mentioned that passengers had acceptance problems. At least during the introductory phase, however, on-board staff in the form of stewards (often former drivers) travelled in the automated metro. In semi-automated metros stewards are still on-board and carry out tasks, e.g. when a system is not working. No job losses as a result of autonomous metros could be identified in the urban public transport providers investigated. However, in the long term the question arises as to whether automated metros will make drivers redundant. In addition, drivers from a classical driving operation background, who in the process of digitalisation are transferred to jobs in customer services or security, need a rather different set of skills and competences. Therefore, and in order to avoid frustration and demotivation, job transfer in the context of vehicle automation needs to be well planned and framed by social dialogue and agreements between employee representatives/trade unions and the transport provider.

In fully automatic operation platforms, railways and vehicles must be equipped with various technical components such as signalling technology and sensors for data collection along the tracks. Train spacing is seen as a core piece of information for automated metros. Here Communication Based Train Control (CBTC) exchanges information between driverless trains and guarantees a constant state of mutual exchange between the trains and control centres, which communicate the exact position, speed, travel direction and braking distance. Automatic Train Protection (ATP) vehicle technology then calculates train distances and controls speeds accordingly via an Automatic Train Control (ATO) that allows for autonomous driving.

9 UITP (2019): World report on metro automation 2018. Statistics Brief.

10 Malla Castells, R. (2011): Automated metro operation: greater capacity and safer, more efficient transport. Powell, J. et al. (2016): Potential Benefits and Obstacles of Implementing Driverless Train Operation on the Tyne and Wear Metro: A Simulation Exercise. UITP (2019): The benefits of full metro automation. Knowledge brief, Brussels.

Digital control systems, also called Intermodal Transport Control Systems (ITCS), are used not only in automated metros but are also quite common in buses and other areas. By allowing the determination of the exact positions of vehicles, control centres can react to any schedule deviation of the vehicle quite quickly. In case of an incident, buses and trains may be rerouted and congestion prevented. Buses are usually followed by GPS but other systems rely on screens and cameras. An adaptive traffic control system (ATCS) is a self-calibrating control solution that automatically adapts the timing of, for example a traffic light, to solve traffic congestion problems and improve traffic flows, allowing buses to be on time. Examples of digital control systems can be found throughout urban public transport companies in Europe.

With the automation of metro lines and digital control systems, the question of accountability and liability arises. Examples from our study show that the division of responsibilities between the individual employees and the digitalised systems that run autonomous processes has not yet been clarified in all cases.

As regards **autonomous vehicles** there are examples for autonomous shuttle service in pilot projects in several cities and on private sites. Autonomous shuttle service closes existing gaps in public transport by connecting poorly developed areas or by providing a 24/7 supplement to existing urban public transport. However, so far autonomous shuttle services mostly have a restricted capacity, and the speed and role of autonomous vehicles in road passenger transport is still limited in Europe.

A special field of application of autonomous driving and assisting bus drivers' tasks by means of advanced driving assistance systems are automatic depot management and automated bus depots, where buses are automatically parked.

Practice example: Fully and semi-automated metros Communication Based Train Control (CBTC) at Budapest Transport Ltd. (BKV)

Budapest Metro is operated by Budapest Transport Ltd. (BKV) and owned by the Municipality of Budapest. The transport manager is Budapesti Közlekedési Központ (BKK Zrt.), which, however, only has limited ownership rights. Line 1 of Budapest Metro is the oldest underground railway in continental Europe. 60 % of public transport in the city is covered by metros. The system currently has four metro lines. Line 2, which first opened in 1970, became partly automated (Grade of Automation 3) in 2013 (there is a supervisor monitoring the train in the cab). Line 4, introduced in 2014, is a new fully automated line (Grade of Automation 4) and runs unattended. In regard to line 4, driving and stopping the train, opening and closing the doors and stopping immediately at a safe location in the event of an incident works automatically. In both cases it took two years to complete the extensive testing periods and to obtain the licenses of operation. The core of the system is the Communication Based Train Control system "Trainguard" from Siemens. The system uses a "moving block" control system, where the protected section for each train is a "block" that moves with and trails behind it, and provides continuous communication of the train's exact position, allowing shortening intervals between trains. The Siemens signalling allows for up to of 30 trains/h. Services run at 2 to 3 min headways in peak times, and at 5 min to 10 min in off-peak hours.

Source: Presentation by Budapesti Közlekedési Központ (BKK Zrt.), project workshop Budapest, 03/04 October 2019.

Practice example: Autonomous Road Vehicles Transdev (France)

Transdev is currently operating different types of autonomous vehicles. Already in 2005 Transdev had the world's first commercial contract for autonomous shuttle transport service in Rotterdam (Netherlands) with six 2GetThere vehicles operating over a distance of 1.8 km to ferrying passengers between a metro station and business centre. Further contracts - albeit of a temporary nature - followed in France and the USA, for example for shuttling passengers across the sites of companies, during events or between park and ride and tram stations. Increasingly autonomous shuttling services are becoming more complex as they encounter open road and mixed traffic. Between 2017–2019, the RNAL Project (Rouen Normandy Autonomous Lab) was developed at Le Madrillet in Rouen as the first on-demand transport service using autonomous electric vehicles on an open road in Europe. The vehicles run on three loops that are connected to a terminal of the Metropolis tramway. Passengers call autonomous mini-busses in real-time through an app. Transdev sees autonomous driving primarily as an advantage for the safety of customers, a contribution to combating the shortage of bus drivers and improving working conditions of drivers. For example, a night collective transportation service offers time schedule extensions, and with that, greater customer satisfaction without the need for night shifts of bus drivers.

Source: Presentation by Transdev, project workshop Budapest, 03/04 October 2019.

Practice example: Demonstration of a fully autonomous garage – by RATP Group, CEA and IVECO BUS

In 2018, a pilot project for a fully autonomous bus depot was carried out in Paris. The pilot project was co-financed by the European Union in the framework of the research programme "European Bus System of the Future 2 (EBSF 2)" and is the first example of such a depot in Europe. The demonstration is the culmination of a technological research project conducted by RATP Group (as the operator and project leader), the research lab CEA (algorithms for bus localization, navigation control) and the bus manufacturer Iveco Bus. The demonstration was held at the RATP Lagny in the level 3 basement bus depot to conduct tests of a fully autonomous bus depot under real life conditions. For the test, electric hybrid buses were equipped with sensors and automatic navigation controls for locating positions and obstacles and steering without human intervention. The bus localization was performed with stereoscopic cameras and inertial measurement units, leading to a near centimetric precision and thus to a successful execution of the project. When the autonomous mode is activated, the vehicle drives into the bus depot and parks itself in the spot assigned by the automatic fleet management system.

The goal of automated bus depots is to shorten time for bus parking and to optimise available space in bus depots located in dense urban areas. They also enhance safety and a facilitate work.

Source: Presentation by RATP Group, project workshop Paris, 20/21 November 2019.

2.2 Digital change in maintenance

Digitalisation and new technologies such as sensors, Internet of Things (i.e. the possibility to network physical and virtual objectives and make them work together through information and communication technologies) in combination with big data gathering and analytics as well as machine learning[11] have contributed strongly to a rapid and deep change in the maintenance of vehicles as well as infrastructure in urban public transport.

While sensors have already been in use for about ten years now, data interpretation is becoming easier due to the more recent technological developments and the strongly increased capacity and infrastructure to send large amounts of data in real time. Based on this, asset management is becoming smarter through self-learning systems that can predict failures. As stock is a liability, also stock and missing part management plays an important part in cost reduction. In addition, predictive maintenance is seen as one of the key applications of artificial intelligence in urban public transport and is considered to become a mainstream feature of predictive maintenance applications in the next five years.[12]

Urban public transport companies involved in the ETF/UITP project also reported that digital technologies such as telematics, drones as well as photos taken by operational staff or even customers are increasingly used for detecting incidents, problems at trackside or in stations.

Practice examples: Digitalisation of maintenance at Metro de Madrid and TMB Transports Metropolitans de Barcelona

At *Metro de Madrid,* projects of digitalised maintenance focus on the use of train and equipment information to improve maintenance plans and predict failures and breakdowns. Furthermore, the state of installations and trains is constantly monitored and maintenance in certain cases can be carried out by telematic applications. Metro de Madrid has also started to modernise/automate warehouses and parts management. Also, the company involves customer in detecting and documenting incidences by taking and sending photos to the maintenance department, thereby launching repair processes.

At the public transport provider *TMB Barcelona* predictive maintenance and automated diagnostic is introduced and consists of a broader range of measures such as remote image taking of the device for verifying the position; threshold-related alarms, failure patterns, and trends analysis to provide quality parameters for condition and predictive maintenance and automated diagnose of cause of failure based in machine learning. Further elements include sensor-based interventions; constant measuring tunnel and track temperature, sensor-based monitoring of rail forces and stressed parts (e.g. train doors) and developing a system to digitalise job orders at bus rolling stock workshops.

Source: Desk research and interviews in the context of the project.

11 Generic term for the 'artificial' generation of knowledge from experience that mimics human learning. An artificial intelligence system (a robot or a computer) can be set to learn from examples, interactions and experience and can embed them into its system as general rules after the learning phase has ended. It will then be able to use that information in the future in similar situations. Machine learning is a part of 'artificial intelligence'.

12 UITP Asia-Pacific, Land Transport Authority (2019): Artificial intelligence in mass public transport, Executive summary.

Digitalisation of maintenance according to experts has certain advantages:[13]

- Lower maintenance and life cycle costs – maintenance before failure, but only when needed;
- Reduction of unplanned outages due to damage;
- Higher availability of plants/vehicles;
- Reduced need for asset possession by maintainers;
- Improved system reliability and safety;
- Offering the possibility to monitor closely asset performance, the behaviour over time and efficiency of maintenance activities.

At the same time, the transformation to digitalised maintenance technologies and processes is related to challenges such as high investment costs, significant infrastructure requirements (e.g. related to big data transmission, handling and procession), legal and certification issues (adaptation of existing mandatory inspection activities, legal and regulatory clarification, subsidies and complex tendering processes, risk insurance coverage) as well as organisational issues (e.g. the adjustment of processes, integration into single platforms, etc.).

Due to technological as well as legal and regulatory issues for example, the use of drones in maintenance is not very widespread and will not be extended a lot soon according to interview partners and workshop participants. Also, while there are some tests of 3D printing of spare parts, the cost-benefit relation is not considered to be beneficial, also since often the CAD plans of the components are not available, because the rights lie with the manufacturers. Another challenge is the combination of materials.

However, due to the efficiency gains of digitalised processes, maintenance systems currently are changing from traditional, reactive approaches to digitalised processes that focus much more on actual conditions and predictions of failure and incidents. This is illustrated in the figure below that shows a roadmap of digitalised maintenance as presented by a representative of GVB, the public transport company of Amsterdam in the context of a thematic workshop.

Practice examples: Digitalisation of maintenance at Transdev

At *Transdev*, the French based international private public transport operators with more than 80,000 employees, the digitalisation of maintenance and the development of "connected workshops" is driven by the aim to guaranteeing and improving the safety and availability of the fleet by an anticipatory, digitalised and connected maintenance regime that is expected to provide a clear added-value for the company in terms of service quality, operational efficiency as well as costs.

According to management representatives, digitalisation and the move towards connected workshops has clear advantages for several dimensions: Overall, advantages are related to the reduction of maintenance costs, rationalisation of processes, communication processes between different entities, optimisation of vehicle fleets. Within maintenance, digitalisation and connected workshops and vehicles enable an improved anticipation of as regards resources and equipment needs and activities. Due to the increase in productivity and efficiency in maintenance works, digitalisation also allows for gaining more time for doing higher value-added works and increasing the competence of workers involved. Furthermore, Transdev also regards digitalised maintenance as having positive impacts on customers (increase in security) as well as the environment (paperless processes).

Source: Presentation by Transdev, project workshop Paris, 20/21 November 2019.

13 See for example: Föllinger, O.; Grochowski, M. (2018): Predictive Maintenance. Presentation at the IVU Public Transport User Forum 2018.

As regards the digitalisation of maintenance, it is important to note that according to experts' estimations, classical 'analogue' corrective, interval based as well as conditional maintenance will continue to exist alongside digital maintenance technologies due to constraints in operation and practical considerations.[14]

Therefore, the move towards digitalised maintenance has to be seen as an evolutionary process that is implemented in parallel to the modernisation of fleets and the introduction of new vehicles that will exist alongside older equipment.

In this context experts and company representatives also highlighted that digitalisation of maintenance is not happening in an isolated way but as a part of a broader digitalisation process that includes increasingly connected vehicles, infrastructure and stations equipped with sensors and other digital devices, telematics, CCTV and GPS. Therefore, company representatives have stressed that digitalisation in UPT companies must be regarded as a holistic process that involves the gathering, processing and analysis of a massive amount of digital data and its integration into one single system. As highlighted by one company representative, the merge of different databases and platforms and the development of a generic platforms for infrastructure and fleet maintenance and monitoring is an essential task in this context (see textbox below).

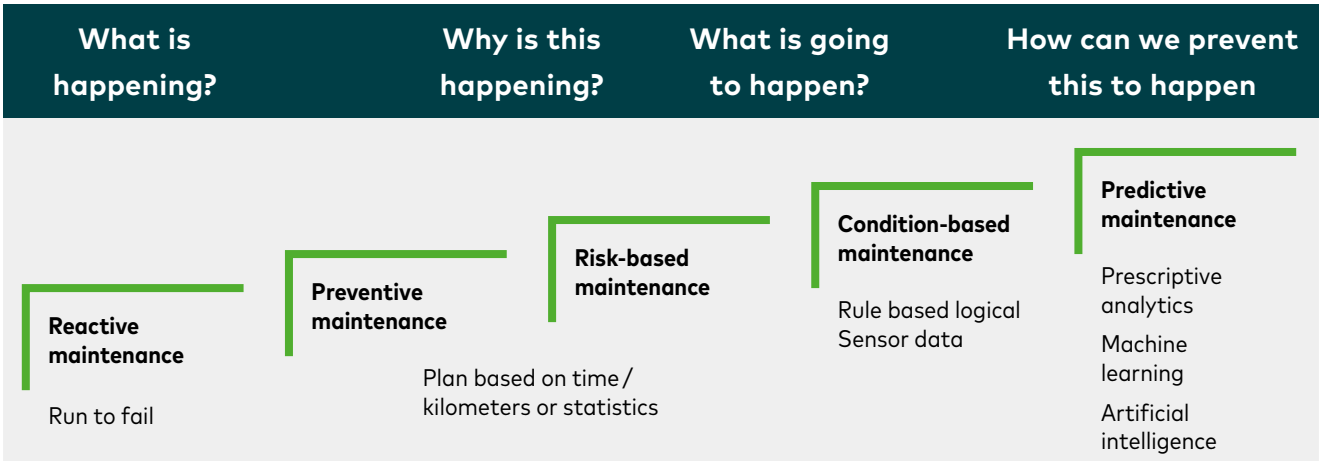


Figure 3: Maintenance Roadmap

Source: Presentation by GVB, project workshop Paris, 20/21 November 2019.

