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Contemporary development directions of ski resorts in Poland in the context of the idea of sustainable development

Abstract: The consequences of climate change, demographic processes, and competition between tourist destinations are serious threats to the profitability of ski resorts and the sustainable development of many towns and regions. This article aims to examine the state of infrastructure development for downhill skiing in Poland, and to determine contemporary directions for the development of ski resorts from the point of view of ensuring the achievement of sustainable development goals. The research methods included an inventory of ski infrastructure, field observation, as well as analysis of ski resorts' websites and social media profiles. In the 2019/2020 winter season, there were 769 ski lifts in Poland, including 119 aerial lifts, with a total length of 302.9 km and a transport capacity of 625,500 people per hour; there were also 826 ski runs with a total length of 445.7 km. Ski resorts' actions in the context of sustainable development included eliminating the negative environmental effects of ski infrastructure, for example, by improving the quality and technology of ski lift equipment and snowmaking systems; maintaining the profitability of ski resorts while preserving an appropriate thickness of snow cover; increasing their financial effectiveness by creating new products and tourist attractions for the summer season; and meeting the expectations of tourists so as to ensure their satisfaction with their stay.

Key words: climate change; development; ski resorts; ski tourism, sustainability

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Introduction

Ski tourism is one of the most popular activities in mountain regions; it is, therefore, one of the principal factors that affect the social and economic development of many localities and regions (Kurek, 2004; Marković & Petrović, 2013). As an example of mass tourism, with its related high financial turnover, skiing has an influence on local entrepreneurship and innovativeness; it also increases employment and income, improves the demographic

situation, raises the quality of services and infrastructure, and improves the so-called 'psychological stability' of residents (Burakowski & Magnesson, 2012; Dorocki, 2022; Krzesiwo, 2016b; Snowdon et al., 2000). Ski resorts around the world are facing many challenges due to climate change (Damm et al., 2017; Fang et al., 2021; Scott, Steiger, Knowles et al., 2020, a nie jak zmieniono na Scott et al., 2020; Steiger et al., 2019), the ageing populations of economically developed countries (Steiger, 2012; Witting & Schmude, 2019), the need for modernisation and innovation, and increasing competition between tourist destinations (Bausch & Gartner, 2020; Krzesiwo & Mika, 2023; Pons et al., 2014; Steiger & Scott, 2020). These constitute serious threats to the profitability of ski resorts and the sustainable development of many mountain tourist destinations.

Poland is among the European countries with the most well-developed ski infrastructure (Vanat, 2022). It is estimated that around four million Poles (10.5% of the population) actively participate in skiing or snowboarding (Polacy na nartach – raport 2018). The development of this form of recreation is of great importance to Poland, and ski resorts play a key role in local tourist reception systems, especially in mountain areas (Krzesiwo & Mika, 2023). Maintaining the ability of ski resorts to continue functioning is crucial to their ongoing development. From the point of view of local communities, preserving the growth of these enterprises is a key issue, as there is a strong economic bond between ski resort operators and other providers of tourist services (Mika, 2014). This dependency is also important from a social aspect: the development of tourist services is principally endogenous and is based to a large degree on local resources.

The dynamic development of ski infrastructure in Poland began in the early 1970s in almost all the mountain regions. Up to the end of the 1980s, ski infrastructure was developed mainly by mining and industrial plants belonging to the State Treasury, as well as by tourist firms. The intense process of exploitation of Polish mountains for downhill skiing was at the time driven and stimulated by distant centres of political and economic power, without the participation of local authorities (Krzesiwo, 2014). A direct consequence of the political and economic changes in Poland after 1989 was the privatisation of ski resort infrastructure.

The first decade of the 21st century saw intense growth in the number and quality of infrastructure for downhill skiing in Poland. This was caused by increases in the number of Poles participating in ski tourism and in the use of snowmaking on ski runs, as well as the appearance of powerful new actors in the ski industry – that is, companies created by local groups of entrepreneurs for the management of new ski resorts (Krzesiwo, 2014). In this period, investment in ski infrastructure was conducted not only in mountain localities, but also in suburban areas and highland ranges, along with lowlands, lake districts and coastal areas.

