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The Future of Mobility

Winners and Losers and New Options in the Public Space

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Abstract

The high proportion of motorized vehicles is leading to significant functional problems, especially in the centers of major cities. At the same time, dependence on fossil fuels is no longer just a climate problem, but also a problem of world peace. Simultaneously, new forms of mobility are developing, especially in cities. Among young people, digital platforms and sharing services are increasingly coming to the fore. "Using instead of owning" is a major trend going along with digitalization and is challenging the relation between private and public transport. As a result of the covid pandemic, new forms of mobile working have gained in importance, which has a strong impact on mobility behavior and further increases the dynamics of digitization through even more flexibilization.

Automated driving and new platforms are also transforming public transport and creating new options. New providers are irritating the established markets. The dominant players in the automotive industry and in public transport are struggling to match this rate of innovation. Digital platform operators are actually better suited to develop, launch and operate digitally mediated mobility services. This also has implications for employment. While the transformation of drive technology in the automotive industry and digitization in production have already led to a decline in the volume of work at automotive manufacturers and their suppliers, new jobs are simultaneously being created in software development and mobility services. However, the transport sector is traditionally male-dominated. In principle, new technologies enable jobs to become more women-friendly. This requires proactive regulation.

Ultimately, however, it is up to the political players to decide who will prevail in the future of mobility and under what conditions products and business models can be developed. The privilege of the private car to use public space is coming to an end. In many cities, city tolls are being considered and scarce space is being redistributed. In the future, whoever has access to scarce public space will do the business in the transportation market. In this sense, politics at the local level is gaining in importance. It determines

the rules for new mobility services. These have great significance for the enforcement of good work.

Digital technologies can be used flexibly. But so far, the differences between men and women in employment rates, the share of part-time work, unpaid care and family work, managerial positions and wages have hardly narrowed. In fact, during the COVID-19 crisis, these inequalities worsened. It is widely recognized that better gender balance not only benefits women, but also brings business and economic benefits. This also applies to the digital mobility of tomorrow.

In the face of digitalization and a new world of "private public transport," union strategies face fundamental challenges: Established industries as well as companies as places for negotiating conflicts of interest are losing importance. The organization of work is becoming more flexible in terms of location and time, its content more abstract and dispositive. The pressure to retrain is increasing, and future training and qualification programs will have to teach more IT skills.

Finally, certain limitations apply to this study. For example, the important trade union discussion of gender equity is only outlined. The important issue of development in the global South is not addressed at all. Geographically, the study is related to the early industrialized and thus early motorized world. The point of reference is primarily Europe, with Germany as the strongest European economy. Even though the study focuses on more recent developments in the field of digital mobility services, this does not mean that long-standing struggles for good working conditions and against exploitation or tariff evasion through outsourcing and contracting are considered unimportant. They are important and will remain so. Rather, we are arguing for a broadening of the perspective, which has so far been primarily sector- and company-related.

Zusammenfassung

Der hohe Anteil an motorisierten Fahrzeugen führt vor allem in den Zentren der Großstädte zu erheblichen Funktionsproblemen. Zudem ist die Abhängigkeit von fossilen Brennstoffen nicht mehr nur ein Klimaproblem, sondern auch ein Problem des Weltfriedens. Gleichzeitig entwickeln sich vor allem in den Städten neue Formen der Mobilität. Bei jungen Menschen rücken digitale Plattformen und Sharing-Dienste immer mehr in den Vordergrund. "Nutzen statt besitzen" ist ein Megatrend, der mit der Digitalisierung einhergeht und das Verhältnis von privatem und öffentlichem Verkehr auf den Kopf stellt. Im Zuge der Covid-Pandemie haben neue Formen des mobilen Arbeitens an Bedeutung gewonnen, was sich stark auf das Mobilitätsverhalten auswirkt und die Dynamik der Digitalisierung durch noch mehr Flexibilisierung weiter erhöht.

Automatisiertes Fahren und neue Plattformen stellen auch den öffentlichen Verkehr auf den Kopf und schaffen neue Optionen. Neue Anbieter irritieren die etablierten Märkte. Die dominierenden Akteure in der Automobilindustrie und im öffentlichen Verkehr haben Mühe, mit diesem Innovationstempo mitzuhalten. Die Betreiber digitaler Plattformen sind eigentlich besser geeignet, digital vermittelte Mobilitätsdienste zu entwickeln, einzuführen und zu betreiben. Dies hat auch Auswirkungen auf die Beschäftigung. Während der Wandel der Antriebstechnik in der Automobilindustrie und die Digitalisierung in der Produktion bereits zu einem Rückgang des Arbeitsvolumens bei den Automobilherstellern und ihren Zulieferern geführt haben, entstehen gleichzeitig neue Arbeitsplätze in der Softwareentwicklung und bei Mobilitätsdienstleistungen. Der Verkehrssektor ist jedoch traditionell männerdominiert. Neue Technologien ermöglichen im Prinzip eine frauengerechte Gestaltung der Arbeitsplätze. Dies erfordert eine proaktive Regulierung.

Letztlich liegt es aber an den politischen Akteuren zu entscheiden, wer sich in der Zukunft der Mobilität durchsetzen wird und unter welchen Bedingungen Produkte und Geschäftsmodelle entwickelt werden können. Das Privileg des Privatautos, den öffentlichen Raum zu nutzen, geht zu Ende. In vielen Städten wird über eine City-Maut nachgedacht und der knappe Raum wird neu verteilt. In Zukunft wird derjenige das Geschäft auf dem

Verkehrsmarkt machen, der Zugang zum knappen öffentlichen Raum hat. In diesem Sinne gewinnt die Politik auf lokaler Ebene an Bedeutung. Sie bestimmt die Regeln für neue Mobilitätsdienstleistungen. Diese haben eine große Bedeutung für die Durchsetzung von guter Arbeit.

Digitale Technologien können flexibel eingesetzt werden. Doch bisher haben sich die Unterschiede zwischen Männern und Frauen bei den Beschäftigungsquoten, dem Anteil der Teilzeitarbeit, der unbezahlten Betreuungs- und Familienarbeit, den Führungspositionen und den Löhnen kaum verringert. In der COVID-19-Krise haben sich diese Ungleichheiten sogar noch weiter verschärft. Es ist weithin anerkannt, dass ein besseres Gleichgewicht zwischen den Geschlechtern nicht nur den Frauen zugutekommt, sondern auch geschäftliche und wirtschaftliche Vorteile mit sich bringt. Dies gilt auch für die digitale Mobilität von morgen.

Angesichts der Digitalisierung und einer neuen Welt des "privaten öffentlichen Verkehrs" stehen gewerkschaftliche Strategien vor grundlegenden Herausforderungen: Etablierte Branchen sowie Unternehmen als Orte der Aushandlung von Interessenkonflikten verlieren an Bedeutung. Die Arbeitsorganisation wird orts- und zeitflexibler, ihre Inhalte abstrakter und dispositiver. Der Umschulungsdruck steigt, zukünftige Ausbildungs- und Qualifizierungsangebote müssen mehr IT-Kompetenzen vermitteln.

Schließlich gelten für diese Studie gewisse Einschränkungen. So wird beispielsweise die wichtige gewerkschaftliche Diskussion um Geschlechtergerechtigkeit nur skizziert. Das wichtige Thema der Entwicklung des globalen Südens wird überhaupt nicht behandelt. Geographisch ist die Studie auf die früh industrialisierte und damit auch früh motorisierte Welt bezogen. Der Bezugspunkt ist vor allem Europa mit Deutschland als stärkster europäischer Volkswirtschaft. Auch wenn sich die Studie auf neuere Entwicklungen im Bereich der digitalen Mobilitätsdienstleistungen konzentriert, bedeutet dies nicht, dass langjährige Kämpfe für gute Arbeitsbedingungen und gegen Ausbeutung oder Tarifflucht durch Outsourcing und Contracting als unwichtig angesehen werden. Sie sind wichtig und werden es auch bleiben. Vielmehr plädieren wir für eine Erweiterung der Perspektive, die bisher vor allem branchen- und unternehmensbezogen war.

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1 Propositions on the General Assessment of the Future of Mobility

Proposition No 1: Existing transportation systems are under pressure and not fit for the future.

The Covid pandemic and Russia's invasion of Ukraine, as well as climate change, demonstrate the vulnerability and susceptibility of the global economy. The western interpretation of modern societies with economic structures based on the division of labor and space is reaching its limits. Central to this is the policy of lowering spatial resistance by heavily subsidizing fossil fuel transportation systems to keep people and goods mobile as indefinitely as possible to ensure economic prosperity while achieving a high level of social integration. The result shows though that a permanent acceleration of mobility can neither secure social stability nor is it sustainable. Digitalization and demographic change put further pressure on social systems. In a simple but also radical consequence, this means that in their present form the transportation modes of the western world have no future: they neither contribute to lasting peace nor can they ensure sufficient social justice. They consume more resources than the earth can sustain, indicators of which are wars, growing social inequality, and the climate crisis.

At the center of this criticism is the car: it needs too many resources, too much space, and no longer works in metropolitan areas. More cars do not promise more prosperity, nor more social progress. Not only in the West, metropolitan areas are clogged up with traffic. Neither does car use in its current form serve as a suitable future model for the Americas, Africa, or Asia.

From a trade union perspective, this has two consequences for a future strategy: Means of transportation are always tied to the respective social system that they literally transport. One is well advised to regard the existing transport systems as needing fundamental reform. Thus, a commitment to preserving the status quo makes in fact no sense, as no lasting success can be expected.

Proposition No 2: Western mobility still has a strong focus on the automobile in passenger and freight transport.

The image of western modernity with the car as its material core is fading. Nevertheless, all political formats have so far focused on the car as *the* means of transport for both people and goods. The western model of a basic market capitalist order and individual freedom was closely tied to the privately used automobile. Public transport, except in metropolitan areas, is organized only as an overflow or residual use: planned for people who cannot or do not want to own a car.

Still, the automobile continues to be the focus of the western world, covering more than 80 per cent of passenger and freight traffic. Life and work are grouped around the car. Settlement patterns in the western world are still built around the car. The "Athens Charter", once a progressive manifesto of western modernity, is still relevant to all political planning programs, and the ordering of public space also still focuses on the car as the dominant means of transport. The auto industry and its unions have benefited from this powerful system. Corporatism has become a stabilizing factor of western societies, where good work brought good money.

But here, too, the limits are clearly perceptible. The western model of unlimited mobility is also reaching its limits because societies have become more diverse and fragile in their social structure. Individualization and pluralization of lifestyles and work patterns are advancing, reinforced by digitalization. Societies are becoming increasingly "singular". Standard life courses with standard biographies are becoming the exception, while old certainties of private happiness are eroding.

Proposition No 3: The future of mobility lies in the digital networking of different means of transport in public spaces.

What will future mobility look like under these conditions? The decisive factors are an increase in efficiency, improved social integrity, and independence from fossil resources. Increasingly fragile social structures and the dissolution of traditional conventions and reliability are also leading to a change in the basic order of transportation. What Jeremy Rifkin called "access" (and predicted in 2000) is slowly becoming empirical reality: functions are becoming increasingly separated from ownership. It is no longer the exclusive ownership of a means of transport that is decisive, but access for a limited period. This is because the latter increases the situational flexibility of always having the right transportation device available in different places with different needs. This shift from "owning" to "using" is associated with general changes in the value chains: less production – more services. This means that fewer devices are being built, while at the same time more digital networking is taking place. The individuality and plurality of social development cannot be stopped. The car made this development possible in the first place, but it needs redefining. Digitization allows everyone to access everything. Everyone can organize their desired form of mobility very individually and very privately. The smartphone makes the networking of cars, bicycles, buses, and trains simple, convenient, and efficient.