Practice examples: Establishing a generic maintenance platform at GVB

UPT providers currently are relying on vehicle fleets that use very different stages of technologies, ranging from the 1990s to up-do-date digital equipment. From the perspective of maintenance and the transition towards predictive maintenance this is a challenge. At the public transport provider GVB in Amsterdam, the development of a generic platform that combines different systems of vehicles, suppliers and data gathered is regarded as a crucial task that currently (end of 2019) is implemented in cooperation with a major industrial supplier company. The aim is to establish a platform that combines baseline data and information from all vehicles.

Source: Presentation by GVB, project workshop Paris, 20/21 November 2019

14 UITP (2019): Digitalisation and Asset Maintenance.

2.3 Digital change in HR management and work organisation

According to various sources as well as interviews and survey responses in the context of this study, HR management not only is affected by digitalisation but also plays a crucial role for a successful management of the digital transformation of urban public transport companies.

As regards the first challenge, digitalisation and new technologies are affecting HR management in different dimensions, e.g. digitalisation opening new possibilities for process optimisation, standardisation and efficiency for example automatization of issuing certificates or payroll accounting, staff dispatching and rostering, developing shift schedules, holiday planning and other employee related services. Furthermore, digitalisation has opened new recruitment channels and new cooperation partners from the digital economy have emerged that offer new types of services in fields such as recruitment, staff or talent management.

Apart from traditional functions that have to be adjusted in the light of new digital technologies and process automation, HR management is playing a crucial role in handling the human factor in the digital transformation process in urban public transport companies: This for example includes the adjustment of job profiles, the delivery of new training contents, format and methods, managing a rapidly changing workforce, developing new forms of work organisation and collaboration as well as developing and adjusting leadership and corporate culture.

In this context it is important to note that digitalisation entails not only the application of new technologies, automation of processes or the adjustment of job profiles. As highlighted in a recent joint project of the German social partners in public urban transport, digital change processes should be regarded as a comprehensive change and reorganisation process that affects all areas of corporate organisation and culture:

> *"The digital reorganisation (...) not only represents a technical change. Rather, digitalisation requires a profound and sustainable process of organisational development, which needs to be focused on people and their skills. Ideally, this process integrates and incorporates to the same degree the technological change, work organisation, qualification and competence development as well as leadership." 15*

Based on the scientific evaluation of exemplary practice cases, the social partners found that the introduction of digital technologies often is related to high and often too ambitious expectations as regards short-term effects (such as increase in efficiency, leaner work processes, increased customer orientation). At the same time the efforts that are needed for organisational and cultural change are underestimated in most cases. It was also found that the planning of digital change process often is based on overoptimistic plans of implementation that often results in problems as regards achieving targets, quality, time schedules as well as costs. Furthermore, poorly panned and implemented digitalisation processes negatively impact on work organisation and flows, service quality as well as health, motivation and acceptance.

15 ver.di (2020): Checklisten für die Gestaltung des digitalen Wandels im ÖPNV. ÖPNV 4.0 – Den digitalen Wandel der Arbeit sozialpartnerschaftlich gestalten. Vereinte Dienstleistungsgewerkschaft, Landesbezirk NRW, Düsseldorf, p. 5. Translation by authors.

Thus, to avoid frustration on all sides, digitalisation processes require a close cooperation and synchronised practices of different corporate functions and a close collaboration between HR and the highest level of management. At all stages and levels there should also be active information and consultation between management and employee representation bodies and trade unions.

HR planning, recruiting and retention

Digitalisation implies not only the introduction of new technologies but also is related in many companies with the development of new business models and the evolution of new strands of activities that did not exist so far, for example in the field of Mobility as a Service (MaaS).

In order to develop a suitable and efficient personnel planning practice, HR needs to be tied closer to strategic corporate planning functions and departments responsible for innovation. Consequently, this also applies when it comes to implementing a digitalisation strategy. What quantitative and qualitative requirements and needs are emerging for the future provision of personnel in the light of digitalisation and new business activities or mobility services? What are the consequences for recruitment, personnel development and personnel adjustment planning? What do the future deployment concepts in the transport service look like? These and other questions must be answered carefully.

For HR, it is essential to identify the future requirement profiles for the individual groups of employees in close coordination with the respective operational and other departments as well as employee representation bodies such as shop stewards, works councils or trade union committees. This is a huge task and challenge because it is difficult to predict today how technical innovations will change tomorrow's working world. What should be considered when selecting drivers against the background that the job profile is increasingly shaped by new technologies and digital systems and in the longer run might be even fully automated? Shouldn't more attention be paid to whether applicants have skills such as flexibility and willingness to learn, knowing full well that drivers will have to be deployed differently in the company in the future? If so, the screening practice that is used currently for personnel selection needs to be adjusted and developed further. At the same time, in many countries it has become increasingly challenging for urban public transport companies to recruit qualified young talents due to labour shortages as well as increasingly demanding expectations of young generations.

Practice example: HR Transformation at Metro de Madrid

At a workshop in the context of the project, senior HR management representatives of Metro de Madrid highlighted several new functions of human resources management that are becoming important for supporting the digital transformation process. Key words in this context are the following:

- Fostering and supporting cultural change and evolution
- Developing a new working model that is based on collaboration, cost effectiveness/awareness, proximity, innovation, people and pride in the own company
- Raising awareness and accompanying employees in the process of the digital transformation process of the company.

It was also highlighted that HR management itself has changed and that certain norms and orientations have become more important, such as: teambuilding, focussing on success, customer orientation, change orientation, making use of digital tools and technologies, future orientation, supporting people, sharing know-how and knowledge, and commitment.

Source: Presentation by Metro de Madrid, project workshop Barcelona, 16/17 January 2020.

In order to attracting highly qualified specialists on the labour market, companies must make attractive offers, not only in financial terms but also as regards working conditions. In this context, HR managers tend to speak of a change from an employer to an employee driven labour market: It is no longer employees who apply to companies, but employers who apply to employees. If companies want to be among the winners under the changing framework conditions, they need to come up with some ideas to persuade applicants to start and stay with them.

As highlighted not only by trade union representatives in interviews in the context of this study but also by HR managers, attractive working conditions also include the need to offer competitive salary levels and remuneration packages (including social and other benefits). It was highlighted in this context that existing salary and wage systems often do not reflect the expectations of IT professionals. Furthermore, remuneration systems need to be adjusted in the light of digitalisation induced job enrichment as well as devaluation trends in existing operational as well as administrative occupational profiles.

Change of existing jobs, evolution of new job profiles and more flexible and smart work:

Digitalisation in urban public transport results in a growing diversity of professional profiles and jobs: The demand for qualified specialists and experts in established professional fields such as operations, repair workshops and in maintenance, in traffic management centres will still exist in the future with the need to adjust skills and competence requirements in the light of new technologies and processes. Besides, new occupational profiles already have emerged, for example in maintenance planning, mobility services, social media and app development and management, big data analysis, cyber security or climate policy and environmental tasks. Both, adjustment of existing professional profiles and the development of new professions are key tasks of HR, vocational education and training (VET) and labour management departments in close collaboration with sectoral trade unions as well as company level employee representation bodies.

These developments illustrate that securing individual employability is a crucial task, whereby HR Management and training departments need to provide orientation, practical advice and the necessary resources to employees. At the same time an active engagement and take up of staff is crucial. This is particularly important as employability is also becoming more complex and a continuous challenge as a result of the increased speed of change. Thus, the ability to learn, self-learning competences and the development of attractive learning environments becomes another very important task of human resource management. Apart from developing systems and practices of continuing vocational training, the provision of technical skills is not enough but must be complemented by the teaching of social and personal soft skills such as problem-solving competences, networked thinking, etc. Against the background of

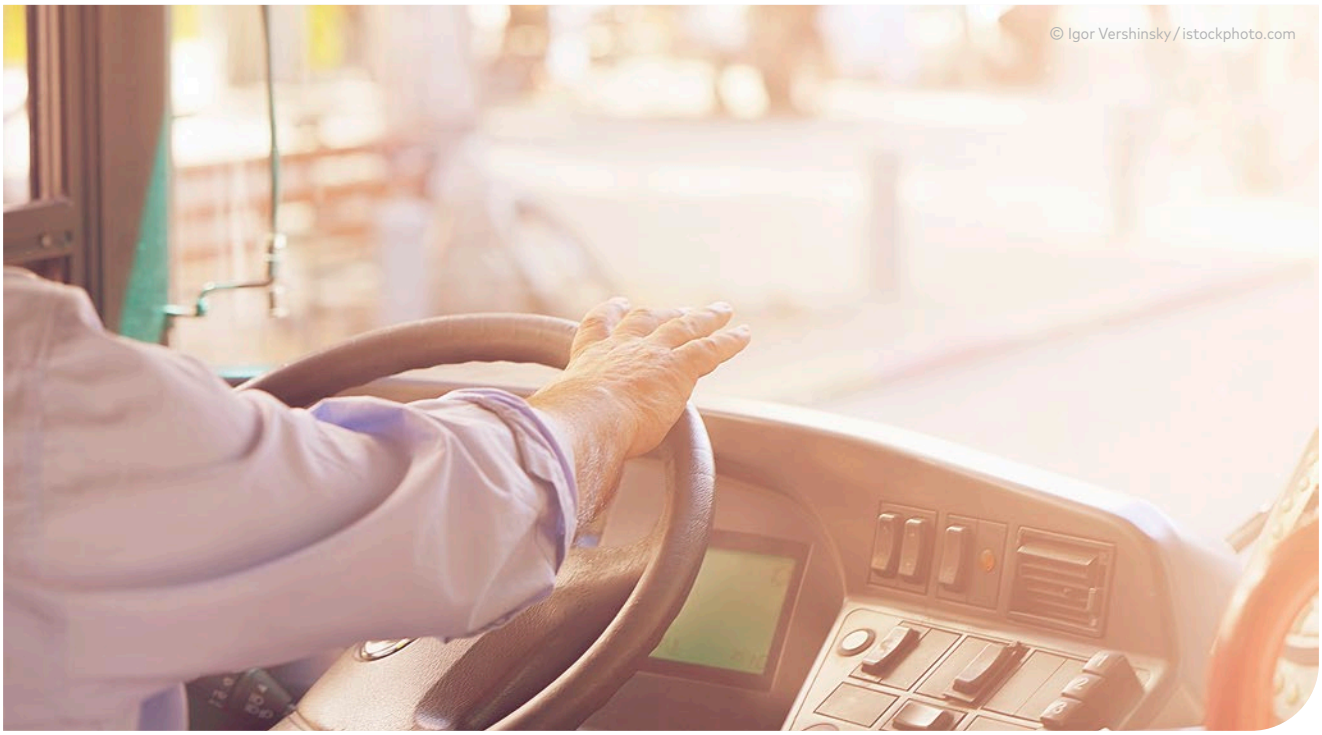
Practice example: Impact of metro automation on job profiles at Metro de Madrid

Ticket sales and customer information has changed already drastically due to digital technologies and tools such as online purchase of tickets, contactless travel cards, new information channels such as apps, social media or the internet.

Based on digitalisation of customer services and in order to avoid making service personnel redundant, Metro de Madrid has developed a comprehensive concept for "Metro Stations 4.0" that also includes new concepts for providing customer support and services. According to this concept, customer service staff, equipped with tablets and mobile phones are moving around (instead of sitting in the ticket office that no longer exists in the new stations) rather than sitting in one place, selling tickets. The occupational profile is characterised by pro-active communication with customers, use of digital tools, multi-lingual capacities (supported by transnational programmes) and multi-modality. Apart from customer care there are also new functions and tasks for the employees in the field of operations, for example an initial diagnostic in case of incidents or the supervision of the station (i.e. the specific physical area of responsibility).

In order to obtain the skills needed for these new tasks, the employee receives training in the use of the tablets and apps installed on it as well as training in customer services as well as on supervisory tasks.

Source: Presentation by Metro de Madrid, project workshop Barcelona, 16/17 January 2020.



labour market shortages training and qualification programmes also need to consider that the workforce in urban public transport companies in terms of age, social, professional and educational background will become more diverse. This results in new needs not only as regard the qualification and competences of teaching/instruction personnel but also training methods and support.

Digitalisation makes it also possible to make work more flexible. It is becoming less and less necessary to work together with team colleagues and/or superiors in the same place and at the same time every day. Teleworking, mobile work, project-related work and networking, including with external experts or platform workers might increasingly shape collaboration in the future. One effect of this emerging development will be that direct communication between employees and between team and manager will decrease. To a much greater extent than today, communication will be technology-based in the future. Many interview partners in this context have referred to the introduction of mobile devices and the introduction of apps or social media-based channels of communication. Against the rapid increase in teleworking, distance collaboration and learning activities in the context of the COVID-19 crisis it is very likely that also in the longer term, teleworking and digital collaboration and learning will remain higher in the future as before the crisis. However, the experience also shows that direct communication and the informal social exchange at the workplace are indispensable as they also contribute to job satisfaction and work motivation.

As highlighted by some interview partners as regards new forms of smart working, also topics such as work intensification and a blurring of work and private life as well as health strains need to be included in the portfolio of further training and qualification measures in companies and should be a subject of the social dialogue. Furthermore, it is important to not only consider administrative, office and project work in the context of digitalisation and smart working but also pay attention to the individual needs of operational staff and professions.

The trend towards individuality must be taken up by learning and training management also. It will be increasingly important to offer tailor-made development measures for all staff groups, including operational staff. Of course, this requires a detailed and professional comparison of current and future competence profiles and job specifications. Instead of standard concepts for all, there is a need for individual, flexible and modular concepts for individual employees that consider not only work-place related requirements but also individual needs, potentials as well as (career) wishes. In this context a clear engagement from the side of the employee is necessary.