The large capital investments, as well as the high costs of maintaining old ski lifts and ensuring an appropriate depth of snow cover on ski runs, resulted in many small ski resorts going out of business in the second decade of the 21st century. For example, within the 8 years from 2012 to 2020, the number of lifts for transporting skiers up slopes in the Polish Carpathians decreased by 8.2%, from 511 to 469. However, despite an overall drop in the number of ski lifts, the number of aerial lifts increased by 44.4% from 63 to 91, and the total transport capacity increased by 15.4% from 347,196 to 400,832 people per hour (Krzesiwo, 2021). This is evidence of further development in the quality of ski infrastructure. High operating costs have resulted in changes to the management of some

ski resorts, which have begun to diversify into two-season destinations to increase revenues. Today, the ski tourism market in Poland has matured, and demand is stable.

Prior research into the development of ski tourism in Poland has focused on identifying and assessing the factors affecting the attractiveness and competitiveness of ski resorts (Krzesiwo, 2014; Krzesiwo & Mika, 2011; Krzesiwo et al., 2018; Nowacki, 2017; Żemła, 2008; Żemła & Żemła, 2006), motives for participating in skiing and the choices made by ski tourists (Hibner, 2020; Krzesiwo, 2014; Żemła & Bołoz, 2022), barriers and limitations to the development of ski resorts (Krzesiwo, 2007; 2014; Krzesiwo & Mika, 2023; Mika et al., 2007), the influence of ski resorts on local economic growth (Dorocki, 2007; 2022; Krzesiwo, 2016b), the structural transformation of ski resorts and directions for spatial development of ski infrastructure (Faracik et al., 2009; Krzesiwo, 2014; 2023), and the size and structure of ski tourist traffic (Hibner, 2018; Krzesiwo, 2016a). The first studies into the state of development of ski infrastructure were conducted in the 1980s in the Podhale region and in the Western Beskid mountains (Baran, 1986; 1987). Similar research was also undertaken in the first two decades of the 21st century, focusing on three areas: the Silesian Beskids (Krzesiwo, 2007; Mika, 2004), the whole of the Polish Carpathians (Krzesiwo, 2014; 2023; Mika, 2009), and the Sudeten mountains (Potocki, 2014).

Although there is literature on issues of ski tourism development and ski resorts in Poland, the scope of these works relates to selected localities or tourist regions, and their timescale covers mainly the 20th century, through to the beginning of the second decade of the 21st century. There is a lack of studies on the state and directions of development of ski tourism across the whole country. With this in mind – and given the dynamic changes taking place in tourism, as well as the threats to the further sustainable development of ski tourism resulting from climate and demographic changes and growing competition from national and foreign tourist localities – this paper aims to show the state of development of downhill skiing infrastructure in Poland, and to determine current directions for the growth of ski resorts from the point of view of ensuring achievement of sustainable development goals. The spatial scope includes all localities in Poland equipped with infrastructure for downhill skiing as of 2020.

Directions of development of ski resorts worldwide – literature review

The development of ski resorts in various parts of the globe is most severely affected by climate change. The most serious consequences for the ski industry are the shortening of the skiing season (Moen & Fredman, 2007; Steiger & Stötter, 2013), and a drop in demand for skiing (Damm, Gruel et al., 2017; Damm, Köberl et al., 2014; Rutty et al., 2017). The effects of climate change have resulted in adaptive behaviours by ski resorts, which have employed three main strategies: snowmaking for slopes, development of the market (i.e. increasing the frequency and number of annual visits of skiers to ski resorts), and diversification of the products on offer (Morrison & Pickering, 2013; Orr & Schneider, 2018; Scott, Steiger, Rutty et al., 2020; Steiger & Abegg, 2013).

