AUTONOMOUS SHUTTLE IN BAD BIRNBACH

Country: Germany

OVERVIEW

Short description of the Good Practice Case:

The GP addresses the autonomous shuttle service operated in the rural area of Bad Birnbach. The service was started as a pilot project in October 2017 with one electric minibus EZ10 of the French start-up EasyMile on a 700-meter-long route from the local market square to the spa (Rottal Terme). The project was developed as cooperation of Deutsche Bahn and DB Regio Bus Ostbayern with the district of Rottal-Inn and the municipality of Bad Birnbach. After the first year, the service was extended with the addition of another stop and another EZ10 electric vehicle. The service currently connects the market square with Badstraße, a street close to the rail station, within a 1.4 Km long route; the duration of the trip is around 12 minutes each way. Four stops are served between 8am and 6pm every day. The EZ10 vehicles, each with a maximum capacity of 12 passengers (6 seats and 6 standing), are equipped with mini ramps and thus are fully accessible for people with reduced mobility. The shuttle service is now under the responsibility of the new DB business unit named "ioki" and is operated by the DB subsidiary DB Regio Bus Ostbayern.

Figure 1. The EZ10 autonomus shuttle in Bad Birnbach.
Source: Deutsche Bahn

Main aspect/issue addressed by the good practice

This Good Practice deals with the category A.2 – "*Moving forward with ICT in public transportation and shared mobility*".

In particular, two fully autonomous EZ10 vehicles equipped with a range of different sensors for detecting and avoiding potential obstacles on the route are used in the rural area of Bad Birnbach.

The GP also deals with the category A.3 *"Transport solutions at bus/train stations for last mile connectivity"*, since the service connects the rail station with the thermal bath and the local market square.

Main objectives of the good practice

The practical objective of the good practice is to offer a safe, affordable and innovative transport service between the railway station, the thermal baths and the local market square.

The high-level objective consists in testing the potential of an autonomous shuttle service for the first/last mile operation in a small rural area. In particular, the GP aim is to gain experience in the operation of autonomous minibuses, to get to know the technology even better and to test the acceptance by the customers.

DESCRIPTION OF THE AREA

Region	*Target area*	*Population*	*Population density*
Landshut, one of 18 regions of Bavaria federal State	68,81 km^2	5 743	83 inhab./km^2

Other

The GP is implemented in Bad Birnbach, a small municipality with around 5700 inhabitants in the district of Rottal-Inn.

The municipality is situated in the Lower Bavarian spa triangle and it is known for its thermal bath, the Rottal Terme. Bad Birnbach is about 43 km south-west from Passau.

Source: An autonomously driving electric bus drives on a street in Bad Birnbach. - Photo: Amelie Geiger / Archive

Target user groups and needs

The autonomous shuttle service is available for all population groups who wish to move between the thermal bath, the Atrium (a cultural meeting place) and the local market place.

The vehicles are equipped with a mini ramp and therefore the service is also available for people with reduced mobility and people in wheelchair. Target users are mostly elderly people (residents or tourists).

DETAILED DESCRIPTION OF THE PRACTICE

Timeframe(s)

The first autonomous shuttle was tested in Bad Birnbach for a period of around 6 months (from April to September 2017). The pilot phase was carried out from October 2017 until spring 2018. To ensure reliable and safe operations, three speed bumps were installed on the road to reduce the traffic speed. In addition, specific street signs were added to draw the attention of the pedestrians. Now, the service is regularly ongoing with two EZ10 electric vehicles.

Bodies involved

The project was developed by the Deutsche Bahn (DB, the German rail operator) together with the district of Rottal-Inn and the small municipality of Bad Birnbach, in close cooperation with the French start-up company EasyMile and TÜV Süd, a company based in Munich specialised in technology testing and certification. EasyMile is a high-tech start-up specialising in providing both software powering autonomous vehicles and also the last mile smart mobility solution, through partnership with other stakeholders.

The service is currently managed by ioki, a subsidiary of Deutsche Bahn specialised in on-demand and autonomous mobility solutions.

Mobility services provided/addressed

The service was firstly launched with one electric minibus EZ10. The shuttle route was approximately 700m long from the local market square to the thermal bath, with only two stops. In mid-March 2018, another EZ10 vehicle was added; in August 2018, the distance was doubled from 700 meters to 1,400 meters with a new stop close to the rail station. Currently two vehicles are traveling alternately on the route where four stops are available: Neuer Marktplatz, Artrium, Rottal Terme and Badstraße. Each EZ10 vehicle has 6 seats and six standing places and is equipped with mini-ramps for people in wheelchair. The EZ10 maximum speed is limited to 15 Km/h in Bad Birnbach. The service is available all weekdays from 8:00 am till 6:00 pm. An onboard assistant is always available who can intervene in an emergency case (for legal reasons). The service is free of charge for residents and tourists. For safety reasons, the bus does not operate in extreme weather conditions, for example during storms or heavy rain.