While companies already today have introduced video-tutorials, e-learning and online courses in their education, training and qualification courses, e-learning in the future will become an integral part

of the standard programmes of further training. Furthermore, online examinations and computer or social media-based communication and collaboration between learners and with teachers/instructors will become an important part of learning.

Continuous learning and competence development will not only become an important prerequisite for making career progress in the respective companies, but modern and innovative learning systems are also regarded by many HR Directors as an important tool to retain employees and motivate them.

According to primary as well as secondary sources, the digital transformation process requires comprehensive adjustment measures as well as significant investments in terms of personnel as well as financial resources in company based continuing training and qualification systems in order to establish a new learning culture.

Practice example: E-learning and virtual reality

TTS is one of the biggest and oldest private organizers of vocational education in Finland, training approximately 8,000 students a year for a variety of professional occupations, including bus drivers. TTS is financed partly publicly and partly through training tendering by companies and authorities. TTS cooperates a lot with companies, employers' associations and trade unions in developing of training

Engaged heavily also in research and development in the national and international context, TTS is also a leading organisation of developing and applying e-learning modules and programmes as well as integrating virtual reality (VR) elements in training courses. As the biggest bus driver trainer in Finland, TTS in 2019 trained around 1,300 bus drivers, making use of 9 buses, 2 high-end simulators and 12 low-end simulators, of which 6 were equipped with VR tools.

TTS policy on applying digital tools in training is based on the concept of blended learning, i.e. the use of the most appropriate educational mode for the envisaged objectives and outcomes. Educational tools applied besides classical class teaching/learning (whereby the traditional classroom no longer exists) include e-learning, distant learning, self-learning and online self-testing of learning results. New learning technologies such as VR are regularly tested and included.

In a presentation of key lessons learned as regards e-learning, using simulators and implementing VR in learning, TTS has highlighted the following:

- Education departments should be aware that the development of e-learning and digital training courses require significant investments related much more to the development of contents and software than to the purchase of the required hardware;
- The role of the trainer changes significantly with trainers becoming much more a coach than a traditional trainer;
- As regards VR use in training, tests with different groups show that the use of VR in combination of self-learning and self-determined learning speed can result in better learning outcomes than traditional, instructor-based learning;
- Thus, independent e-learning and the usage of new learning technology such as VR can save valuable time for vocational education and training (VET) departments, allowing trainers to focus on those trainees who need more assistance and guidance as others.

Source: Presentation by TTS Työtehoseura, project workshop Barcelona, 16/17 January 2020.

Leadership and corporate culture

In terms of work organisation and management styles, digitalisation is closely linked to flat hierarchies, virtual teams, mobile work and the expansion of network structures. This often collides with existing management and corporate cultures in public transport companies and the need to adjust and introduce "cultural changes". According to experts, "virtual leadership" as well as "leadership at a distance" will play an increasingly important role. Furthermore, it was highlighted by interview partners that this implies also a transition from control orientated leadership to stronger results orientated leadership.

Managers must act less as commanding superiors, but rather see themselves as a companion, coach and guide for employees. An increasingly important management task will be to give employees the necessary degree of freedom and to promote independent thinking and acting. At the same time, managers must ensure that they support and guide employees on their way into the new working world. This also implies that managers have a high level of sensitivity to possible overload and stress situations.

Managers also play an important role in securing and developing the employability of employees. Here, the middle management and direct supervisors, are playing a crucial role because they are closer to the employees than the HR department and are therefore better able to get an idea of strengths and weaknesses of individual employees. Apart from these roles, managers as well as HR management play an important role in providing guidance and orientation for employees in general in the context of the digital transformation process.

Digitalisation and technological change for many incumbent employees is a source of feeling insecure about the future of the own position and role in the company. Managers play an important role as regards clarifying the current and future relevance of jobs and profiles, positions and roles in the context of corporate transition strategies.

Thus, from the perspective of managing the HR dimension of digitalisation, managers at all levels are crucial actors for a successful transformation process. This includes to integrate all employees in the digital journey: While it should be comparatively easy to persuade younger employees with a greater affinity for technology, it is much more difficult with older employees who have worked for years in the same structures and under the same conditions. For older employees, the introduction of digital technologies and processes often is a challenge.

This challenge has been addressed by transport companies for example by projects bringing together "digital natives" and "digital immigrants", i.e. younger workers to share knowledge and experience with older colleagues.

Health, well-being at work and working time

A fundamental goal of health management is to convey to managers and employees that they must be mindful in dealing with their health. In a digital working world, this goal is becoming more important, especially against the background of the blurring boundaries of work and leisure.

In this context, interview partners have referred to the need to rethink current framework conditions and to develop suitable solutions that provide guidance for individual employees.

HR managers have highlighted the need to rethink existing working time regulations that do no longer reflect the reality of work organisation and preferences of many employees. At the same time, trade union representatives have highlighted concerns about a renaissance of excessive and irregular working time regimes in the context of digitalisation and online work.

2.4 Digital change in customer services

As in most other sectors, customer service is an important issue in urban public transport. Often there is a positive relationship between employee satisfaction and customer satisfaction. Good service improves customer satisfaction and is thus directly linked to maintaining and expanding the customer base.

Driven by the expectations of customers who are familiar with digital services from other industries and bring these expectations to public transport, companies in the sector have started to expand their digitalisation in the area of customer service. Services such as **WIFI** and **infotainment** but also **Real-Time Passenger Information (RTPI)** (providing passengers with information about public transport services in "real time" via screens at stops, stations and apps) are aimed at improving customer satisfaction.

In addition to customer expectations, digitalisation in the area of customer service is also driven by other factors. These include cost reduction, cost efficiency and the development of digital technologies, especially by start-up companies operating in this space. Another important driver is the increasing appearance of competitors and alternatives to public transport. Digital mobility platforms and Mobility as a Service (MaaS) are considered to be a game-changer. Various services in the field of transport are related to the new mobility services, including functions such as (complex intermodal) journey planning, booking systems and real-time information, but also on-demand accessibility and mobile data connectivity.

In general, digitalisation in customer service makes access to public transport much easier for users with smartphones or similar digital tools. However, it can have an exclusive effect for passengers with little access to digital equipment, such as some elderlies or socially/materially deprived people. Advantages of digitalisation in customer service are the possibility to offer more – and to a greater extent tailormade – services to customers. One has however to remain attentive to the potential impact of those more tailor-made mobility solutions on employment and working conditions. Above all, the aim is that travellers should be encouraged to choose public transport over private car use; this, in the sector's jargon, is known as modal shift.

Mobility as a Service (hereafter MaaS) is a term used to describe digital transport service platforms **(mobility platforms)** that enable users to access, pay for, and get real-time information on a range of public and private (multimodal) transport options, such as public transport, ride-sharing, car-sharing, bike-sharing, scooter-sharing, taxi, car rental and ride-hailing. MaaS is often seen as an emerging tool to reorganize transport in order to tackle mobility and sustainability challenges via offering an alternative to private vehicle ownership. MaaS connects users/passengers and providers of transportation (MaaS providers) through a service platform which is operated by an integrator. The crucial questions for politics, public authorities and the public transport providers are who the MaaS integrator is, how the platform is governed and how contracts are designed. The role of the integrator can be taken by different actors, such as the public transport authority or public transport operator, but also by a tech firm or actors from the banking or the telecommunications sectors. One challenge is to create fair access for providers of transportation and to regulate MaaS in a public interest perspective. This can be guaranteed, for example, by establishing urban public transport companies as the backbone of the system. Another challenge is also to create a level playing field in terms of working conditions and ensure fair working conditions for all mobility service providers participating in the platform. One possibility could be to only select MaaS partners that comply with minimum working and employment conditions, ideally defined on the basis of a social dialogue. There are some MaaS providers characterised by low wages and other poor working conditions.

Mobility Platforms: Different models according to UITP

UITP identified several MaaS models and actors as integrators. The models differ in their effects on mobility options, transport quality, energy use and modal shift, but also in the number of users. The following overview shows the identified models of MaaS conditions, and their impact on mobility:

MaaS Model 1: Commercial integrator

- Marketplace with agreements between the MaaS provider and transport operators;
- Competition and free, unregulated markets; perceived as providing a customer-oriented and innovative solution;
- Doubts on whether it would be socially inclusive; data would probably not be shared with public authorities, thus unable to improve existing public transport services and planning with data analytics; risk of a bias in the presentation of transport options is perceived as high.

MaaS Model 2: Open back-end platform

- Set up by a public entity with rules determined by the public authority;
- Serves as public infrastructure on which different actors could build a MaaS solution; all mobility providers have to provide access to their data and open up their application programming interface (API's); competition;
- Perceived as offering a customer-oriented, innovative and impartial service; local mobility providers are more likely to be integrated; financing the open back-end platform needs to be addressed.

Maas Model 3: Transport as the integrator

- MaaS run by public transport with selected mobility services; rules set by public transport;
- Other mobility services providers may have to open up their application programming interface (API's);
- Public transport already has the largest customer data base, and is the backbone of sustainable urban mobility;
- Perceived as being able to achieve the highest increase in sustainable mobility, being socially inclusive and best aligned on public policy goals, as data would be shared with public authorities.

Source: UITP (2019): Mobility as a service: report. https://www.uitp.org/sites/default/files/cck-focus-papers-files/Report_MaaS_final.pdf.
UITP (2019): Ready for Maas? Easier mobility for citizens and better data for cities. https://www.uitp.org/sites/default/files/cck-focus-papers-files/Policy%20Brief_MaaS_V3_final_web_0.pdf.

Furthermore, the UITP publications conclude that MaaS means a greater need for collaboration among companies and the necessity for dealing with questions of data access and data rights. Risks that UITP identified include:

- Risk of losing the customer relationship;
- Risk that the MaaS provider will become the gatekeeper;
- Risk of disclosing data and business model to competitors;
- Risk of bias in algorithms or unfair competition.

As a result, the MaaS integrator should follow fair business rules, for example, in regard to terms and conditions for the reselling of the transport services and a non-discriminatory approach towards all mobility service operators. UITP concludes that MaaS can be "a brilliant tool for more sustainable mobility if deployed around mass public transport and active modes."[16] However, it is also clear that public transport must continue to offer a wide range of services, as not all customers benefit from these new solutions.

There are several examples of MaaS offers in Europe designed in different ways – reaching from basic integration (integration of booking and payment and integration of information for journey planning) to advanced integration of the service offer (including contracts and responsibilities in a tailored mobility package). However, they are often still in the introductory phase and are not yet profitable.

For the MaaS system to work and transport modes to be combined, various services in the field of transport that are related to the new mobility services need to be connected. These include functions such as (complex intermodal) journey planning, booking systems and real-time information, but also on-demand accessibility and mobile data connectivity. Service providers may offer to take over these tasks for the public transport companies.

Practice example: Advanced Integrated MaaS – the WienMobil App of Wiener Linien (Austria)

In 2017 the public transport provider Wiener Linien first introduced MaaS. The MaaS concept includes different mobility providers such as public transport, bicycle, car sharing and taxis by 18 partners. The concept uses the app "WienMobil". The mobility app was developed by a subsidiary of Wiener Linien, the start-up "upstream". The app enables journey planning by accessing real-time information – including disruptions and other incidents –reservation and booking of different means of transport. Additional information, such as the price and environmental friendliness of a selected route, completes the results. Furthermore, the app enables users to buy tickets or pay rental providers directly - also taking into account existing public transport tickets (such as annual passes) or memberships with certain car sharing providers.

In 2014 the position of MaaS Mobility Consultants, who provide services to customers, was introduced at Wiener Linien. The Mobility Consultants work in local customer services centres and inform and advise passengers and other interested persons on the city's MaaS concept.

Source: Presentation by Wiener Linien, project workshop Vienna, 4/5 March 2020.

16 UITP (2019): Mobility as a service: report. https://www.uitp.org/sites/default/files/cck-focus-papers-files/Report_MaaS_final.pdf

Practice example: Maas by Transdev – Building a MaaS solution

Transdev offers services for urban public transport companies in the area of designing and operating MaaS solutions. Transdev provides integration services (development of user interface, operational platform, management of data, maintenance and updates) as well as MaaS operation services (general contractor -, partner - and contract management, marketing, customer services and call centre). In spring 2020 Transdev ran four MaaS initiatives and invested in several external initiatives in various cities.

The MaaS concept of Transdev is based on a mobility paradigm that builds on public transport and enables competition, improves safety, efficiency and environmental outcomes and focusses on inclusiveness and accessibility to ensure access for all. Furthermore, it is set up to integrate all modes of local transportation. Important areas of focus for Transdev to achieve the full potential of MaaS are customer service, data collection and analysis, operational efficiency and network design, mobility policy as well as incentives and constraints, contract management, business models and revenue sharing.

Source: Presentation by Transdev, project workshop Vienna, 4/5 March 2020.

MaaS is a new concept. Many market players entered the field recently and responsibilities are not yet defined. At the same time trust plays a very important role. For example, data analytics based on the usage data, including de¬mand data, from the MaaS operation can provide transport operators valuable insight on how to adjust their network or service. Transport operators may feel concerned about disclosing their data, as they see different perceived risks (such as MaaS provider becoming the gatekeeper to all demand and usage data or disclosing the business model to competitors by sharing data). These challenges make fair business rules for Maas integrators and a shared cooperative and trustworthy approach involving all actors important. The involvement of trade unions can ensure that attention is paid to social aspects. A step towards this is to establish a common platform for cooperation and to enhance a certain degree of standardisation.

As the importance and value of data increases, so does the significance of **passenger data analysis.** Software and hardware solutions in passenger data analysis are usually provided by external IT companies. Applications are based on the evaluation of geodata and sensors using Near Field Communication (NFC). Passenger data analysis enables data-driven decision-making and technologies for frequency measurement. The recording of passenger numbers can help to better analyse the impact of increasing numbers of passengers in public transportation.

A further part of customer services is **on-demand transport.** In the past, demand responsive transport mainly focused on less popular regions as a feeder for public transport, or on irregular traffic, for example at airports. Today, however, the concept is seen more broadly: On-demand transportation and seamless mass-transit systems by matching service levels more closely to demand. The benefits are lower operating costs and easier access to transportation. On the other side there can be a social cost in form of more precarious forms of employment and working conditions. Besides on-demand transport by public transport providers or companies cooperating with them, there is increasing competition from third party providers. The reservation of services is done by digital means – so called e-hailing applications via mobile phones or the internet. Providers of on-demand transport are not only public transport companies or members of partnerships with them, but also private providers. The private providers partly rely on workers without fixed-term contracts. Some on-demand services are challenging regarding social conditions, such as precarious work contracts without social security protection or unregulated working time.[17]

17 See Eurofound 2018: Employment and working conditions of selected types of platform work.

Practice example: Setting standards and the integration of new market players – by Koninklijk Nederlands Vervoer (the Royal Dutch Transport Federation, KNV)

KNV, the Royal Dutch Transport Federation (KNV), is the umbrella organization representing commercial passenger transport operators in the Netherlands.

