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INFLUENCE OF MODERN CABLEWAYS ON THE DEVELOPMENT OF MOUNTAIN TOURIST CENTRES

ABSTRACT

The paper studies the problem of constructing cableways with advanced technology and their influence on the operation and development of cableway companies from several aspects. Modern cableways with detachable grips enable faster carriage of passengers. They have the possibility of transporting more passengers over the same distances. Recently, this trend of introducing modern cableways has been particularly present in chairlifts which carry skiers. Such chairlifts with detachable grips allow transport of skiers over greater distances and therefore must have respective ski slopes covering wider areas which in turn affects the expansion of the mountain tourist centres. The chairlifts with detachable grips require more knowledge and personnel to manage and maintain them, as well as more investment capital.

KEYWORDS

cableways, grips, skiing, ski slopes, winter tourism, mountain tourist centres

1. INTRODUCTION

Cableway companies involved in the transport of passengers in mountain areas realize most traffic during the winter months, when passengers are mainly skiers. Every cableway company tends to offer best quality service, and long queues of skiers waiting in front of slow cableways may have a very negative influence on the quality of service of the mountain tourist centres.

The problem of the skiers queuing in front of slow cableways may be solved by limiting the number of sold skiers' tickets, but this does not mean that the skiers in a major ski centre with several cableways would be uniformly distributed per cableways. Similarly, by selling seasonal ski tickets it would be impossible to determine which would be the peak days, i. e. on which days there would be fewer skiers on the ski slopes.

Most frequently, the problem of queuing skiers at cableways is solved by installing faster cableways with greater capacities, i. e. introducing chairlifts with detachable grips into service. These make it possible to detach the chairs in the starting and final station from the carrying-hauling rope, thus providing comfortable loading and unloading.

However, this one-sided solution, the replacement of an older chairlift with fixed grips by the new chairlift with detachable grips can lead also to some unexpected consequences that may have a negative impact regarding the quality of the entire service of the mountain tourist centre.

At the moment, in Slovenia, there are 4 chairlifts with detachable grips – three in the ski centre Cerkno and one in Kranjska Gora. This number is not final, since the cableway companies plan to construct some more [3]. Similarly, in the ski centres in Croatia, the construction of chairlifts with detachable grips can be expected in the future.

2. CHAIRLIFTS WITH DETACHABLE GRIPS

Chairlifts are devices in which chairs are fixed to the carrying-hauling rope, travelling in the same direction. At the beginning of the appearance of chairlifts, the chairs were fixed to the carrying-hauling rope. The possibility of fast transport of skiers in such chairlifts is low, since the maximum speed is limited (max. 2 m/s for passengers – pedestrians and max. 2.5 m/s for skiers) [5] due to the method of entering the