The most commonly used adaptive tool for dealing with a changeable climate is snowmaking (Haanpää et al., 2015; Hopkins, 2014; Steiger & Scott, 2020). The need to increase snow production leads to high operating costs, caused, among other factors, by the high cost of electricity worldwide, as well as the prices of the snowmaking

systems themselves; these costs prove to be prohibitive for some ski resorts (Scott et al., 2019; Steiger & Mayer, 2008; Walters & Ruhanen 2015). The closure of some ski resorts results in less competition in the market, which in turn leads to a redistribution of skiers to resorts that are more resistant to climate change (Pons et al., 2014; Scott, Steiger, Rutty et al., 2020). The shortening of the skiing season and the concentration and growing number of skiers in resorts that are able to manage with the changeability of the climate result in an increase in overcrowding (Rutty et al., 2015). To avoid this, ski resorts invest in increasing the capacity of ski runs, ski lifts and cableways (Rutty et al., 2015; Scott, Steiger, Rutty et al., 2020). Managing the flow of visitors in ski resorts will be of increasing importance in limiting the effects of overcrowding. Better distribution of skiers can be achieved using tools for managing flow in real time (Pikkemaat et al., 2020), as well as dynamic pricing strategies (Haugom & Malasevska, 2018; Malasevska et al., 2017a; 2017b).

Most of the remaining adaptive strategies focus on marketing activities and diversification of the products on offer. Some resorts have changed their business models from single-season winter destinations to two-season or year-round destinations (Hopkins & Maclean, 2014; Gilani et al., 2018). They try to develop alternative tourist activities that can be participated in outside the winter season or throughout the year (Ghaderi et al., 2014).

An important direction taken by ski resorts around the world is the introduction of changes to management in order to meet sustainable development criteria (Krzesiwo, 2015). For many, looking after the natural environment is a priority, as excessive exploitation of their natural surroundings causes a drop in attractiveness and tourist competitiveness (Flagestad & Hope, 2001). The operators of ski resorts are ever more aware of their responsibility for the environment, which is why, among other initiatives, they are trying to reduce their carbon footprints (Falk & Steiger, 2018). This is achieved, for example, by reducing energy consumption, increasing the use of renewable sources of energy, cutting greenhouse gas emissions, and using environmentally friendly business practices and means of transport to ski destinations (Giannelloni & Robinot, 2015; Poldermann et al., 2020). Some resorts also participate in voluntary environmental protection programmes and do their best to obtain ecological quality certificates (Little & Needham, 2011; Rivera et al., 2006).

The most important factor affecting profit indicators is the size of a ski resort, in particular the total length of ski runs (Falk & Steiger, 2020). As a result, since the beginning of the 21st century, the number of ski lifts and ski runs linking neighbouring ski areas has increased (Falk, 2017; Tuppen, 2002). The aim of this type of initiative is to attract skiers to a region by offering a greater choice of runs and the possibility to use many ski lifts with a single ski pass; above all, such initiatives allow resorts to take part in joint promotional activities (Krzesiwo, 2015). Falk (2017) claims that such horizontal cooperation between ski resorts leads to a 12% increase in overnight stays, with the greatest benefits felt by satellite ski resorts and remote villages.

In the choice of destination, of key importance is the way in which ski resorts communicate with their client target group. Currently, the principal form of communication and commercialisation is the Internet. According to Cristobal-Fransi et al. (2018), who studied the use of information and communication technologies by ski resorts in France and Spain, resorts in these countries are advanced in terms of their use of the Internet

as a real promotional tool; however, they still do not make use of the whole range of interactive possibilities that it provides.

Research methodology

The research process for this study was divided into several stages. The first stage lasted from March to June 2020 and involved the gathering and organising of source materials; these were obtained by conducting an inventory of ski infrastructure in Poland. Data were obtained from the official websites and Facebook profiles of companies managing ski resorts. Particular attention was paid to how up to date the analysed pages and fanpages were. If there were any doubts as to the existence of a given ski resort or ski lift, a lack of activity on social media, or a lack of the required information on the Internet, the owners of the resort/lift were contacted by phone or email. After the data had been gathered, a database was created in a spreadsheet.

