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GEOGRAPHIC AND TRAFFIC ASPECTS OF POSSIBILITIES FOR IMPLEMENTING ROPEWAY SYSTEMS IN PASSENGER TRANSPORT

SUMMARY

The paper studies the ropeways as a special subgroup of land traffic system from the interdisciplinary aspect of the traffic sciences and geography. The ropeways have seen a propulsive technical and technological development over the last several decades. Therefore, the paper gives an overview of the types of ropeways with special emphasis on the technologically most advanced ropeways. Regarding the lack of studies on the ropeway issues in Croatia, the space distribution of ropeways in the Republic of Croatia has been analysed. The ropeways, as well as other transport modes, affect the space, and since ropeways are considered environmentally friendly traffic modes, their impact on the environment is analysed, both in the mountains and in the cities. Moreover, the economic influence of ropeways on the surrounding area is studied as well.

KEY WORDS

ropeway, surface lift, aerial ropeway, chairlift, gondola, funicular

1. INTRODUCTION

Traffic sciences and geography are partly complementary in their research. Since the geography is a science about the objects, phenomena and processes in geo-sphere and their interdependence and about the functional arrangement of space and the human – environment relationship, this automatically makes transport one of the objects of study in geography, within the frame of geographic discipline which is called transport geography¹. The motive of this paper is the interdisciplinary method of processing the problems in the area of transport, in this case, the ropeways.

The research done until now about the ropeways shows that the ropeways have been relatively well studied from the aspect of technical sciences, i.e. transport science. The foreign authors have studied the problems of ropeways, dealing with technical and technological characteristics of ropeways, development of the ropeway systems of single countries, safety on ropeways and on ski areas, relationship between the ropeways and tourist infrastructure and the problems of ropeway capacities. Their research has been applied to the territory of Slovenia, Austria, Germany, etc. There are very few Croatian scientists who are involved in the study of ropeways, particularly the problems of ropeways in Croatia [1], [2].

From the geographic aspect, especially the traffic geography, the topic of ropeways has been poorly studied since only one paper refers geographically to ropeways, and in this it does it as part of the public urban transport [3].

The majority of the past research refers to ropeways in mountainous areas, and few papers cover the topic of ropeways in cities as a form of public urban transport.

Therefore, the objective of this paper is to approach in an interdisciplinary manner the study of ropeways for the carriage of people and from a dualistic point of view of the transport sciences and the geography to define the notion of ropeways and an attempt will be made to find their place in the traffic system, to give a presentation of the historical development of ropeways, to study the problems of ropeway types, to present the condition of the ropeway traffic in the Republic of Croatia and to study the problems of ropeway impact on the environment (in mountainous regions and in the cities), as well as the economic impact of rope-

ways on the space. The methodology used is the one typical for the traffic sciences (methods of traffic demand analyses, functionality, justification of introduction into traffic) and geography (cartographic method, processing and analysis of the statistical data).

2. DEFINITION OF ROPEWAYS AND THEIR PLACE IN THE TRAFFIC SYSTEM

Whether approached from the viewpoint of traffic sciences or geography, according to the geographic environment in which it operates, traffic is generally divided into: land (road and rail), air, water (sea and inland waterways), pipelines, telecommunication and postal traffic.

Ropeways represent a special form of land transport with different types of designs and geographic environments in which they operate (on the ground i.e. snow, in the air, underground) and therefore they are difficult to include in one of the subgroups of land traffic, thus occupying a special place in transport system of a certain space. Ropeways represent a type of transport of people or cargo by vehicles (cabin, chair or basket) attached to a rope [4], [5].

The notion of ropeway is usually related to the carriage of skiers² and other tourists in the mountains, but ropeways today are generally used to carry people (mostly in the mountainous regions, but also in urban environments as a type of public urban passenger transport) and material goods (e.g. transport of stone, ores, wood, etc.).

3. HISTORICAL DEVELOPMENT OF ROPEWAYS

Until the advent of mountain and ski tourism, ropeways had been used for the transport of people over rivers, inaccessible mountain parts and the similar. Besides, ropeways were used also for the transport of material goods and even for military purposes. The first documents about ropeways state that the ropeways were used in Japan as early as in the 13th century, and it is assumed that they had been used even earlier than that. The first ideas about ropeways were given by Leonardo da Vinci and by Fausto Veranzio (in 1616 in his book "Machinae novae").

The first ropeway that was erected and successfully operated is credited to Adam Wybe in Gdansk from 1644. The first funicular in the world is the Reisszug (exists today also) in Salzburg, connecting the Hohen-salzburg Castle with the foot, built in 1495 or 1504.