KNV initiated a "Maas Lab" involving numerous companies in the public and private urban transport sector and MaaS providers, among others. The goal of the initiative is to organize the new market players and find a basis for working together. The initiative wants to promote a shared learning experience, scaling effects and professionalism. The participants of the lab are currently involved in seven regional MaaS pilot projects under the direction of the Ministry of Infrastructure and Water Management. The pilot projects are carried out in different regions in the Netherlands, each focusing on a different objective, such as improving the accessibility of the region, improving the use of urban space or better and cheaper transport. All projects are subject to a framework agreement which stipulates, for example, that public transport be in the centre of the approach. Another aim in cooperation with other Benelux countries is to develop a certain degree of standardisation. The standardisation can cover, for example, the aspects of operator information, planning, booking, trip execution, payment and support. Furthermore, an open data system for MaaS is to be developed.

Source: Presentation by Koninklijk Nederlands Vervoer, project workshop Vienna, 4/5 March 2020.

Practice example: Digital customer communication – video travel centres of Deutsche Bahn/DB Vertrieb (Germany)

In 2013, Deutsche Bahn with its subsidiary DB Vertrieb introduced its first virtual travel centres, which support customers via video conferencing or video sales. Currently, there are 90 video travel centres in railway stations or video ticket machines in ten German federal states, and further expansion is planned. Customers can activate a video chat at the terminals by pushing a button and become connected to an employee at one of the seven video centres in Germany. The employee of the video centres appears on screen and can give personal advice on planning the journey or buying tickets. The employee also has remote access to the ticket machine and can select the right tickets for the customer. Customers benefit from the fact that personal customer services in ticket sales can be ensured even from smaller stations. Customers also benefit from longer and more consistent business hours. For Deutsche Bahn it became easier to replace personnel when employees were sick or on holidays, and break-related closure of small travel centres can be avoided. At the same time the work in video travel centres comes with certain advantages, such as working time flexibility, making it easier to recruit personnel.

Source: Presentation by Deutsche Bahn, project workshop Vienna, 4/5 March 2020.

The area of ticketing can look back on a history of automation. In the past, most ticket offices had already been closed and replaced by ticket vending machines. Thus, the newly introduced virtual tickets further reduce the need for ticket offices (and ticket machines). Virtual tickets in the form of plastic traveller cards (also called smart cards) are relatively widespread in the sector and ticket-apps or mobile ticketing (tickets via mobile phones) are becoming more important. Contactless payment offers are very widespread among public transport companies. So far, however, plastic traveller cards or apps are largely offered in addition to rather than replacing traditional paper tickets. The main advantages of visual tickets for the public transport companies is reduced costs. Another positive cost factor is that virtual tickets can be easily modified. Apps and systems for mobile ticketing are mostly made by large vendors (e. g. Infineon), whereas in-house developments in public transport companies are rare. The newest innovation is a ticketing system that detects if a passenger is on board a public transportation vehicle. The passenger can activate an app on their cell phone when entering a public transportation vehicle and is billed automatically upon exit. Hamburg is currently testing such a ticketing system under the name "Check-In/Be-Out".

Customer communication is a cross-sectional topic in areas of customer services and another point of focus of the digitalisation efforts of public transport companies. Digital developments in customer communication include, for example, the presence of transport companies in social media, but also focus on the expansion of communication channels. The number of contacts via e-mail is generally increasing, and communication via WhatsApp is also widespread. Representatives of the companies emphasize the fact that the new communication channels are positively perceived by the customers. However, as customer interaction takes place more often outside formal structures, guidelines for employees are necessary to create a uniform response. This might create a challenge where customer communication was outsourced in the past. Some urban public transport providers, such as Metro de Madrid, use apps for interaction with passengers. Metro de Madrid also uses this app to learn about disturbances in the operating process and issues regarding the condition of vehicles. In general, public transport providers still emphasis the need for personal contacts in customer communication, even though these might not be face-to-face.

© Sebastien Durand / shutterstock.com

3. Effects of digital change on employment and work

In this chapter the effects of digitalisation on employment, working conditions and tasks and skills are analysed. Hereby, we focus very much on evidence and experiences that have been gathered in the context of the analysis of the three focus areas of research, i.e. operations, maintenance and customer services.

3.1 Effects on employment: Change of job profiles rather than substitution

The most important question regarding employment is whether there are (or will) be job losses in the urban public transport sector due to digitalisation and automation.

Popular fears that new technologies and automation may make labour redundant in an increasing number of occupations have been fueled by studies, which for example have claimed that up to half of U.S. jobs are automatable within the next two decades.[18] However, as other research and analyses have shown, such occupation-level studies severely overestimate automation potentials, because they neglect that workers already adjust their tasks to new technologies at the job level.[19] More recent studies such as a report of the EU Commission's High Level Group on the impact of the digital transformation on EU labour markets[20] come to the conclusion that automation and digitalisation do not necessarily lead to net employment losses but rather impact differently on middle-skilled routine work that face the risk of automation. Thus, digitalisation is leading to job polarisation: routine face the risk of automation, while digitalisation augments the productivity of the most skilled jobs and the least-skilled jobs survive because they cannot be automated nor greatly benefit from new technologies. A further effect that was highlighted by the High Level Group as well as other studies is that digitalisation is likely to foster the trend of increasing diversity of work arrangements, not only by the emergence of new forms of employment such as platform work but by fostering more flexible forms of work such as teleworking or mobile work.[21]

A recent comprehensive study on the impact of digitalisation on employment in transport sectors carried out an analysis for road, rail, aviation and maritime up to 2040.[22] One of its main conclusions is that the introduction of automation will not be revolutionary but an evolution, and that in many areas it will not lead to a reduction of workforce but a shift among functions.

18 Most prominently here are the studies of Fry and Osborne. See: Frey, C. and Osborne, M. (2017): The future of employment: How susceptible are jobs to computerisation?

19 See for example: Arntz, M. et al. (2016): The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis.

20 European Commission (2019): Report of the high-level group on the impact of the digital transformation on EU labour markets.

21 See for example: Eurofound and ILO (2017): Working anytime, anywhere: The effects on the world of work.

22 World Maritime University (2019): Transport 2040: Automation, technology, employment – the future of work.

For rail, digitalisation is expected to have the following impacts in the type of work undertaken by rail employees:

- As automation advances, the need for train drivers will not disappear but this occupation will evolve into a "vehicle and service agent".
- Maintenance will have higher emphasis on continuous monitoring and prevention, possibly from remote locations. Robots are expected to assist in specialised tasks.
- Customer services will be impacted, as personalised applications will become standard.
- New services will facilitate intermodal connections.

As regards **operations,** reports by companies involved in the project as well as workshop contributions have indicated that automation and digitalisation have not (yet) led to job losses. This also is due to active recruitment of drivers in the context of urban public transport expansion as reported by company and trade union representatives in countries such as Finland, Denmark and Germany. In Copenhagen for example, even though the introduction of a driverless metro led to the closure of some bus lines, there were no redundancies as in general there is a lack of bus drivers.

Examples from other countries show that automation and digitalisation in urban public transport has not substituted drivers' jobs in operations but led to significant change in occupational profiles and job contents. In Hungary and France new roles and functions have been created (e.g. former drivers changed their jobs to supervision and piloting of the system). At Metro de Madrid, the prior model of station management foresaw four different functions which are today covered by one function: the station supervisor. A similar scenario was highlighted by TMB in relation to the automation of metro lines as the figure below shows.

As the figure shows, the major impact of digitalisation and automated driving in urban public transport so far has been changes in and mergers of occupational profiles: Drivers take over tasks in areas such as customer care services as well as in the field of infrastructure supervision and monitoring.

As highlighted by a trade union representative at TMB in Spain, the deployment of driverless metro line operates in Barcelona was accompanied by training for workers destined for that line, in order to have access to other jobs, such as control centers. In this way the loss of their work was avoided. With the establishment of more lines without driver (light rail at Barajas Madrid airport), in the future it is evident that there will be other changes, which must be monitored by the Unions to avoid destruction of jobs.[23]

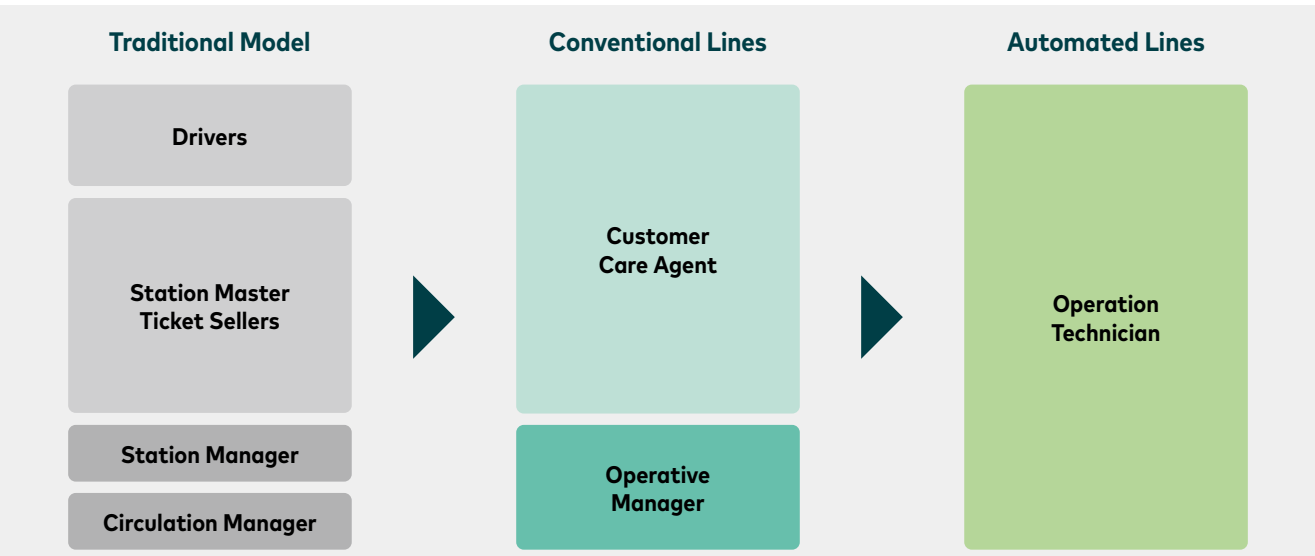


Figure 4: TMB Metro Line Staffing in traditional, conventional and automated lines

Source: Presentation by Transports Metropolitans de Barcelona, project workshop Barcelona, 16/17 January 2020.

23 Interview with a representative of FSC-Carretera, the Federation of Citizens Services of CCOO.

As between 60–80 per cent of employees working in urban public transport are drivers, the question of what will happen to them in case of further automation is of utmost importance.

When examining digitalisation in **customer service,** interviews carried out in the context of the project as well as workshop presentations showed that there is a strong increase in digital tools and processes. Sales processes and back office tasks are increasingly automated and in administrative functions more and more workstreams become digital (SAP, purchase processes, communication). In some companies (e.g. Wiener Linien), there are also tests with chatbots for standardised communication with customers.

Digitalisation of customer service required an increase in employment in IT occupations, which however are affected by skill shortages. This is also one of the reasons why external service providers play such a big role in the digitalisation of customer service. Other occupational groups which are growing were mentioned in connection with data analysis tasks. Against the background of MaaS concepts and passenger data analysis, there is an increasing need for transport planners, engineers, mathematicians, computer scientists and big data analysts. It should be noted here that such new occupational profiles are very much male dominated. This contrasts to the traditional staff profile in customer service that is characterised by a high share of female workers, often on a part-time basis.

Some interview partners and workshop participants noted that the introduction of ticket machines and the introduction of transport cards have caused job losses, primarily among low-qualified workers, most of them women. In the UK it is reported that buses have seen the loss of "clippies" – traditionally female roles for issuing tickets and collecting fares on buses. However, the reduction in the number of ticket vendors did not lead to the dismissal of the relevant employees in all countries studied; there are examples for redeployment agreements that transferred ticket sellers to service jobs in customer information or office positions, in some cases resulting in an improvement of working conditions. Public transport companies indicate that the reduction in the number of ticket sellers is for the most part considered as completed and no major effects are to be expected for the future.

As regards **maintenance,** urban public transport companies report a shortage of skilled workers among mechanics and IT engineers. This development is often met by an increased need for personnel due to raising passenger numbers in public transport. There is also evidence of digitalisation adding new occupational profiles in maintenance. Materials testers are needed for example in checking axes with ultrasonic devices. Before, the axes were often only visually inspected.

Also, maintenance planners were pointed out as a further new job profile in the context of the project.[24] Job contents include the anticipation of staff, skills and workshop needs, monitoring technical performance indicators, overseeing technical budgets, gathering technical data on vehicles and monitoring technical performance indicators and planning of future interventions.

In the future, artificial intelligence (AI) will be able to help reduce the amount of human effort, but today it still requires significant input from competent and experienced personnel.

As highlighted by company and workers representatives, future employment and development is also driven by the need to maintain skills and knowledges in maintenance and repairs of different stages of technology: Urban public transport companies are operating vehicles and manage infrastructures that to large parts still is based on traditional technologies.

Study on the impact of digitalisation on occupational profiles by Union des transports publics et ferroviaires (UTP) (France)

The study of impacts on occupational profiles and the evolution of jobs, trades and skills researches the effects of digitalisation on eight occupational groups, including in safety, maintenance, operations, and marketing. The study comes to the conclusion that some occupations and tasks will disappear due to the digitalisation of tasks (especially in administration due to office automation) or be outsourced to external providers. The report also found that there is an increasing diversification of tasks as new fields of activities emerge and services are becoming more complex (e.g. in IT-systems, passenger relations and contract management). In general, manual labour is decreasing in importance while analytical work, such as data analysis, becomes more important. Furthermore, a specialization in job families that especially concern technical occupations is occurring due to the further development of IT solutions. In addition, the study found an overall increase in the average level of qualifications requirements and of technical and IT skills. It was also noted that customer services and customer information are growing in relevance. For example, customer service skills play an increasing role for drivers.