Legal Framework

The autonomous shuttle service in Bad Birnbach, and more generally the implementation of transport services with autonomous vehicles, is regulated at the national level through the German Road Traffic Act. The latest amendment (June 2017) of the Act requires the presence of an onboard operator who constantly monitors the driving process (running a vehicle without human supervision is also not yet permitted under the Vienna Convention on Road Traffic). In particular, the driver is obliged to remain aware of the traffic and the vehicle to a degree that he can react in case of a malfunction or any other situation which cannot be handled by the automated driving function. Further, the driver must use the automated driving function as intended (e.g. a function intended for use on highways should not be used in town). Vehicle, safety and operational concepts were assessed by TÜV Süd.

Cost and Financing sources

At the moment, the service is depending on public funding as well as support of the project partners. A business case has not been developed yet. The service is completely free of charge for passengers since there is a strategic interest of all partners and stakeholders to learn and professionalize the service instead of creating a revenue stream.

Organizational set-up

The EZ10 shuttle can offer three modes of configuration. A “metro mode” where the vehicles serve every stop systematically, a “bus mode” that offers a stop only when requested by the passengers and finally the “on demand” mode that allows users to have a shuttle bus to the stop of their choice on request thanks to terminals or a mobile application. In Bad Birnbach, the EZ10 vehicles follow a fixed-route public transport service operational model.

The service is orchestrated and organized by the Deutsche Bahn subsidiary DB Regio Bus Ostbayern, which also involves the approval for public transport and the management of the service personnel (e.g. safety operators). In total, there are seven safety operators currently on board of the shuttles, one chief operator (taking charge of technical and organisational issues) and one Head of operations (responsible for the

DETAILED DESCRIPTION OF THE PRACTICE

coordination of the service, the application for public transport, etc.).

Supporting technologies

The vehicles used are bi-directional driverless shuttle equipped with a set of sensors for detecting and avoiding potential obstacles on the route. The standard equipment foresees:

- Lidar sensors: two 3D Lidars (central front and rear) and four 2D lidars (4 corners), which provide 2D and 3D perception maps of the physical environment to allow for precise vehicle positioning and obstacle detection;
- GPS antenna, which determine the precise position of the vehicle at any time through the communication between a GPS sensor and a base station;
- Initial Measurement Unit (IMU), which measures vehicle accelerations and rotations, allowing the vehicle to confirm positioning information and improve precision;
- Odometry, which measures the displacement and speed of each wheel to estimate the speed of the vehicle and change in vehicle position.

The vehicles are fully electric, with 8 kWh Lithium ion 48V tension battery, an autonomy of around 14 hours and with 7-hour charging time on average.

The shuttle follows automatically - as on virtual rails – a predefined fixed route. The route was recorded (including the stops) during the testing phase; the lidars connected to the on-board computer analyse the effective path and allow the EZ10 electric vehicle to locate precisely and move without a driver.

In Bad Birnbach, there is always a travelling companion (safety operator) onboard who can intervene if necessary, for example by triggering an immediate stop or by manually avoiding obstacles by a joystick. Although the bus recognizes obstacles and stops in time, at the moment it cannot deviate from the route on its own to avoid obstacles such as parked cars.

Source: From left, 2nd mayor Franz Thalhammer and district administrator Michael Fahmüller, with Annegret and Hans Bäcker from Düsseldorf, were delighted with the 10000th passenger. Photo: Kurverwaltung Bad Birnbach

The speed is electronically limited to 15 km/h.

The management operations are carried out with EasyMile's EZFleet, a set of software and mobile apps that supervise multiple vehicles at once.

INNOVATION ASPECTS

ORGANISATIONAL RESPONSIBILITIES AND PARTNERSHIP WORKING ARRANGEMENTS

The subsidiary ioki of Deutsche Bahn worked in close cooperation with the vehicle provider (Easymile) and the local authority in order to set up the conditions for guaranteeing the safe operation of the service in the planning phase.

LEVEL OF PUBLIC SECTOR FINANCIAL SUPPORT

The project is financed both by ioki/Deutsche Bahn (project management, acquisition and operation of the bus and other vehicles, accompanying research) as well as the municipality of Bad Birnbach (public relations, structural measures for infrastructure upgrading on site). The project is seeking a partial reimbursement of costs by the Bavarian state government.