The invention of the steel inter-twinning rope (1834) and electrical energy facilitated the development of advanced forms of ropeways. The first ropeways transporting skiers started to be erected in the beginning of the 20th century³, so that the first rope-

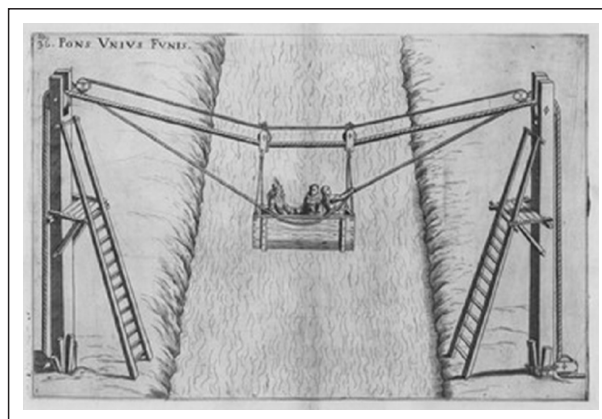


Figure 1 – Fausto Veranzio's ropeway

Source: <http://www.nsk.hr/HeritageDetails.aspx?id=378>, 01. 03. 2010.

way in the world that was used entirely for the carriage of skiers was erected in 1908 in the German place Schollach in the Schwarzwald Mountains. At that time the leading countries regarding the number of ropeways were Germany, Austria and Switzerland whereas Italy and France joined them a bit later. It should be emphasised that the United States of America did not lag significantly behind Europe, and it is assumed that the first chairlift in the world was constructed precisely in the USA in the Sun Valley in 1936.

The real development and construction of ropeways in the world started after the World War II. It is estimated that in Europe until 1990 about 20,000 ropeways had been constructed [6]. Today's estimates according to the International Organisation for Transportation by Rope (OITAF) range around the number of 30,000 different types of ropeways in the world, and about 58% are ropeways in the European Union countries [7].

4. CLASSIFICATION OF ROPEWAYS FOR TRANSPORT OF PEOPLE

Today in the world there is a whole series of different designs of ropeways for the transport of people and sometimes it is difficult to determine the types of ropeways because of the similarities between individual types and the increasing technological development. The classification of ropeways in the paper is done according to their technological characteristics as determined also in the Act on Ropeways for Transport of People and the Regulations on Minimal Conditions for Operation Safety of the existing ropeways, surface lifts, and funiculars for the transport of people in Croatia, but also according to the geographic environment in which the transport operates and the type of ropeway vehicle. Therefore, the ropeways may be divided into:

1. surface lifts,
2. aerial ropeways,
3. funiculars.

Taken into consideration are the ropeway models which are produced by the leading world corporations for the production of ropeways: Doppelmayr/Garaventa Group and Leitner technologies.

4.1 Surface lifts

Surface lifts are a form of ropeways which use hauling devices to haul persons on skis or other adequate equipment along the hauling track.

The simplest form of a surface lift is a surface lift with a low-laid guide rope. This is a form of surface lift where the haul rope is below the level of the hauled person's head. Regarding the low travelling speed and user-friendliness, they are intended primarily for the skiers - beginners.

Types of high-rope surface lifts are T-bars and J-bars. These are relatively simple forms of ropeways where the rope circulates around the horizontal bull-wheels at the height of ca. 3 – 4 metres above ground. Bars are suspended on the rope which at their ends have a plate or a grip in the form of letter T or in the form of letter J.



Figure 2 – High-rope surface lift

Source: <http://www.doppelmayr.com>, 01.03.2010.

The advantage of the surface lift lies in the simplicity of design and handling, low production and maintenance costs and low dependence of the ropeway operation in adverse weather conditions in the mountains. Besides, this type of ropeway is often used also on glacier ski areas where the configuration of the base and the weather conditions do not permit construction of the more complex ropeway designs. The drawback of surface lifts, compared to the more complex types of ropeways, is low rope speed and low transport capacities. The average speed amounts to about 2m/s, and it can amount maximally to 3.5m/s with transport capacity of up to 1,440 persons/hour [8]. The drawback of surface lifts lies in the direct exposure of the users to weather conditions. Compared to the more complex designs, these types of ropeways are usually applied

on short distances (up to one kilometre), but there are also solutions on significantly longer destinations (e.g. T-bar surface lift on the Tiefenbach Glacier above the Austrian Sölden in the length of 2,099 metres).