In the second stage of the study, conducted between July 2020 and September 2022, onsite observations were made, and analysis was carried out of ski resorts' websites and their profiles on social media, in the context of new investments and attractions offered to tourists in the summer season. In addition, during a conference organised by the Polish Ski and Tourist Resorts Association in September 2022, 10 interviews were conducted with representatives of leading ski resorts in Poland on completed and future investments, implemented marketing campaigns, current development trends, and the problems and challenges facing ski resort administrators and local authorities.

The third stage of the study, conducted between October 2022 and March 2023, consisted of a detailed elaboration of the source material. In March 2023, a re-inventory of ski infrastructure was conducted in the 26 largest ski destinations in Poland, to determine the changes that had occurred since 2020.

The state of downhill skiing infrastructure in Poland

In the 2019/2020 winter season, there were 303 companies in operation managing ski areas in Poland – ski resorts[1] and single ski lifts (Table 1). There were 769 ski lifts, including 119 aerial lifts, with a total length of 302.9 km and a transport capacity of 625,500 people per hour, as well as 826 ski runs with a total length of 445.7 km (Table 2).

Ski areas in Poland are located in the mountains (the Carpathians and Sudetes), the Subcarpathian basins and the highlands, as well as the lowlands, lake districts and coastal areas (Figure 1). The vast majority (81%) are in mountain localities. Around two-thirds of all ski infrastructure is in the Carpathians, and around one-fifth in the Sudetes. Among the 171 localities equipped with ski lifts and cableways, almost 70% offer a narrow scope of services. They have between one and three devices for transporting skiers up slopes, and their total transport capacity does not exceed 3,000 people per hour (Table 3). The remaining 51 localities can be designated as ski destinations.[2] They are of varying rank

[1] In this work, the term 'ski resort' refers to a ski infrastructure complex managed by one owner operating under one name, with one ski pass and located in one or more localities (Krzesiwo, 2014).

[2] According to Krzesiwo (2014), a ski destination is a 'tourist locality characterised by a large degree of ski infrastructure, and with appropriate service facilities connected to providing for tourist traffic'.

Table 1. Infrastructure for downhill skiing in Poland in the winter season 2019/2020

Region		Number of localities equipped with ski lifts and cableways	Number of ski resorts / single ski lifts (business)	Number of ski lift devices		Total length of ski lift devices [m]	Total transport capacity of ski lift devices [persons / hour]
				total	including cableways		
Coasts		1	1	1	0	280	700
Lake Districts		20	20	56	3	15,166	37,890
Lowlands		6	6	15	2	4,504	10,300
Highlands		22	23	72	2	21,260	48,400
Subcarpathian Basins		1	1	1	0	500	800
Mountains	Sudetes	30	60	155	21	61,348	126,623
	Carpathians	91	192	469	91	199,844	400,832
Total		171	303	769	119	302,902	625,545

Source: author's own study

Table 2. Ski runs for downhill skiing in Poland in the winter season 2019/2020

Region		Number of ski runs	Total length of ski runs [m]	Number of ski runs equipped with snowmaking	Total length of ski runs equipped with snowmaking [m]	Number of ski runs with artificial lighting	Total length of ski runs with artificial lighting [m]
Coasts		2	640	2	640	2	640
Lake Districts		54	18,780	51	16,680	51	17,070
Lowlands		14	5,137	12	4,837	14	5,137
Highlands		67	22,210	67	22,210	66	22,090
Subcarpathian Basins		1	500	1	500	1	500
Mountains	Sudetes	160	93,700	132	77,200	101	50,865
	Carpathians	528	304,704	464	245,234	414	204,357
Total		826	445,671	729	367,301	649	300,659

