
Master Thesis - Abstract



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Topic: **Basic Principals of a Combined Parcel Delivery and Transit Service in Rural Areas**

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The supply of rural areas has always been a problem for the agents of the Transport service, of both passengers and freight. These areas in particular are usually thin and disperse populated, with large distances between neighboring houses. This means that a central location would still be far from most of the houses and difficult to reach for a great part of the population living in this region.

In the light of the forecasted demographic and structural change of the population, this situation tends to further worsen. In Germany, the population is stagnant since the last decades, but the tendency is that a decrease in this number happens. Another change that is predicted to happen is the aging of this population. The birth rates are decreasing, while the life expectancy rises. Less children and youth mean a decrease of the student transport, that forms in many rural regions the backbone of the public transport. Also the elderly people don't represent positive effects for the public transport, once they show an increasing affinity for private transport.

In the rural areas this decrease will probably be stronger, due to a process of urbanization that is happening all over the globe, but specially in industrialized countries, driven by strong economic conditions and corresponding employment opportunities that can be found in the urban centers. Mostly younger people are moving to urban centers to take advantage of these opportunities. With less people, the demand for the service sector decreases as well, and many businesses move towards bigger agglomerations. This creates a vicious cycle, because makes the rural areas even less attractive to live.

Within the field of the transport supply and demand in the rural areas the problem is the same. The demand decreases even more, which makes the average costs of a single trip higher. The agents of Public Transport as well as shipping companies are facing comparatively low degrees of network utilization in these areas. Therefore, this whole situation led to a lower supply, with reduction of transport services or even elimination of some routes. And again the vicious cycle happens. With less transport supply, this areas become less attractive for the population.

Novel solutions to secure the supply of these regions with mobility services and goods gain further importance in order to ensure a reasonable level of service as part of the public welfare. Cooperation between public transport and companies of the parcel delivery market appears to be an appropriate solution to cope with the specific problems at hand.

The objectives of this work are then to identify these problems, describe them in details and estimate the feasibility of alternatives that use the combination between parcel delivery and transit service with autonomous vehicles. For that, the main features of both services will be approached, as well as specific aspects regarding autonomous vehicles and automated steps within the processes of the described services.

The first chapter of the work gives a brief introduction to the concept of rural areas and the distribution of those areas within the German territory. Besides, the main problems concerning mobility issues in rural areas are introduced. The chapter finishes with the explanation of the main objectives that motivated the work.

The second chapter provides a deeper analysis of the process of parcel delivery. It begins with more generalized aspects, from the starting steps at the factory, and describes the main operations involved in the chain up to the final customer. As the focus of the work consists of the final leg of the delivery process, the steps connecting the parcel to the recipient, from the regional depot of the carrier, gain higher importance. The delivery to the final customer may be executed by different methods, which differ in respect to the presence or absence of the recipient by the delivery time and the local in which the good is collected or picked up. The specific aspects of each method is presented and compared, with the issues that the features of rural areas may cause.

The third chapter focus on the operation of public transport, especially in the regions of low demand. The problems concerning the provision of such service in rural areas are approached again, highlighting the vicious effect that may occur and the effect over the living conditions. Then, possibilities of flexibility for the service, regarding both temporal and spatial aspects, are indicated as potential measures to cope with the issues presented. Each form of flexibility is clarified, with the respective strengths and weaknesses, according to the point of view from users and operator. A brief explanation of the Dial-a-Ride and Share-a-Ride problems is presented followed by the requirements for a successful implementation of such flexible forms. A typical process of public transport, seen from a passenger's perspective, is presented, as well as an example of evaluation of travel times, the generalized cost, which expresses in monetary terms the variables considered in a decision.

The fourth chapter is dedicated to the combination of the services of passengers and parcels transport, in respect to the peculiarities of rural areas. The two transport processes present many coincident aspects. But more interesting for the implementation of the combined service is the analysis of the conflicting aspects and how they shall be solved, resulting in a service that brings advantages for the several individuals involved. Some particular aspects are analyzed with more accuracy, such as the determination of the routes and time windows for the beginning and end of the journeys. The features of the combined service are then put together in a morphological box, that is a table where all possible characteristics are listed, showing the range of possible options for each feature. The next subchapter is dedicated to present the evaluation method, mentioning the criteria to be used and the weighting method that will indicate the relative importance of each criterion according to the perspective of each involved agent.

The fifth chapter gives to the reader an overview of technological aspects that may interfere in the implementation of autonomous vehicles on such form of combined service and the impacts that it would bring. The highest level of vehicle automation is still not feasible, due to a series of regulations and technological aspects, but it is expected that this situation changes in the near future with the recent advances within the field. The chapter states the advantages and challenges of adopting such form of operation and the components of the system of automation.

The sixth chapter gathers data about an example of rural area from the real world to illustrate the typical parcel volumes and demand for public transport. It begins with socio-demographic data about the region, then introduces

information about the structure of the public transport and about the delivered parcel volumes, based on estimations with population data and its structure from the region and from Germany overall.

In the seventh chapter, alternatives of the combined service are designed and presented. The aspects of the combined service gathered at the fourth chapter, as well as aspects of automation are combined in four different forms. For alternatives with different vehicles, the number of trips needed to cover the demand was calculated. The draft version of the morphological box, presented before, is then fulfilled with the specific characteristics from each alternative. The criteria and the weights defined previously are also put into practice in a decision matrix, that evaluates each alternative according to each criterion and indicates the most suitable form, by the perspective of each agent.

In the final chapter, conclusions from the work are done, with an indication of the most adequate solution among those presented.