4.2 Aerial ropeways

Aerial ropeway is a form of ropeway where transport is carried out at a certain altitude above ground. Regarding the type of vehicle, the aerial ropeways can be divided into chairlifts and cabin ropeways.

a) Chairlifts

Chairlifts are aerial ropeways in which the chairs of a certain capacity are attached to an elevated circulating rope at some dozen metres above ground (sometimes even more). The capacity of such a chairlift ranges from a single person (older types of chairlifts) all the way to eight persons (modern chairlifts). There are two types of chairlift designs:

- older types of chairlifts are designed with the chair being permanently fixed to the circulating rope;
- more recent type of chairlift consists of the chair which is attached to the main circulating rope using the technology which allows the chair to be detached from the main rope at terminals and to be attached to the auxiliary slower drive in order to allow skiers and tourists to be loaded more easily on the chairlift, i.e. unloaded from the chairlift, and after that the chair is reattached to the main faster circulating rope. Such chairlift design is called "detachable" chairlift.



Figure 3 – Detachable chairlift

The absolute advantage of chairlifts is the capacity which is among the highest among ropeways, and depends on the size of the chair and may amount to 4,000 persons/hour (for eight-chair lifts) [9]. Another advantage of chairlifts lies in their user-friendliness, especially regarding skiers who do not have to take off the equipment during transportation. The rope speed is higher compared to the T-bar and J-bar surface lifts,

and amounts to 5.6m/s, the speed of operation of the chairlifts of the latest generation [8], but the mentioned speed is somewhat lower than in case of the other more complex types of ropeways. The drawback lies in the exposure of the users to weather conditions (precipitation, wind, cold) unlike cabin ropeways. The more recent designs of chairlifts are equipped with the heating of the seat and protection against wind in the form of a canopy made of glass-plastics which is lowered if necessary. The loading entrance of the users on the chairlift is equipped with movable carpets that facilitate the entry.

b) Cabin ropeways

Technically and technologically much more complex designs of ropeways are the cabin ropeways. This type of ropeways features transport cabins (of different sizes, numbers and capacities) permanently or detachably connected to the rope (or several ropes) at a height of several dozens of metres, and at places even more. Cabin ropeways, unlike chairlifts and surface lifts, serve to overcome the difficult relief conditions and substantially bigger altitude differences that may amount even up to 1,000 metres (e.g. cabin ropeway above Chamonix which stretches from Plan de l'Aiguille at 2,317 metres a.s.l. to 3,842 metres a.s.l. to Aiguille du Midi).

Some manufacturers usually refer to cabin lifts of the capacity of up to 16 persons as gondolas whereas they use special names for cabin lifts of higher capacities (e.g. funitels, funifors, aerial tramways, etc.). The users usually use the term gondola for any form of cabin lifts.

The advantages of cabin lifts lie in the possibility of overcoming large altitude differences and difficult relief conditions, at relatively high rope speed (up to 12m/s) and the protection of the users against adverse weather conditions. The drawbacks lie in the high costs of construction and maintenance and the



Figure 4 – Cabin ropeway

Source: <http://www.doppelmayr.com>, 01.03.2010.

dependence of the ropeway on weather conditions (especially strong wind) which are getting reduced due to the increasingly improved construction solutions in new cabin lifts.

There are several types of cabin ropeways that are sometimes difficult to be distinguished due to their differences in technical characteristics.

A combination between a chairlift and a cabin lift is called a *telemix* or combined installation. This design of ropeway has cabins and chairs attached to the same rope according to a certain arrangement. This type of ropeway provides a number of advantages in the winter and summer tourism since it allows skiers the usage of chairlift while at the same time the non-skiers can use the cabin. The drawback of a telemix ropeway is the impossibility of overcoming large altitude differences precisely because of the chairlifts, so that they are still seldom used among ropeways [8].

Gondolas are type of cabin lifts, attached to a rope at certain intervals and with cabin capacity of up to 16 persons. There are designs and types of gondolas with two or three ropes enabling the use of higher capacity cabins (up to 40 persons). Apart from this advantage, bi- or tricable ropeways have higher stability against wind gusts thus realising the possibility of overcoming higher altitude differences and featuring lower energy consumption due to lower cable friction during operation. The drawback of this type of cabin ropeways lies in higher costs of construction and maintenance. The capacity and the speed of gondolas on a single cable is up to 3,600 persons/hour at 6m/s [9] whereas for bi- or tricable gondolas this is up to 6,000 persons/hour at 7.5m/s [9].