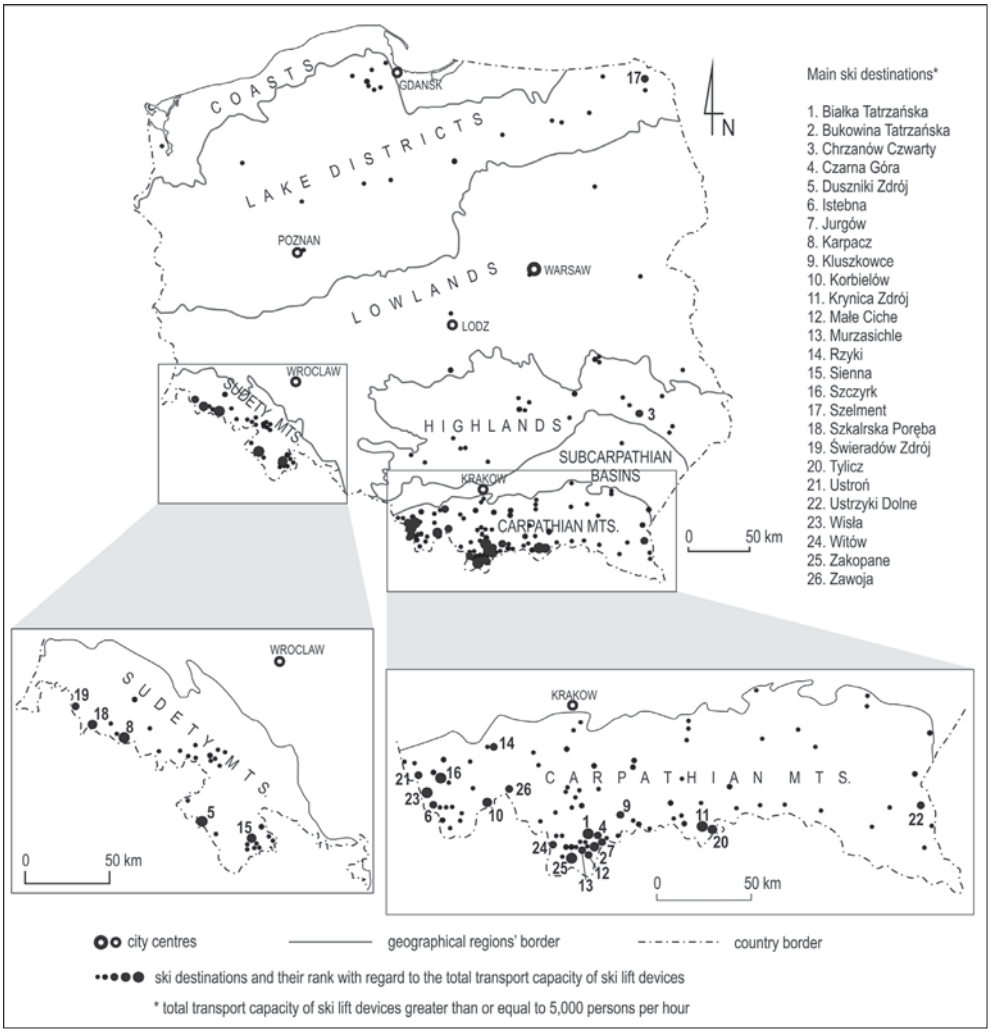
Source: author's own study

Table 3. Number of localities equipped with ski lift devices in Poland in the winter season 2019/2020

Region		Number of localities equipped with				Number of localities equipped with ski lift devices with a total transport capacity [persons / hour] of			
		1 ski lift	2–3 ski lifts	4–5 ski lifts	>5 ski lifts	≤ 1,000	1,001–3,000	3,001–5,000	≥ 5,000
Coasts		1	0	0	0	1	0	0	0
Lake Districts		4	12	2	2	5	12	2	1
Lowlands		1	4	1	0	3	2	1	0
Highlands		2	13	6	1	3	15	3	1
Subcarpathian Basins		1	0	0	0	1	0	0	0
Mountains	Sudetes	9	13	1	7	11	11	3	5
	Carpathians	21	36	14	20	30	26	16	19
Total		39	78	24	30	54	66	25	26