Digital access to all means of transportation creates the conditions for an efficient and very convenient use of transportation. Individualization does not require an exclusive device; individualization means roaming the transportation landscape. In future, there will be two levels of transportation: firstly, the means of transportation

themselves, such as cars, buses, and trains, and secondly, networking as a new service: Mobility as a Service.

Proposition No 4: The arenas of political negotiation are changing.

Trade union struggles have always focused on organizing to advance workers' interests. With a high degree of organization, it has been possible to shape working conditions and wage structures effectively and successfully in prospering industries. Especially in Germany, the auto industry is considered a successful example of union politics. State interests have generally supported this arrangement in Europe, not least because automobiles were enabled to dominate and occupy public space to a significant extent. The public transport sector, subject to state direction and financing, is also usually considered a successful example of trade union interest politics. To a large extent, working conditions and pay structures have been shaped in the interests of employees, among other things through a high degree of organization and the effective threat of strikes. Here, state interests have generally focused on the provision of minimum standards of transportation services, usually not based on efficiency criteria.

Yet in the age of digitalization and sustainable transport policy, these venues of trade union struggle are losing their significance. Due to the trends described above, it must be assumed that in the coming years, politics will be concerned with curbing the number of cars and making less public space available for them. But the public transport sector is also coming under pressure, as more and more public payments will have to be justified in terms of whether buses and trains are still efficient enough after the pandemic and in the age of digital services. In general, policymakers cannot continue to ignore the shortcomings in the performance of traditional transport providers – especially after the experience of the pandemic – and will be forced to act. Germany has so far provided a strong shield for guaranteeing the continued existence of public passenger transport with the construct of services of general interest, which has also been in the trade unions' interest. Though with the amendment of the Passenger Transportation Act and new options for the operation of autonomous vehicles on public roads, entirely new opportunities to change these basic orders are legally possible for the first time.

How this will be reflected in changes to the employment structure can currently only be estimated roughly, limited to submarkets. Germany is of particular interest in this regard. Uber, Google, and Tesla have already announced that they will be active in Germany with new products, as the country is considered a traditional car country with a very restrictive bureaucracy. So those who manage to establish new products and services in Germany benefit from a great deal of kudos, appearing to be able to hold their ground in other markets as well.

In addition to a strong automotive industry, Germany has a public transport sector under special state protection. Calculations by the National Platform for Electromobility (NPE) and the National Platform for Mobility (NPM) as to what effects shifts in the transport sector can be expected to have on the number and quality of jobs have been available for Germany since 2012. Depending on different premises and biases, these numbers look different of course. But when all studies are taken together, a consistent picture emerges. It can be expected that by 2050, about one-third of employment in the construction of automobiles will be eliminated. This is due to annual productivity gains coupled with a slight decline in output volumes. In the much smaller traditional public transport sector, a decline of around 10 per cent is expected by 2050, because financing will no longer be possible at the previous level, and capacities will be reduced. Overall, though, the development of new services around digital networking will compensate for this loss. As a result of these shifts, the future total volume of employment will probably remain the same. However, skills profiles will shift considerably, and what pay structures and working conditions will look like will also depend on the success of trade union interventions. Yet the conditions for these disputes are changing fundamentally.

Against the background of the challenges described above, the question of the future of transportation systems and the quality of work will be decided by the political redesign of the public sphere. Union success will depend on their respective presence in these new arenas. It can be expected that business models will depend on the space available for operating the respective equipment and the conditions attached to it. While both the "car system" and "public transport" have been politically protected up until now, this is going to change in the coming decades. The companies of the digital platform economy have been undermining this supremacy for some time. The Californian company Uber is a pioneer in this respect and has successfully claimed new business areas throughout the world. If such digital companies were to become more established in quantity, options would be significantly altered not only for the traditional cab and rental car industry, but also for public transport. As spaces in metropolitan areas are becoming increasingly scarce and new pooling services could significantly reduce the number of vehicles, ultimately, companies in the automotive industry would also come under pressure. It remains to be seen who will dominate the business of autonomous vehicle fleets. The question is whether car manufacturers or public transport providers could currently master this. Can this new service be integrated into their core business? It has been announced that in future, public service contracts will be put out to tender as functional services in order to improve efficiency in transportation.

Proposition No 5: The new players operate differently: a new set of rules.

From a trade union perspective, it is crucial that the new companies serve the megatrend of "access" rather than ownership. This approach of the platform economy is in line with a "higher reason". It fits in with our times in terms of convenience, operating qualities, and the variety of options for sustainable transportation. This has significant consequences for the business model in question. After all, these companies are not guided by quarterly financial statements and are not disciplined by business management analyses (BWA) in small-scale business processes. They think "bigger" in the truest sense of the word and pursue the idea of time, namely, to provide transportation services that are committed to using rather than owning. Operating in harmony with this "higher reason" also provides the basis for financing these companies. The core of the business model is not primarily an operating profit, but the marketing of an idea. This only works if this basic idea is credible and plausible in individual references and, above all, can be demonstrated as scalable. If this is the case, then venture capital firms or even the classic capital markets are the primary financiers with a view to increasing the value of this idea in the long term. Whether Google, Apple, Tesla, or Uber: all U.S. companies with a very high stock market value operate on this basis. At the same time, traditional opportunities for trade unions to participate in decision-making are generally difficult to realize in these business models. Unions can only achieve something for the workforce if the earnings situation opens up a corresponding scope for distribution in the first place. Capitalizing on an idea, a prospect, or a hope and sharing in the profits represents a new challenge. Also, in order to be able to influence issues of working conditions more effectively in tech companies, new options of trade union activities beyond traditional works council work would be useful. In summary, the boundary conditions for future trade union work in the transportation sector are:

- *Conventional car production and the operation of public buses and trains are coming under severe pressure and will lose importance.*
- *For future mobility providers, business success will depend on the political shaping of the public sphere.*
- *Companies that are successful in the new mobility services operate by marketing ideas.*

Proposition No 6: Unionist modes of struggle must change.

Regarding the future of mobility, the strategic question for trade unions is how to effectively represent workers' interests under these changed boundary conditions. This could probably be achieved less by focusing on the companies and enterprises but rather through a strong engagement in defining the operating conditions for

the new services in the public sphere. After all, to be in line with a "higher reason" and thus generate funding opportunities, public space must be made available as a new business field. In democratic societies, the rules for future management can only be determined in a public discourse and regulated by parliaments in the appropriate forms of tendering and awarding. Through the management rules of these spaces, it is the public sector that determines who can credibly market these new ideas, where and how, in order to generate operational profits. These rules must provide answers to the following questions: who is allowed to park, drive, load, and how much does it cost? What space should private vehicles occupy in cities at all, and what does regulation for robo-taxis look like? What data must be made available to whom, when, and in what formats?

This would also redefine a lever of union power. As a defining point for business success, the individual organization, the company, loses importance, while local politics gains. Whether good work is paid well depends on the publicly defined rules for such services: it is becoming apparent that in future, not only buses and trains will be defined in their operating conditions by a public service contract, but also the offer of scooters, bikes, and cars in the form of sharing, leasing, hailing, or pooling. In concrete terms, this means that in future, anyone who wants to do business using public space, including in the form of marketing a good idea, must ensure "good work". Trade unions must renegotiate with the municipalities what the conditions are for this in detail. As a result, as a field of trade union activity, companies are losing importance, while the local level is gaining with its framework-setting competence. Influence on the guarantee of "good work" can be exerted via the politically legitimized participation bodies such as political parties, but it can also lie in participating in the public discourse. The central question is though what such trade union activity would look like. The public sphere can certainly not be defined simply by a high degree of organization in the workplace and the implicit threat of strikes. It would be conceivable to secure "good work" through traditional political representatives defining standards, but the reputation and standing of the companies themselves could also be made an issue. Those who do not offer good work ought to have trouble marketing their respective good idea. Trade unions could form new and strengthened alliances with NGOs to influence the formation of opinion and the reputation of companies. The example of Uber shows that if a reputation is damaged, state regulation can block new markets altogether, as the examples of France and Germany have shown. In the long term, though, such a policy can only be successful if the entire political space is covered and completely redesigned.

Local actors always work within a larger political framework. Whether this will be the respective national legislative competencies or whether the EU will develop into a Europe of the regions is not yet decided. In any case, trade unions are well advised to actively shape the international and national political framework conditions for the good work of new services in the public sphere.

2 Platforms and Mobility as a Service: New Power Relations

In future, two different levels will define traffic: first, the means of transport such as cars, trains, buses, bicycles, and the necessary infrastructures such as roads, bridges, and rails. In addition to this, a second level will provide these services through digital platforms and decide over access, the form of use, and control and billing of the systems. Whereas analyses used to be grouped around the individual modes of air, road, water, and rail, and transport systems were differentiated between (private) road vehicles on the one hand and (public) bus and rail systems on the other, this second level will determine the future of mobility. People no longer buy or lease a single means of transport, but book temporary slots, access points that are used for a limited time and space, depending on availability and purpose of use. Accordingly, the digital presence of the various devices on these platforms increasingly determines which device is used in what manner and with what frequency. Access to individual means of transportation no longer takes place directly, but only mediated via digital media.

2.1 New Options Through Digital Networking

The current state of the transportation market is comparable to that of the internet before the invention of browsers. Before the introduction of Mozilla or Netscape, access to the options of the worldwide web was only possible through complicated hieroglyphic-like addressing, practically only usable by experts. With the help of browsers and by agreeing on common protocols, an interface that could be used by everyone could be established, which made searching and finding addresses child's play. Browsing through the entire world with an IP address became easy and convenient for everyone.

Mindful of this, intermodal services could resonate strongly. With an app, access to all publicly available means of transport could be made possible. Booking information, access, and usage would be all managed under one customer account. The new service would be responsible to the end customer, who would be the holder of all rights and obligations. The service itself would simply buy from the transport provider whichever service the customer clicks on and secure the transaction by the corresponding digital available legitimation. During use, the tariff and terms of use proclaimed by the transport provider would apply. With the app, all valid and digitally available offers of all public transport and affiliated sharing providers could be used. From one-way tickets over e-trolleys and pedelecs to long-distance journeys and car-sharing cars. One could book both planned and spontaneous trips. The app would always show the current surroundings and the matching means of transport available. These services would manage the customers' master data. The transportation providers, in turn, would only see the ID. This function could be

called single sign-on, even though the term roaming, borrowed from the mobile communications market, seems more appropriate.