A form of permanently attached cabin ropeways (gondolas) to the cable are called pulsed-movement aerial ropeways. They have cabins grouped (usually 3 to 5 cabins in one group) at equal intervals. Regarding the fixed attachment to the rope, the rope speed of the entire ropeway is reduced whenever a group of cabins arrives to the terminal in order to unload the passengers, which is considered the main drawback of this type of ropeways. The advantage lies in the lower costs of construction, use and maintenance in relation to ropeways that are detachable. They are used on shorter distances, and the highest speed is up to 7m/s [9].

The Austrian manufacturer Doppelmayr has patented and improved a type of cabin ropeway called funitel. A funitel is a type of cabin ropeway which consists of cabins attached to two ropes set at the same level and at intervals of 3.2 metres. The main advantage of funitels lies in their high lateral stability which provides resistance to wind gusts of up to 100km/h and it is extremely suitable for spanning the windy areas in the mountains. The funitel speed is up to 7.5m/s, and the carrying capacity is up to 4,000 persons/hour [9].

Cabin ropeways for overcoming the largest altitude differences and with cabins much larger than gondolas represent an advanced type of ropeways and several designs, depending on the manufacturer are distinguished.

Reversible ropeways, jig-back ropeways or aerial tramways are cabin ropeways where, as a rule, two cabins use one or two ropes. The driving electrical motor hauls one cabin towards the valley and its weight hauls the opposite cabin uphill. The two cabins pass each other at the middle of the track. The cabin capacity of these ropeways is up to 200 persons. The total ropeway capacity is up to 2,800 persons/hour [8], and the rope speed is high and may amount to up to 12m/s [9].

The Austrian Doppelmayr patented and improved the type of reversible cabin ropeway called *funifor*. A funifor is a reversible cabin ropeway with the difference that the two cabins are not interconnected, so that single cabin operation is possible. In case of a breakdown on one cabin, the other cabin can form an airbridge for rescue.

4.3 Funiculars

Funiculars, if located in mountainous regions are also called "mountain railways" or "ski railways", represent a type of ropeways where two wagons are attached to a cable and move along the rails. In case of funiculars with two wagons, the system operation principle is similar to that of reversible cabin ropeways – while one wagon is moving down, the other is moving up. There is also a version with one track with a short separation on the two tracks at the mid-point allowing the wagons to pass each other, and the version with two completely separate tracks, and there are also versions where only one wagon operates. The capacity of the wagons is up to 400 persons i.e. they can carry up to 3,000 persons/hour, and they operate at a speed of up to 14m/s [9]. Common designs of such railways pass through underground tunnels so that they are also called "under-mountain railways".

The notion of ski railway or mountain railway is not completely suitable since it does not include all the railway users because they do not carry exclusively skiers but also other tourists, and if they are located in the cities, then also by various other users. Since the mentioned railways are sometimes used in the cities for the transportation to reach a certain elevation or an elevated part of the city which most often cannot be called a mountain, which makes it inappropriate to call this railways a mountain railway. The proper name for this type of ropeways is funicular, although, at the mention of the funicular the associations often refer to the examples that operate exclusively in the cities for the purpose of public urban transport, with a far



Figure 5 – Zagreb funicular

Source: <http://www.zet.hr>, 01.03.2010.

smaller capacity of cabins (e.g. Zagreb funicular) than the funiculars which are used to transport tourists in the mountains.

The designs of funiculars with a single wagon and one tracks (or a single rail if "monorail" is considered) are called by their manufacturers Doppelmayr and Leitner *inclined elevators*. The operation principle is a combination of a funicular and a common elevator, with the exception that this elevator does not operate vertically but rather at a certain inclination, and the cabin attached to a rope operates along the ground i.e. along rails.

Low dependence on weather conditions, large capacity, and the highest rope speed of all the ropeways are the advantages of funiculars compared to other types of ropeways, and the drawbacks of funiculars are high costs of construction and maintenance.

5. ROPEWAY DESIGNS IN CROATIA

In the Republic of Croatia there are 23 locations at which today the ropeways are operating or operated before (Figure 6). If only ropeway locations are considered (regardless of whether they are in operation or not), interesting data is obtained that there are more locations with ropeways in the central part of Croatia than in the mountainous Croatia.

In winter season 2009/2010 a total of 23 ropeways operated, out of which 5 chairlifts, 17 surface lifts (T-bar, J-bar and low-cable surface lifts) and 1 funicular on twelve locations in the country. In early summer of 2010 new cabin ropeway was put in operation in Dubrovnik, thus connecting the town with mount Srđ.