Source: author's own study

Figure 1. Ski destinations in Poland in the winter season 2019/2020



Source: author's own study

depending on the degree of development of ski infrastructure. In first place among the localities are Białka Tatrzańska, Bukowina Tatrzańska, Krynica Zdrój, Szczyrk, Wisła and Zakopane in the Carpathians, and Duszniki Zdrój, Karpacz and Szklarska Poręba in the Sudetes. Each of these localities has over 20 ski lifts, with a total transport capacity exceeding 15,000 people per hour.

From a technical point of view, in Poland there is a predominance of surface ski lifts: supported – platter lifts (50.4%) and T-bar lifts (7.2%), unsupported – platter lifts (7.3%) and handle tows (10.5%), and magic carpets (9.1%). The remainder (15.5%) consists of cableways: two cable cars (two sections), three funicular railways, four gondola cableways, one combined cableway (chairs and gondolas), and 109 chairlifts (1 one-person, 20 two-person, 3 three-person, 65 four-person and 20 six-person lifts).

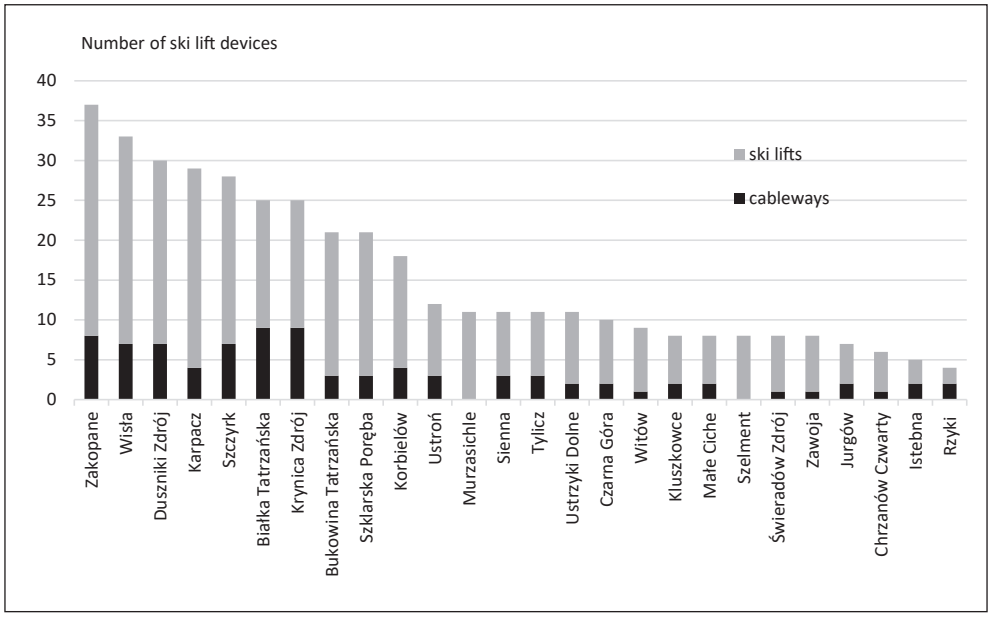
Among the 303 companies that own downhill skiing infrastructure, 128 have one ski lift (42.2%); the other 175 (57.8%) manage ski infrastructure complexes. In 2020, the largest ski resorts were Kotelnica Białczańska (Białka Tatrzańska), Szczyrk Mountain Resort (Szczyrk), Pilsko-Jontek (Korbielów) and Jaworzyna Krynicka (Krynica Zdrój) in the Carpathians, and Czarna Góra Resort (Sienna), Ski Arena Szrenica (Szklarska Poręba), Karpacz Ski Arena (Karpacz) and Winterpol Zieleniec (Duszniki Zdrój) in the Sudetes.