Source: Union des transports publics et ferroviaires (UTP) (2019): Etude prospective sur l'évolution des emplois, des métiers et des compétences: Rapport complet de l'étude. https://www.utp.fr/note-publication/etude-prospective-sur-levolution-des-emplois-des-metiers-et-des-competences-dans-le.

24 Presentation of Transdev at the workshop on maintenance in Paris, November 2019.

3.2 Effects on tasks and skills

As already highlighted in the previous section on HR management, digitalisation in urban public transport has a significant impact on existing job profiles across all corporate areas. At the same time desk research and results from other studies have shown that companies often underestimate the need to invest in in retraining and re-skilling of existing staff, involving actively vocational education and training (VET) schools and departments as well as social partner organisations and company level employee representation bodies.[25]

With digitalisation tasks and job profiles in **operations** have changed for drivers as well as employees working in control centers. At *TMB Barcelona* with the automated metro the personnel on the train are totally focused on customer services and system availability, being freed from repetitive tasks. The "Operation Technicians" have a high degree of technical knowledge. In Italy, the *ATM Group (Azienda Trasporti Milanesi)* with the automated driverless metro, stewards are now located along the line with customer service tasks and aid recovery systems in case of incidents.

With the automation of the metro, also the skills and competences demanded from control center staff have changed. The control center staffs control train movements, power supply and passenger surveillance, manage stewards, and deal with alarms, among other tasks. With the switch from a traditional to an automated metro the system has changed from a low to a high complexity system. This requires control room operators to carry out multiple tasks and have broader and deeper knowledge and a wider understanding of issues. In this context, IT and technical skills are becoming more important.[26]

Autonomous road transport: Experiences and perceptions of drivers

The University of Applied Sciences, Fresenius conducted projects on the perceptions of professional drivers of autonomous driving. A project on autonomous driving of trucks in cooperation with DB Schenker and MAN used a 2-vehicle platoon, where only the first vehicle was controlled by a driver. The second truck followed the first autonomously and was manned by a platoon driver who was supposed to intervene if necessary. During the test drives on a public highway between two German cities a neurophysiological analysis of the platoon driver was recorded and showed that there were no differences between self-driving and autonomous driving in regard to brain activity, fatigue and stress. Another topic of the study was to research the perception of digitalisation before and after the experiment. The results of the study showed that the acceptance of the technology increased massively after drivers participated in the tests and used the new technology. The analysis showed that previous concerns, such as difficulties in use or safety concerns, decreased very significantly or disappeared entirely. This also holds true for concerns about passing vehicles or the (short) distance between the two platoon trucks (15 m) and fear of hacking. In another project, the university surveyed bus drivers about their perceptions of digitalisation. Again, it was shown that most drivers were initially critical of digitalisation. Drivers saw a core part of their profession as mastering a large vehicle by themselves. If the vehicle drives autonomously, for example, these driving skills are no longer used. The project results therefore point out that it is important to involve employees, to communicate possible scenarios and to highlight which valuable activities remain when other tasks are replaced by technologies. One starting point is to underline positive aspects of the use of new technologies for the employees.

Source: Presentation by Institute für komplexe Systemforschung (University of Applied Sciences, Fresenius), project workshop Budapest, 03/04 October 2019.

25 Degryse, C. (2016): Digitalisation of the economy and its impact on the labour markets.

26 Desk research and interview with FIT-CISL (IT).

In particular employee representatives in the context of the project have highlighted that the deployment of new technologies and digitalisation often neglects the impact on cognitive and soft skills requirements. For example, a trade union representative has highlighted the following experiences in the context of the introduction of automated metro line operation in Budapest: The implementation of digital technologies and processes is a complex task that requires strong coordination and the participation of all relevant stakeholders. However, the necessary changes in the organisational structure were implemented much slower than the introduction of new technologies. This has caused insecurity and resistance both amongst lower management levels as well as in the workforce.

In **maintenance,** digitalisation according to interviews and workshop presentations results in job contents and task changes such as fewer repairs and more anticipation and checking of items before they break. While the process that mechanics work with technical devices has started long ago and has led to a change in job profiles from mechanics to mechatronics technicians, today competences in dealing with electric and hydrogen buses, IoT, analysing sensor data and adaption of maintenance schedules are becoming more important.

For example, at *DB Regio,* due to changes in the train with air conditioning and electronics today almost no locksmiths are needed, but more mechatronics and climate electronics technicians. Both craft and electrical engineering skills are needed. Mechanics are now working a lot more with computers. At *GVB* in Amsterdam, before a bus mechanic had to look what was wrong and then order the parts. Now this is completely automated. Vehicles come in based on a schedule in an approach of predictive fleet maintenance. Mechanics scan their order and receive an automatic signal from the warehouse where they can pick up the parts that already have been sorted for them. When the order is done, a picture and the bar code are scanned and transferred to the SAP system automatically, so it is known which part was replaced.

The digitalisation of **customer service** has led to changes that affect both the tasks and the qualifications of customer service representatives. The IT user knowledge and digital skills of this group has increased greatly. Customer service representatives are contact persons for customer concerns and work in customer service centres and call centres. However, they increasingly answer customer requests via social media using, for example, chats in apps and WhatsApp. Equipped with tablets and other mobile devices customer care officers are also increasingly mobile staff as the example of the Metro de Madrid in section 2.3 shows.

A challenge is that customer inquiries have become much more complex. With the help of apps or the internet, users of public transportation are often able to answer simple questions such as timetable enquiries themselves, leaving only difficult cases for dealing with customer service representatives. In addition, within the framework of MaaS but also in other projects with cooperation partners, customer service representatives are increasingly asked by users to answer questions covering the entire travel chain, focussing on parts outside the influence of the public service provider. In addition, there are inquiries about the technology of smartphones, for example the installation of apps, that often exceed the scope of competence of customer service staff.

3.3 Effects on working conditions

There are certainly a broad range of positive effects of digitalisation on working conditions in urban public transport when implemented with a "just transition" approach, i.e. in close cooperation between management and labour and based on negotiated solutions between the social partners: work becomes cleaner, healthier, less dangerous, less noisy and less pollutive (e.g. in the context of carbon-free drive technology or automated depots). Digitalisation can also facilitate work organisation due to predictable and more transparent work and staffing requirements. Due to the increase in mobile work possibilities, digitalisation may also contribute to a better work-life balance and worker friendly time schedules and rosters.[27]

However, at the same time digitalisation will have negative effects on working conditions if not regulated in a balanced way and implemented poorly: Prominent issues has been "always on working cultures" and increasing blurring boundaries of working and leisure time, increase of precarious forms of work (e.g. zero hours or on-call contracts, temporary part-time work, 'bring your own device' practices, work intensification by new tasks and responsibilities resulting in new psycho-social strains. The increasing "datafication" of the workplace and the massive use of CCTV, GPS and other devices in the context of driver assistance systems also have the potential of being used for surveillance and performance monitoring.

As highlighted by interview partners and workshop participants, in the field of **operations** digital technology might improve working conditions by facilitating tasks, but they also have the potential to cause more stress and increase the workload for employees. Where drivers take over service tasks when metros are automated, working conditions of employees may change positively due to mixed work, continuous services with paid break, recreational periods during service, no permanent sitting and more movement in the service. Facilities such as platform safety systems may increase safety for both passengers and staff. At the same time, increased multi-tasking or moving to service tasks may result in discussion about remuneration and adjustment of wage groups: In case a driver is taking over additional or other tasks in return less driving-related activities is this regarded as up- or downgrading in terms of job contents and demands? In order to avoid risks and a worsening of working conditions, the answer to this question should be developed jointly by management and employee representatives/trade unions.[28]

Driver assistance systems: Potential risks

The "Green Road" driver assistance system is aiming at reducing accidents, lowering costs and maintaining compliance. It is used for example by coach and bus operators in the UK. Settings cannot be changed or adjusted by the transport provider but must be agreed with the provider of the system. The bus company does not control the data including performance data of the bus drivers. While at first it has been designed to improve fuel efficiency, it is now also used to monitor and discipline drivers. If the "score" of a driver is too low, CCTV footage will be looked at (there are up to 11 cameras in one bus).

This example illustrates how important it is to frame and regulate the use of driver assistance systems (as for example in Finland) in order to avoid personal consequences for drivers (including the risk of losing the job) but to support "underperformers" by additional training to improve their abilities.

Source: Interview with Unite trade union, UK.

27 See also UITP (2019): The benefits of full metro automation.

28 In this context, see also the results of the of a multi-annual transnational project led by UITP on the "European Bus System of the Future" (EBSF) that was carried out between 2008 and 2012 and was co-financed by the EU FP7 research programme: https://trimis.ec.europa.eu/project/european-bus-system-future#tab-docs.

Regarding driver's assistance systems, the central question is for what purpose they are used, i.e. whether the system is used for the sole purpose of facilitate driving or whether it is also used to identify drivers that perform below average, resulting in a "punishment culture" of work.

When it comes to the effects on working conditions in **maintenance,** digital change in maintenance may lead to facilitation of work as sensors make maintenance work much more predictable and work requirements more transparent. For example, in Sweden, in the workshop the buses are transported by a sort of conveyor belt making the work cleaner and therefore healthier and easier. Other examples show, that a gain of time and a more efficient way to work may result from the possibility that assets are controlled and even reinitiated remotely. Where the metro operates nearly 24/7, maintenance work must be carried out in a tight time frame.

This example illustrates that the introduction of digital processes and automation often influences work organisation and processes, including working time requirements. This not only relates to maintenance but also other corporate areas, e.g. operations or traffic and infrastructure management were digitalisation may even allow for larger flexibility and moving between telework and office or shop floor presence. As working time changes, including the introduction of new forms of shift-work or mobile work are very sensitive issues of working conditions, there is a need to develop solutions that not only match cost and efficiency related requirements but also the interests of employees (considering also the diversity of interests, e.g. between younger and older, "digital natives" and "digital immigrants") in order to avoid feelings of overload, insecurity and demotivation.

The increasing use of tablets and digital devices in maintenance as well as repair workshops and warehouses have an impact on work that entails much more than substitution of paper by electronic documentation: Digitalisation has increased massively the amount of data that is available. Documentation requirements by technical regulators have increased a lot. Also, in case of damage, proof of which component was used, and which tasks completed must be ensured. Documentation on paper that was not as comprehensive was replaced by digital documentation.

Employees have to document their work directly on a tablet. The recorded data such as mileage of trains, work orders, work processes, working hours and the note when work is done is immediately transferred into the system. The documentation on the tablets has increased the qualification requirements. Thus, social dialogue and negotiated solutions between management and employee representatives are important in order to prevent that the recording of working hours increases the pressure on employees.

3.4 Impact of digitalisation on women's work in urban public transport

Digitalisation is sometimes discussed as a potential means for increasing female employment. Employment in transport in general is male dominated, with the share of women only being around 22 %.[29]

Numerous initiatives at the company level in public transport are aimed at increasing the number of female employees. An international study by the International Transport Workers' Federation (ITF) on the impact of the future of work on women in public transport, which is based on case studies outside of Europe, shows that the reasons for women's low participation in the transport sector are poor working conditions (including work-life-balance), safety (experiences of harassment and violence), gender stereotyping and gender discrimination.[30] UITP and ETF have two projects dealing with women's employment and gender equality in the European public transport sector. With the intention of increasing the share of female employees in urban public transport, the European social partners' joint project WISE I (Women Employment in the Urban Public Transport Sector, 2011–2012) offered the first European-wide comparative study on women's employment in public transport.[31] The report focuses on issues relevant for improving the gender balance in the sector, such as the reconciliation of work and family life, health and safety at the workplace, training, recruitment and wage equality. Following the WISE I project, ETF and UITP agreed on joint recommendations to increase the share of women in urban public transport.

Joint recommendations on women's employment in urban public transport

The recommendations of the social partners to promote female employment in the urban public transport sector set the aim of having at least 25 % female workers by 2020 and 40 % by 2035 in urban public transport. To archive this, the recommendations conclude that the attractiveness of the sector must improve in order to attract and retain women. Furthermore, discriminatory barriers must be removed. The recommendations focus on:

- Recruitment policy;
- Qualifications, training and career opportunities;
- Work-life balance (reconciliation of work and social life);
- Health and safety at work;
- Equality in wages;
- Working culture and gender stereotypes;
- Corporate policy.

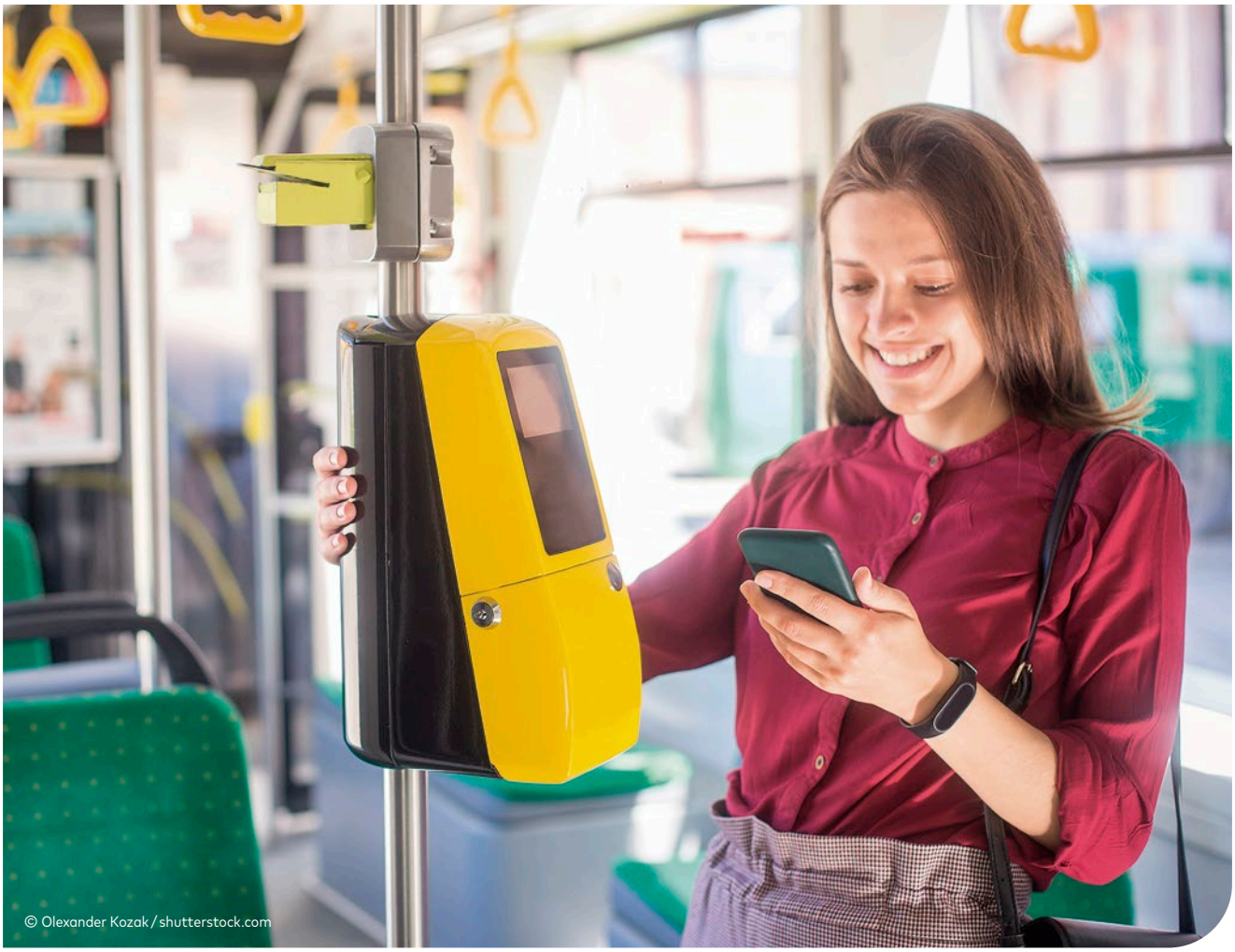
Each topic contains measures and tips for improving working conditions and the wellbeing of workers in that particular area. Furthermore, social partners committed to monitoring the implementation of the joint recommendations on a regular basis.