According to the number of ropeways, and especially those that are currently operating, the majority is located in Gorski kotar, whereas the funicular is located in Zagreb. The Zagreb funicular is the oldest transport means of organised public transport of passengers in Zagreb opened in 1890, a year before introduction of the horse-drawn tramway. During a year the

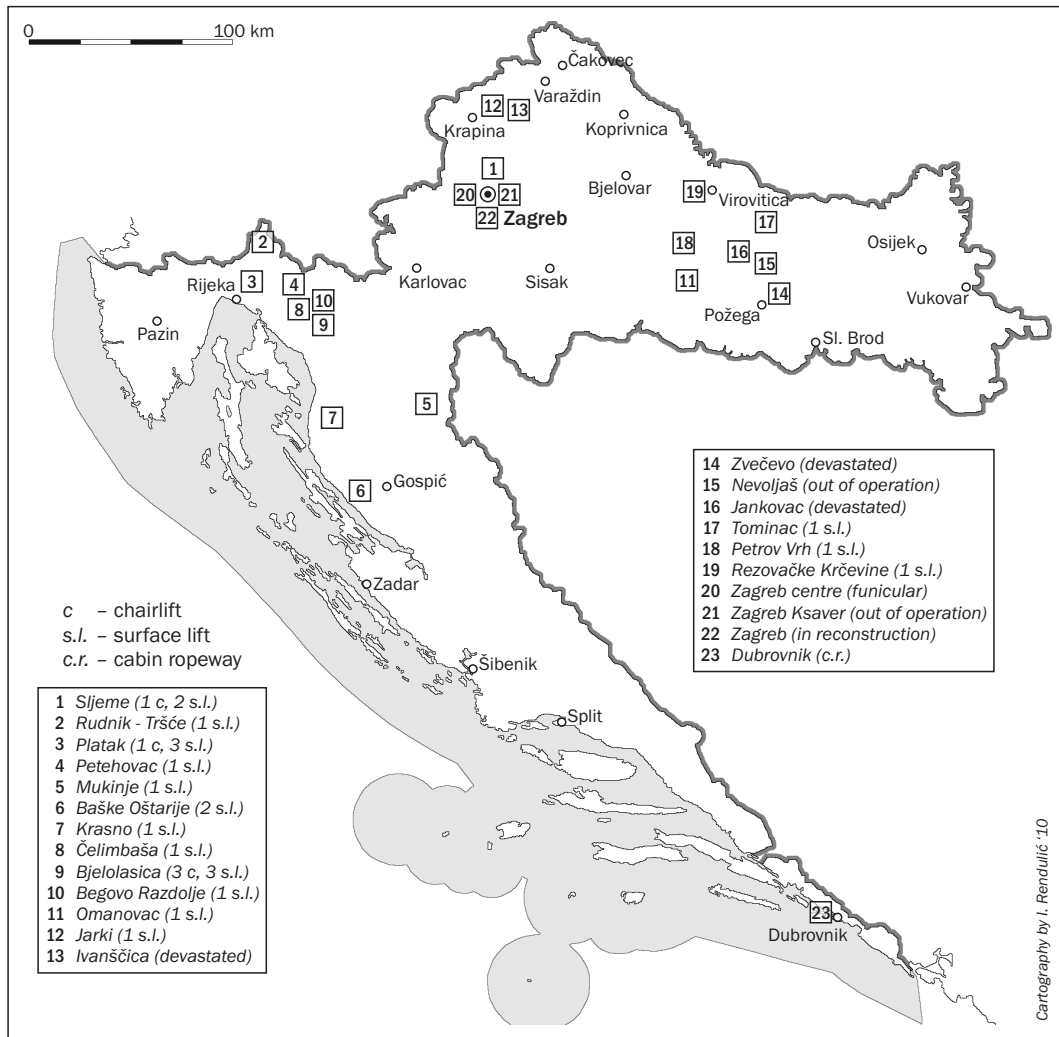


Figure 6 - Physical distribution of locations with ropeways in the Republic of Croatia (situation on the 1st of September 2010)

cabins pass on the average about 4,000 km and carry about 675,000 passengers (2008).

A small funicular in Zagreb was also constructed within the buildings of the Ksaver residential area (between the streets of Medveščak and Jurjevska) which never started to operate, and the idea was that it was to serve the tenants as substitution for stairs.

The main barrier to the development of ropeways in Croatia is the lack of financial means for their maintenance and modernisation which are the main causes of non-operating of individual ropeway devices. An example is Begovo Razdolje where the operation of the ropeway, after many years of operation, in winter season 2009/2010 was suspended due to technical drawbacks.