In the digital age, self-mobility will thus be interpreted even more radically and without any device-related restrictions. Slots will simply be managed. "Physicality" disappears behind digitality. I decide here and now what I use. Planning and deployment efforts are radically minimized, and application options become even more diverse. What appears digital can be used instantaneously – or later. The technical characteristics of the various devices, be it a car, bicycle, train, or bus, recede in importance. From a sociological point of view, it is unlikely that modern, democratic societies will abandon the path of digitalization. In this respect, pre-modern structures are overcome by means of technology. Laws or regulations from the analog era can hardly stop the self-determination of the ego in the long term, even in traffic. And the radical thing about digitality is that the private sphere no longer needs its own exclusive space. This means that – leaving the circumstances of the pandemic aside for a moment – vessels "experience" a different meaning. With the button in my ear and the mobile device in my pocket, I have everything I need with me; my immediate surroundings and thus also the quality of the space around me disappear or at least become less important.

As a result, the weights in the value chain of transportation are also shifting. Automobile brands are fading, cars are becoming simple pieces of equipment, and their use is decided upon in a digital marketplace. It is one of the subtle effects of digital applications: wants and needs, indeed consumer behavior as a whole, are being changed by smartphone use without individuals always being aware of it. It is true that an app alone still does not transport a person from A to B. But it is also true that it is not always available. Anything that does not appear digitally, that is not available, ceases to exist.

If you take a close look at the individual stages of the value chain, the hardware components represent a much larger share of the value, but whether these components are used at all, how they are used and combined, is decided by the rulers of the platforms. The company Clever Shuttle – a provider of on-demand transport – has calculated that the software components, including all scheduling and billing processes, represent only 10 to 15 per cent of the overall service process. But it is precisely this part of the product that determines whether the much larger remaining part is used in the first place.

Digital media are also increasingly changing the immediate driving and travel experience. The immediate experience is increasingly being eclipsed by the digital. Time spent in space is being used more and more to be online, and journeys on local and long-distance public transport are good opportunities for communication and information. Not with fellow passengers, but with friends, relatives, and acquaintances elsewhere in the world. With the exceptions of vacation and other adventure trips, the use of transportation is turning into individual infotainment.

This has considerable consequences for employment and qualification profiles, but above all for power constellations. Whereas in the days of the analog transportation world, it was important to develop good hardware qualities, and the famous "gap dimension" was an indicator of a car's value, in future, this alone will no longer be sufficient. Whether the hardware can hold its own, whether it is bought and used, will be decided by a vehicle's presence on the digital level. To put it bluntly, power has shifted from hardware to software, and the quality of apps and programs is crucial for economic success. This will obviously necessitate different business models and, above all, completely different qualification profiles, which will be discussed in more detail further on. Fundamental professional understandings will also change though. For successful software, "trial and error" is a decisive prerequisite, whereas in traditional mechanical engineering, the opposite is true: a risk-averse approach dominates, always operating from the secure "state of the art". The dominance of the skilled worker is thus clearly relativized.

2.2 The Car as a Type of Smartphone

These options offered by digital platforms are only just beginning to emerge. However, the extent to which digitization is already changing hardware can be seen in the car as a product and in the example of Tesla, a carmaker that sees the vehicle as a kind of smartphone. Tesla is Apple and Foxconn in one company, as it were: high-quality hardware is produced, but it is both shaped and controlled by a software brand image. While the options are installed in the vehicle technology, the valorization is produced by the software. Analogous to the smartphone, the hardware receives regular updates. The individual vehicles are permanently modernized, so to speak, by the company's own software via an open-air interface. Following an update, one suddenly finds the images of a camera for reversing on the display, which had not been activated before the update. For the understanding of a car, this is revolutionary. It is no longer an individual model series or permanently installed construction parts that characterize a vehicle's properties and value, but the latest update. And like smartphones, as these updates evolve, the hardware eventually becomes insufficient and must be replaced by new hardware.

The path taken by Tesla is not only being rewarded by the stock market – the company's valuation has been as high as that of all major automakers combined – but the new understanding of an automobile established by Tesla is also being adapted by competitors. VW AG's platform project for example puts everything in the way cars have been built at Volkswagen so far in the shade and is practically a copy of Tesla – a company that has only existed in its current form since 2008.

But in the world of Tesla, the dominance of software and its associated skills is only the first step in the new digital networking. In the U.S., cars are already being sold as part of a domestic power plant that enables a complete energy supply based on

renewable energies, in that the storage landscape is expanded around the car batteries and becomes a "Micro Smart Grid" through bidirectional charging. Yet most automakers (the only exceptions besides Tesla being Toyota and Honda) still avoid this idea – which is not new – because the control center is still in the hardware and not in distributed systems as in the case of grids. The dominant understanding among carmakers is that intelligence is built into the car itself and not hidden in a multi-part system.

Tesla's next step, also preconfigured, is to extend the vehicle into a sharing system. Buyers of a Tesla can simply "free up" their vehicle for use by others, creating a private sharing business. Open digital access allows easy use by others suitable for private but also commercial sharing as well as intermodal offers.

With all other manufacturers, this function is not possible either, because the CAN bus – the control heart of a car, so to speak – is a permanently installed relic of sealed-off firmware, stemming from a hardware philosophy that knows no networking.

Tesla is therefore the only car manufacturer able to use the options of automated driving (see below) to enter new business models. Tesla has successfully managed to integrate both levels of hardware and software in one company. That makes it also a part of a digital platform economy like the one operated by the big tech firms.

2.3 The Isolated World of Public Transport Operators

Public transport operators, on the other hand, have not yet entered the world of new digital platforms. Neither the large state-owned railroad groups such as the French National Railway Company SNCF, the Swiss and Austrian Federal Railways SBB and ÖBB, or the German Railways DB, nor the private international bus and rail operators such as Go Ahead, Transdev, or Arriva have entered this segment beyond prototype applications. Quite the opposite: similar to the automotive manufacturers stuck in their (hardware) core business, public transport operators are busy securing their existing market segment. However, in Europe, or indeed in other parts of the world, public transport is organized via tenders, and the terms and conditions for transport services to be provided are set by the authorities or agencies commissioned by them, and are generally heavily regulated. There is virtually no entrepreneurial leeway in public transport markets.

In addition, public transport companies around the world are struggling with the effects of the pandemic. Pre-pandemic traffic volumes have yet to be regained. Due to complex political requirements, the entrepreneurial options of public transport companies in local and long-distance traffic are often very limited. However, as a rule, the companies that have won a transport contract are adequately financed, regardless of whether they are privately or publicly owned. Yet to invest in the busi-

ness of digital platforms, they lack the incentives, the capacities, and the competencies. Companies are therefore more inclined to seal off their existing business from digital platforms and to prohibit digital networking among themselves. Large companies have a number of research projects on autonomous driving or new digital services, but these are not linked to their core business and do not play a strategic role. The decisive factors are solely operational concerns, the famous circulation plans. Whether an offer make sense is not decided by customers, but solely by the logic of the operation. Hence, there are line offers that nobody needs, fares and honeycombs that nobody understands, but which are not noticed because nobody notices them. Those without an alternative buy a subscription, others do not even board a train. There is no need to digitize the service. A ticket vending machine or even the occasional service at the ticket counter are sufficient.

To date, no company or association in Europe allows external companies – even those from its own industry – to market tickets or other offers. The use of external customers remains excluded. Likewise, dynamic travel data is not made available, or only to a limited extent. In April 2022, the German Federal Cartel Office issued the first warning in this regard. Previously protected markets are becoming increasingly porous.

Generally, in transport the topic of big data is not yet an issue. It is true that there are a number of static timetable data from public operators as well as position data from the many rental and sharing vehicles. But as a general rule, all providers are concerned to keep their systems rather closed and not to reveal any dynamic data. National regulations also bear significant data protectionist traits. At the EU level, the revision of the European Directive MMTI DEL VO regarding dynamic data and possible regulatory approaches for multimodal booking systems are scheduled for 2022, but these will then have to be laboriously translated into the respective national law. In principle, the General Data Protection Regulation in Europe safeguards personal rights even when operating digital platforms. Personal data is only created and processed for billing purposes or at the express request of the person concerned. For the rest, the legal rules of digital payment apply, at least in Europe.

What about the role of big data and access to data? The transport sector could also benefit from big data. A lot of data is generated via sensors in the various means of transport, but also on the user side via positioning tools. Google's tracking data alone should provide an accurate picture of traffic flows and even individualized mobility patterns. Transport providers as well as transport planners and researchers are interested in these data. Although movement data must be anonymized for data protection reasons, they nevertheless allow patterns to be formed that are useful in many cases. Accordingly, aggregated movement data are in high demand. So far though, the use of privately generated data by third parties is either not possible at all or only possible subject to payment. Data from public institutions, on the other hand, are already to be disclosed, and for interested parties, access is to be created

free of charge. However, there is a general need for platforms for the fast and efficient exchange of data of different provenance. This requires a clear regulatory framework and standardization of data formats and transfer points. An intensive discussion on this is currently being held at the EU level (cf. in detail LEMO 2020).

2.4 Old Economy Companies Avoid New Economy Options

In summary, it can be said that the options of the digital platform are not yet being used by the transportation industry's existing players. Automakers remain stuck in their core business of hardware production. Only Volkswagen has recognized that in future, software features will control even the construction and functionality of cars and that the chassis, too, will be increasingly equipped with intelligence to bring the vehicles to automation levels 3 and 4. However, all but one of the world's automakers have decided to refrain from the operation of digital platforms and sharing systems. Individual manufacturers such as Volkswagen are attempting to establish a presence in at least sub-segments through the company's own rental car company.

Admittedly, other automotive companies consider the "robo-taxi" business with its reinvention of public transport a growth market. But the management teams of the largest manufacturers are hesitant as none of the groups wants to go into operations. At present, for example, out of the conventional auto firms, VW AG is in talks with Arriva and Transdev, and parallel activities are being prepared with the recently purchased subsidiary Europcar. Toyota and GM are also in trials with their own activities or with subsidiaries. But neither the carmakers nor the large private or public transport companies are willing or able to enter this future market.

The only exception is once again Tesla. The U.S. company is setting the pace for automakers and the future software offensive, and already has its sights firmly set on networking the car into new energy as well as sharing systems. Tesla is the only company that has a strategic and operational command of both levels of the new mobility market, i.e., hardware and software.

With a view to the options of digital platforms in connection with automated vehicles, it must be stated that neither the automotive manufacturers nor the transport companies with public sponsorship or public service contracts are going to become relevant players in this field at present or in the future. When asking leading representatives of these industries, one gets the impression that the companies without an operative transport business will dominate the business with digital platforms. First and foremost, of course, Google and Amazon, but also Uber, Lyft, and ViaVan. The reasons for this have already been indicated. Their corporate cultures do not operate in constrained traditional professional understandings and serve the narrative of the new mobility. This promises to be more efficient and, above all, more sustainable. The combination of high utility value, combined with significantly

lower environmental impact, also leads venture capitalists to step in with large sums of money.

From a trade union perspective, this is relevant because the degree of organizing is very high in the automotive industry, still good in public companies in the transport industry, but vanishingly low in companies in the digital economy.