Source: UITP; ETF (2014): Joint recommendations: Strengthening women employment in urban public transport. Brussels.

29 European Commission (2018): Business case to increase female employment in Transport.

30 Wright, T. (2018): The impact of the future of work for women in public transport.

31 UITP; ETF; Akademie of Verband Deutscher Verkehrsunternehmen (n.y.): Project Wise: Project Report: Women Employment in Urban Public Transport.



In order to assess and support the implementation of the joint recommendations from WISE, the European social partners developed WISE II (Women's Employment and Gender Policy in Urban Public Transport Companies in Europe).[32] WISE II looked into the quantitative evolution of women's employment in Europe in the UPT sector, giving an overview on the European legal framework for equal opportunities. Most importantly, it highlighted strategies and examples of company and trade union activities to promote women's employment.

There is currently very little literature available on the effects of digitalisation on gender in European urban public transport. The research done in the framework of our project comes to the conclusion that there are hardly any specific differences in the impacts of digitalisation between women and men. Rather, the effects of digitalisation differ between occupational groups – which, however, are often gendered. For example, digitalisation through automated metros mostly affects men, as they make up the biggest shares of drivers, while digitalisation in ticket selling affects women, as ticket selling is a traditionally female occupation.

32 UITP; ETF; EVA (2016): WISE II – Women's Employment and Gender Policy in Urban Public Transport Companies in Europe: Examples of policies and practices. https://www.uitp.org/sites/default/files/cck-focus-papers-files/WISE%20II%20Brochure%20English.pdf.

In general, it is assumed that for some employees, digitalisation will improve the compatibility of family and work, which would benefit women in particular, who still take on the majority of care-related tasks.

The reorganisation of working time and the decoupling of working time and the place of work in the course of more mobile work can lead to more time sovereignty and design options for a good work-life balance. While flexible working hours are becoming increasingly widespread, home office is, however, rarely a possibility in public transport. A prerequisite for gaining positive effects of the independence from time through digitalisation is that flexible hours or mobile work are desired by the employee and are subject to clear rules. Otherwise, there is a danger that professional and private obligations become intertwined and can no longer be separated. The constant availability of employees via digital communication can stand in the way of a good work-life-balance.

The decline in physical labour, for example through automation in maintenance, could also influence women's employment participation. In addition, the trend towards more customer services is also seen as beneficiary to female employment, as women are often assumed to have high social skills which are necessary in fields such as customer communication. Women already make up most customer service employees.

Company specific networks established in many public transport companies to support the careers of women and fight discrimination can be a good basis for ensuring that digitalisation does not over-proportionally affect female employees in a negative way.

One example is ensuring that training requirements due to digitalisation are implemented in a non-discriminatory manner. As studies show, this often is not the case: Regardless of the specific sector, women still are underrepresented in IT skills and also less likely than men to receive support for the acquisition of specific knowledge and practice in handling ICT devices.[33] A starting point for the greater involvement of women in qualification is, for example, the offer of further training during working hours to avoid a clash with care responsibilities.

33 Sorgner, A. et al. (2017): The effects of digitalization on gender equality in the G20 economies. Kiel Institute for the World Economy.

© mmphoto / stock.adobe.com

4. Measures to shape digital transformation and transition management

4.1 Introduction

Digitalisation in public transport companies affects all functional and operational areas. It is not only a technical challenge but also has a significant impact on employment and work in urban public transport companies.

As the last chapter has shown, the overall number of workers employed, job description, job roles, training and re-skilling, monitoring and surveillance among other aspects are affected by digital change. The existing and forthcoming technological upheavals need to be flanked by appropriate strategy regarding employees in urban public transport companies. Here social partners can step in to make a just transition and develop the digitalisation process in a positive direction. An overall result of this study is that urban public companies as well as social partners in the sector very much agree about the need to manage the digital transformation process and shape the implementation on the ground and for employees in a joint manner.

Social partners' initiatives that have been identified in the context of this study, show that employers, employees and their representatives can lead a constructive dialogue, develop proactive strategies to shape the transformation processes and form a win-win situation for all parties involved. Good practice examples as emerging from interviews and workshops in the context of the project are described in the following sections.

4.2 Good practices of social partners initiatives shaping digitalisation

In the following, initiatives are presented where social partnership has shaped digitalisation in the direction of improving employment and working conditions. Both the starting points and the objectives of the initiatives differ.

Their objectives can be summarised in the following key messages. Chapter 4.2.1 concludes that established areas of social dialogues and participation of employee representatives offer convenient starting points for shaping digitalisation processes in urban public transport. Chapter 4.2.2 states that the involvement of employees and their representatives enables workers to proactively react to digital changes transforming their work. In addition, the workplace knowledge of the employees can be used

to understand the impacts of digitalisation on work and make technical developments more efficient and effective (see chapter 4.2.3). Furthermore, chapter 4.2.4 concludes that a strategic analysis by the social partners of the effects of digitalisation is best oriented towards professions and occupational groups to observe differences in impact. Initiatives to shape digital change are embedded in all kinds of industrial relations systems and can lead to a sustainable and human-centric approach for dealing with digitalisation and its impacts on work (see chapter 4.2.5). And lastly, chapter 4.2.6 deals with trade unions' demands and recommendations with regard to the implementation of digitalisation processes.

4.2.1 Established areas of social dialogues as starting points for shaping digitalisation

A starting point for shaping digitalisation is provided by fields in which employee representation is traditionally active and forms of social dialogue have already been established. This includes in particular the protection of employment, the improvement of working conditions and the training of employees.

For example, the **adjustment of occupational profiles** and learning contents often foresees the involvement of employees and their representatives in the process. In some cases, an increase in learning and competence requirements has derivative effects on job classification and pay.

Another important field where social partners at the company level are active is the issue **of data protection and the prevention of individual performance and behavioural monitoring via new technologies.** A number of collective agreements and company level agreements address the issue of monitoring and surveillance of workers and largely avoid the use of data to monitor employees. One example is the group level agreement on the introduction, use and adaptation of data processing systems of *Netinera* Deutschland GmbH, a subsidiary of the Italian state railway *Ferrovie dello Stato Italiane*. This agreement defines concrete provisions concerning digital performance monitoring, such as the requirement that the information generated must have a specific and documented purpose and cannot be used to assess the employee's behaviour in general. The agreement also requires the involvement of works councils in these processes.

Practical example: Strong involvement of social partners in vocational education and training by TTS Työtehoseura

At TTS in Finland that provided vocational training for a broad range of occupational groups, including for bus drivers, social partners, i.e. companies, employer organisations and trade union federations are strongly involved via a training advisory group.

TTS who is not only the biggest training provider for bus drivers but also a leader in the application of e-learning and new learning technologies such as VR (see also textbox in section 2.3), involves social partners by the following activities in particular:

- Development projects' steering group with Union and Federation representatives 4–5 times/year;
- Bilateral meetings with Union and Federation;
- Bilateral meetings with companies;
- "Breakfast meeting" 4–5 times a year for information exchange with Union and Federation representatives;
- Joint activities to foster common industry image and training marketing.

Source: Presentation by TTS Työtehoseura, project workshop Barcelona, 16/17 January 2020.

A further point is seen in the danger of the extension of **working time and constant availability** through personal accessibility e.g. by teleworking, mobile devices and tablets. Trade unions and worker representatives ask for clear boundaries guaranteeing the right to privacy. At Keolis, a multinational transportation company that operates public transport systems, an agreement was signed between social partners with the aim of protecting the private life of the employees and regulating the right to disconnect.

Social dialogue is also an important means for **averting the risks of job loss due to digitalisation.** An example in this context is the experience at Metro de Madrid where the company and trade unions have negotiated several collective agreements in the context of digitalisation and changes of work organisation that include provisions of job security and further qualification. Such agreements for example cover employees in the field of ticket sales and customer information that have been heavily affected by digitalisation.

Within the framework of the concept "Metro Stations 4.0" of Metro de Madrid and the elimination of ticket offices and manual sales employees, new positions in the area of customer services were created to retain staff. The new customer assistants, who are equipped with tablets and mobile phones, carry out several assistance services for passengers but also function as station supervisors. Section 2.3 describes the changes in the area of mobile customer services at Metro de Madrid as a practical example. The changes were accompanied by a number of collective agreements concluded between 2001 and 2016. The agreements contain a number of clauses that ensure the transition to a new service model for customer support and a new organizational model.

These include:

- Collective Agreement 2001–2004, Clause 18 on the "Improvement of Productivity";
- Collective Agreement 2005–2008, Clause 16 on "Measures to improve the organization of work";
- Collective Agreement 2009–2012, Clause 16 on "Measures to improve the productivity and reorganization of work" and Clause 18 on "Network extensions and further extensions of the light rail operation;
- Collective Bargaining Agreement 2016–2019, Clause 16th on "Modifications in the organization of work."

The collective bargaining agreements dealt with, among other things, adjustment processes, the type and duration of further qualifications and the use of tablets.

A further common approach is to prevent job loss through **retraining.** Our research shows that, despite massive changes, there have hardly been any redundancies, as instead employees were mainly transferred to other jobs.

Practice example: Agreement between Arriva and 3F

An agreement between *Arriva* and the Danish trade union *3F* illustrates this: In September 2019 a new metro ring opened in Copenhagen, which meant that the bus network in this area had to be reduced. Arriva estimated that around 100 bus drivers were threatened by dismissal. On the other hand, it was foreseen that in the future the need for bus drivers will increase due to a general shortage of drivers.

Against this backdrop Arriva, 3F Copenhagen Drivers, together with a training centre, started an extensive training program lasting six months for all bus drivers. For example, classes exist on foreign languages and IT, and lessons for a truck driving license are taught. Drivers receive 85–100% of their pay while on training. During training drivers are replaced by colleagues, thereby avoiding layoffs.

Source: Desk research and interviews in the context of the project.

4.2.2 Employee involvement in digital transformation

Employee representation can accompany change processes with the aim of balancing employee interests such as good working conditions, work-life balance, participation in efficiency gains. In social dialog process, which is characterized by participatory practice, employee representatives can distribute information on digitalisation among employees and at the same time act as a channel of communication between employees and management. If a mutual agreement has been reached with management on digital transformation, worker representatives can explain the decisions reached to employees and thus promote the implementation of what has been decided.

In several companies, urban public transport initiatives are taking place to inform and discuss with employees the processes and impacts of digitalisation and thereby **increase trust and reduce insecurity within the workforce.** *Wiener Linien* in Austria launched a project to analyse the effects of digitalisation on employment in January 2018. Within the framework of the project, 15 workshops with 409 employees from 45 departments were conducted. Works councils also participated in the project. The topics of the workshops were mainly the employee perceptions of risks and rewards in terms of digitalisation process at Wiener Linien. In addition, an employee survey was developed to analyse benefits and disadvantages of digitalisation processes. One of the results of the workshops was the introduction of a "DigiBlog" to keep employees up to date and informed with the digitalisation processes.[34]

In regions around Florence in Italy the trade union *FILT CGIL* and several public transport providers conducted the study *"Digitalisation in local public transport related to workers and customers"* to gather opinions and demands of stakeholder on the digital transformation of public service.[35] In the scope of the project 234 interviews with employees were conducted. The study focused on various areas of digitalisation such as ticketing, passenger information and intramodality, vehicle fleets, vehicle maintenance and traffic control as well as impacts on work organisation and skills.

4.2.3 The use of workplace knowledge to improve effectiveness

While progress is increasingly being made to introduce new technological developments in urban public transport, the introduction of this new technology rarely considers its impacts on work and employment. In some cases, a gap remains in terms of **proper work design and competence development for the successful embedding of these new technologies in the workplace.** Projects that record employees' experiences while using the new technologies and the effects of digitalisation on their work and tasks can present a starting point to close this gap. Especially in the development phase of new technologies public transport companies are involving the employees of relevant departments to enhance the performance of digital equipment. For example, for the development of driver assistance systems, *Transport for London (TfL)* analysed the experiences of the bus drivers using the equipment during the test runs.

Regarding the *Deutsche Bahn's virtual travel centres* the works council and employees were involved in designing the technical solution and the sales processes and setting up the video centre, among other changes.