Currently, there is only one cabin ropeway operating in Croatia (in Dubrovnik). The Sljeme ropeway, which connected Zagreb and the top of Medvednica, was of gondola type, but due to the breakdown on the drive electrical motor it has been permanently closed. A construction project of a completely new cabin rope-

way at Sljeme has been developed. There are still several projects in Croatia to construct ropeways, and one of them is the project of connecting Medveja with the top of the mountain of Učka.

6. ENVIRONMENTAL IMPACT OF ROPEWAYS

Since traffic and environment are two interconnected units, the fact is that their relation is very complex. At the mention of the environmental impact of traffic, as a rule the first association is the impact on air quality. However, apart from the air quality, traffic affects also other environmental components such as e.g. land use and its degradation, disturbance of the hydrological processes and water pollution, ecological degradation and noise. Apart from affecting the environment, the traffic has influence on the society as well [10].

Since the largest number of ropeways operates in the mountainous regions and serves the tourists, the impact of ropeways on the environment and the soci-

ety will be to the maximum extent presented from this point of view.

6.1 Environmental impact of ropeways in mountainous regions

The impact of ropeways on the environment and the society, and also in the mountains can be reflected in the construction and usage.

In the construction of ropeways, the environmental impacts can be multiple. During the construction itself inadequate disposal of waste material can cause negative impact on the environment, but by complying with all the measures of environmental protection and protection at work, such impacts are reduced to minimum. If the works are not performed in compliance with the regulations, this may lead to erosion of soil due to removal of soil cover because of construction works, as well as to the negative impact on the surface and underground waters. In case of wooded areas, because of the construction of the corridor of ropeway track which is several dozens of metres long (e.g. in case of the future Sljeme ropeway it will amount to 16 metres) [11], the forest vegetation is permanently lost and community of grass and thickets develop within the mentioned corridor.

During the ropeway construction, negative impacts can be reflected on the settlements and the population (especially if e.g. the bottom station of the mountain ropeway is inside the settlement) regarding noise and poorer air quality and destruction of roads caused by heavy machinery, but these impacts are of temporary character.

In using the ropeway, the environmental impacts can also be multiple. The physical existence of the ropeway in space should also be mentioned (towers, terminals, ropes) which may certainly disturb the appearance of the space, but also, the ropeway itself may become a symbol of space (example of Zagreb Funicular). If the measures of environmental protection are not respected, negative impacts can be on waters (e.g. leakage of fat and oil) and soil (if erosion processes are not prevented during construction). Permanent impact on flora is present in the ropeway track corridor (in case of wooded areas) since forest vegetation is permanently lost and is not restored. Positive impacts of the ropeway on the environment can be reflected in e.g. mountainous regions which have ropeway as alternative to road (e.g. Mariborsko Pohorje in Slovenia) and, in that case, the number of road vehicles is reduced which results in the reduction of negative impacts on the environment. If the level of noise of the ropeway itself is considered, it should be mentioned that the drives of today's ropeways are constructed in such a way that the noise impact of the drive engines on the environment is reduced to a minimum.

When speaking of terminals in traffic one should have in mind that the terminals are an extremely significant factor in traffic, to occupy specific locations in space and to have important impact on their environment. Traffic is increased at access terminals to ropeways (mostly at bottom terminals) due to parking places (surface and underground) which are usually located, as a rule, at such locations, which is also reflected on the increased noise level. To raise the attractiveness of such spaces next to ropeway terminals (tourist and economic factors), tourist, trade and catering facilities are opened in these areas, which is related to the process of permanent settling of population in the wider area (opening of tourist accommodation capacities, commercial and catering facilities) and the process of daily commuting into the mentioned areas in order to perform the activities there.

Ecologically, ropeways represent a green form of traffic (electric energy propulsion, low level of greenhouse gas emissions during operation, low level of noise, ...). Ecological impact of ropeways may be also negative, since the increase in ropeway speed and capacity affects also the increased number of skiers at ski resorts, which then require more ski runs, which eventually leads to the impact on the environment (especially in wooded areas regarding deforestation and vegetation degradation) [12], [13].