3 Employment in Transition: State of the Discussion

The discussion about changes in employment in the transportation sector involves several dimensions. Firstly, automation and digitization as a double base trend have an impact on the scope and nature of employment as a whole. This affects production, as described above using the example of VW, but also services, including logistics. Automated driving is one variant of this. Secondly, in vehicle manufacturing, the change from the combustion engine to the electric drive is associated with a reshaping of the value chain and an overall reduction in the number of workers required. This will particularly affect traditionally highly unionized and attractively paid jobs in production. Some of these will be eliminated. And thirdly, the structural change that has already begun in the transport sector toward growing service shares, such as in driving services or digital platforms, also has a significant impact on employment. In the course of this structural change, new employment relationships are emerging in partially unregulated labor markets with a high share of (pseudo) self-employed. There are multiple interactions between these three dimensions of employment change. With in-company qualification programs, the driving change on the employment side can be organized in a socially acceptable way, at least to some extent. Yet the switch from the "old world of production" to a "new world of services" is difficult. The skills and qualifications required in each case differ from the previous ones, as do the respective training and occupational biographies.

On a European or even a global scale, making quantitative and qualitative statements about the impact of these trends in mobility on an empirically evident basis is possible only to a limited extent. In the following, the debate on the impact of changes in the transport sector on employees is traced using the case of Germany. In Germany, an intense debate has taken place since the early 2010s, particularly about the impact of electromobility on employment. For a long time, the highly competitive construction of combustion engines, especially in the premium segment, was considered the core competence of German manufacturers. Moreover, the automotive industry remains a key industry in Germany. For this reason, a number of studies were prepared, particularly as part of the "National Platform for Electromobility (NPE)" and subsequent "National Platform for Mobility (NPM)", in order to assess the impending effects as early and comprehensively as possible. These studies

can be taken as examples of both the trends and the magnitude of the shifts in the transport sector.

3.1 Mobility Economy as a Whole: More Employment Despite Structural Change

Together with the Fraunhofer Institute for Systems and Innovation Research ISI and on behalf of the Böckler Foundation, in the fall of 2020, M-Five presented a study on the overall economic effects of transformations in the mobility economy. The study focuses on the electrification of powertrains and the digitalization of vehicles and the resulting mobility services as well as production and distribution methods. The study considered the entire mobility economy, not just the motor vehicle sector. In two different scenarios, an electrification scenario (ES 2035) and a mobility services scenario (MM 2035), the employment effects in the areas of road vehicles, other vehicles (production), electrics and electronics, motor vehicle trade, land transport, and other transport were simulated. The elimination and creation of employment in all areas was eventually accounted for under "total transport".

In the calculations for both scenarios, there is a loss of employment in road vehicle production. This is primarily due to the elimination of conventional powertrain components. As in other studies, the consequences of the reduction in powertrain parts for electric traction become evident. The volume of work required to produce an electric motor is significantly lower than for the internal combustion engine. In addition, it is assumed that in 2035 the value-adding input products will still be imported to a considerable extent. The loss of employment can only be partially offset by increases in the development and production of innovative components such as driver assistance systems, increased infrastructure expansion, and more new jobs in mobility services (surface transport). At the same time, in both scenarios, many jobs are lost to automation. New employment can be created by growing public transport and, in the MM 2035 scenario, by new car services – especially car-sharing. Schade et al. see uncertainties in the employment effects of automation, digitization, and artificial intelligence. They point to technological, regulatory, and competitive developments that are difficult to predict.

The assumption is that the climate policy target is to be met in both scenarios. The internationally defined and binding CO_2 emission reduction targets (which have since been tightened further) are to be achieved. Therefore, in the ES 2035 scenario, a steep electrification curve is assumed with a moderate reduction in the number of vehicles, while in the MM 2035 scenario, the number of vehicles decreases drastically, and a shift to public transport as well as significant bundling effects due to a boom in sharing services are assumed. As a result, the two scenarios differ not only in that the mobility market in 2035 looks completely different in each case. The employment effects of the two development paths also differ significantly: "In both scenarios, the negative total employment shift by 2025 compared with 2015 is in the

order of 1 million gainfully employed persons (FTEs). By 2035, the figure increases to around 2 million. This means that at least two million workers will lose their current jobs because they will no longer exist. However, the positive employment shift is even larger at both points in time, and in 2035 it is about twice as high as the negative employment shift, so that up to 4 million people can be offered new employment in growing sectors" (Schade et al. 2020: 193).

Overall, both scenarios assume an increase in employment by 2035. The authors are thus significantly more optimistic than Cacilo and Haag, who published a study on the "Employment Impacts of Vehicle Digitization" in 2018, outlining a Mobility-as-a-Service (MaaS) scenario by 2030 that would lead to employment losses in the vehicle manufacturing sector. According to Cacilo and Haag, these would intensify after 2030. Anticipating a widespread establishment of MaaS not before the late 2020s, they write: "Since the period under consideration ends in 2030, the deceptive effect of a moderate development is created. However, if the period under consideration were extended, between 2030 and 2035 employment needs would shrink to a fraction of what they are today" (Cacilo, Haag 2018: 96). The M-Five authors link their optimism to the expectation that battery cells and entire battery systems, including power electronics, would in future be produced in Germany. The scenarios also assume such a shift of cell and battery production – so far mainly located in Asia – to Germany and Europe. This is the only way to achieve a high level of employment and the targeted value creation in the mobility industry. This also applies to the production of semiconductors and sensors for driver assistance systems (DAS) through to autonomous driving, as well as to development and software-side control. An important potential for employment and value creation in Germany lies in the production of hardware and software.

The authors see two possible variants for the development path of multimodality in the MM 35 scenario, without hiding their leaning toward the second variant: on the one hand, they see a "low-cost variant", meaning a cross-financing of low-cost mobility services by using the data generated. This variant, ultimately financed through advertising and neglecting the real costs of mobility, is likely to be not only detrimental to privacy, but also associated with low incomes for employees. On the other hand, they consider a "premium variant" to be possible – and desirable. In this variant, users' mobility data remain private. Mobility services are not cross-financed but priced to include environmental and privacy costs. Employees in this market would, the authors assume, be adequately compensated. However, they link these market predictions to certain preconditions being in place: strong data protection would be needed, as would be the existence of one or a few European IT companies with the necessary skills in big data, cloud storage, and sufficient credibility with regard to privacy. In the authors' view, creating these conditions should be the goal of an ambitious European industrial policy.

Using Volkswagen (VW) as an example and on behalf of VW's Sustainability Advisory Board, Herrmann et al. from the Fraunhofer Institute for Industrial Engineering IAO also attempted to capture both the quantitative and qualitative effects of electrification and digitalization on the automotive sector in their study "Employment 2030" (see Herrmann et al. 2020). As far as the scope of employment is concerned, they draw a picture characterized by a "multiple intertwined juxtaposition of job creation, job upgrading and job loss" up to the year 2030. In view of demographic changes, i.e., foreseeable waves of retirements and a shortage of skilled workers, the associated adjustments could probably be made. Changes in the demands on the future workforce pose a greater challenge, as they require a "massive buildup of skills". According to the authors, this is associated with a "profound change in corporate cultures". The keywords are well known from corporate culture debates: more interdisciplinarity, more flexibility, flat hierarchies, cross-company cooperation, open data, more diversity. All of this is associated with a broad transformation of a previously rather pillarized and clearly functionally divided industry. Hermann et al. see the core tasks of the upcoming structural change not only in the development of skills, especially in the development and application of information and communication technologies, but also in the necessary transformation in all company dimensions.

The latest interim report of WG 4 of the National Platform Mobility (NPM) also argues that power electronics will be crucial in terms of employment policy, especially in future vehicle construction. This applies to all vehicles with an electrified powertrain, from mild hybrids (in some cases already micro-hybrids) and plug-in hybrids to battery- and fuel cell-electric cars, trucks, and buses. It is required for both a high AC voltage for the drive itself and a low DC voltage for auxiliary units. Favorable energy consumption and thus a high vehicle range require efficient power electronics. Both on the vehicle side and for the charging infrastructure, power electronics play a major role. Hence, WG 4 sees considerable employment potential in this area. Particularly high employment effects are seen in the use of hydrogen fuel cells, but this is likely at best in niche applications, at least in the passenger car sector. Overall, one of the authors sums up the employment development for German manufacturers as follows: "With the know-how available in this country, Germany can play a leading role, or even the leading role, in the fields listed and beyond, and tap the value creation and employment potential offered in each case. However, this is also necessary. After all, the value added and employment that will disappear in the course of the transformation with the internal combustion engine will be considerable. Compensation will only be possible by operating in a dominant position in as many of the future relevant areas as possible" (Borrmann 2022).

In recent discussions about the employment effects of structural change in the mobility economy, the areas of logistics and CEP services have received increasing attention. For example, Alexandros Nikitas et al. (2021) estimate employment effects of a progressive spread of Automated Driving in freight transport and distribution. They examine the impact of these technological changes on logistics employees and

their labor relations. The focus is on digitalization in urban food logistics in terms of perceptions of autonomy and control from the perspective of the workforce. They want to know what labor relations look like. The analysis is based on a qualitative study with professional drivers as well as courier drivers in urban food logistics. As a result, the simultaneity of autonomy and control that occurs with the integration of new technologies into work organization becomes evident in everyday life. Managers and their need for control play an important role. On this basis, the authors call for the scope for shaping digitization processes to be used so that employees' autonomy can be strengthened.

In a short study for the Rosa Luxemburg Foundation, Candeias and Krull (2022) also focus on the employment effects of structural change in the entire mobility sector. For the automotive industry, they see – as do the other studies – the digitization of mobility and the change in drive systems to e-mobility, in addition to increased competition in the course of transnationalization and an accompanying surge in rationalization. Each of these aspects is associated with increasing pressure on collectively agreed standards, pay, and working conditions, as well as rising demands on employees and more work intensification. As a result of these factors, some of which are mutually reinforcing, the authors expect a reduction in employment in the vehicle manufacturing sector in the order of several hundred thousand people. Accordingly, they call for independent and more far-reaching concepts and practices for a real and just mobility transition and a socio-ecological restructuring of the mobility industries. In their view, this is only possible in an alliance of employees and trade unions from different sectors, together with the environmental and climate movement, the social and political left, and critical science.

3.2 Similar Effects in Europe

This discussion on the effects of automation and digitalization, on the shift in the type of engine away from the internal combustion engine (the so-called "Antriebswende"), and on the structural change of the transport sector toward electrification and more services, as presented in the German example, finds its counterpart in the Europe-wide view. For example, the CAR Institute has presented a simulation of the effects of stricter CO_2 emission limits leading to accelerated electrification of powertrains for the European automotive industry (CAR 2021). The simulation's starting point is the EU Commission's plan to impose stricter limits on CO_2 emissions for new cars. According to this plan, from 2030 onward, fleet average emissions of only 47.5 grams of CO_2 per kilometer are to be permitted for new cars, which corresponds to a halving of the current limit and cannot be achieved with internal combustion engine technology. The simulation examines the impact of such stricter regulation on employment in the automotive industry of the five EU member states Germany, France, Italy, Spain, and Slovakia. These countries assemble approximately 70 per cent of the total number of passenger cars produced in the EU.

The analysis based on data for 2019 and 2020 shows that only minor negative employment effects are expected for the automotive industry from the accelerated electrification of powertrains. The losses range from 1.8 per cent in Germany to 2.1 per cent in Spain. Overall, 1.9 per cent of today's jobs in the European auto industry would no longer be needed in 2030 to produce the by then slightly increasing number of cars (with a rapidly increasing share of e-vehicles).