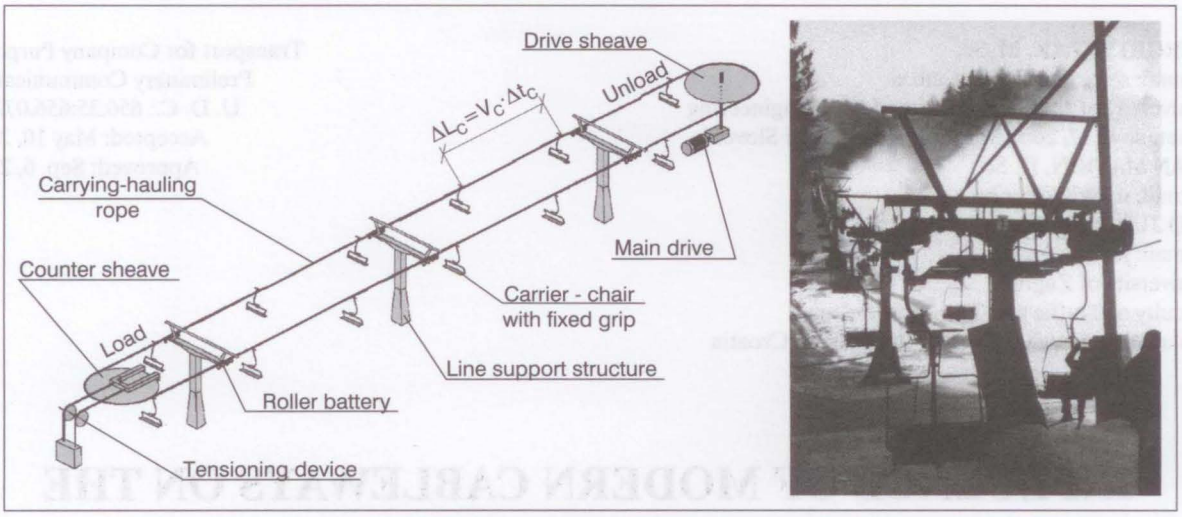

Figure 1 - Chairlift with fixed grips

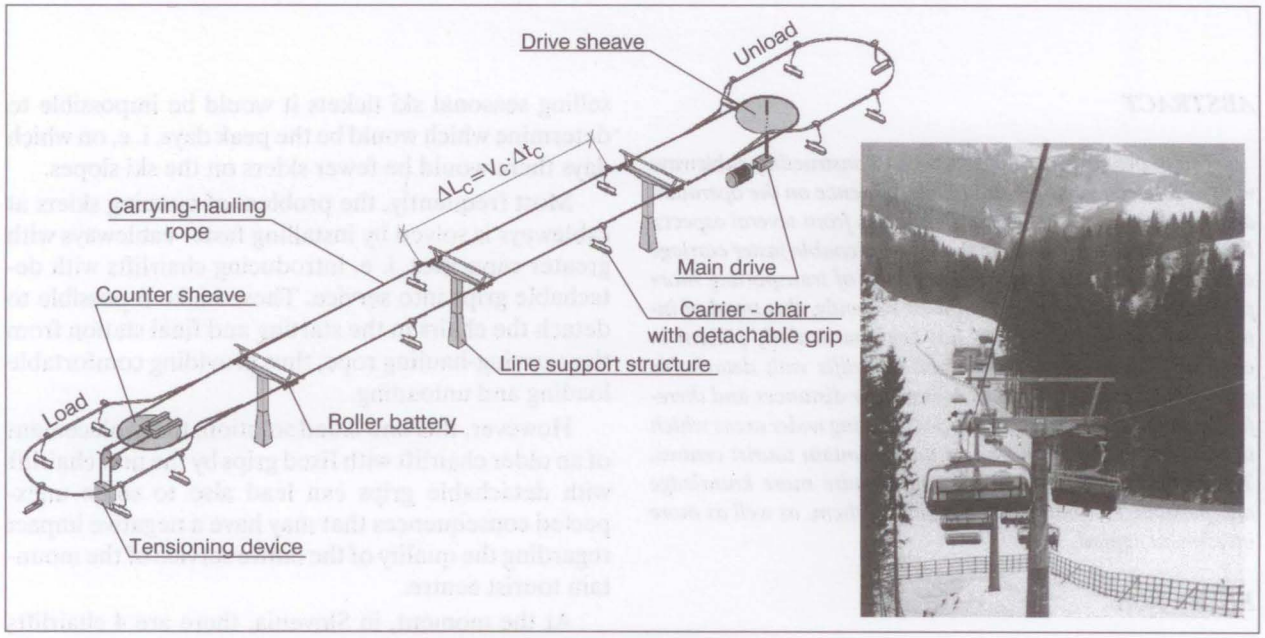

Figure 2 - Chairlift with detachable grips

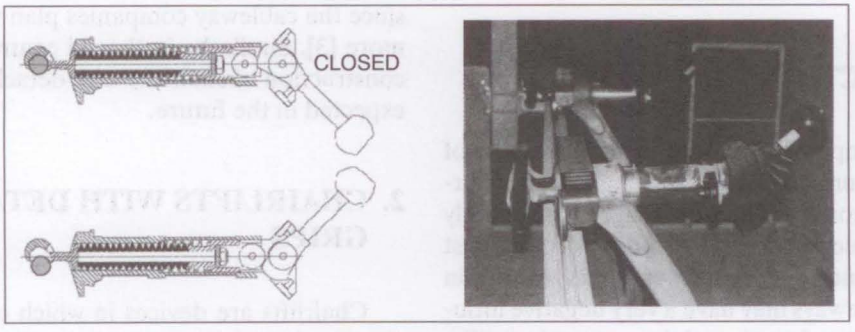

Figure 3 - Detachable grip

cableway, since the passenger has to sit on a chair which is moving at the speed of the carrying-hauling rope.

