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INTEGRATED REGULAR TIMETABLE AND SPATIAL FACTORS IN AUSTRIA AND SWITZERLAND

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Abstract: *Railway passenger transport is a story of success in Switzerland. The timetable scheme of the integrated regular timetable (IRT) is an important factor of its success. Structural factors like population and agglomeration structures and the extent of the commuter traffic between the conurbations nevertheless play an important role too. Austria and Switzerland differ much in these structural factors. Therefore one cannot expect a similar success from the implementation of an IRT in Austria. Nevertheless it may help to improve ridership and the share of railways on the modal split in Austria, especially in certain regions.*

Key Words: Success of passenger railway services, Integrated regular timetable, Passenger demand, Population density, Agglomerations, Geography

1. INTRODUCTION

Switzerland is a country of train-users: On average, each Swiss travelled 2,430 km by train in 2013. Thus, Switzerland is world champion in this discipline. Within Europe, Austria is on second place with a respectful distance of around 1,000 km behind Switzerland.
The basis for the success of the passenger railways in Switzerland forms a dense offer on a dense railway network. In 1982 a nationwide regular timetable was implemented, which was consistently expanded to an integrated regular timetable (IRT) in the following decades and will also be further expanded.
Swiss railways are leading the field by far in a range of parameters, e.g. passengers transported and share in the modal split at both short- and long-distance travels [1]. The IRT is said to be a key factor of this success. Therefore different sides repeatedly demand the introduction of a nationwide IRT in Austria. They hope to improve the situation of the Austrian railways and generally of public transport significantly by transferring the successful Swiss model. Today, the share of public transport of the modal split is

substantially lower in Austria than in Switzerland, and considerably fewer passengers are transported in Austria.
So the question which has to be answered is whether an introduction of a nationwide IRT in the Austrian long-distance passenger traffic is promising success, given the structural parameters in Austria, and if one can reckon with similar increases in passenger numbers as in Switzerland.
It is assumed that the success of offerings in rail passenger transport is on one side determined by the design of the offer itself, such as timetable structure (e.g. IRT), quality and quantity of the offer,... On the other side it is influenced by various structural, "external" factors. Relevant factors include geography and topography, population and agglomeration structures and the extent of the commuter traffic between the conurbations. These „external“ factors will be examined in more detail below.

2. THE INTEGRATED REGULAR TIMETABLE [2]

The aim of the IRT is an optimal connection of different train and/or bus lines in certain hub stations. In these hubs there are connections to and from all directions with short transfer times. Therefore the trains and buses from multiple directions have to reach the hub station nearly simultaneously and have to leave it nearly simultaneously too, after waiting for some minutes in the station to enable the passengers to change trains.
The underlying clock-face scheduling means that departures take place when the minute hand is at the same place every hour (e.g. 6:15, 7:15, 8:15, etc.). The headways between the trains are always constant. In the example the trains go every hour. Other common intervals are half an hour and two hours. The goal of clock-face schedules is to increase the attractiveness and versatility of public transport. They are easier to memorize for passengers, because departure times repeat.
The meeting points of trains of a line are determined by the fixed clock intervals. They are located in the nodes themselves and exactly in the middle between two nodes. The driving time from one node to another equals half the interval or an integer multiple. When the trains go every hour, half the interval is 30 min. Thus, every 30 min a node can be established. The possible driving times between two nodes are 30 min or integer multiples (60 min, 90 min, …).
These strict timetable requirements result in certain demands on infrastructure and operations. In many cases, infrastructure upgrades are necessary to reach the desired driving time between two hubs. On single track lines the train-meeting points – which are determined by the headways – must be upgraded to double track. In the nodes, an IRT also requires a certain infrastructure, enough platforms and enough capacity on the feeder lines in particular, because trains from multiple directions reach and leave the station virtually at the same time.
In a well-executed IRT the departure times are easy to memorize, and changing trains is easily done without much waiting time. These advantages of an IRT often bring a considerable increase in customers to the railway companies.
In Switzerland, the concept of integrated regular timetabling is consistently pursued since the 1980s. In Austria, ÖBB basically is using a regular timetable for it’s long-distance-trains. There are also several nodes in this system, but until now no nationwide, fully-fledged IRT is established, with a well-thought-out and consistently implemented node system, good connections between urban and mainline trains as well as between long-

distance lines. Current plans propose the successive establishment of an IRT in Austria in the coming years.

