Student research on CAT: Perspectives on port authorities' business models and LSP's fleets

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Four students of Rotterdam School of Management have immersed themselves in the world of Connected and Automated Transport (CAT). During six months they have made themselves familiar with this domain. Each of them investigated a different research question related to the realization of Connected and Automated Transport innovations in the Logistics sector. Their research included:

- Investigation of business model impact of Autonomous Vehicles (AVs) in port contexts – Luise Abraham;
- Impact investigation of automated transport on fleet management services – Miruna Lorga;
- Automated Transport, vehicle routing and fleet planning – Bima Setiawan;
- Exploration of service network design and fleet composition for mixed autonomous fleet platooning – Niels Steenland.

In this short article we give a brief overview of their research and most important findings. Want to know more? Don't hesitate to contact TNO or RSM.

> **Business models of port authorities are expected to be impacted by the introduction of Automated Vehicles. Port authorities are advised to rethink (elements of) their business model.**

Through interviews with Port of Rotterdam, Port of Antwerp, Hamburg Port Authority, Port of Los Angeles and terminals ECT and Eurogate a first exploration is conducted on how port authorities perceive Automated Vehicles and whether their ***business models*** might be affected. It turns out that port authorities are responding in different ways, influenced by the current level of automation in the port. Some ports take a more frontrunner role as pilots with autonomous trucks are conducted by the port authority (e.g. Hamburg). Other ports take a more facilitating role in providing both the physical and digital infrastructure for AVs (e.g. Los Angeles). All in all, outcomes do not seem to be straightforward. All ports however tend to agree about the importance of (new) partnerships (with new stakeholders) and the potential of using AV data for optimizing traffic flow in port areas. This study is a nice starting point for further discussion and exploration.

> **Besides driving, truck drivers carry out a package of tasks. To reap the benefit of driverless vehicles, *all* of these tasks would need to be reallocated. This makes it difficult to sketch a transition path from human-operated to driverless operations.**

In the future, Connected Automated Vehicles (CAVs) may be able to act autonomous, i.e., without interference of or control by a human driver. However, truck drivers fulfill more tasks than only driving, including vehicle maintenance, vehicle fueling/charging, freight (un)loading, freight securing & monitoring, route planning & vehicle scheduling. By interviews with Logistic Service Providers (LSPs) it was investigated whether these tasks and ***fleet management services*** could be carried out by other stakeholders. The interviews revealed a trend to outsource vehicle maintenance to Original Equipment Manufacturers (OEMs). Furthermore, it turns out that imagining a future with driverless vehicles is difficult for LSPs, due to the multitude of tasks that would need to be organized in a different way if not taken over by the driver. Major cost benefits of CAVs would only emerge at the moment where all current driver tasks are allocated to different parties, and consequently no human presence on board would be required. In contrast, partial allocation of tasks would temporarily increase total cost. This makes it difficult to sketch a feasible transition path from human-operated to driverless operations.

> **Deploying automated vehicles in a truck fleet could significantly improve business operational performance, given the longer operation hours and reduced operational costs of automated vehicles. Question is how fleet performance will be affected by the adoption of automated vehicles.**

Removal of the driver from the vehicle will allow for longer and more flexible vehicle operating hours, because the vehicle could always operate continuously without considering admissible driving hours of the driver. Also, when equipped with communication technologies, automated vehicles are able to communicate with their surroundings and e.g. request for preference at intersections. The thesis research investigated the impact of automated vehicles deployment on ***fleet planning*** by means of Pickup and Delivery with Time Windows (PDPTW) models. Experiments showed that automated vehicles outperform manual vehicles in operational costs and travel times. The same set of orders could be performed with a lower number of trucks. The student research has some shortcomings, but it holds promise for useful follow-up research.

> **When following trucks in a platoon can operate driverless, investing in such autonomous trucks, or in trucks that can be operated both driverless and by driver can be beneficial if transportation volumes and route density are high enough.**

The thesis investigates the ideal ***fleet composition*** in the scenario where leading trucks in a platoon need to be human-driven, while following trucks may be operated autonomously. Taking fuel-savings related to platooning and driver costs for human-driven trucks into account, a mathematical model determines the optimal fleet size (distinguishing between driverless and human-driven trucks), assigns trucks to requests, routes trucks, and pairs them to platoons based on a set of transportation requests. Results show that deviating from the shortest route from origin to destination is beneficial if it creates platooning opportunities, that investments in autonomous vehicles can mitigate effects of driver shortages, and that investments in vehicles that may operate both with driver and driverless may be worthwhile. These effects are moderated by the transportation volume, or better said the route density that creates transportation opportunities.

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