The appearance of detachable grips on the chairlifts has made it possible to reduce the speed at loading and unloading of passengers. This facilitates greater comfort, since the passenger can sit on a chair that at loading or unloading moves at very low speed (max. 1 m/s for passengers-pedestrians or max. 1.3 m/s for skiers) [5]. The possibility of fast transport of

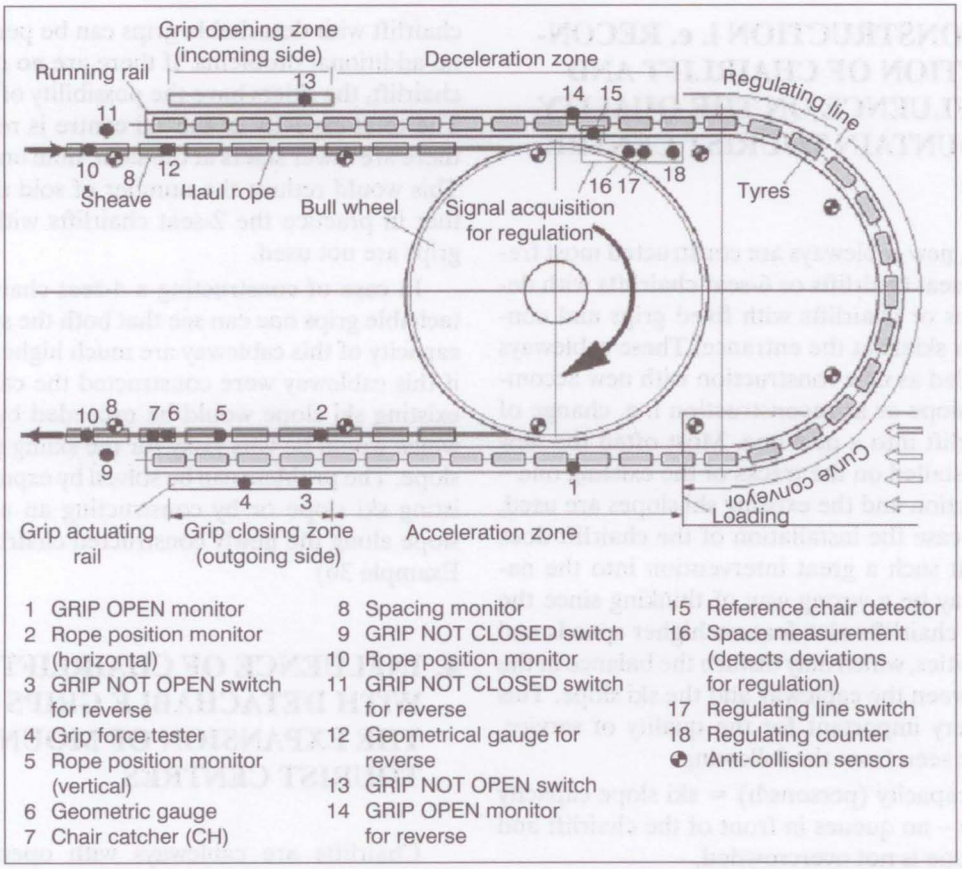

Figure 4 - Mechanical equipment and safety devices in station of cableway with detachable grips [1]

passengers in this example is greater, because the speed of the carrying-hauling rope is higher (5 m/s) [5].

The mentioned advantages result from the possibility of detaching the grips of the carrier at the station from the carrying-hauling rope, which allows the chair at the station to move at a lower speed by means of the conveyor. The detaching of the chairs is provided by the detachable grips and all the other mechanical and electric equipment at the station.

