

# The impact of logistics innovations in rural areas

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**Abstract.** The aim of this paper is to identify the main drivers of and differences in logistics innovations in rural areas, particularly compared to the situation in cities. By using empirical findings from 16 case studies in Southern Germany, it can be shown that some fundamental differences exist. The lack of suitable infrastructure in rural areas in particular, such as 5G and charging stations, is one main reason why various current innovations, including real AI in logistics or alternative drives and fuels, are viewed with scepticism. In addition, some changes, such as autonomous delivery, are simply not considered necessary.

## 1 Introduction

In both theory and practice, a prosperous future for the logistics industry is closely linked to the ongoing implementation of innovations. Hence, the further development of logistics services is mainly based on the successful implementation of new technologies, advanced processes, and the use of information technology [1, 2]. Concepts, such as augmented reality, same-day operations, autonomous delivery or predictive shipping, are an outcome of these considerations and are already being implemented in many surroundings.

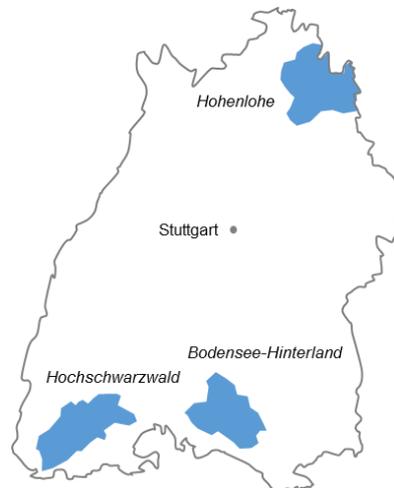
However, logistics innovations in rural areas have, thus far, been rarely considered in research [3, 4, 5]. This lack of scientific discourse is highly problematic, because logistical requirements in rural areas are often completely different from those in the cities. Whereas customer service requests might be the same in both surroundings, conditions for logistics service providers are completely different. A high volume of shipments in cities is replaced by long travel distances in rural areas, traffic jams by inadequate road conditions, and environmental zones with traffic restrictions by a lack of charging stations for vehicles with alternative drives and slow cellular networks.

For this reason, this paper focuses specifically on the conditions of logistics innovations in rural areas. From an ongoing research project funded by the economics ministry of Baden-Württemberg, the

current status, first findings and preliminary conclusions are presented.

## 2 Methodology

The aim of this paper is to identify the specific problems of logistics innovations in rural areas by using a participatory research approach. Rural areas are regions with less than 150 inhabitants per km<sup>2</sup> [6]. The examination is based on three regions, which can be seen as representative of the diversity of rural areas in Baden-Württemberg (see Figure 1).



**Figure 1.** Selected regions (own graph).

In each region, between four and eight company case studies were conducted. These represent a selection of companies with a shipment volume characteristic

of rural areas, but with different logistical challenges. All case studies were collected via partially standardized interviews in the summer of 2020 (see Table 1).

Region	Case studies	Industry sectors
Bodensee-Hinterland	4	- wine wholesale - warehousing and logistics - load securing material - loading systems
Hohenlohe	8	- furniture - engines - freight forwarding - breweries - parcel services
Hoch-Schwarzwald	4	- forklifts - measuring technology - freight forwarding

**Table 1.** Overview of case studies (own table).

The case studies were supplemented by an extensive literature review. In addition, the knowledge was to be expanded in workshops with the case study participants. However, these workshops from the original plan had to be postponed due to the COVID-19 pandemic situation. Nevertheless, valuable insights have already emerged from the case studies. These findings are presented below.

### 3 Findings

#### 3.1 Main fields of innovations in rural logistics

In current literature, various approaches that name and subdivide innovations in logistics are found [2, 7]. In addition, the authors have dealt intensively with logistics innovations in previous studies [8, 9]. From this research, a total of 17 core innovation fields in logistics were identified [9]. However, this selection does initially not refer specifically to rural areas. Therefore, the influencing factors were first subjected to an extensive evaluation process. The aim was to determine which factors are likely to be of special importance in rural areas.

For this purpose, an impact analysis was carried out. This clarified how strong the expected impact will be in rural areas and whether innovations in these specific rural areas are more likely to be perceived as opportunities or risks. In this way, the original 17 factors could be reduced to seven factors: (i) digitalization, (ii) autonomous delivery, (iii) location advantages, (iv) resilience, (v) green logistics, (vi) labour conditions and (vii) political perception. Factors (“fields of innovations”) and findings from the 16 company case studies on the impact on logistics innovations are described more in detail in section 3.2.

#### 3.2 Characterization of the fields of innovations in the selected company case studies

In the case studies, the need and impact of innovations, in particular, in the identified seven fields have been evaluated in detail. For each field, specific aspects for rural areas could be identified, some of which differ significantly from the conditions in urban logistics:

*Resilience:* Resilience describes the ability to cope with external disruptions and difficult situations without any significant internal changes, such as mass layoffs or insolvency. Some companies reported that they had not implemented a crisis management strategy before this year, when this became necessary in order to deal with the COVID-19 pandemic situation. However, other companies made special reference to being small and medium-sized enterprises. They pointed out that as a small business, crucial decisions have to be made every day. A dedicated strategic crisis management strategy is therefore not relevant, and COVID-19 has not yet changed that.

*Green logistics:* This field includes climate and environmentally friendly innovations in logistics and transport to reduce the impact on people’s quality of life, e.g. by reducing CO<sub>2</sub>, air pollution, and noise. This includes, in particular, the implementation of alternative drives and new fuels. The companies often reported that the use of alternative fuels is currently unthinkable in rural areas. Due to the lack of charging options, there is no possibility to switch to batteries or H<sub>2</sub>. Most companies want to wait for suitable infrastructure to become available first.