3. GEOGRAPHY AND SPATIAL PATTERNS [3]

Austria reaches 577 km from east to west and 296 km from north to south. The total area amounts to 83,879 km^2. It has three major regions, the hilly countries ("Vorländer") and basins at the edge of the Alps, the gneiss and granite highlands and the Austrian Alps.
Most urban centers and the largest proportion of the population are located in the hilly countries and basins in the north, east and southeast, which account for about a third of Austria's surface. Almost two thirds of the Austrian territory is covered by the Alps, which are mostly only sparsely populated. The main settlements in the Alps are located in the larger valleys of the Rhine, Inn and Mur/Mürz and in the Klagenfurt Basin inside the Alps.
Switzerland's dimensions are more compact in comparison to Austria; it reaches 220 km from north to south and 348 km from east to west. It covers an area of 41,284 km^2 and also consists of three major regions, the Swiss Central Plateau ("Mittelland"), the Alps and prealpine lands ("Voralpen") and the Jura. The sparsely populated Alps in the southern half of the country account for about 50% of the countries territory. Two-thirds of the Swiss population live in the mostly hilly Central Plateau between Alps, Jura, Lake Geneva and Lake Constance. Since the Central Plateau accounts for about only 30% of the national territory, it has a high population density of 450 inhabitants/km². Thus it is one of Europe's most densely populated regions. Almost all the major conurbations are located in the Central Plateau.

4. SETTLEMENT STRUCTURES AND AGGLOMERATIONS

In the year 2011 Austria had a resident population of 8,420,900 persons on an annual average. Out of this, 66% or 5.5 million inhabitants are currently living in urban areas. The largest conurbations are Vienna (about 2 million inhabitants), Graz (330,000 inhabitants), Linz (280,000 inhabitants), the Rhine valley (260,000 inhabitants), Salzburg (220.000 inhabitants) and Innsbruck (200,000 inhabitants) [4].

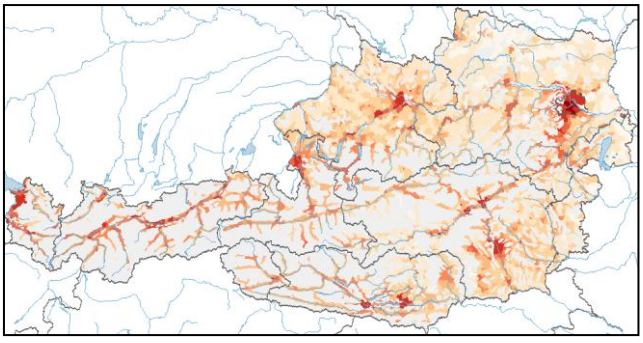

Figure 1. Population density per km^2 in Austria as in 2001. Dark-grey shaded zones indicate densely populated areas [5]

The population density in Austrian municipalities is shown in Figure 1. There are two main settlement axes north and south of the Alps. The northern axis runs from Vienna - St. Pölten – Upper Austrian central region to Salzburg (- Innsbruck - Rhine Valley), the southern one from Vienna - Wr. Neustadt - Mürztal to Graz (- Carinthia). The illustration shows that there is one large metropolitan area – Vienna in the east of the country. The other metropolitan areas are much smaller and spread all across over the country.
At the end of 2011, Switzerland had a resident population of 7,950,000 persons [6]. 73% of them are currently living in urban agglomerations. The largest conurbations in Switzerland are Zurich (about 1.2 million inhabitants), Basel (850,000 inhabitants), Geneva (700,000 inhabitants), Bern (350,000), Lausanne (340,000 inhabitants), Lucerne (210,000 inhabitants) and St. Gallen (150,000 EW). Basel and Geneva are situated close to the border. Therefore also the inhabitants of the agglomeration parts which are not located in Switzerland are included. shows the population density in the Swiss municipalities.

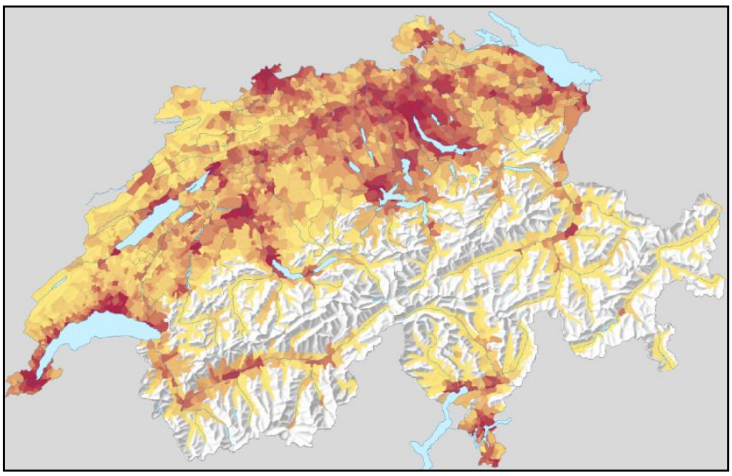

Figure 2. Population density per km2 in Switzerland as in 2010. Dark-grey shaded zones indicate densely populated areas [7].