In case of cableways with detachable grips various procedures are performed in different zones at the station:

- *grip opening zone*: when the carrier (cabin or chair) arrive at the station, it is detached from the ropes in the grip opening zone. The carrier reaches the running rail, actuating then the signal for opening the grip and detaching from rope. Thus the carrier can move independently of the rope speed.
- *deceleration zone*: when the grip is open and lies with its bottom surface on the sheaves which lie along the running rail and guides the carrier through the station. The braking force is transferred by means of the sheaves and the friction to the grip which causes the carrier to decelerate.
- *regulating line*: regulating line maintains the necessary spacing between the carriers. The more recent cableways have in this section a detached conveyor with its own propulsion.
- *curve conveyor*: in this zone the carrier moves at the transit speed, which is much lower than the speed of the ropes through the station. The curve direction of the carriers is determined by the conveyor. The carriers move by means of a conveyor. In this zone the carrier is loaded.
- *acceleration zone*: when the carriers are loaded with passengers they reach the acceleration zone. The grip is still open, the acceleration force is transferred over the sheaves to the bottom friction surface of the grip. The speed of the carrier increases up to the speed of the carrying-hauling rope.
- *grip closing zone*: In this zone the grip closes onto the carrying-hauling rope. Before the carrier leaves the station the closure of the grip on the rope is controlled.

For proper functioning of all the described procedures safety devices and signalling devices are necessary and they control all the described procedures. Should these devices register a malfunctioning, they have to alarm the workers or automatically stop the cableway.

3. NEW CONSTRUCTION i. e. RECONSTRUCTION OF CHAIRLIFT AND ITS INFLUENCE ON THE QUALITY OF MOUNTAIN TOURIST CENTRE OFFER

Recently, new cableways are constructed most frequently as 4-seat chairlifts or 6-seat chairlifts with detachable grips or chairlifts with fixed grips and conveyor belt for skiers at the entrance. These cableways can be installed as new construction with new accompanying ski slope or as reconstruction i. e. change of the old chairlift into a new one. Most often the new chairlift is installed on the tracks of the existing one – as reconstruction and the existing ski slopes are used, since in this case the installation of the chairlift does not represent such a great intervention into the nature. This may be a wrong way of thinking since the more recent chairlifts also feature higher speeds and higher capacities, which may disturb the balance in the capacity between the cableway and the ski slope. This balance is very important for the quality of service, which can be seen from the following:

- chairlift capacity (persons/h) = ski slope capacity (skiers/h) – no queues in front of the chairlift and the ski slope is not overcrowded,
- chairlift capacity (persons/h) < ski slope capacity (skiers/h) – queues in front of the chairlift in case of a greater number of skiers and the ski slope is not maximally loaded,
- chairlift capacity (persons/h) > ski slope capacity (skiers/h) – in this case there are too many skiers on the ski slope, and the skiing safety is reduced.

The following example shows the influence of the special characteristic of the chairlift type on the respective ski slope, which is in any case the same. These examples show a case of reconstruction i. e. replacement of the old chairlift by a new one.

Example: The ski centre has one 2-seat chairlift with fixed grips in the length of 1.2 km and one ski slope in the length of 1.2 km, which can accommodate at a time a maximum of 200 mid-skilled skiers. The capacities of the cableways and ski slopes are the same which means that the chairlift supplies precisely the number of skiers that can ski safely, without risk, down the ski slope and there are no queues at the chairlift.

What will happen if the existing chairlift were replaced by a chairlift with detachable grips. The calculation was made for a 2-seat chairlift with fixed grips, 2-seat chairlift with detachable grips and 4-seat chairlift with detachable grips. These chairlift types are used most at the ski centres. The data, equations and results are presented in Table 1.

The calculation in Table 1 shows that the replacement of the 2-seat chairlift with fixed grips by a 2-seat chairlift with detachable grips can be performed with no additional problems. If there are no queues at the chairlift, the skiers have the possibility of skiing more. The total capacity of the ski centre is reduced, since there are fewer skiers at the same time on the chairlift. This would reduce the number of sold ski tickets, so that in practice the 2-seat chairlifts with detachable grips are not used.