Out of the 826 downhill ski runs, 78.7% are easy (blue), 18.5% difficult (red) and 2.8% very difficult (black). In terms of length, 64.0% is on easy runs, 30.7% difficult, and 5.3% very difficult. Easy ski runs predominate in all landscape zones. The majority of the difficult and very difficult ski runs are in the Carpathians – 106 and 15, respectively.

Two additional but crucial elements of ski infrastructure are snowmaking and artificial floodlighting. As many as 729 (88.3%) downhill ski runs with a combined length of 367,301 m (82.4%) are equipped with devices for snowmaking (Table 2). Artificial floodlighting for skiing after dark is installed on 649 (78.6%) slopes with a combined length of 300,659 m (67.5%). The lowest percentage of floodlit ski runs is in the Sudetes (63.1%). In regions outside mountain areas, floodlit ski runs make up 97.1% of the total. A total of 32 runs with a combined length of 36,456 m can be used for alpine skiing competitions as they are licensed by the International Ski Federation (FIS). This type of ski run is only found in the Carpathians (26) and Sudetes (6).

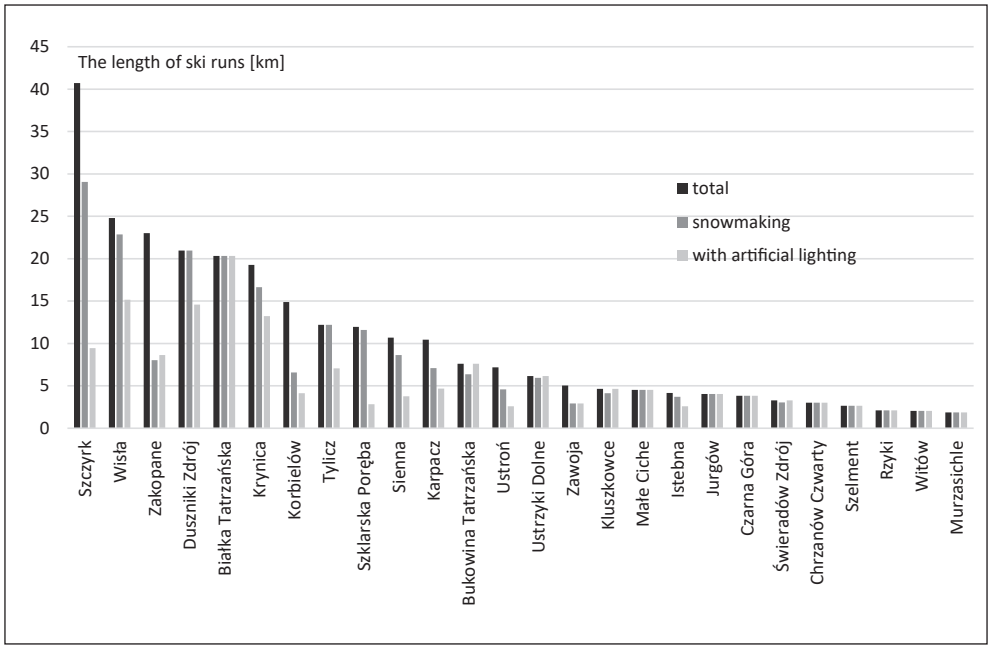
From the inventory conducted in the first half of 2020, it can be seen that 26 localities contain the most well-developed downhill skiing infrastructure. The combined transport capacity of ski lifts and aerial lifts in each of these localities is equal to or higher than 5,000 people per hour. Most of these tourist resorts are in the Carpathians (19) and the Sudetes (5) (Figure 1). The largest numbers of ski lifts are found in Zakopane (37), Wisła (33), Szczyrk (28), Białka Tatrzańska (25), Krynica Zdrój (25) and Bukowina Tatrzańska (21) in the Carpathians, and Duszniki Zdrój (30), Karpacz (29) and Szklarska Poręba (21) in the Sudetes (Figure 2). The ski destinations best equipped with cableways are Białka Tatrzańska (9), Krynica Zdrój (9) and Zakopane (8). The largest number of people can be transported by ski lifts in Białka Tatrzańska (32,975 people per hour) and Duszniki Zdrój (31,200 people per hour). Next in line are Krynica Zdrój, Wisła, Zakopane and Szczyrk, where the combined transport capacity of ski lifts and cableways are respectively 29,250, 28,232, 27,435 and 26,800 people per hour. The greatest numbers of downhill ski runs are in Wisła (44), Szczyrk (42), Duszniki Zdrój (37), Krynica Zdrój (33), Zakopane (33) and Białka Tatrzańska (31). In terms of the length of runs, Szczyrk holds first place with 40.7 km, followed by Wisła (24.8 km), Zakopane (23.0 km), Duszniki Zdrój (21.0 km) and Białka Tatrzańska (20.3 km) (Figure 3). The ski destinations with the most runs with snowmaking equipment are Wisła (42), Duszniki Zdrój (37), Białka Tatrzańska (31) and Szczyrk (30). The same localities also have the largest total length of ski runs with snowmaking equipment (22.9 km, 21.0 km, 20.3 km and 29.0 km, respectively). The most floodlit ski runs are found in Białka Tatrzańska (31), Wisła (28), Zakopane (28) and Duszniki Zdrój (26), while the greatest combined lengths of floodlit ski runs are in Białka Tatrzańska (20.3 km), Wisła (15.2 km), Duszniki Zdrój (14.6 km) and Krynica Zdrój (13.2 km).

