# Paradigm shifts by multimodal user oriented transport services and platforms

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## Introduction and objective of the paper

This paper describes an exploration of future multimodal user oriented transport services and platforms built around innovative business models. The assessment of the (possible) upcoming developments highlights the main implications for different stakeholder and society/EU as a whole. Before specifics for the transport sector are discussed, a general assessment is done of the upcoming innovative business models as part of the digital transformation.

## Digital transformation and innovative business models

New business models and business strategies which have shaped in the past years are being applied in a growing number of working areas. These business approaches take optimal benefit from the new technological possibilities and the acceleration of innovation. The new technologies are applied in an innovative way replacing existing structures and removing traditional barriers and cost elements by automation (digital transformation). Known examples of services using new business strategies are for instance Airbnb and Uber. Tim O'Reilly (2017) has generalised these 'Business model of the new economy' and differentiates the following key components:

- Information instead of material (for instance a smaller stock)
- Deliver a magical user experience (user needs plus something "unimaginable")
- On-demand service provision (when the user needs it)
- Design around network platforms (ICT platform with defined rules)
- Coordination is done by algorithms (no human intervention needed)
- Employees are supported by technology (technology instead of training/education)
- On-demand asset and labour management (no unused capacity possible)

Some practical implications of this approach are the following:

- Due to the significant cost reduction and service improvement that can be achieved simultaneously these services will disrupt traditional markets.
- Since use is made of a platform and decisions are made by algorithms, the rules for all involved are very clear but rigid. The platforms on which these services are offered, set the rules to be followed by the suppliers and users of services. Also quality monitoring of services delivered and fair pricing mechanisms based on real-time demand and supply information can be embedded.
- For the operational activities where labour is still needed no training/education is needed so workers are easily replaceable; no fixed contracts are needed.
- Ownership of assets is where possible avoided and is organised such that the risks for unused capacity is minimised and the organisation is resilient for fluctuations in demand.
- Availability of real time and integrated information is a key requirement for the business model. This is easier to establish when the whole process in in hands of one organisation rather than when cooperation of different entities is required.
- The likelihood of matching demand and supply is larger and therefor the service level higher, when more people make use of the same service; this creates a tendency towards a few large players dominating the market.

## Exploration of new business models in the transport sector

In the following a high level exploration is described, using the characteristics of the upcoming new business models which are applied to the transport services for different future automation levels. The exploration is qualitative and deductive and only highlights the main tendencies resulting from this digital transformation. First passenger mobility is described followed logistics.

<u>Passenger Mobility</u>

In the following tables the cost components and risks are listed for different options for dedicated public transport (PT) and for collective PT. In the comparison of options for individual PT the business model of Uber reduces the risks to the minimum by on demand management of labour and assets; drivers and vehicles are only paid for actual use. At the moment level 5 automation is introduced this business model will not be valid anymore, since in the first place no driver is needed and secondly private car possession could become less popular. Especially for peak hours on demand management of vehicles could get problematic which will make that the

provider of the services will need to have their own vehicle stock, introducing risk for unused assets in off-peak periods. Using these (hybrid) vehicles also for other services such as for instance city logistics is mentioned as option. For the user within the segment of individual mobility, the reduction of costs is the main advantage. Since no driver is needed the privacy can be similar to a private car although the car cannot be personalised according to individual preferences.

| **Comparison of (current and future) dedicated mobility services; management of cost component and financial risks** | | | | | | |
|---|---|---|---|---|---|---|
| **service** | **characteristics** | **dependency/risks** | **management** | **Client services** | **administration/ payments** | **ownership assets** |
| **taxi (current)** | hired car + driver | unused assets, unused personnel | traditional | contracted personnel | contracted personnel | company |
| **Uber (current)** | hired car + driver | driver service quality | small | automated | automated | mostly driver |
| **Green Wheels (current)** | hired car + self driving | driving quality driver, unused assets | small | automated | automated | company |
| **On demand CAD (level 5) service (future)** | Hired CAD | unused assets | small | automated | automated | mixed; depending on car ownership assumptions |

For collective PT (on-demand as well as fixed services) the ownership of the vehicles will remain with the provider of the services and therefor in case of level 5 automation the main cost reduction concerns the labour costs of the driver and automation of the administrative and service activities. Occupancy of on-demand services can be improved by pricing mechanisms (width time-window, pre-ordering) and predictions using travellers historical behaviour. The low occupancy in off-peak periods remains a challenge to solve; alternatives for the use of available capacity will be looked for such as logistical distribution activities.

| **Comparison of (current and future) PT services; management of cost component and financial risks** | | | | | | |
|---|---|---|---|---|---|---|
| **service** | **characteristics** | **dependency/risks** | **management** | **Client services** | **administration/ payments** | **ownership assets** |
| **PT: bus, tram, metro, train (current)** | fixed services + driver | low occupancy rate (costs assets + driver) | traditional | contracted personel | contracted personel | company |
| **on demand PT : (small) bus (current)** | flexible services + driver | low occupancy rate (costs assets + driver) | small | automated | automated | Company; could evolve to Uber constuction |
| **on demand PT : (level 5) automated bus (different sizes) (future)** | flexible services | low occupancy rate (costs assets) | small | automated | automated | Company |
| **tram, metro, train (level 5) automated (future)** | fixed services | low occupancy rate (costs assets) | small | automated | automated | Company |