After the at times dramatic warnings of drastic job losses as a result of the transition in the types of engine in the 2010s, the mood has recently turned. In the fall of 2021, Agora Verkehrswende, together with Boston Consulting, published an overview of the job losses often feared in public debates in some key European automotive-producing countries following an accelerated drive transformation by 2030 (Agora Verkehrswende 2021). According to this, the transformation in engine types will have only a minor impact on the overall number of jobs. The reasons for this are not only to be found in electrification: in addition to the elimination of jobs in the labor-intensive production of internal combustion engines, this is in fact also due to continuous productivity growth, which in developed industries is 1 to 2 per cent per year. Incidentally, the risks of transformation in the auto industry and thus also the employment losses are unevenly distributed in several ways. Firstly, between the OEMs and the suppliers, and secondly between the suppliers themselves. The suppliers who have been producing parts for the combustion engine are particularly hard hit. It is therefore not surprising when in its "Global Risk Monitor" 2021, the consulting firm Deloitte assigns the highest risk ratings to the manufacturers of combustion engines, exhaust systems, interiors, and fuel systems (Deloitte 2021).

The probably relatively low negative effect on employment in the automotive industry is based not least on the assumption that the competitive position of European automakers will improve compared with their Asian and North American competitors. For as the authors argue, "an early switch to electric cars promotes the build-up of economies of scale and future competitive advantages in the automotive industry. If the switch to CO_2-free passenger cars in Europe comes too late, Europe will be exposed to competitive and cost disadvantages, in contrast to Asia and North America" (CAR 2021: 2). In their study, they emphasize the potential for new jobs in battery cell production, for example. Stricter EU emission limits thus lead to positive employment effects. This aligns CAR's authors with the findings of a 2018 Cambridge Economics study, "Reviewing the impact of the low-carbon mobility transition on jobs", which also assumes only minor losses in vehicle manufacturing employment (Cambridge Economics 2018). Coping with employment losses will also be facilitated by the fact that the advanced average age of workforces in car companies will lead to an above-average number of retirements within the current decade. This could avoid layoffs. However, this does not diminish the relevance of retraining and qualification programs.

In fact, the transport sector as a whole is likely to see a slight growth in employment. The authors of Agora Verkehrswende and Boston Consulting expect a net increase of 25,000 jobs: While up to 180,000 jobs will be lost at traditional automakers, 95,000 new jobs will be created in battery production. The great demand for charging infrastructure will lead to the creation of 70,000 new jobs. The demand for skilled workers with an electrical engineering focus is rising massively. In their estimates, one of the things needed is a further training offensive. As a result of the transformation, there are around 260,000 new jobs to be filled in battery manufacturing, software development, and the construction and operation of charging infrastructure. Agora Verkehrswende and Boston Consulting point out that, in addition, retirement and fluctuation are expected to create a need for more than 800,000 personnel by 2030. Every second job in the automotive industry will have to be filled. At the same time, many activities are changing, or jobs are being eliminated altogether. Almost as many employees will have to be retrained, a good third of them for completely new requirement profiles (Agora Verkehrswende 2021).

The positive overall balance cannot hide the fact that there will be significant shifts in value creation at OEMs and suppliers, and thus also in employment. Boston Consulting, for example, expects European OEMs and first-tier suppliers to shed 500,000 jobs by 2030, while new suppliers, the energy companies, and infrastructure providers will create almost as many new jobs (Boston Consulting 2021: 26). Cambridge Economics, but also management consultancies such as Boston Consulting or McKinsey, have repeatedly pointed to the creation of new cross-sector employment. This is because a completely new charging infrastructure needs to be built for electromobility. A rapid transition to electromobility will benefit sectors such as the construction industry, the electricity industry, the hydrogen industry, and service providers for billing and roaming for charging processes.

The vehicle industry's change in drive technology from the combustion engine to the electric drive is at the center of professional and public attention. Apart from electromobility, with the digitalization of the mobility sector, new good jobs will be created, especially in IT. There has been a greater need for workers in the transport sector for some time now, though only in traditional occupations such as vehicle drivers and in the logistics sector, especially truck drivers, while employment in similarly traditional counter operations for ticket sales is declining, due to automation and online ticketing. Then again, new and generally well-paid jobs are being created in software programming and maintenance. The demand for IT specialists is growing both in the automotive sector and in public transport. It can only be met in part by retraining employees. This demand for IT skills meets with a competing demand in other sectors, resulting in an overall higher level of pay. In addition to higher wages, the new IT employees in the transport sector are likely to have additional individual demands on working conditions. Issues such as the work-life balance and working from home will become more important.

3.3 What Skills Will Be Needed in the Future and How They Can be Secured

The skill level in the automotive industry continues to rise. The transition in the type of engine and, above all, connected and automated mobility require a great deal of software expertise. Software developers are recruited through new hires and company acquisitions. The automotive industry is setting aside substantial budgets for this purpose. IT competencies are fiercely contested. Both the OEMs' platform strategies and their powertrain electrification activities rely on IT specialists.

In addition to IT skills, more traditional design and engineering skills will be needed, especially in manufacturing (Cedefop 2021). At the same time, electrotechnical skills will become more important for vehicle and (charging) infrastructure maintenance as well as for monitoring operations and crisis management. In these service sectors, too, the qualification requirements will be high; not least, direct customer contact requires soft skills. The same applies to public transportation. A public transport extended by MaaS needs a professional customer connection, in which soft skills such as empathy skills, crisis management, and improvisation skills matter. As a consequence, the specific skills and qualifications required in future will be diverse. To a large extent, they are demanding and include soft skills, such as in MaaS offerings with customer contact.

The challenge is great. In future, skills and qualifications that have so far not existed, or only inadequately, will be needed on a large scale both in the automotive industry and in the other branches of the transportation sector. For the key automotive industry alone, considerable retraining and qualification efforts will be necessary to successfully manage both the change in drive technology from internal combustion engines to electric drives and the even more far-reaching transformation from the private car's predominance to passengers being driven in a networked and automated manner. In their joint study, Agora Verkehrswende and Boston Consulting describe three different qualification paths for approximately 800,000 employees for the adaptation services of the European automotive industry to an accelerated transition away from the internal combustion engine (Agora Verkehrswende 2021: 15). Firstly, "in-service training associated with remaining in the company and with slightly changed requirements". This concerns most of those employees who will not retire by 2030 or who will be newly hired with new qualification requirements, i.e., about 500,000. Secondly, "retraining and job changes to a similar industry and/or job description", which concerns about 190,000 employees. And thirdly, a "transfer to another industry and/or to a new job description". This is recommended for about 70,000 employees.

In the EU Commission's "Study on the social dimension of the transition to automation and digitalization in transport, focusing on the labor force", prepared by a consortium led by the Dutch consulting firm Ecorys, several proposals are made on the

basis of a stocktaking in order to achieve the necessary adjustments to qualifications and skills in a socially acceptable manner. This catalog of recommendations addresses primarily sectors outside vehicle production, i.e., public and commercial transport. However, it is largely applicable to the automotive industry, which is currently undergoing radical change.

As it were, the preamble to the catalog of recommendations is a call for a broad awareness of the urgency and scope of the adjustments to qualifications. In addition, several recommendations are proposed both at company and inter-company level and for the political framework at European and national level (EU-Com 2021). These should bring more binding force to the qualifications sector, which is often plagued by non-binding declarations of intent. For this reason, they are presented in detail below:

- *Lifelong learning system: at an early stage, as it were in preparation for the digital transformation and automation in the transport sector, employees should participate in lifelong learning programs. Companies, trade unions, and employee representatives should jointly identify skills gaps that need addressing. Existing support tools like the "European Skills Agenda" should also be used.*
- *Duty to train: the duty to provide continuing education includes the responsibility of companies to offer such education. Accredited training institutions should develop continuing education programs, with the involvement of partners in the social sector. New legislation should be enacted at EU level for this purpose.*
- *Joint training teams of younger and older employees in companies: in these mixed teams, a mutual exchange of know–how should be facilitated. Older employees can support younger ones, particularly in routine tasks, while conversely younger ones pass on their knowledge of new technologies to older employees.*
- *Attracting young and, in particular, female employees and retaining them in the long term: young and, in particular, young female employees should be recruited specifically by offering flexible working models and career options for female employees.*
- *Mitigating the risks of digitalization and automation in collective agreements: decisive provisions on the consequences of digital transformation and automation should be included in collective agreements. For example, a budget for further training and health promotion could be made available at company level. In addition, joint change management plans should be drawn up in companies.*
- *Industry–specific social funds to manage the transformation in the short and medium term, especially for lower–skilled employees.*

- *Establishment of national social funds: these funds should be used to set up courses and curricula needed to train the future workforce in the skills required to be ready for new occupations that will be created through automation and digitalization.*
- *Use EU and national funds to support SMEs: support SMEs using European and national funding to address the social impact of digital transformation and automation.*

Beyond this catalog of recommendations, specific training courses and degree programs at universities need to be aligned with the new qualification requirements. This is an education and science policy task that must be carried out primarily at the national level. Training and study content must be modernized accordingly.

4 Case Studies

4.1 Case Study (1): Automated Driving

4.1.1 Background

As described above, the path dependencies of the traditional car producers, which have been successful for decades, are enormous. They generally have difficulty with digitization, but above all with forms of use other than exclusive, private access (see Canzler, Knie 2016; Boes, Ziegler 2021). Car manufacturers want to preserve the "joy of driving"; they understand "automated driving" to mean sophisticated driver assistance systems. The development and testing of automated vehicle concepts, whose technical scope ranges from distance warnings and lane assist to automatic parking and convoy driving on highways, is taking place in the automotive industry under the auspices of the prevailing state of automotive technology. The narrative of the private automobile continues to be regarded as the fixed point, and the valid performance and quality standards are aligned with this. The goal of all research and development projects is the somewhat more comfortable and safer, privately owned car with the basic idea of "self-driving".

In the meantime, U.S. digital companies such as waymo or cruise, but also Chinese platform providers are working on the software and hardware of autonomous driving vehicles (Daum 2019). Even though existing vehicle models are being equipped with this, the underlying business model consists in services of "being driven".

4.1.2 From Hell to Heaven: Automatic Driving

Electrification of drive technology is one step toward the transition of transportation, but just as important is a drastically more efficient organization of transportation with fewer passenger cars and a significant shift to resource-efficient public transportation. Asking whether automated driving could become part of the solution

or part of the problem reveals the immediate need for a political framework. This is also, but not exclusively, about a radical technical innovation. It is about a paradigm shift in transportation policy from driving to "being driven".

We are still a long way from the goal of comprehensive mobility with fewer vehicles and a drastically reduced use of resources. At present, the professional and media attention for automated driving (AF) is mainly focused on the traditional car. Images of cars whose occupants no longer have to steer and pass the time playing parlor games have dominated media representation since the 1960s. But automated driving does not necessarily have to be thought of as a continuation of private automobility. An alternative path opens up if we think of the development toward automated vehicles as a shift toward a radically modernized, multi-optional public transportation system. In this development path, autonomous driving vehicles are part of a modernized public transport system. Passengers are being driven in these vehicles of various sizes and equipment. The principle of use is commonly referred to by the somewhat futuristic term robo-taxi. This expresses their high degree of automation, which no longer requires drivers, while those being driven can no longer influence the driving process. The vehicles are autonomous in their operation, their mission is programmed, and if necessary, they can be monitored remotely. Therefore, it makes sense to speak of autonomous driving in this case, also in distinction to automated driving as being support functions for the private car that continues to be controlled by a driver.