In case of constructing a 4-seat chairlift with detachable grips one can see that both the speed and the capacity of this cableway are much higher. Therefore, if this cableway were constructed the capacity of the existing ski slope would be exceeded by 66 percent, which would be very risky for the skiing safety on this slope. The problem can be solved by expanding the existing ski slope or by constructing an additional ski slope along the newly constructed chairlift (Figure 5, Example 3b)

4. INFLUENCE OF CHAIRLIFT WITH DETACHABLE GRIPS ON THE EXPANSION OF MOUNTAIN TOURIST CENTRES

Chairlifts are cableways with open chairs and therefore the passengers are more exposed to weather elements, wind, rain and frost. The transport of passengers is time-limited to 10 minutes (600 s) [7]. Maximum speed of the chairlift with detachable grips is 5 m/s. It is higher than the speed of the chairlift with fixed grips (2.5 m/s if the passengers are with skiing equipment), and therefore the length of the line of the chairlift with detachable grips is greater.

Maximum length of the chairlift:

- for the chairlift with detachable grips:

$$L_{Cmax1} = t_{max} \cdot V_{C1} = 3000\text{m}$$

- for the chairlift with fixed grips:

$$L_{Cmax2} = t_{max} \cdot V_{C2} = 1500\text{m}$$

Based on these results one can conclude that modern chairlifts enable reaching greater lengths and therefore the skiers have better possibilities for skiing. For better skiers this possibility is necessary, since this is made possible by the latest skiing equipment, preparation of ski slopes and compact snow. The skiers' speeds are higher, the average speed being 45 km/h and $V_{85} = 59$ km/h [4]

Considered from the aspect of economy, the construction of the longer cableway is certainly more economical, since the most expensive cableway assemblies are precisely at stations where the most of the mechanical and electrical equipment is concentrated. The investment costs per km are also lower in case of longer cableways.

Table 1 - Calculations of data for different types of chairlifts that relate to the same ski slope

Type of data	Symbol and equation for calculation	Existing 2-seat chairlift with fixed grips	New 2-seat chairlift with detachable grips	New 4-seat chairlift with detachable grips
Number of seats on carrier	n	2	2	4
Line of chairlift	L_C	1000 m	1000 m	1000 m
Max. allowed chairlift speed [5]	V_C	2.5 m/s	5 m/s	5 m/s
Minimum interval between the carriers [5]	$\Delta t_C = 4 + \frac{n}{2}$	5 s	5 s	6 s
Distance between carriers attached to the carrying-hauling ropes (Figure 1, Figure 2)	$\Delta l_C = \Delta t_C \cdot V_C$	12.5 m	25 m	30 m
Chairlift capacity	$Q_C = \frac{n}{\Delta t_C} \cdot 3600$	1440 persons/h	1440 persons/h	2400 persons/h
Number of skiers who are carried by the chairlift	$n_C = \frac{L_C}{\Delta l_C} \cdot n$	160 persons	80 persons	132 persons
Ski slope length	L_S	1200 m	Ski slope is in all cases the same $L_S = 1200$ m $n_S = 200$ $V_S = 2.4$ m/s $\Delta t_S = 2.5$ s $Q_S = 1440$ persons/h	
Max. number of skiers on ski slope	n_S	max. 200		
Ski slope capacity (if balanced it equals the cableway capacity)	$Q_S = Q_C$	1440 persons/h		
Average interval between the skiers on the ski slope	$\Delta t_S = \frac{3600}{Q_S}$	2.5 s		
Average speed of the skiers on the ski slope (including stops)	$V_S = \frac{L_S \cdot \Delta t_S}{n_S}$	2.4 m/s		
Number of skiers on ski slope and cableway	$n_C + n_S$	360 persons	280 persons	332 persons
Number of downhill runs per hour of one skier per ski slope	$n_{HS} = \frac{3600}{\frac{L_S}{V_S} + \frac{L_C}{V_C}}$	4 downhill runs/h	5.14 downhill runs/h	5.14 downhill runs/h
Occupancy of chairlift at 100% occupancy of ski slope	$\eta_C = \frac{\Delta t_C}{n \cdot \Delta t_S} \cdot 100$	100%	100%	60%
Occupancy of ski slope at 100% occupancy of chairlift	$\eta_S = \frac{n \cdot \Delta t_S}{\Delta t_C} \cdot 100$	100%	100%	166.6%
Ski centre capacity if additional ski slope is set	$n_C + n_S \cdot \eta_S$			465 persons