6.2 Environmental impact of ropeways in the cities

In the analysis of environmental impact of ropeways, the increase in the number of constructed ropeways in the cities that serve as means of public urban transport should certainly be mentioned [14]. The examples of successful ropeway operation in the city are cabin lifts in New York in the USA, Constantine in Algeria, Caracas in Venezuela or Medelline in Columbia. Ropeways in the cities as means of public urban transport, generally, have a whole series of advantages: low level of greenhouse gas emissions, shortening of travel time compared to bus or car, easier overcoming of certain barriers compared to bus or car (e.g. elevations, water flows, residential objects, etc.). The advantages of ropeways can be seen by the data from the city of Constantine in Algeria about the reduction of operative costs and reduction of CO₂ by 80% on the relation operated by a ropeway [14]. In Algeria they decided to invest in the construction of ropeways in three more cities.

The extent to which ropeways represent an acceptable form of traffic (especially in the cities) can be seen in *Figure 7*. Compared to a bus, ropeways consume much less energy and emit substantially less greenhouse gases into the atmosphere.

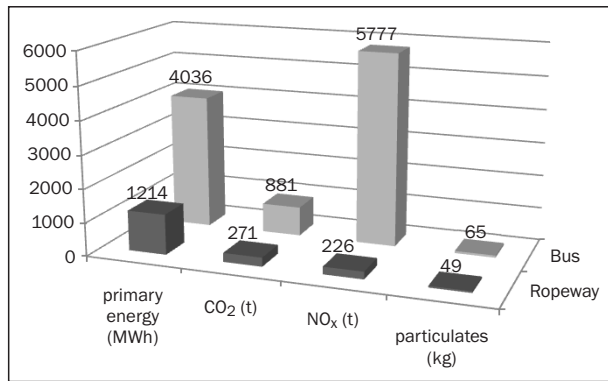


Figure 7 – Comparison of ropeways and buses regarding energy usage and exhaust emissions

Source: Ökobilanz der BUGA Koblenz GmbH

The ropeways may have also negative impact on the environment in the cities during construction (e.g. inadequate disposal of waste material, noise and poorer air quality caused by heavy machinery) and during operation (e.g. leakage of oil and lubricants). However, by applying the measures of environmental protection and protection at work, such influences may be reduced.

The mountain ropeway terminals and terminals of ropeways in the cities can act as attractive factors in a wider surroundings of the terminal itself. Therefore, the ropeway terminals in the cities, in order to increase the circulation of people will feature the process of concentration of various services, first of all shops and restaurants, and then naturally the process of commuting workers, as well as the process of permanent settling of people as consequence of the attractiveness of the location itself. It should however be remembered that terminals may have negative impact due to the increased level of noise and traffic because of the parking lots which are constructed at such locations.

7. ECONOMIC SIGNIFICANCE OF ROPEWAYS

Apart from environmental impact, traffic also affects the economy of a certain space. As the most important influence one should certainly emphasise the role of traffic in the GDP of a certain space [15].

Regarding the prevailing use of ropeways in the mountainous regions, as an example of economic significance of ropeways in the economy of a country, Austria has been taken as a representative of a typical mountainous country.

There are currently 254 companies in Austria that are involved in the transport of people by ropeways (owning not exclusively the surface lifts but also other types of ropeways), that employ about 14,300 people. About 550 owners (private persons or companies) should be added to this number, who own only surface

lifts, one or several. The mentioned 254 companies own 2,091 ropeways (surface lifts, chairlifts, cabin ropeways and funiculars), and if the surface lifts of those 550 small owners are added, then this results in a total of 3,003 ropeways in Austria [16].

Figure 8 presents the revenue values obtained from the ropeways⁴ for the mentioned 254 companies realised in winter season⁵ 2000/2001 to 2008/2009. These 254 companies realised in winter season 2008/2009 a revenue of 1.166 billion euro, and in winter season 2007/2008 - 1.050 billion euro which is an increase of almost 10%, and compared to winter season 2006/2007, when a revenue of 858 billion euro was realised, an increase of 26%. If winter seasons 2008/2009 and 2000/2001 are compared, the data shows that the revenue increased by 37%. Since the revenue realised from ropeways in the summer season is much lower and ranges around 80 million euro [16], if the value of the realised revenue for the winter season 2008/2009 only was considered, this would result in the fact that the ropeways of all the 254 companies participate in the GDP of Austria with 0.5%⁶, which is an excellent data knowing that the entire winter tourism of Austria accounts for 4.1% in the total GDP [16].

If one takes into account the total revenue values (not just from the ropeways) of these 254 companies which amount to 2.58 billion euro, the data show a participation in the GDP of Austria of 1.1%⁶.