And what about shared automated mobilities? Regarding the acceptance of sharing and on-demand services, in addition to price, reliability is particularly important. Real-time information and precise positioning functions are indispensable. This is why nationwide network coverage is needed. This applies to transportation sharing as well as to MaaS. But good IT network coverage alone is not enough for integrated mobility services. There needs to be cooperation between the various service providers that is not even noticeable to users, if not all mobility options are integrated with one provider anyway. So far, this is the exception. As a rule, public transport companies and one or even several sharing providers must work together and speak to the customer with one voice. A dilemma becomes quickly apparent though, because in such a cooperation, none of the partners wants to be a mere supplier and thus invisible to customers. This brings up the question of who is to be the "face to the customer". One way out of this dilemma is white-label offerings on technical platforms – from the customer card to an app and a telephone hotline to the invoice with different logos. These allow the cooperation partners to maintain their own customer relationship. However, to operate these white-label platforms, a "neutral service provider" would be required, and this service provider of service providers would demand a corresponding margin.

For the acceptance of pooling offers and bundled rides in automated driverless shuttles, it is crucial that the objective safety of passengers from harassment and violence is guaranteed and likewise that the subjective feeling of safety is maintained. In the case of driverless shuttles, the safety issue has not been resolved for good. Up to now, the usage procedures have always included the collection or comparison of the personal data of the inquirer for identification purposes. Individual usage criteria such as "drive only alone/maximum of two" or "as a woman, drive only with women" can also be stored in the user profile. Otherwise, all operators rely on remote monitoring via video technology. Whether this is sufficient, and what the consequences of possible acts of violence transported by the media can be, remains open.

In recent years, the discussion of automated and autonomous driving has been dominated by a view of the internationally agreed gradation of levels of automation (Canzler et al. 2019). Implicit in this was a continuation of the dominant model of the private car, with successive additions of assistance functions. The focus was on convenience and safety gains for the car as we know it. The battle over the potential of autonomous driving beyond these convenience and safety functions has only just begun. International consulting firms (e.g., Arthur D Little 2021) are also getting involved. A more detached overview of the strengths and weaknesses as well as the manifold implications of automated driving is provided by a recent article, which concludes that in addition to a large number of ambivalent findings, there are still a number of unanswerable questions that lie beyond the foreseeable technical advances (Othman 2022).

In automated driving, for years there have been spectacular announcements about what types of vehicle would be on the road by when and how they would revolutionize road traffic. The terms "automatic" and "autonomous" are often mixed up or used interchangeably. As a rule, and since there are still no practical examples of actual autonomous fleets, the term refers to partially automated vehicles. In the U.S. and China, though, test vehicles from various digital companies are driving under real-life conditions and are gathering a great deal of experience, or rather: they are collecting data in order to learn. Especially the Google subsidiary waymo has amassed a considerable wealth of experience and has built up a lead over its competitors.

When looking at development and testing projects, a fundamental difference between innovation cultures in Europe and the U.S. stands out. In Europe, pilot tests are carried out in protected laboratory situations, usually on hermetically sealed test tracks, under strict prior control and following elaborate approval procedures. In the U.S., on the other hand, tests are carried out in real road traffic, with one or even two occupants who can intervene in the event of danger, and of course in compliance with applicable regulations. In the U.S., the vehicles are on the road in real life though, exposed to erratic road traffic. The willingness to take risks and make

technical adjustments in a trial-and-error process is much higher among the Californian digital companies than among European car manufacturers (cf. Daum 2020).

4.1.3 The Vision of Car Manufacturers: The Automated Private Car

In addition to the technical and legal challenges, it remains to be seen which vision of the use of automated and later autonomous vehicles will prevail. The ideas of the traditional car manufacturers differ from those of the U.S. tech companies in particular.

The major automakers are primarily working on the gradual expansion of driver assistance systems such as the "Traffic Jam and Highway Chauffeur". This will enable drivers to avoid having to steer, at least temporarily, in traffic jams and when driving on highways, and to turn their attention to other activities. As usual, these technologies are being introduced via the luxury segment in the case of expensive and complex additional technical systems.

The big issue here is the return phase, that is, the period of transition from a vehicle's automated driving back to a human driving. There are no standards for this yet. The central problem as to where the responsibility of the human ends and that of the machine begins has not been solved. To avoid accidents, it is crucial that there are clear processes for the driver to return to the role of the vehicle operator. User acceptance will only occur if this transition is stress-free (cf. Stilgoe 2017). The question is which "secondary activities" would be allowed for drivers and how a quick role change – within a few seconds and possibly from a state of relaxation or half-sleep – from being driven to driving could be achieved.

In general, it must be ensured that in the event of a malfunction or emergency, a partially automated vehicle's occupant can intervene. Paradoxically, this becomes more difficult the less frequently an emergency occurs. There is a great risk that the person being driven would "forget" how to drive on his or her own and take too long to settle back into the unaccustomed role of driver. Pilot tests with partially automated vehicles have been plagued with these difficulties of the so-called handover for years, without finding a solution (cf. Morgan et al. 2017). A number of research projects are testing rules and technical warning signals for when the passenger returns. Vehicle manufacturers are thus holding on to the core of the traditional concept of the car as a private vehicle. Automobility is to become even simpler and more convenient thanks to automation functions – but as little as possible is to change the actual business model.

4.1.4 The Vision of U.S. Digital Companies

U.S. digital companies are pursuing a completely different vision. Google and its waymo subsidiary are using artificial intelligence methods to improve the algorithms for actual autonomous driving with every test kilometer driven. In selected

areas, test vehicles offer comprehensive point-to-point mobility as robo-taxis without any driver intervention. Technically, the Google subsidiary relies on a combination of radar, camera, and lidar (light detection and ranging).

Before a waymo vehicle rolls onto the road, it is fed with data from a detailed map of the driving environment, containing information such as roads, intersections, or fixed objects on the side of the road. This prior knowledge of permanent features of the operational terrain allows the sensors to focus on moving objects and other road users.

Waymo and the other digital companies are "open" in the exploitation of their technical options. They are banking on the fact that products and services that have demonstrated their mass utility value will find a business model without the immediate operational business having to produce a positive result. Neither strict business ratios nor ecological indicators are the yardstick for the strategic success of these companies, but in fact the big picture. However – and here European companies regularly underestimate their U.S. competitors –, they rely on functioning blueprints. After all, the imagination of investors in particular is only really stimulated if some proof of success can be provided.

As a result, the U.S. and Chinese digital companies seem to be in a much better position to implement the options of autonomous driving in new business models, because the old path dependencies of private and exclusive access to a means of transport do not play a role here.

4.2 Case Study (2): Public Transport and Public Space

4.2.1 "Private Transport Becomes Public, Public Transport Becomes Private"

Until now, high car availability has always gone hand in hand with public transport services under pressure. In principle, (partially) automated driving opens up additional options for public transport and can thereby make it more attractive. The old dichotomy between private and public transport could disappear, since automated on-demand services are flexible and more geared to individual needs than any conventional bus or train service, no matter how short the interval. Conversely, with individually assembled intermodal mobility solutions, private mobility is at least partially managed by public transport. This new relationship could be described as "private transport becomes public, public transport becomes private".

Connecting public transport with automated driving is still a dream of the future. However, in rural areas, new areas of application are opening up for (partially) autonomous shuttles. Gaps in a "hub-and-spoke concept" can be filled well, especially since the shuttles need exempted routes or lanes to operate, which are easier to set up in rural areas than in cities (Hunsicker 2018). Overall, and not just for rural areas, automated systems come with high hopes, given driver shortages and the high

share of personnel costs in public transportation operating costs. In terms of operating economics, shuttle systems not only offer more flexibility, but with their significantly lower operating costs also significant advantages over buses in the medium and long term.

Automated shuttles could act both as catalysts and as an element of a new flexible public transport attractive enough to become a real alternative to the private car. If, at the same time, the privileges of the private car, above all the lavish supply of roads and (almost) free parking, were consistently to be reduced, the number of cars could be reduced step by step – down to one tenth of the previous overall amount. Vehicle savings on such a scale can only be achieved if not only the technical prerequisites are created, but if comprehensive changes in the traffic framework conditions are implemented at the same time: for example, in the form of an area-wide pricing of road use and parking, a consistent reallocation of public spaces in favor of the most efficient modes of transport, and a reduction in parking areas for private vehicles. There is also a need for an intelligent regulatory framework that links new and old forms of service in a user-friendly way. In summary, as part of a linked public transport system, automated vehicles in a fleet operating mode would enable a significant reduction in transport devices if the necessary policy framework were to be in place. Whether automated driving fleets hit the road, and whether they turn out to be a blessing or a curse, depends less on technical developments than on the political will to regulate.

4.2.2 An Innovation Window Has Opened

On-demand transportation, automated shuttles, and potentially, autonomous vehicle fleets could become game changers in possessing the potential to fundamentally change the transport sector. However, these fleets require the political will and a matching framework. Quite surprisingly, at the beginning of 2021, the German Federal Ministry of Transport proposed a draft for a new law, the "Law on the Amendment of Road Traffic Regulations [...] on Autonomous Driving as well as on an Ordinance on the Approval and Operation of Motor Vehicles with Autonomous Driving Functions in Specified Operating Areas (Autonomous Vehicles Approval and Operation Ordinance - AFGBV)", which offers considerable room for maneuver. This explicitly authorizes driverless vehicles on public roads. Accordingly, it is possible that the operation of a motor vehicle is no longer controlled by a vehicle driver, but by a "technical supervisor" not stationed in the vehicle. This would make the outlined paradigm shift from automatic driving to "being driven" possible. Given the progress of digital companies, especially waymo, there is now indeed an opportunity to make autonomous vehicle fleets part of a modern and flexible public transport system with proactive regulation.

In a widely acclaimed model study in 2016, the International Transport Forum (ITF) outlined a scenario in which autonomous shuttles were used to complement an integrated public transport service. In this scenario, widespread deployment of public autonomous fleets is associated with a radical reduction in private car use (OECD/ITF 2016). Self-driving vehicles thus become a new public transport service that, in combination with an efficient rapid bus and (road) rail network, achieves a high level of individual serviceability. Based on empirical studies, it can be approximated that a system of fully autonomous shuttles – embedded in a hub-and-spoke system – would enable the stock of vehicles in cities to be reduced to around 50 vehicles per 1,000 inhabitants (see ITF 2018).

4.2.3 Public Transport Operators at an Impasse

The idea of autonomous fleets understood in this way is in fact a play on public transport. More in the focus of public attention, however, are other varieties of automated driving. Both the gradual automation of the private car and the vision of the "robo-taxi" driving autonomously are being pushed by traditional car manufacturers on the one hand and digital platform providers on the other, with a great deal of research and development effort. But neither vehicle manufacturers nor the platform providers have sufficient experience with management in public spaces. It is also questionable whether they possess the necessary empathy to do so.

Yet transport is public because it is supposed to serve a general, precisely public, transport interest. Accordingly, a community can force operators to present offers in spaces and relations where transport demand is weak and far below the threshold of economic viability. There are several ways to achieve this: the city or municipality operates the transport service under its own management and pays the deficit from the municipal budget, the most common procedure to date. Or – if external funding is available – the service for the relevant area is put out to tender. In this case, high-frequency routes are usually combined with low-frequency routes. There are several other variations, but they are similar in that a public interest is defined in a particular standard of service that would not be provided using the usual entrepreneurial formats.

