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QUO VADIS AUTONOMOUS DRIVING, OR WHY THE ROBO-TAXI HAS NO CHANCE IN GERMANY!

Until a few years ago, autonomous driving seemed technically impossible, and numerous projects by major car manufacturers were discontinued with billions in losses. A few years ago, Waymo and several Chinese manufacturers had a breakthrough and went into serial application. With the development of end-to-end processes, some providers quickly achieved an impressive driving performance and are also trying to enter the Robo-taxi market. Robo-taxis are currently being tested or even used already around the world. I would like to recap the history and shed some light on the situation in Germany.

The term »Robo-taxi« came up over 10 years ago. The first version was Google's autonomous two-seater without a steering wheel or pedals, which I affectionately called the »bubble car«. Then Waymo was founded, focusing solely on the Robo-taxi several years ago with investments between \$15 billion and \$50 billion in the process. Technically, Waymo has solved the problem of autonomous driving and is currently the benchmark. These taxis cause eight times fewer accidents than human drivers.

Unfortunately, the costs are over \$150,000 for one car, due to high sensor complexity and self-developed computing platform. Added to this are the operating costs for monitoring the vehicles and, for example, repairing the expensive components. In many countries, taxi drivers are very inexpensive because they're paid the minimum wage, like \$25,000 per year. This means that Robo-taxis often do not pay for themselves within their operating life. This does not even include depreciation on development costs.

Other vendors of autonomous Robo-taxis, such as Pony.ai, Baidu, and WeRide, coming from China and have achieved similar functionality with lower investments. Their sensor platform is cheaper than Waymo's, enabling these companies to offer the same functionality as Waymo in China. However, the use of Robo-taxis there sparked protests from taxi drivers who lost their jobs.

Another criticism came from customers who want to get into a taxi quickly wherever they are. According to the rules, Robo-taxis are allowed to pick up passengers only at designated stops. Taxi drivers ignore this and stop for customers directly on the street. For these two reasons, operations in some cities were suspended and the manufacturers referred to other markets, such as Europe.

A recent study has been done by the Deutsche Bahn / German railway which operates many buses in public transport. It shows – like some others – that Robo-taxis induce 40% more traffic in cities. This is due to arrivals and departures as well as transfers from public transport to Robo-taxis. Many cities do not have the needed traffic space, which is why they reject Robo-taxis.

Tesla, NVIDIA, Wayve, and some other suppliers rely on so-called end-to-end software solutions for cost reasons. These use camera data only, train a neural network, which results driving in a manner very similar to humans. This solution saves costs, both in sensor technology and development, because not every new route has to be measured. Many experts doubt that this solution meets European safety requirements. At the very least, an approval is doubtful.

So where does autonomous driving in Germany really make sense and is possible? I see the most technically and economically useful application whit local city buses.

- **The route is always the same, which makes the costs of route mapping negligible over the vehicle's lifetime. Also, the safety concept is quite manageable because the bus can always stop safely due to its low speed.**
- **Buses often run 18 hours a day and the personnel costs for drivers are high, so the business model is trivial. In addition, there are not enough drivers, so if public transport is to be expanded, autonomous buses are the only solution.**
- **The expansion of public transport reduces individual traffic which means less congestion on the roads.**

We are pursuing this path and are aiming for an initial demonstration in Munich next year. A company spin-off is already in the planning stage, which will enable us to offer our own software stack for Level 4 autonomous driving.

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