Impact of the changing service levels will not be the same everywhere. In the following table a differentiation is made of the relevance of some key drivers for success for urban, inter-urban and rural services.

| Drivers for PT options choice in the transition towards level 5 automation (future); 5=high relevance, 1=low relevance | | | |
|---|---|---|---|
| | urban | inter-urban | rural |
| low density will lose from new business models (not competitive) | 3 | 4 | 5 |
| low frequency schedules will lose share to on demand (even at some higer costs) | 3 | 4 | 5 |
| door to door is prefered over connecting rides (even at some higher costs) | 5 | 4 | 3 |
| limited supply of on demand (increased waiting time and higher costs) | 1 | 3 | 5 |

From this we can derive the market potential of the PT options in these sub-markets, which is summarised in the following table. Especially for rural areas dependency on the new PT concepts will be high since they are expected to replace the traditional low frequency/density services in these areas. This can lead to a better availability of PT than before, however when prices are determined real-time based on demand/supply there is a risk that this goes together with higher prices, which leads to reduced inclusiveness for lower-income groups with high PT dependence; this may lead to further urbanisation of this group. At the same time CAD owners can increase their driving distances and may move to rural areas (CPB 2017).

For urban and inter-urban mobility shared CAD and on demand PT may take over part of the traditional PT especially where the densities are low and traffic volumes small. Also here driving distances are likely to get longer and the share of the motorised (or non-active modes) modes will increase. As such the pressure on the road capacity will increase; especially for urban areas this may lead to complications due to limited availability of space (TNO 2018).

| Market potential of PT mobility options with level 5 automation (future); 5=high potential, 1=low potential | | | |
|---|---|---|---|
| services | urban | inter-urban | rural |
| On demand car | 5 | 3 | 2 |
| on demand bus (different sizes) | 3 | 2 | 4 |
| scheduled bus | 1 | 3 | |
| tram | 3 | | |
| metro | 3 | | |
| train | | 4 | 1 |

Logistics

For logistics/freight transportation the characteristics of possible new concepts and development of major cost components are listed by automation level of the trucks.

| Comparison of truck services at different autopmation levels; organisational changes, management of cost component and financial risks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| truck automation | main changes/innovations | characteristics | dependency/risks | management | demand/supply matching | administration/ payments | ownership assets | operation |
| level 3 | platooning | efficiency gains due to coopration by platooning | unused assets, unused personel | traditional | contracted personel | | company | contracted personel |
| level 4 | platooning, last mile services/DCs/hubs at highways | Upcoming split automated long distance services on highways and last mile services with drivers | unused assets, unused last mile personel | traditional | partially automated | partially automated | company/ asset provider | contracted personel for first/last mile activities |
| level 5 | as above + city distribution services | last mile services combined with city distribution services | unused assets | small | automated | automated | company/ asset provider | contracted personel only for service aspects (incl. handling) |

For level 3 platooning can create some efficiency gains focussed on energy use and emissions. A major change can be expected when level 4 automation is available since labour costs can drop significantly for especially medium to long distance services. Currently labour costs account for about 50% of the total costs for road transportation (Panteia 2018). This will make it attractive to have logistical nodes and business activities in general situated at roads where level 4 automated driving is allowed. Where this is not the case it can be an option to bring the truck to the nearest entrance point for the automated driving network and pick it up near its destination. This will be a competitive solution especially in cases where the driver also delivers other services.

Hubs/DCs may evolve at the edge of cities from where the city distribution is organised. Business activities in general (including shops) will favour locations situated at the 'level 4 automation network' to obtain a competitive cost advantage. Especially when completion of level 5 automation takes long, this may lead to shifts of logistic & business locations and creation of required facilitating physical infrastructure. Level 5 automation will make all locations equally attractive again. However, the expected increase of road use for passenger mobility leads to capacity issues, especially within cities. The (hub-oriented) network/facilities created in the period of level 4 automation might therefor remain unchanged.

Within this transition new logistical business models/services will evolve, which will offer the services for which data is available in the system. Automation of the trucks and terminals will make the organisation lighter since less labour management has to be done. Matching demand and supply can be done real time by algorithms and administrative processes (contracting, payment) can be automated as well. The more capacity is available in the system the more attractive offerings of the platform/service will be for the users. A large system could be established by combining the capacity of many different suppliers. However currently most companies are hesitant to cooperate and share the required data/information. In this situation the larger global players such as Amazon and Alibaba, will be able to make a better offering and could push smaller players from the market.