Current operators of public transport services, typically rail and bus operators, are not in a position to generate the necessary investment funds and provide the necessary skills, neither in Europe nor in North America. Rather, it is the digital companies, spending immense sums on the development of autonomous fleets, that are pushing the technology development of automated driving. Globally, the automotive industry, too, invests billions of euros in these systems. Public transport companies, on the other hand, have not played a major role in the race to develop this technology, with no money earmarked for research and development of autonomous systems. Public funding does not even cover modernizing rail infrastructure, let alone developing and testing automated fleets. While there have been a number of pilot

trials, these have generally been discontinued after their test phase or even earlier. An overview of these trials – as of the end of 2019 – is provided by Antonialli 2021.

4.2.4 Opportunities and Risks of Automated Driving for Sustainable Mobility

The intermediate stages of semi-automated vehicles reached today, both in the form of the major car manufacturers' partially automated private cars and the robo-taxi prototypes of waymo and others, raise the question which technical developments are conducive to climate protection goals, a desired reallocation of public transport space, and a generally improved quality of life, or on the contrary, which ones might foster conflict with these political goals (cf. Dangschat 2017; Fleischer, Schippl 2018). The main focus lies on possible safety and convenience effects for the (partially) automated car: new functions such as automated driving over long distances, on the highway, or even a traffic jam assistant are being developed by manufacturers with the aim of increasing the comfort status and strengthening the attachment to the devices. If this succeeds, the number of vehicles and kilometers driven with a low occupancy rate would presumably increase. After all, if time spent on the highway or in traffic jams can be used better, for instance on phone calls, entertainment, or relaxation, it becomes more attractive to take a longer commute to work. The currently existing advantage of public transport would be lost, and transport would become even more exclusive (ISI 2019).

Unregulated automated vehicle fleets that are not intermodally contained are not sustainable in any way (Lyons 2018). Yet many municipalities lack the understanding and know-how to develop autonomous driving vehicles as integrated elements of an attractive public transport. Using the Stockholm metropolitan region as an example, Wallsten et al. were able to show how few municipal transport politicians and local transport authorities were able to play an active role in the design of a networked public transport offer: "At present, there are several obstacles and difficulties for municipalities in taking a clearer leadership role. They do not have all the necessary institutional conditions to lead a smart and sustainable transition. (...) Most importantly, if public actors do not take on a proactive governing strategy now, they might end up in a future situation with diminished institutional capacity" (Wallsten et al. 2021). Moreover, appropriate operational actors in pursuit of the public interest are often lacking. Neither platform operators nor car manufacturers have a sustainable and socially balanced public transport in mind; they want to sell their services or their vehicles profitably.

Hence, the development of autonomous vehicle systems for the purpose of modernizing public transport is also a political issue. Here, the task is to use autonomous driving as a building block of multi-optional and environmentally friendly mobility in accordance with the mobility transition. The framework conditions of transport must be designed or existing regulation be changed in such a way that automated

driving vehicles are integrated into a multi-optional transport structure (Knie, Ruhrort 2019). Then, in perspective, the development of automated vehicles can play a key role for both ecologically efficient and urban-friendly transport and for improving transport accessibility in rural areas. In concrete terms, this would also involve giving vehicles their own lanes. This is difficult to implement in European cities, but much easier on the outskirts and in rural areas or in new neighborhood projects.

In addition to the potential cost savings, another advantage for operators compared with conventional buses would be that (partially) automated shuttles can be deployed much more flexibly and are more adaptable to changing topographical and infrastructural conditions. The typical area of application is in the connection to stops and stations ("hubs"); they serve settlements, but also commercial areas, hospitals or (high) schools in on-demand mode in the form of feeder services ("spokes"). Although the transport volumes are limited due to limited space capacities, the flexibility in the service forms and times is significantly greater than with conventional buses. Even traditional scheduled services can be operated by such shuttle systems during off-peak periods (Hunsicker et al. 2017). The cost per kilometer in regular operation is difficult to estimate. In a first cost simulation, McKinsey calculated kilometer costs for trips in pooled robo-taxis for the year 2030 that are higher than those of the traditional scheduled bus, but significantly lower than the costs for trips with a private car (McKinsey 2022). However, these calculations only consider moderate additional cost burdens for private car traffic by 2030; an ambitious city toll for private vehicles, from which robo-taxis would be at least partially exempt as part of public transport, would change the results considerably.

Yet the shuttles that have been (partially) automated to date are still far from operating regularly. Many technical and operational issues have neither been technically standardized nor legally clarified. A considerable gap exists between the technical standard achieved and a robust series operation, and economies of scale are not yet achievable. Some studies on possible fields of application exist though. In particular, commuters could use these services to overcome the "last mile" (Mira-Bonnardel 2021).

If one wants to introduce such a system, a fundamental problem in the public transport sector becomes apparent. It is not only the lack of financial strength compared to other industries, but primarily the lack of an innovation culture that prevents operators of long-distance and local public transport systems from catching up. Moreover, the legal structure of public transport operators, transport associations, and special-purpose associations is not at all geared to dealing with open issues of the future. Transport operators are operational providers, and the ordering organizations are bodies set up for the court-proof tendering of standardized transport services. Tender competition is based exclusively on cost. The logic of the

public transport system prevents innovation as the latter is not reflected in the system, let alone rewarded (cf. Canzler, Knie 2016: 39 ff.).

The traditional indicator of patent applications points to a solid know-how base in Germany in the field of automated driving; from 2005 to 2017, Germany even held the lead worldwide, and has been among the top three since then (cf. Sievers, Grimm 2022). Nevertheless, there are hardly any real-world applications to date, nor are there any models designed specifically as shuttle vehicles. In view of this, the conclusion of Sievers and Grimm can be agreed with: "The concrete embedding of autonomous driving in the overall mobility system, the design and interaction of vehicles and infrastructure, and the resulting opportunities and risks with regard to ecological and social sustainability are open questions. Strategy formation is therefore of central importance. Exchange between stakeholders from politics, business, science and civil society plays an important role in this" (p. 9). The arena of this exchange is the urban public space. This is where it will be decided whether and how automated driving will get "on the road".

4.3 Case Study (3): Gender Aspects of New Mobility

The transportation sector is not gender neutral. It is traditionally male-dominated and characterized by various gender differences at all levels of employment. Gender disparities exist not only in job compensation, but also in career access and advancement opportunities. While improvements can certainly be expected with the New Mobility in view of these grievances, in principle, new technologies allow a design of use – also of jobs – that meets the needs of women. Digital technologies can be used flexibly. One problem, though, is an unclear data situation, because there are often no traffic data disaggregated by gender: "For example, in the context of urban travel, understanding what it is that women want from cities and how this translates into a vision for urban transport should be at the heart of public policy. This will require much finer and differentiated knowledge of travel behavior and people's needs than has been the case in the past. New data sources can help develop that knowledge base, but it is important to avoid biases that have become ingrained in past transport policies" (ITF 2021: 5). Transport policy, like transport planning, still stems from a male perspective. The proportion of women in decision-making positions has increased somewhat in recent years, but overall, the dominance of men remains unbroken. This is also the case in educational institutions.

Over the past two decades, the discrepancy between men and women in employment rates, in the share of part-time work, unpaid care and family work, in management positions, and wages has hardly narrowed (EIGE 2020). In Europe, the average of female employees in the transport sector is 22 per cent (compared to 46 per cent of the total workforce). It looks as if the COVID-19 crisis has further deepened the divide (ITF 2021: 11f. & 37f.). Even though the share of employees within the transport sector differs significantly between maritime and aviation, for example,

historically the low overall share of women has led to gendered patterns of behavior and, within these, to discriminatory working conditions. It is widely recognized that a better gender balance not only benefits women, but also has business and economic benefits. Economic productivity increases in companies and organizations with a balanced gender ratio and, conversely, the overall risk of poverty in society decreases. Since the risk of poverty is generally higher for women than for men, not least because of the significantly higher proportion of part-time employment, a higher employment rate is at the same time also a promising step toward effective poverty reduction.

In traditional transport companies in both vehicle production and public transport, gender balance is still a long way off. The advent of smart mobility has brought about high hopes that gender gaps, both in employment shares and in pay and management appointments, will become smaller than in the traditional transport sector (Woodcock et al. 2020). This has not been the case so far though. Rather, old industry patterns seem to be repeating themselves. The EU project TInnGo (Transport Innovation Gender Observatory) should be seen against this background: "TInnGO is a 3 years research project funded in the context of the HORIZON 2020 Programme of the EU, aiming to create a framework and mechanisms for a sustainable game change in European transport through a transformative strategy of gender and diversity sensitive smart mobility." In ten European countries, the project aims to identify reasons behind the problem of gender stereotypes that have a lasting impact and to develop recommendations to shed these outdated patterns (Pirra et al. 2021).

4.3.1 Female Movement Patterns and Digital Inequality

On the user side, gender differences play an equally important role. How do movement patterns differ by gender? Due to the gendered division of labor in the household, women often have multiple tasks and activities. Women make shorter commutes and have more trip chains with a higher proportion of non-work-related trips. They travel off-peak more often than men and are more flexible in their choice of transportation. They use public transport and cabs more often and their own cars less than men (see Ng & Acker 2018). Given these findings, it can be assumed that women have a high interest in flexible digital mobility services and in intermodally enhanced public transport.

Both for new mobility services and especially for automated driving, the motives and interests of the users are of great interest. Acceptance depends on this. Thus, in addition to how reliable and affordable a service is, which is important for all users, safety is of particular concern for women. In addition to cost and accessibility, the subjective feeling of safety is decisive for the acceptance of existing as well as new mobility offers. Inclusivity is another requirement for mobility services. All age groups and especially the disabled and elderly must be addressed. The expectation is

that, on the basis of identified requirements for new mobility services and a corresponding product design, the necessary qualifications for the employees can also be defined. In this context, the TInnGo project also problematizes the gender-specific attribution of transportation technologies, especially the automobile, which has often not been disclosed to date. Using the example of automated driving, the authors show the interpretive disputes about images of the future: "Existing studies of the emerging field of smart mobilities point in different directions when it comes to attraction and use by various groups. On one hand, there is a utopian notion of a new beginning with automated cars as an avenue toward a more equal and genderless mobility regime. Here the coming of the driverless car is foreseen, at least in principle, to loosen the strong bonds of men, masculinity, and cars from the automobility era (...). On the other hand, several studies find serious exclusions of women and potential racism of smart mobility proliferated in the automated car (...)" (Christensen et al. 2020: 19).

With regard to digitalization, two concerns remain: firstly, that the design of digitally based mobility services has a male bias, and secondly, that there are significant gender differences in the availability (and possibly also in the quality of use) of digital devices.

4.3.2 The Impact of New Mobility and Digitalization on Employment and Good Work

The flexibility in New Mobility employment is attractive to a lot of women. Nevertheless, as in the conventional occupational fields of public transport, they encounter gender-specific stereotypes: it is still not uncommon for their suitability to work in public transport to be doubted. What is more, violence and sexual harassment continue to be a major problem for female employees in the transport sector, exacerbated by shift work (Wright 2018). The proliferation of ticket vending machines is leading to the loss of counter jobs, which affects women in particular. A further automation of ticket sales is to be expected, although passengers often regret this.