*Labour conditions:* This describes the use of business models in which the companies consciously take on social responsibility, e.g. in working conditions, delivery conditions, cooperation and shared use of staff. In order to retain good staff at an early stage, companies in rural areas often support local associations and maintain close ties, especially with skilled workers like truck drivers. In addition, they rely on loyalty and long-term relationships as well as cross-generational employment. Their bond with the workforce is very high. However, companies also have concerns about losing employees to local competitors as part of a sharing economy.

*Location advantages:* The respondents disagreed on the relation between innovation and location. Mostly, the availability of expansion areas is seen as the main advantage with distance to the nearest motorway as the biggest disadvantage. When local business partners in rural areas close or cease to exist for any reason, the inefficiency of logistics often increases dramatically, since new business partners are often far away. However, companies also point out that they like the rural surroundings at the company headquarters, where they have often been

for a very long time. If more people were to move back to the countryside in the future, location could become a strategic advantage. Currently, however, there is much competition for labour between companies in the region, which is why specialists need to be sourced nationally and not only regionally.

*Autonomous delivery:* Autonomous systems enable vehicles to move without the influence of human drivers (e.g. autonomous trucks, other driverless transport systems, delivery drones). Such systems are already common in warehousing, regardless of location. However, their use in transport logistics in rural areas has a mainly negative perception. The infrastructure in rural areas (e.g. narrow and winding roads) was often considered by the respondents to be too complex for autonomous systems. There is also a lot of anticipated bureaucracy related to the use of autonomous vehicles. At the same time, these systems are currently not considered necessary. For example, autonomous systems for loading and unloading have already been tested. These take up too much space behind the ramps and can therefore not be implemented.

*Digitalization:* Digitalization concerns the integration of virtual networking, intelligent devices, availability of data from different parties in real time, problem solving in the virtual world, and a data-based individualization of production and logistics processes. In the case studies, particular reference was made to the need for a suitable 5G data infrastructure in rural areas as a necessary condition for digitalization: parties first need a comprehensive network in order to be able to access digital data in real time. Even if this is currently often not the case in rural areas, most of these companies have already gone paperless as part of their internal processes. Further digitalization is desired, but only as long as this does not add any further steps that complicate processes.

*Political perception:* This includes political measures that support innovative changes and adjustments, e.g. monetary support or legal relief. The companies pointed out that political support, in particular, for an expansion of the rural infrastructure is urgently needed. In addition, more should be done to increase the prestige of the systemically important profession of truck drivers. Logistics companies especially complain about a lack of political support for creating the necessary conditions for decarbonizing road freight (e.g. availability of fast charging stations and subsidies for additional ongoing costs relating to emission-free vehicles).

### 3.3 Discussion

The case studies showed that the possible impact of logistics innovations in rural areas is assessed very differently by the companies. The individual situation, and the need for change in which the respective

company finds itself appears to play the major role. At first glance, this is considered to be significantly more important than “rural” surroundings in general, and thus the spatial structural conditions in which the company is based.

Based on this preliminary main finding, various hypotheses on the impact of logistics innovations in rural areas can be derived from the case studies (see Table 2).

Field	Impact	Current conditions	
		<i>external</i>	<i>internal</i>
<b>Digitalization</b>	high	poor	good
<b>Political perception</b>	high	poor	-
<b>Resilience</b>	medium	-	good
<b>Green logistics</b>	medium	medium	medium
<b>Labour conditions</b>	medium	medium	good
<b>Location</b>	low	good	good
<b>Autonomous delivery</b>	low	poor	medium

**Table 2.** Impact of logistics innovations in rural areas (own table).

Currently, none of the innovation fields in which a high impact of logistics innovations in rural areas that creates a strong demand for the implementation of innovative solutions is rated highly with respect to the current external conditions. The progress of digitalization in particular, but also general political support, are seen as obstacles. Internally, on the other hand, companies see themselves as being particularly well prepared for digitalization. However, the respondents understand very different things by the term “digitalization”, ranging from paperless work to artificial intelligence.

Interestingly, there seems to currently be hardly any need for autonomous driving. The economic benefits are often not yet seen. Occasionally, however, potential is perceived. For example, autonomous vehicles could help reduce the problem of inefficient empty journeys that may occur when serving locations in rural areas. At the same time, autonomous driving could be an important argument for nationwide 5G expansion.

The current situation concerning green logistics is assessed somewhat more highly. But here, too, the central questions are unresolved, especially with regard to the decarbonisation of transport. The same applies to the external conditions for improving resilience, especially since the companies believe that they can largely shape this area independently.

## 4 Implications

The inconsistency in the evaluation of different fields of logistics innovations in rural areas suggests that there is considerable need to look for further

explanations, particularly in (1) the dynamics of innovation processes in rural areas and (2) the connections between the fields. Therefore, these two points should be given special attention in the further course of research.

Experience from other research shows that interaction between the case study partners has proven to be particularly promising for further knowledge generation [10]. For this reason, the workshops that were postponed due to COVID-19 are to be rescheduled. Innovation scenarios will be developed together with the companies and additional experts. The aim is to make the full innovation potential of logistics available for rural areas, while at the same time keeping an eye on the specific conditions there.

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## Authors' Background

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**Tobias Bernecker** has been a full-time professor at Heilbronn University since 2011. He holds a Dr. rer. pol. from the University of Stuttgart, Germany. Before joining Heilbronn University, Tobias Bernecker worked for the Ministry of Transport of Baden-Württemberg as an advisor. He is specialised in the field of transport policy and transport economics, particularly infrastructure development and financing strategies. Business and market modelling for ERS are aspects of his current research as well as connectivity in freight forwarding, innovative urban transportation and projects in the field of public transport.

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