34 Presentation by Wiener Linien, project workshop Vienna, 4/5 March 2020.

35 Lanini et al. (2018): La digitalizzazione nel trasporto pubblico locale: Ricadute su utenti e lavoratori. FILT CGIL.

Practice example: Joint social partners project UPT 4.0 in Germany: Bottom-up approach with strong workplace involvement

In Germany, the social partners in urban public transport in North Rhine Westphalia (ver.di trade union and the Association of German Transport Companies, VDV) together with six urban public transport companies carried out a project that focussed on the implementation of model-like digitalisation project in urban public transport in six companies, each concentrated on a specific topic or technology (mobile devices and work organisation; digital business models and mobility systems; digitalisation of maintenance and diagnostics; 3D printing in workshops and warehouses, HR management 4.0; homeoffice and cloudwork; further training and education 4.0) and the impact of digitalisation on workplace environments, work organisation, skills and competence needs and further aspects, e.g. health and safety issues. All projects were characterised by a strong involvement and participation of employees and management representatives at workplace level. The bottom-up approach of workplace participation was motivated by the central idea that this is the only way to shape the digital working world sustainably and jointly generate knowledge that enables both employees and decision-makers to meet the challenges of digitalisation in a practical way. The project resulted in the elaboration of practical guidelines and good practice examples, a guide defining general criteria for good work in UPT 4.0 as well as a joint vision of the social partners and the involved companies as regards employment and work in UPT 4.0.

Source: ver.di (ed.) (2020): Leitbild „Arbeit im ÖPNV 4.0": Zur Zukunft des öffentlichen Personennahverkehrs im digitalen Wandel. In cooperation with the Institute for Social Science Research ISF Munich, Düsseldorf; https://oepnv4_0-nrw-arbeit4_0.verdi.de/.

4.2.4 Strategic analysis of professions and occupational groups

Fact finding is currently of high importance to investigate the actual **impact of digitalisation on employment and work.** In order to gain an overview of the specific effects on tasks, job-profiles and skills, studies need to focus on analysing individual professions and occupational groups in public transport. This research context also offers a starting point to develop strategies for upskilling for a group of employees or to assure their retention elsewhere.

A comprehensive study of impacts on occupational profiles and the evolution of jobs, trades and skills was carried out by the *Employers' Association for Public Transport, UTP,* in France in liaison with several trade unions (CFDT SNTU, FO UNCP, FNST CGT, SNRTC CFECGC, UNSA TU).[36] The study analyses the effects of digitalisation on eight occupational groups. Methodologically, the study is based on interviews, discussions in working groups, and a broad document and statistical analysis. The results of the study are presented in chapter three above (section 3.1). The purpose and goal of the study was to identify the main contents of work for professions in public transport, to analyse changes regarding tasks and skills due to digitalisation and other changes, and to identify and quantify training requirements to deal with these changes. Key findings show that starting points for a proactive approach lie in job classifications, contents of training, design and type of training, skill assessments and recruitment.

A similar project analysing the effects of digitalisation on several occupations (drivers, dispatchers, maintenance staff, cleaners, telephone agents and conductors, among others) was commissioned at *Deutsche Bahn* in Germany together with the trade union *EVG*.[37] The study concludes that tasks are changing, new activities emerge, and old activities disappear, the organisation of work and responsibilities are changing, and skill requirements are being transformed.

36 UTP (2019): Etude prospective sur l'évolution des emplois, des métiers et des compétences: Rapport complet de l'étude.

37 Beile, J.; Hadwiger, F. (2018): Die Digitalisierung gemeinsam gestalten: Welche Chancen und Herausforderungen ergeben sich für die Beschäftigten des DB-Konzern?

4.2.5 The embeddedness of social dialogue

The system of industrial relations differs between the countries and social dialogue takes on various forms and approaches. While in some countries processes of social dialogue are embedded in a well-regulated system of rights and obligations, and outcomes of the discourse are institutionalized via regulations, the bargaining processes in other countries are less structured. Nevertheless, in all systems examples can be found of how social partners shape the outcomes of digitalisation.

In the Netherlands, cooperation between the social partners at national level is shaped by the "Polder-model". Within the framework of the model, trade unions and employers of urban public transport companies meet every six weeks to discuss employment matters, such as payment structures, job security but also (digital) transformation. One of the initiatives resulting from this is a joint initiative analysing the medium and long-term impact of digitalisation on the sector and in particular on work.

In some settings agreements take the shape of collective agreements and company level agreements. Quite common are joint agreements on data protection. Also, the introduction of revolutionary technologies, such as automated metros, is accompanied by company agreements. However, overall, there are only few company-level agreements dealing with digital transformation in the transport sector. One of them is the company-level agreement between Deutsche Bahn and EVG trade union.

Finally, and as already mentioned above (see textbox in section 4.2.3), a major outcome and result of the joint social partners' project "Public transport 4.0" has been a joint mission statement of the involved trade union, the participating companies as well as the employer organisation as regards the future of work in urban public transport, published at the beginning of March 2020. As this document and the six key principles defined by the social partners and the involved urban public transport providers are highly relevant, it is documented in the textbox below.

Practice example: Collective agreement on Work 4.0 at Deutsche Bahn AG

In 2016, Deutsche Bahn and its employers' association AGV MOVE[38] and the rail transport trade union EVG signed a collective agreement on Work 4.0 dealing with the future of work within the context of digitalisation. The agreement includes criteria for the evaluation of the impacts of digital innovations on work, a procedure for changing occupational tasks against the backdrop of digitalisation, and rules for mobile work and the availability of employees e.g. via cell phones among others. The collective agreement Work 4.0 also established a digital roadmap for a concerted approach to introducing digital innovations. This includes steps such as ensuring that respective advocacy groups are included early in the process of planning, developing and introducing digital innovations; discussing and agreeing on specific impact assessments of digitalisation or, if applicable, agreeing on an arrangement for dealing with consequences. The agreement also provides for the social partners to work together on numerous digitalisation model projects. Projects are still ongoing and include studying the impact of digital innovations on professions, stopping digital stress before it starts, telework, competency shifts, gender equality, training planning and technology development. Working groups of the social partner representatives and external experts have been organised and conferences are being held in the framework of the project. As a result of the project on digital stress, virtual travel centres were introduced, as employees of conventional travel centres felt stressed about future employment option against the backdrop of digitalisation. The process is ongoing and has led to a sustained development of new collective bargaining rules in the current collective agreements such as the option for employees to take more vacation time instead of a pay increase.

Source: Presentation by Deutsche Bahn/AGV MOVE, project workshop Barcelona, 16/17 January 2020.

38 www.agv-move.de – employers and business association of mobility and transport service providers (AGV MOVE)

Public transport 4.0 – Shaping the digital change in work in a spirit of social partnership

In shaping the digital change, we are guided by the following guiding principles:

(1) "We shape the digital change in public transport in a spirit of social partnership and responsibility"

Co-determination and workers participation constitute the basis for a responsible management of digital change. The utilisation of the innovation potential requires the active participation of all employees. By joint agreements between management and employee interest representation bodies on employee participation we address existing fears and concerns. Digital reorganisation processes require adequate resources in terms of time, personnel and financing.

(2) "We regard digitalisation as a tool to further develop high-quality mobility and public services in the interest of our customers"

We regard digitalisation as an opportunity for stronger cooperation between transport providers and with other actors in public transport. We also regard digitalisation as a tool to further develop the key role of urban public transport providers a key and attractive provider of mobility services (...).

(3) "Digitalisation contributes to securing the future of companies and offers additional employment opportunities in urban public transport"

The social partners in urban public transport are actively engaged in new digital technologies and use them in a sustainable way for new products and innovative business models. The motivation of this is the joint interest to use digitalisation as a means to guarantee the service quality for customers, to improve working conditions and guarantee sustainable and safe employment. Our aim is to grow as a sector and to strengthen and further develop our existing position in the mobility sector.

(4) "Digitalisation needs good working conditions, qualified staff and clear rules"

Making the best out of innovation processes can only be achieved if employees are motivated. Therefore, we are committed to the criteria of 'Good Work' that have been developed in our project. We will accompany the changing world of work by new and innovative qualification offers as well as attractive working and employment conditions for employees. This includes clear rules in work organisation, for qualification and working time management. This also implies the use of digital innovations in order to implement an integrated approach of health protection.

(5) "An appreciative and responsible corporate culture is both basis and purpose of successful digital change management in urban public transport"

Sensitivity for diversity, inclusion and freedom from discrimination are a matter of course for us. They guide our actions when shaping digitalisation processes. Digitalisation and its opportunities are not able to replace personal communication within the company - social relations between employees and "analogue" spaces are important for good work (...).

(6) "For us, digitalisation means a sustainable and responsible handling of data"

Data privacy is a key criterion of personal security for customers and employees. (...) We will protect sensitive employee data with special care. Monitoring work performance and behaviour is not the purpose of digitalisation. The responsible handling of personal data is a prerequisite for a sustainable identification of employees with their work and their company.

Signatories: ver.di – Bundesverwaltung, Fachbereich Verkehr; Verband Deutscher Verkehrsunternehmen (VDV); Aktiv Bus Flensburg GmbH; Bochum-Gelsenkirchener Straßenbahnen AG; Kölner Verkehrs-Betriebe AG (KVB); MVG Märkische Verkehrsgesellschaft GmbH; Rheinbahn AG; WSW Wuppertaler Stadtwerke mobil GmbH

Source: ver.di (ed.) (2020): Leitbild „Arbeit im ÖPNV 4.0": Zur Zukunft des öffentlichen Personennahverkehrs im digitalen Wandel. In cooperation with the Institute for Social Science Research ISF Munich, Düsseldorf; https://oepnv4_0-nrw-arbeit4_0.verdi.de/. Original text has been translated and slightly shortened by authors of this report.

4.2.6 Demands and recommendations from trade unions

Trade unions formulate demands as well as recommendations to support a human-centred approach on digitalisation. However, for the most part trade unions make these demands for all sectors rather than sector-specifically for public transport. For example, *Younion* from Austria, which represents around 150,000 members in urban public transport as well as other sectors in public services, focusses on a proactive approach to shape the digital transformation in the sense of "Good Work". "Good work" is understood as less physical and psychological stress, less routine work, age-appropriate work arrangements, avoiding night work, a good work-life balance and shorter working hours. Consequently, *Younion's* demands focus on training and re-skilling, involvement of workers representatives when implementing new technologies, prevention of surveillance and monitoring of employee activity in the workplace, data protection, and health and safety measures.

The Spanish trade union *Federación de Servicios a la Ciudadanía – Comisiones Obreras (CCOO)* makes similar demands.[39] Changes in work organisation, requirements for re-skilling and effects on health and safety due to digitalization processes should be topics for social dialogue and be dealt with in collective bargaining agreements. Furthermore, the trade union also addresses the issue of surveillance to monitor employee activities.

Quite similar, the Swedish trade union *Kommunal* reported in the context of a workshop in the framework of the project about its demands to protect employees' personal integrity and to regulate the introduction of new technology by collective agreements (see textbox below).

Practice example: Protection of employees' personal integrity in the context of new technology deployment by KOMMUNAL trade union

In Sweden, the trade union *Kommunal* has developed several principles and key aspects that should be respected by urban public transport providers when introducing new technologies in order to protect the personal integrity of the staff.

The employer should inform the trade union in advance, negotiate the implementation of the technology, inform employees and ask them for permission before deploying the technology. It is important that in relation to each technology, e.g. a green box, GPS or cameras, the specific purpose is explained. Furthermore, it has to be guaranteed that the technology is used restrictively, i.e. only for the specific use but not for general surveillance of employees and/or monitoring performance.

Therefore, collective agreements on new technologies should include at least on the following:

- Type and purpose of the equipment
- When it can be used
- Who has access to the data?
- How long can the data be saved?
- Cannot be used for action against employee
- Must not violate personal integrity.

Kommunal recommends that these principles should be reflected when negotiating collective agreements.

Source: Presentation by KOMMUNAL trade union, project workshop Barcelona, 16/17 January 2020.

39 CC.OO (2016): El transporte público. http://www.fsc.ccoo.es/noticia:207823--El_transporte_publico.
CC.OO (2016): Industria 4.0: Una apuesta colectiva. http://industria.ccoo.es/3726499875c9feb2f83c5e2d866a4a0d000060.pdf.

The British trade union *Unite* proposed an agreement directly targeted at public transport. Establishing permanent involvement with employee representatives is the subject of a draft agreement from 2017 of the British trade union Unite. The union is currently in the process of negotiating such agreements with various public transport companies. However, due to the Covid-19 crisis no agreement could be concluded so far. The *"New technology agreement to accompany the threat of automation"*[40] by Unite aims at shaping the process of introducing new technology for the benefit of employees. Underlying principles for the introduction of new technology are, among others:

- New technology should benefit the employees und jobs should be protected;
- Cost savings from any introduction of new technology should be reinvested into more and better jobs;
- Proper training and re-training need to be ensured and new skills or responsibilities need to be recognized and compensated for through pay increases;
- There needs to be a fair use of monitoring and surveillance;
- If new technology offers the possibly to reduce the overall number of working hours required from a group of workers, the number of hours should be reduced without any loss of pay.

In addition, an apparatus should be set up for dealing with new technology issues, including special negotiating committees and technology sub-committees with shop stewards. In these committees the business case for new technologies and the impacts on work and employment ought to be discussed before implementing them in the public transport company. In addition, on the employee side, there will be a designated new technology representative from the shop stewards. This person will investigate issues arising from the introduction of new technology and worker complaints workers regarding new technology. This person should also inform employees about new technologies.

40 Unite (2017): Draft New Technology Agreement.

5. Conclusions: Why a strong involvement of social partners in digitalisation in urban public transport is needed

For the most part, urban public transport companies are already engaged in processes of digital transformation and the deployment of digital and automation technologies. When designed well, digitalisation improves efficiency and saves money (even though the initial costs can be large). It is also necessary to develop attractiveness for passengers.

While scarce public funding – a situation that has dramatically worsened by the COVID-19 crisis[41] – on the one hand limits financial resources and investment possibilities in urban public transport, limited funding is, on the other hand, also the motivation for cost gains due to digitalisation. Digitalisation is seen not only as a necessity for making urban public transport fit for the future in terms of competitiveness and efficiency but also as a lever to improve service quality and working conditions as well as maintaining the role of urban public transport companies as key players in public service provision and the backbone of future urban public mobility. Urban public transport has an essential role for delivering public services that are inclusive, accessible and affordable for all passengers. In politics and by authorities and companies in urban public transport, a successful digital transformation strategy can contribute to accomplish this public service mission.