A large proportion of new driver jobs is emerging in platform-based ride-hailing services. Ride-hailing and -pooling services are increasing worldwide, but unregulated platform-based operations are nonetheless a general problem. The overall risk of exploitation is high, and for women, there are additional dangers. The risk of violence and sexual harassment, for example, may cause female drivers to avoid night shifts as well as certain urban areas. While IT technologies can also be used for warning and protection purposes, trust in such protection technologies has not been particularly high (ITF 2019: 28f.). In addition, there are the stresses from the car work disproportionately performed by women and the requirements of maternity leave. Both factors put women in an unfavorable competitive position when competing with men for coveted driver jobs.

A fundamental problem with any digitization, as in transportation, is the digital gap. When approximately 90 per cent of jobs require basic digital skills, as is the case in Europe, though just under one-fifth of students and employees in information and communication technologies (ICT) are women, the problem becomes more entrenched with each digitization push (ITF 20201:7). Without specific support programs for women in New Mobility and in the digitization of the traditional transport industry, the gender gap will widen even further.

4.3.3 Necessary Qualifications: System Understanding and User Perspective

Even if the battle for interpretive sovereignty over future images in mobility is not yet decided, this study pursues the vision of an integrated and intermodal mobility based on personalized information and communication technologies. Such a future Smart Mobility is intermodal and, from the user's point of view, an integrated service. It is undisputed that this will require new skills and qualifications on the providers' part that amount to more than just IT competence. In addition to specific technical expertise, these include a "system understanding of mobility" and an empathic "user perspective". In order to achieve these qualifications, a change in general (high) school education is needed, as well as a change in in-company education and training. A gender balance in the transport sector, yet to be achieved, is a prerequisite for this.

As with other hitherto male-dominated sectors, the following also applies to the transport sector: the more women can move up in the hierarchies of companies and organizations, the more they can serve as a role model for others. This could successfully change gender norms in the sector. Less male-dominated work structures are in turn attractive to women, who can "choose" their jobs, as in the field of information and communications technologies. The key factors in this competition for qualified women are: flexible working hours, a safe and appreciative work atmosphere, good remuneration, and opportunities for further training. This applies even more to the smart mobility sector and MaaS providers.

There is another reason why a gender balance is so important in the transportation sector: half the customers (at least in passenger transportation) are female. Female customers have both different movement patterns and different needs. We know from feminist transportation research that "female trip chains" are often different because work trips are often connected to trips related to care and family work. Women's trips tend to be shorter but more complex and have larger non-motorized components (Joelssen, Lindkvist 2019). In public spaces, women are often victims of sexual harassment; in a survey on France, for example, nearly 90 per cent of women reported harassment in train stations, trains, and other public transportation (Trautmann 2019). For this reason alone, it is important that public transportation be designed from a female perspective. In general, the importance of public space becomes clear. Transparency in the design of public spaces, transport stations, and of

transport means is a prerequisite for improving the sense of security for women – and for everyone: "The more women are involved in designing, operating and managing mobility services, the more female transport users will feel at home on public transport and the better the image they will have of public transport through the high-quality services they experience daily" (Trautmann 2019).

5 In the Focus of the Trade Unions: Good Work

The traditional union bastions in the transport systems are in decline. This is particularly true of the automotive industry. The industry has long been familiar with the "productivity dilemma" (Abernathy 1978), and especially the unions are in a quandary. Let us consider the powerful German IG Metall: on the one hand, IG Metall sees itself as an admonisher and has traditionally called for entrepreneurial foresight in order to secure jobs in the long term (IG Metall 1990). On the other hand, it is precisely the works councils of Daimler, VW, and BMW that have long denied their corporate management basic innovations such as different drive systems, new vehicle concepts, or excursions into other industries such as digital platforms (Canzler, Knie 2019). The chairman of Daimler's works council, for example, was still vehemently calling for an exit from the business field of new mobility services in the fall of 2020 – in stark contrast to his IG Metall representative, who has come around to proposing this as a future perspective (Tagesspiegel Background, Oct. 12, 2020). But the works council is not only a powerful player at Volkswagen and Daimler. At BMW, practically all activities in new business areas of digital services were torpedoed by the powerful works council head Manfred Schoch. The maximum change that is being supported is that in drive technology.

The automotive industry is evidence of the "corporatism" that has long characterized Germany and France (Esser et al. 1983). This is a tight-knit network between the state, companies, and unions, which is regulating, controlling, and, above all, stabilizing the basic order of the markets and the quality of industrial relations. The high degree of reliability and mutual trust guarantees growth and job security – at the expense of flexibility and innovative capacity.

It is not only the automotive industry that faces this dilemma though. Public transport, frequently discussed as an alternative to the car, faces similar constraints, albeit with considerably less relevance for the transport economy. Let us return to the German case: in the overall transport market, long-distance transport by Deutsche Bahn AG and regional transport by various operators together with local transport by cities and municipalities (public transport) accounts for no more than 16 per cent (MiD 2019). This is also because public transport is financed and provided by the state in the form of services of general interest. As a rule, it is not organized as an entrepreneurial task, but as a utility. Notably, more than two-thirds of local public transport is in municipal hands. In these companies, verdi is the

dominant union; in rail transport, it is the EVG or the much smaller GDL. There is no entrepreneurial profit motive as a basis for the daily tasks in this transport segment. Ever since the rail reform in 1994, elements of competition have been introduced, though these relate solely to the invitation to tender for transport contracts. Companies compete for these contracts, which are usually very generous, and are then protected from competition for 10 to fifteen years. Especially in the case of local public transport, the unions make sure that this protection mechanism continues to exist. The product and its manufacture remain "frozen", so to speak. While this safeguards employee rights, it prevents new services from being developed, tried out, and, if necessary, repositioned, similar to the automotive industry. As a result, public transportation continues to function as it did fifty years ago, with its tried-and-tested large containers, ticket vending machines, ticket counters, tariff zones, and paper tickets. Dynamism and growth are deliberately not envisaged in this form of "corporatist provision of public services"; rather, the individual segments such as long-distance trains, regional trains, buses, and cabs are finely sorted, and their forms of operation are legally secured. In this world, no new forms of service crop up or, like car or bike sharing, they are at best accepted as niche services.

The dilemma for the GDL, EVG, and verdi unions is therefore the same as it is for IG Metall: defending existing interests comes at the expense of the new. Innovations in public passenger transport are indeed rare. At the same time, the unions are not taking action against politically intended disadvantages of buses and trains and the preference for the private car. After all, the popularity of buses and trains can only increase if at the same time, and in addition to the necessary improvements in service, the privileges of car use are being restricted. These privileges are enormous. For example, parking private vehicles in public spaces qualifies legally as "public use" and can take place anywhere. The primary goal of road traffic regulations is the safeguarding of an optimal traffic flow of cars, while company car privileges mean that car sales are financially lucrative for employers and employees alike, at the expense of lost tax revenues and social security contributions.

A crucial question is: How can a race to the bottom be prevented in the new service job sector? The minimum wage should be high enough to act as a safeguard against wage dumping. This is particularly relevant where no collective agreements exist to date or where they have been abandoned. However, underpaid work in self-employment cannot be prevented in this way. Therefore, all tenders and licensing for mobility services must require proof of sufficient payment, also for the individual consortium partners. Anyone bidding for mobility services as a partner in a bidding process must be able to declare and prove that all employees are adequately paid. This also applies to self-employed persons who are subcontracted, for example. A local fair pay level should be part of the tender itself. Finally, a transparency requirement in the bidding process for working conditions as for pay not only helps in the decision-making process but is also the basis for critically assessing the reputation

of bidders among the interested local public. Reputational competition fueled in this way is likely to result in good work being paid well.

So far, unions have done little to change the prevailing structures of the transport market. For a long time, they have helped to stabilize the existing forms of supply, including their legal safeguards. They have helped to put a kind of "innovation lid" on the transport sector: everything remains as it was. However, this is no longer sufficient to secure the existing sales channels – and thus also the volume of employees. The markets are changing, the political framework is shifting globally. This is obvious in the automotive sector. Large markets such as China or the U.S. state of California are changing the rules of the game in such a way that vehicles with combustion engines cease to be an option. Europe is following suit with the "Fit for 55" program.

For public transport, equally drastic changes are on the horizon. The future of transportation systems, like the quality of work, will be determined by how public space is designed and how access to public space is regulated. If the scarcity of space leads to the dismantling of the privileges of the private car and, at the same time, the digital prerequisites for sharing and pooling business models are in place, urban transport services will change fundamentally.

The advance of the U.S. company Uber also indicates the limits of previous business policies for companies in the public transport sector. Although it has been possible to push the U.S. company back in highly regulated markets such as France or Germany, "Pandora's box" is now open. It is clear to all involved that the flexible use of existing resources is the right, contemporary path to sustainable mobility. Who will operate and offer the new mobility services is currently an open question. This depends not least on the character of public tenders. If in future, public service contracts are put out to tender as functional services, the competition for efficient intermodal offerings could become a competition among providers of "total packages". From the perspective of employees in the transport sector, the question of "good work" will then be decided in the requirements of the tenders. It is the task of the trade unions to ensure that the conditions for "good work" and good wages are part of the tenders.

The background to the changes in the transport sector – and ultimately also to the trade union strategies – is the megatrend of "using instead of owning". The success of platform business models built on this megatrend will depend on more than regulation and the political design of public space. For union strategies, this means that the individual company will become less important, while both the regulatory and local policy levels will gain in significance. This is shown again by looking at the tenders: if not only traditional transport services with buses and trains, but also sharing, leasing, or pooling options are put out to tender as potential offers in overall packages, the concrete tender conditions will matter. What the conditions look like in practice should be the subject of negotiations between trade unions and local

authorities. The local level with its framework-setting competence becomes more relevant. It is then more important than ever to gain the authority to interpret what "good work" is. The reputation of the companies themselves could become an issue – and a problem. Those who do not offer good work should not stand a chance in tenders for several reasons.

How do unions become players with the power to define and interpret public policy? The starting point of our argument is that in future, more than ever, it will be decided at the local level what is and is not possible in the public sphere. The transport sector is strongly affected by this. For example, public transport can benefit significantly if a city toll is introduced for private cars or if parking spaces on urban land are reduced. What transport and urban planning decisions are made depends, on the one hand, on the respective political majority and, on the other, the activities of civil society actors. Also, these two factors influence each other. Against this background, we advocate that trade unions actively engage in the discourse on the design and use of public space. In doing so, they should first develop their own coherent position and defend it in an evidence-based manner based on studies. For this purpose, an exchange with academic partners should also be sought. As a next step, alliances with political and civil society actors should be sought. In this way, it may be possible for trade unions to become strong voices in the struggle to define what the "livable and sustainable city of the future" should look like. However, such a proactive discourse strategy requires that trade unions and their functionaries not only focus on representing interests in their sector, but also get involved in fundamental discussions. In addition to "good pay" and "quality of work", "fairness of land use in the city" and "safeguarding the quality of urban life in the light of the climate crisis and resource efficiency" would then become central trade union issues.

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