Apart from the influence on the GDP of a certain region, within the economic significance one may also consider the impact of traffic on tourism. Traffic participates in tourism and recreation either as the means of arriving to a certain tourist destination (i.e. attractive point) or combined with the nature, may represent a tourist attraction, i.e. a tourist destination. Ropeways are a means used e.g. by skiers to reach the beginnings of the ski runs and further ski i.e. recreate themselves, but the ropeways (together with nature)

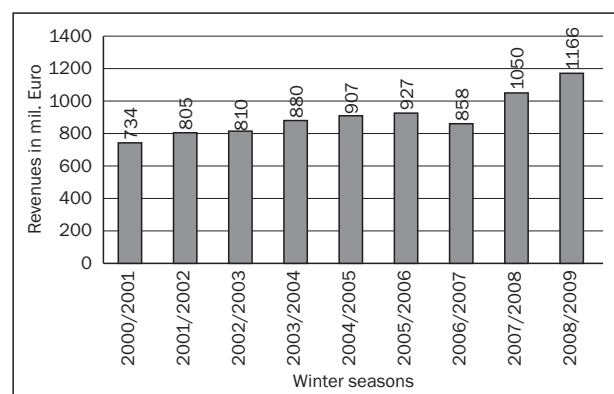


Figure 8 – Revenues of 254 Austrian companies for transport of people by ropeways in winter seasons (in mil. euro)

Source: <http://www.seilbahnen.at/presse/wirtschaftsdaten>, 01.03.2010.

can also represent tourist attractions in themselves (e.g. travelling by means of the ropeway system from Chamonix in France over the mountains of Mt. Blanc to Courmayeur in Italy or travelling by ropeway up to Nob Hill in San Francisco) [10].

8. CONCLUSION

Ropeways represent land traffic and considering their historic development, they may be included in the older forms of transport. Over the last thirty years or so, they have experienced a significant development from the technological and safety aspect. Their significance is immeasurable in the mountain and ski tourism and in certain cities as a form of public transport. From the ecological aspect the ropeways represent a very acceptable form of transport. Their economic significance in certain countries is substantial, both in revenues and in the employment rate. Although the construction and maintenance of ropeways requires substantial financial means, in the Republic of Croatia the existing ropeways should be reconstructed since they are the precondition of developing mountain and ski tourism. The ropeways can represent the attraction of the tourist destinations, but they are, first of all, an indispensable part of infrastructure with additional advantage of significantly lower environmental impact compared to other traffic systems.

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SAŽETAK

MOGUĆNOSTI PRIMJENE SUSTAVA ŽIČARA U PUTNIČKOM PRIJEVOZU S GEOGRAFSKOG I PROMETNOG GLEDIŠTA

U radu se proučavaju žičare kao posebna podskupina kopnenog prometnog sustava s interdisciplinarnog gledišta prometnih znanosti i geografije. Žičare imaju propulzivnu tehnički i tehnološki razvoj posljednjih nekoliko desetaka godina, stoga se u radu daje pregled vrsta žičara s posebnim naglaskom na tehnološki najsuvremenije žičare. S obzirom na nedostatak istraživanja problematike žičara na teritoriju Republike Hrvatske, analizirana je prostorna raspodjela žičara u Republici Hrvatskoj. Žičare, kao i ostale vrste prometa, imaju utjecaj na prostor, a kako se žičare smatraju ekološki prihvatljivim oblikom prometa, analizira se njihov utjecaj na okoliš, kako u planinskim prostorima, tako i u gradovima. Osim toga, istražuje se i ekonomski utjecaj žičara na prostor.

KLJUČNE RIJEČI

žičara, vučnica, viseća žičara, sjedežnica, gondola, uspinjača

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1. Transport geography is a branch of economic geography which researches and studies the physical and geographic conditions and types of traffic, their distribution and the role and significance in the environment, organisation of space and economic significance.
2. Today in the world, skiing is the most widespread winter sport and most of the notions still originate from the word skiing (ski resort, ski run, ski lift ...) so that the notion of skiing in this paper covers the sports of skiing and snowboarding, and the term skier covers both skiers and snowboarders.
3. The first device in the world for transporting tourists and skiers was constructed in 1868 in the form of a rack-and-pinion railway which carried skiers to Mt. Washington in the U.S.A., but rack railways are classified as railway traffic and not ropeways.
4. Many companies engaged in the ropeway transportation of people, own parking lots and some accompanying service facilities (shops, restaurants and other catering facilities), and some companies even offer accommodation facilities, which, apart from marketing, serve as another part of revenue sources.
5. Winter season refers to the period from 1 November to 30 April.
6. Calculated by the authors based on the GDP data of Austria for the year 2009 of 238.8 bill. euro.

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