Levels of digitalisation vary across countries and even within companies in the same country. According to the results of a survey launched by UITP in 2017 among its members, a majority (58%) of the respondents have already implemented a strategy for digital transformation in their businesses. However, strategies can be designed quite differently: 57% of all respondents have a specific department which focuses on digitalisation supporting a company-wide digital transformation. However, 60% of all respondents do not have a specific human resources strategy, even though 62% acknowledge that there is not a sufficient number of employees with adequate digital expertise in the company. About 80% of the respondents believe that they will need more fine-tuned and advanced IT-skills. Urban public transport is the central actor for the most environmentally friendly, economically and socially sustainable transport system. This is the case irrespective of the advancement of individual urban public transport providers as regards the deployment of digitalisation strategies and digital transformation of their business model. Digitalisation has the potential to strengthen this position and make urban public transport fit for future and increasingly competitive with new mobility actors and providers. At the same time, it has to be ensured that the role of urban public transport as a key provider of public services is maintained and that universal access for all kind of users of public transport is guaranteed.

There are no clear development paths for digital change, but rather the digital transformation must be actively shaped. This report pointed out concrete implementations and impacts of digitalisation processes and good practice examples. A general result of our research is that effects on employment are widely expected. So far, digitalisation has amounted

41 Here it has to be noted that even though urban public transport has maintained the scope of service supply even during the lockdown, public transport – in contrast to urban mobility and clean transport – has not been mentioned in the European recovery plan that was presented by the EU Commission on 27 May 2020. See: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_940.

to a change of job profiles rather than substitution of existing jobs. The change of job profiles leads to extensive needs in re-training and re-skilling. A company culture in which digitalisation is seen positively and related changes are seen as providing opportunities for employees and the company, can be supportive. In this context, it is necessary that employees are motivated to be open to changes and to work with the new technologies. Several aspects of working conditions have been upgraded through digitalisation. Nevertheless, it should also be noted that digitalisation may have negative effects on working conditions if not regulated in a balanced way. This concerns the "always on" working culture and work-life balance as well as the massive use of CCTV and other devices that have the potential of being used for surveillance and performance monitoring.

Digitalisation also leads to other challenges for public transport companies. Beside the above-mentioned financial constraints, it affects (market) access and the competitiveness of public transport companies. This becomes clear in the area of MaaS, for example, but is also visible in the area of maintenance concerning data access and data rights. External IT providers are increasingly hired to provide software and hardware solutions making public transport companies more dependable on third party services. This raises important questions as regards the access and the ownership of the big data that is gathered in urban public transport.

Social partners need to keep up with the speed of digital developments and strengthen their role in influencing employment, working conditions and qualifications. Social partners have an important role to play in shaping the digitalisation process and leading to a sustainable and human-centric approach for dealing with digitalisation. For example, they can substantially contribute to developing the digitalisation process in a positive direction in terms of employment, fair working conditions, qualifications, inclusion and equal opportunities and participation in productivity gains. Depending on national framework conditions, the forms of participation as well as outcomes of social dialogue at different levels may differ. The practices and initiatives presented in the report showed how a win-win-situation for all parties involved can be formed by focusing on constructive dialogue, negotiation and just transitions.

Cornerstone aspects of fair digital work in urban public transport 4.0 that were identified in the context of this project can be summarized as followings:

- Employment and job security;
- Employability, skills and competence development;
- Working conditions and working time;
- Diversity and equal opportunities.

The results of our project suggest some underlying principles on how to shape the impact of digitalisation upon the cornerstones in a human-centred manner. Research collected in the context of this project shows that it is essential that workers, their representation bodies and trade unions are involved and participate actively in digitalisation in urban public transport. The involvement of employees (and their representatives) enables a proactive response to digital change and improves technical development and technology introduction processes from the deployment at the workplace to major investment decisions at the company top-level. Thus, the involvement of workers and their representatives increases the chances that investments made in digitalisation pay off. The involvement of trade unions and employee representatives is beneficial in all stages of the digital transformation processes, but in general joint discussions should take place as early as possible. For example, companies can initiate a digitalisation plan and already involve trade unions and other workers' representatives in the process of designing that plan. Furthermore, a regular exchange between managers and employees on digitalisation issues can be established and improve adaptive performances on all sides.

Measures should be oriented towards the goal of job security, health and safety, and job satisfaction. In particular, they should also focus on challenges and consider the concerns of workers (e.g. loss of influence, skill losses, substitution of jobs). Furthermore, a regular procedure for jointly assessing staff development regarding work requirements and skill needs can accompany the constant changes in work in the context of digital transformation. In this context a strategic regular assessment of changes in professions and occupational groups is helpful. This approach can be safeguarded by agreements that secure certain rights, for example regarding information and participation. Lastly, and based on the determination of the need for qualification, continuous training and upskilling for employees play a role. In the context of gender mainstreaming training concepts need to take appropriate measures to provide gender equality.

References

Arntz, M.; Gregory, T.; Zierahn, U. (2016): The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis, OECD Social, Employment and Migration Working Papers, 2016, No. 189, OECD, Paris. https://www.oecd-ilibrary.org/docserver/5jlz9h56dvq7-en.pdf?expires=1591713022&id=id&accname=guest&checksum=488F3AA99B7ECBECBFA1C446C6633CDD.

Beile, J.; Hadwiger, F. (2018): Die Digitalisierung gemeinsam gestalten: Welche Chancen und Herausforderungen ergeben sich für die Beschäftigten des DB-Konzern? Unpublished manuscript.

Brennen, S.; Kreiss, D. (2014): Digitalization and Digitization. http://culturedigitally.org/2014/09/digitalization-and-digitization/.

CC.OO (2016): El transporte público. http://www.fsc.ccoo.es/noticia:207823--El_transporte_publico.

CC.OO (2016): Industria 4.0: Una apuesta colectiva. http://industria.ccoo.es/3726499875c9feb2f83c5e2d866a4a0d000060.pdf.

Degryse, C. (2016): Digitalisation of the economy and its impact on the labour markets. ETUI Working Paper, Brussels. https://www.etui.org/Publications2/Working-Papers/Digitalisation-of-the-economy-and-its-impact-on-labour-markets.

Deloitte (2015): Transport in the digital age. Disruptive trends for smart mobility. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/bps/deloitte-uk-transport-digital-age.pdf.

ECD (2019): Going Digital. Shaping Policies, Improving Lives. Paris. https://www.oecd.org/publications/going-digital-shaping-policies-improving-lives-9789264312012-en.htm.

Eurofound 2018: Employment and working conditions of selected types of platform work. https://www.eurofound.europa.eu/publications/report/2018/employment-and-working-conditions-of-selected-types-of-platform-work.

Eurofound and ILO (2017): Working anytime, anywhere: The effects on the world of work. Publications Office of the European Union, Luxembourg, and the International Labour Office, Geneva. https://www.eurofound.europa.eu/publications/report/2017/working-anytime-anywhere-the-effects-on-the-world-of-work.

European Commission (2017): Sectoral Social Dialogue Committee Road Transport, Work programme 2018 – 2019. Adopted on 27 October 2017. https://circabc.europa.eu/sd/a/d3477a24-53a5-42ec-b0f3-a7737b873151/Road-2018-2019-WP.pdf.

European Commission (2018): Business case to increase female employment in Transport. Final Report; https://ec.europa.eu/transport/sites/transport/files/2018-business-case-to-increase-female-employment-in-transport-final-report.pdf.

European Commission (2019): Report of the high-level group on the impact of the digital transformation on EU labour markets, Brussels. https://ec.europa.eu/digital-single-market/en/news/final-report-high-level-expert-group-impact-digital-transformation-eu-labour-markets.

Fernández-Macías, E. (2018): Automation, digitisation and platforms: Implications for work and employment. Eurofound, Publications Office of the European Union, Luxembourg. https://www.eurofound.europa.eu/publications/report/2018/automation-digitisation-and-platforms-implications-for-work-and-employment.

Föllinger, O.; Grochowski, M. (2018): Predictive Maintenance. Presentation at the IVU Public Transport User Forum 2018. https://www.ivu.de/fileadmin/ivu/pdf/aktuelles/awf/2018/Vortr%C3%A4ge/Dienstag/03_Session_Innovationen_und_Trends/AWF2018_Predictive_Maintenance_Integration_with_IVU.suite_DE.pdf.

Frey, C. and Osborne, M. (2017): The future of employment: How susceptible are jobs to computerisation? In: Technological Forecasting and Social Change, 2017, No. 114, pp. 254 – 280.

Lanini, L.; Patelli, M.; Timpano, F. (2018): La digitalizzazione nel trasporto pubblico locale: Ricadute su utenti e lavoratori. FILT CGIL.

Malla Castells, R. (2011): Automated metro operation: greater capacity and safer, more efficient transport. In: PTI, November/December 2011; p. 15–16; http://metroautomation.org/wp-content/uploads/2012/12/PTI_2011_6.pdf.

OECD (2019): Going Digital. Shaping Policies, Improving Lives. Paris. https://www.oecd.org/publications/going-digital-shaping-policies-improving-lives-9789264312012-en.htm.

Powell, J. P.; Fraszczyk, A.; Cheong, C.N.; Yeung, H.K. (2016): Potential Benefits and Obstacles of Implementing Driverless Train Operation on the Tyne and Wear Metro: A Simulation Exercise. In: Urban Rail Transit (2016) 2 (3–4):114–127. UITP (2019): The benefits of full metro automation. Knowledge brief, Brussels. https://www.uitp.org/knowledge-brief-benefits-full-metro-automation.

Schildt, H. (2017): Big data and organizational design – the brave new world of algorithmic management and computer augmented transparency. In: Innovation, Vol. 19, Issue 1, pp. 23–30. https://www.researchgate.net/publication/309896514_Big_data_and_organizational_design_-_the_brave_new_world_of_algorithmic_management_and_computer_augmented_transparency.

Sorgner, A.; Bode, E.; Krieger-Boden, C. (2017): The effects of digitalization on gender equality in the G20 economies. Kiel Institute for the World Economy; https://www.ifw-kiel.de/fileadmin/Dateiverwaltung/IfW-Publications/Alina_Sorgner/the-effects-of-digitalization-on-gender-equality-in-the-g20-economies/digital_women-final_report.pdf.

UITP (2017): Digitalisation in Public Transport, Brussels. https://www.uitp.org/sites/default/files/documents/News/UITP_Digitalisation_Report_2017.pdf.

UITP (2018): Digitalisation in public transport: Accepting the challenge! Brussels. https://www.uitp.org/news/digitalisation-public-transport-accepting-challenge.

UITP (2018): The Public Transport Workforce in the Artificial Intelligence Era. https://asiapacific.uitp.org/public-transport-workforce-artificial-intelligence-era.

UITP (2019): Artificial Intelligence in Mass Public Transport. UITP Asia Pacific Centre for Transport Excellence (CTE). https://www.uitp.org/sites/default/files/UITP%20AP%20CTE%20-%20AI%20in%20PT%20Executive%20Summary%20-%20Dec%202018.pdf.

UITP (2019): Digitalisation and Asset Maintenance, September 2019. https://www.uitp.org/events/maintenance-and-asset-management.

UITP (2019): Mobility as a service: report. https://www.uitp.org/sites/default/files/cck-focus-papers-files/Report_MaaS_final.pdf.

UITP (2019): The benefits of full metro automation. Knowledge brief, Brussels. https://www.uitp.org/knowledge-brief-benefits-full-metro-automation.

UITP (2019): World report on metro automation 2018. Statistics Brief. https://www.uitp.org/sites/default/files/cck-focus-papers-files/Statistics%20Brief%20-%20Metro%20automation_final_web03.pdf.

UITP Asia-Pacific, Land Transport Authority (2019): Artificial intelligence in mass public transport, Executive summary, December 2018. https://www.uitp.org/sites/default/files/UITP%20AP%20CTE%20-%20AI%20in%20PT%20Executive%20Summary%20-%20Dec%202018.pdf.

UITP; ETF; Akademie of Verband Deutscher Verkehrsunternehmen (n.y.): Project Wise: Project Report: Women Employment in Urban Public Transport. http://www.wise-project.net/downl/final_wise_project_report.pdf.

UITP; ETF (2014): Joint recommendations: Strengthening women employment in urban public transport. Brussels. https://www.etf-europe.org/wp-content/uploads/2018/09/JR_Strengthening-women-employment-in-UPT_EN.pdf.

UITP; ETF; EVA (2016): WISE II – Women's Employment and Gender Policy in Urban Public Transport Companies in Europe: Examples of policies and practices. https://www.uitp.org/sites/default/files/cck-focus-papers-files/WISE%20II%20Brochure%20English.pdf.

Unite (2017): Draft New Technology Agreement. https://unitetheunion.org/media/1236/draft-new-technology-agreement-october-2016.pdf.

UTP (2019): Etude prospective sur l'évolution des emplois, des métiers et des compétences: Rapport complet de l'étude. Union des transports publics et ferroviaires.

ver.di (2020): Checklisten für die Gestaltung des digitalen Wandels im ÖPNV. ÖPNV 4.0 – Den digitalen Wandel der Arbeit sozialpartnerschaftlich gestalten. Vereinte Dienstleistungsgewerkschaft, Landesbezirk NRW, Düsseldorf. https://oepnv4_0-nrw-arbeit4_0.verdi.de/++file++5e624ceb09b896bf80aa6342/download/Handreichung-Checklisten_final.pdf.

ver.di (2020): Leitbild „Arbeit im ÖPNV 4.0": Zur Zukunft des öffentlichen Personennahverkehrs im digitalen Wandel. In cooperation with the Institute for Social Science Research ISF Munich. Vereinte Dienstleistungsgewerkschaft, Landesbezirk NRW, Düsseldorf. https://oepnv4_0-nrw-arbeit4_0.verdi.de/.

Voss, E./Rego, R. 2019: Digitalisation and Public Services: A Labour Perspective, Public Services International and Friedrich Ebert Foundation. https://publicservices.international/resources/publications/full-report---digitalization-and-public-services-a-labour-perspective?id=10382&lang=en.

World Maritime University (2019): Transport 2040: Automation, technology, employment – the future of work. https://safety4sea.com/wp-content/uploads/2019/01/World-Maritime-University-Transport-2040-Automation-Technology-Employment-The-future-of-work-2019_01.pdf.

Wright, T. (2018): The impact of the future of work for women in public transport. International Transport Workers' Federation (ITF), Friedrich-Ebert-Stiftung (FES). https://www.itfglobal.org/en/reports-publications/impact-future-work-women-in-public-transport.

Zuboff, S. (2019): The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. New York.

UITP EUROPE

ETF

EVA

wmp consult

With financial support
from the European Union