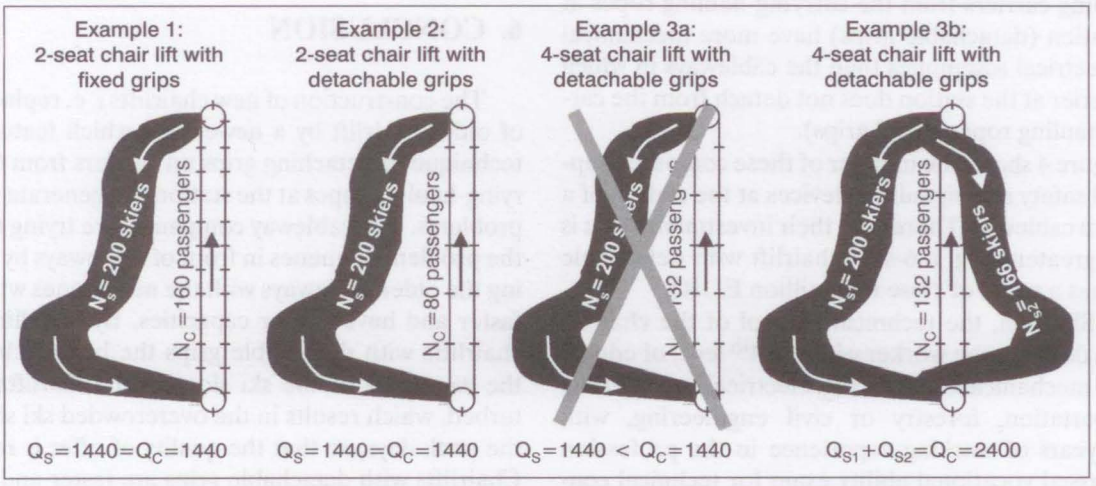

Figure 5 - Examples of installing three different chairlifts along the same ski slope

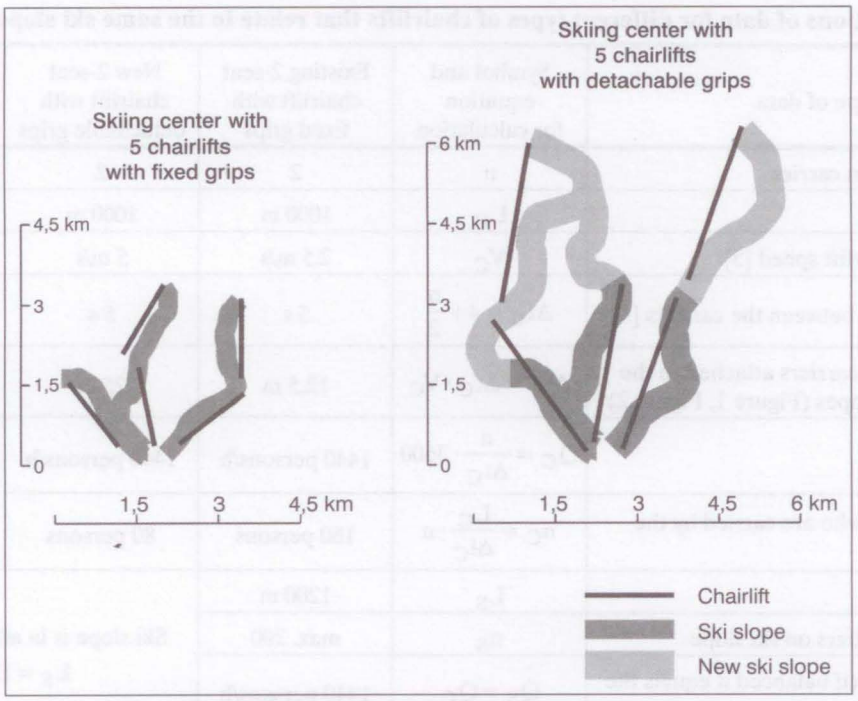

Figure 6 - Occupancy of the mountain tourist centre area by chairlifts with fixed grips and chairlifts with detachable grips