Services can arise concentrating purely on making the required assets (trucks, terminals, etc) available. The large logistical service platforms can cooperate with these asset providers which makes it possible to apply on-demand asset management and as such reduce their financial risks in periods of low demand. New specialised companies could arise for level 4 automated freight transportation for which mainly capital is needed and no labour force. Traditional trucking companies could be held back in a fast shift to automated trucks by the obligations towards their contracted drivers but are better positioned to deliver the services where drivers are still needed (first and last mile, value added). Combined passenger mobility/city logistics vehicles/services could evolve in case of level 5 automation as concluded in the passenger mobility assessment.

The significant cost reductions by level 4/5 automation could have big implications for the modal split. Although the rail sector is also working on automation and improvement of quality of service, the timing of market readiness of the innovations will decide the direction of the modal split (Smart-Rail 2018). Given the complexity of the rail system at this moment it seems likely that rail innovations will go slower than for road. In the table here below an estimate is given for each of the possible situations.

A cost reduction of road transport of 50% enables, in some cases, even a shift of bulk flows from rail to road. This could lead to increased road congestion where one of the intended targets of road automation is to reduce congestion. Development of the rail sector can be accelerated when use is made of technological developments made in other sectors such as the automotive sector (Smart-Rail 2018).

**Balance between road and rail for different automation levels and rail service improvements**

| **rail vs road services** | **additional improvements rail** | **truck (level 3)** | **truck (level 4/5)** |
|---|---|---|---|
| **trains** | **none** | status quo | price for long distance road transport significantly reduced (20%-40%) and for rail slightly reduced. Small demand for combined services. More freight transport on highways. |
| **train (level 3)** | **shared logistical information system** | reduced risk for shippers and increase demand for combined services | |
| **train (level 4/5)** | **shared logistical information system, self organising rail system, automated terminals** | | Change price difference road/rail much smaller than above. Rail service information exchange, reliability and flexibility closer to road service quality. Integrated information system with rail terminals functioning like the future highway hubs. Potentially some more demand for combined services. |

### Transport market and governance implications

Many implications can be derived from this exploration of which a selection is listed below:

- The platforms and their algorithms determine many important aspects within the mobility and logistics sector. Especially in case of full automation a simple change of settings could make a large difference in mode choice, routes chosen, revenues of a specific asset provider, salaries earned by workers and tax incomes of the government. These platforms and algorithms therefor provide powerful steering mechanisms with predictable/certain and collective outcomes. Transparency of the algorithms applied is essential to be able to ensure fair market conditions and ethical decisions. Being able to influence these algorithms is also very interesting and even essential for policy makers; legislation can be designed to ensure the algorithms make socially desirable choices/decisions.
- The new business models/services tend to result in market domination by a few large players. As is currently the case with e.g. Uber and Lyft, these players could be global/non-EU service providers even though the service provided and assets used are clearly local within the EU. Financial revenues might flow outside the EU with no taxes paid to finance amongst others the required infrastructure construction/maintenance and

other societal costs caused by the services. New legislation is required to maintain the balance and ensure economical sustainability of the changing societal organisation which comes along with the disruptive innovations.

- Harmonisation of systems, standardization and interoperability initiatives are complex and require involvement of many stakeholder groups. For instance, communication between smart vehicles and infrastructure require harmonization of infrastructure investments of national, regional and local governments as well as the private sector. Timely anticipation and early start of these processes and investments is essential.
- For passenger mobility the major paradigm shifts due to use of new business models and platforms are expected to occur at the moment level 5 automation comes to market, leading to changes in the PT system. With level 3 and 4 automation also changes are expected in cost structures and modal split, but the overall mobility organisation will remain similar to the current one but with potentially some growth for the sharing options.
- Inclusiveness of all income groups should be guarded since the (currently unknown) pricing of the upcoming on-demand services could lead to unwanted effects, especially in rural areas.
- For logistics at level 4 automation disruptions will take place due to large cost savings that can be achieved by new business models and changed logistical organisation; about 50% of the costs can be saved for driverless stretches. Shippers will be driven by competition to make use of these cost reductions as fast as possible, which will lead to a fast transition to the automated services wherever this is possible.
- Connectivity to the 'level 4 network' provides shippers/companies a competitive advantage which could influence the location choice of companies. The design of the 'level 4 network' should be done pro-actively by policy makers and infrastructure managers taking these possible implications into account.
- The attractiveness of the new passenger mobility services tends to lead to more vehicles on the road and less use of other modes. Also, the radical cost reduction that can be achieved for road freight transport could lead to a shift from rail to road if the innovation of rail does not keep pace. Balancing the innovation speed of the different modes is therefore essential, in order to rule out counterproductive impacts. For instance, transfer of road innovations such as the vehicle communication technology to the rail sector (including tram and metro) could accelerate the rail automation process and also ensure harmonised vehicle communication especially in cities (tram, metro).
- Although the new services have the potential to establish a highly interconnected transport system, they can only incorporate those modes/options for which information can be made available to the system. Since they can also deliver high quality services with only road options included, they therefor could lead to divergence of market potential of the modes as well. Active high-level governance of information sharing and collective and multi-modal information platform development could ensure a more balanced availability of transport services.

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