The size of permanent settlement area, the size of population and therefore also the average population density are approximately the same in both countries. But there are great differences in the geographical distribution of the population and also of agglomerations.
While the Austrian agglomerations are relatively evenly distributed all over the country, their Swiss counterparts are concentrated in the Central Plateau in the north, northeast and west of the country. Only Lugano in the south and – to a much lesser extent – Geneva and Lausanne in the far west of the country find themselves in some kind of remote location.

5. DISTANCES, TRAVEL TIMES AND POPULATION POTENTIAL BETWEEN CONURBATIONS

In Austria, distances between adjacent conurbations frequently amount to more than 100 km, especially at the connections that cross the Alps. A concentration of agglomerations can be found in eastern Austria. The urban areas of Vienna, St.Pölten, Wiener Neustadt,

Bratislava, Sopron and Györ (the last three of them are located in neighbouring states near the border) are situated relatively close to each other, with distances of no more than 100 km. Concentrations of urban areas can also be found in Upper Austria / Salzburg (Linz, Wels, Vöcklabruck, Salzburg, Passau, Steyr), Styria (Graz, Leoben, Kapfenberg) and Carinthia (Klagenfurt, Villach).

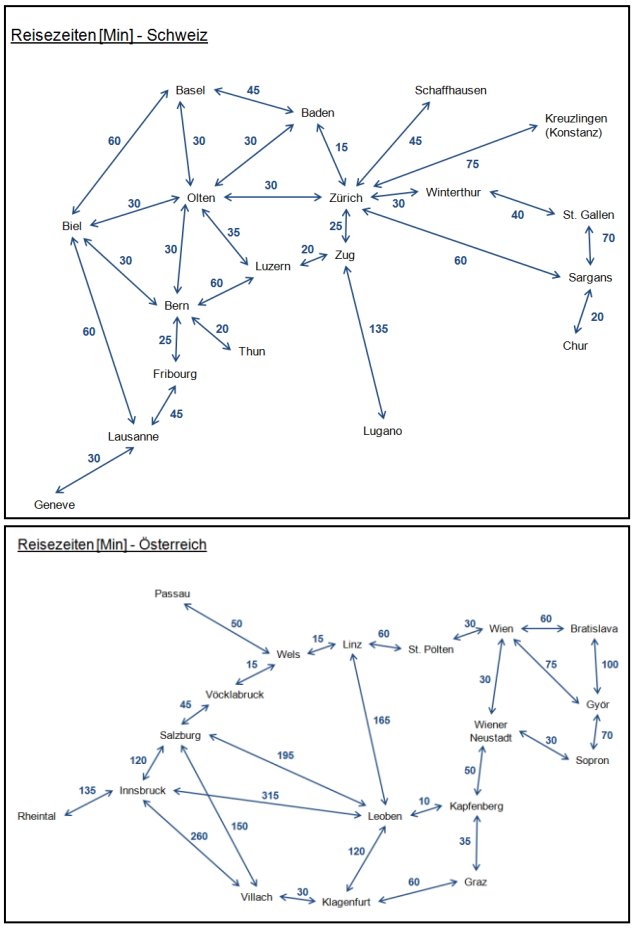

Figure 3. Traveling times between agglomerations in Austria and Switzerland in minutes

Figure 3 shows the travel times between the metropolitan areas [8]. While Alp-crossing connections take several hours, travel times of no more than one hour between adjacent conurbations are found in the eastern region. This is also the area where to some extent one can find a net-like arrangement of urban areas like in Switzerland. Relatively short travel times between agglomerations despite some greater distances can also be found on the well-constructed Western Railway Vienna-St. Pölten-Linz-Wels-Salzburg / Passau and on the Southern Railway in the section Kapfenberg / Leoben-Graz – Klagenfurt – Villach. Here, however, no network structure exists. City regions are strung together in a line.