By constructing several chairlifts with detachable grips allows the mountain tourist centre to cover larger areas (Figure 6). In this way the quality of offer is increased, since they can offer more kilometres of ski slopes and the skiers can ski longer, wasting less time on the cableway ride. However, such expansion would also mean greater intervening with the environment in which the mountain tourist centres are located.

5. NEW CABLEWAYS AND PERSONNEL POTENTIAL

The more recent cableways with the technique of detaching carriers from the carrying-hauling ropes at the station (detachable grips) have more mechanical and electrical assemblies than the cableways in which the carrier at the station does not detach from the carrying-hauling ropes (fixed grips).

Figure 4 shows the number of these computer-supported safety and signalling devices at the station of a modern cableway. Therefore, their investment value is much greater (e. g. a 6-seat chairlift with detachable grips has a value of close to 5 million EUR).

In Slovenia, the technical control of the chairlift can be done by one worker with the 4^{th} level of education in mechanical engineering, electrical engineering, transportation, forestry or civil engineering, with three years of working experience in the profession and passed vocational ability exam for technical control of cableways. The training of the technical operator of a cableway in Slovenia takes three days (22 hours), which is not sufficient for the complexity of the modern cableway technology.

If we compare those responsible for safe cableway operation on chairlifts, where the passengers ride "through the air", and those responsible for safe air traffic operation, where formal education is necessary (at the level of engineers) and special training for different types of aircraft in the duration of one or several months, one can see that there is a big difference.

The comparison between the cableway traffic and the air traffic system is appropriate because the values of the new cableways are comparable with the values of the smaller passenger planes.

6. CONCLUSION

The construction of new chairlifts i. e. replacement of older chairlift by a newer one which features the technique of detaching grips on carriers from the carrying-hauling ropes at the station can generate various problems. The cableway companies are trying to solve the problem of queues in front of cableways by replacing the older cableways with the newer ones which are faster and have higher capacities. By installing such chairlifts with detachable grips the balance between the capacities of the ski slopes and chairlifts is disturbed, which results in the overcrowded ski slopes in the peak days, so that the quality of offer is reduced. Chairlifts with detachable grips are faster and enable carriage of passengers over greater distances, which

on the other hand results in the need for larger areas in the nature. The complexity of the new chairlifts with detachable grips is greater and it requires also staff with more knowledge and education for technical control, maintenance and management of modern cableways.

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SAŽETAK

UTJECAJ MODERNIH ŽIČARA NA RAZVOJ GORSKIH TURISTIČKIH CENTARA

Članak proučava problem izgradnje žičara s modernom tehnikom i njihov utjecaj na rad i razvoj žičarskih poduzeća s više gledišta. Moderne žičare s tehnikom priklopnih spojki omogućavaju brži prijevoz putnika. One imaju mogućnost da na jednakim relacijama prevoze više putnika. U posljednje je vrijeme ovaj trend uvođenja modernih žičara naročito prisutan kod sjedežnica koje služe za prijevoz skijaša. Ovakve sjedežnice s priklopnim spojkama omogućavaju prijevoz skijaša na većim daljinama pa zbog toga moraju imati pripadajuće skijaške pruge veće površine, što ima utjecaj na širenje gorskih turističkih centara. Sjedežnice s priklopnim spojkama zahtijevaju više znanja i osoblja za upravljanje i održavanje i isto tako više uloženog kapitala.

KLJUČNE RIJEČI

žičare, spojke, skijanje, skijaške pruge, zimski turizam, gorsko turistički centri

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