INTERCONNECTIONS BETWEEN SHARED AND PUBLIC TRANSPORT SERVICES

The services carried out with the two autonomous vehicles act as feeder services between the railway station and the main points of interest in Bad Birnbach. The service is a green, safe and accessible solution for the last mile connectivity.

ICT CONNECTIONS AND IMPACTS OF THE TECHNOLOGICAL SOLUTIONS IMPLEMENTED

EasyMile EZ10 offer a safe and turnkey autonomous mean of transport which includes the driverless vehicle, autonomous driving software, fleet management system as well as remote control centre. The solution implemented in Bad Birnbach is particular innovative in the fact that the vehicles are not in controlled environment (like campus, hospitals, etc) but on open (not structured) public area.

OTHER (E.G. SOCIAL INNOVATION, ETC.)

N/A

ASSESSMENT

Ridership and other key metrics/results (through key-indicators, where applicable)

The shuttle service was officially launched in October 2017 with one EZ10 vehicle. In May 2018, the service had carried out around 10,000 passengers covering 4900 kilometres. On average, around 50 passengers a day used the bus service. In summer 2018, it was decided to add another electric EZ10 vehicle and another bus stop. In 2018, the figures registered a positive trend: the transported passenger were about 15 000 in August 2018, 20 000 after one year from the turn off. In March 2019, the passengers transported amount at 27 218 with an average of 61 passengers a day (+22% respect to May 2018), and with 15 389 kilometres.

The service has been commonly recognised as green and safe from the residents of Bad Birnbach. It has to be noticed that in more than one and a half year, no accidents have been registered, apart from a mini-accident when a motorist bumped against the stationary bus while parking (and therefore without any responsibility from the autonomous vehicle provider).
The pilot project in Bad Birnbach thrilled locals and tourists to such an extent that, for example, when a EZ10 vehicle did not pass for half a day due to software updating, there were immediate complaints. Local interviews showed that the bus service has become part of everyday mobility.

The project is also interesting for other municipalities. For example, representatives from the district of Wunsiedel in the Fichtelgebirge recently visited the Lower Bavarian town and tested the eBus.

Good Governance

The project was set up to gain experience in terms of professionalizing processes and products dealing with driverless public transportation systems in rural areas as well as gaining experience in operations. According to the given goal, the project delivered a broad bandwidth of operational data, which has been shared and evaluated with the manufacturer Easymile to optimize the technical platform of the vehicle system and thus increase reliability. Moreover, since the project start of the project in 2017, there has been a significant increase of overnight stays (tourism) in Bad Birnbach, which is attributable to the effective marketing activities, public relations and media coverage of ioki/Deutsche Bahn and the city of Bad Birnbach.

In various different fields of the project organisation, the private-public partnership model brought up different benefits for handling complex tasks regarding a new and innovative public transport approach.

Success factors/strengths

The EZ10 minibus in Bad Birnbach is one of the first driverless electric bus that travels in public traffic in Germany and is a pioneer for mobility in the country. It is particularly relevant because it is one of the first cases in Europe which investigates the possibility of replacing conventional PT services in a rural area with low demand with autonomous vehicles. Passengers feel comfortable with the service, and there are positive feedbacks with respect to the safety perceived, comfort during the travel and waiting time at stops.

Since the project is the first pilot in the field of autonomous mobility in public transport it acts as a benchmark for operational and approval processes in autonomous public transport mobility, which had a big impact on the creation of a working group related to autonomous mobility on a national level. It furthermore offers approaches for standardization regarding realization other projects dealing with Autonomous Mobility in Germany and beyond.

Difficulties encountered/weakness

Considering that the priority was to test the impact of the autonomous solution on an open public space, a business model for this type of solution has not been developed yet. Therefore, the service is completely dependent on public subsidies. The long-term sustainability of this kind of solution needs to be analysed in order to understand if this service can be a cost-effective solution for last mile transportation.

The regulation for the implementation of fully autonomous vehicles in Germany and in Europe still forces the operator to guarantee one person onboard that can intervene in case of emergency or issues. This fact limits the cost savings due to the absence of the driver thanks to autonomous driving. Furthermore, there is little freedom in design for such tests on a technical level to speed up the development steps in autonomous mobility. In this example the discrepancy between legislation and potential innovation for fully autonomous vehicles becomes very obvious.

FEATURES THAT ARE CONSIDERED TO BE GOOD PRACTICE (LESSON(S) LEARNT)

The GP is particularly relevant in the fact that it shows an interesting solution for dealing with last mile solution. In particular, it is a pioneer in the field of autonomous transportation and it could constitute a new business case for solving the last mile solution in low demand or sparsely populated areas.

REFERENCES FOR FURTHER DETAILS

Contact of the operator and of relevant stakeholders

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Key references

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