The travel times on the southern runway were adopted, assuming the existence of the Semmering Base Tunnel and the ride over the Koralm-Railway between Graz and Klagenfurt (commissioning for 2023 provided).
In Switzerland, the distances between the population centres are on average significantly below 100 km. In most cases the Swiss conurbations are arranged like a net with many cross-connections. The con-centration of the metropolitan areas in the Central Plateau and prealpine lands and the resulting short distances are reflected in short travel times between conurbations. Figure 3 llustrates this situation.
Many of the larger cities have connections in all directions, e.g. Zurich, Olten, Bern and Lucerne. Traveling between adjacent conurbations in many cases takes no longer than 30 minutes, and only on a few connections it takes more than 60 minutes [9].
In order to make a well-based proposition about the theoretical population potential for passenger railways we assume that long-distance train connections are attractive only up to a certain travel time, especially in the commuter traffic with high passenger numbers. This travel time is supposed to be 60 minutes in one direction at maximum. Furthermore it is assumed that there is already a decrease in the attractiveness if travel time exceeds 30 minutes.
Therefore 30- and 60-minute isochrones (travel time by rail) are drawn around the metropolitan areas. This provides information about the number of people who live in other conurbations within a time distance of 30- and 60-minutes.The respective metropolitan area itself is of course not taken into account. 15 conurbations in Switzerland and 14 in Austria are considered.
In Austria, significant population potentials with more than 100,000 people in a 30- or 60-minute isochronous can be found in the area around Vienna, on the Western Railway (settlement axis north of the Alps) Vienna - Upper Austrian central area - Passau / Salzburg and on the Southern Railway in the section Leoben-Kapfenberg-Graz-Klagenfurt.
In Switzerland, with the exception of St.Gallen and Lugano significant population potentials exist in all agglomerations already within the 30-minute isochrones, which is not the case in Austria.
If we sum up all the population within the 30- and 60-minute-isochrones around the examined agglomerations, the cumulative population within the 30-minute isochrone amounts to 10.1 million in Switzerland and to 5.3 million in Austria, which is only about half as many. Within the 60-minute-isochrone there are 25.8 million inhabitants in Switzerland compared with 8.2 million in Austria, which means the relationship is more than 3:1.

6. SUMMARY, CONCLUSION AND OUTLOOK

In Switzerland and Austria there are similar large landscapes and major regions. The population in both countries is comparable in size and the population of each concentrated in the flat and hilly countries. But while nearly all of Switzerland’s urban areas are situated in short distances from each other in the flat and hilly countries in the north of the Alps, they are divided in two principal settlement axes north and south of the Alps in Austria, resulting in greater distances from one another. Some inner-alpine Austrian agglomerations are also relatively far away from the other metropolitan areas.
The structure of the agglomerations in Austria and Switzerland is very different. In Austria there is Vienna as a very large conurbation. Besides there exist rather few and smaller

metropolitan areas. By contrast, it is striking that the largest Swiss conurbation Zurich has only about half as many people as Vienna. But the other Swiss metropolitan areas tend to be substantially greater than the Austrian, so that the Swiss conurbations are more homogeneous in number of population. In addition, the number of agglomerations is much larger in Switzerland than in Austria.

If one draws 30- and 60-minute isochrones around the metropolitan areas and calculates the population in other conurbations within these isochrones, it appears that these population numbers are two to three times larger in Switzerland than in Austria. This is due to the more populous agglomerations in Switzerland and the shorter distances and traveling ties. As a result the potential for passengers is much higher in Switzerland than it is in Austria.

But it's not only about the theoretical potential for passengers. It's also about the actual numbers of commuters between the conurbations. Daily commuter traffic plays an important role for public transport. In Austria, this traffic mainly occurs as short-distance traffic within an agglomeration. Long-distance commuter traffic between different agglomerations is insignificant with a few exceptions and occurs predominantly as weekly commuter traffic [10]. By contrast there is a strong flow of daily commuters and business passengers between conurbations in Switzerland, thanks to the short distances between the urban centres, the multi-polar urban structure with the "magic triangle" Zurich-Basel-Bern and the strong economic and administrative links between the agglomerations [11].

As a conclusion it can be said that there are certain factors of success of the passenger-transporting railroad in Switzerland that could definitely be implemented in other countries such as Austria. These could e.g. be the timetable concept, the ticket policy and the (political) will to make railways more attractive. But as shown, Austria and Switzerland differ widely in other, structural factors of success. Therefore, due to the much lower population potential, commuter numbers and longer travel times, one cannot expect similar increases in ridership in Austria's inter-city long-distance services as in Switzerland. The selected scheduling concept has no significant impact on this. Hence the implementation of an IRT in long-distance railway transport could not change anything on this basic fact.

Even though a Switzerland-style increase in ridership cannot be expected, the implementation of an IRT in Austria's long-distance passenger traffic would probably increase ridership and the share of railways on the modal split, due to better connections between trains, shorter travel times and, ideally, more frequent connections.

It must be noted that in certain Austrian areas there exist structures similar to those in Switzerland (small distances in time and space, net-like structures), for example in the eastern region around Vienna and in Vorarlberg's Rhine Valley. An implementation of an IRT with its various benefits appears to be especially promising in those areas at the level of local and regional transport.

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