Figure 2. Number of ski lift devices in Poland's largest ski destinations in 2020



Source: author's own study

Figure 3. Total length of ski runs, total length of runs equipped with snowmaking, and total length of runs with artificial lighting in Poland's largest ski destinations in 2020



Source: author's own study

Table 4. Infrastructure for downhill skiing in Poland's largest ski destinations in 2020 and 2023

Ski destination	Number of ski lift devices			Total transport capacity of ski lift devices [persons / hour]		
	2020	2023	change in 2020–2023	2020	2023	change in 2020–2023
Lake Districts						
Szelment	8	8	0	6,540	6,540	0
Highlands						
Chrzanów Czwarty	6	6	0	5,600	5,600	0
Sudetes						
Duszniki Zdrój	30	31	1	31,200	31,500	300
Karpacz	29	27	-2	20,930	20,530	–400
Sienna	11	12	1	12,850	13,150	300
Szklarska Poręba	21	21	0	16,215	16,215	0
Świeradów Zdrój	8	8	0	6,250	6,390	140
Carpathians						
Białka Tatrzańska	25	25	0	32,975	32,975	0
Bukowina Tatrzańska	21	17	–4	17,114	15,794	–1,320
Czarna Góra	10	10	0	9,700	9,700	0
Istebna	5	5	0	6,900	6,900	0
Jurgów	7	7	0	8,400	8,400	0
Kluszkowce	8	8	0	6,800	6,800	0
Korbielów	18	15	–3	14,745	13,645	–1,100
Krynica Zdrój	25	25	0	29,250	30,400	1,150
Małe Ciche	8	8	0	9,250	9,250	0
Murzasichle	11	11	0	7,400	7,400	0
Rzyki	4	4	0	6,200	6,200	0
Szczyrk	28	27	–1	26,800	26,590	–210
Tylicz	11	12	1	10,790	13,790	3,000
Ustroń	12	12	0	8,075	8,075	0
Ustrzyki Dolne	11	13	2	10,000	10,900	900
Wisła	33	34	1	28,232	29,592	1,360
Witów	9	9	0	5,550	5,550	0
Zakopane	37	37	0	27,435	27,835	400
Zawoja	8	4	–4	5,180	3,900	–1,280
Total	404	396	–8	370,381	373,621	3,240

Source: author's own study

In 2020, there were 404 ski lifts operating in the 26 largest ski destinations (52.5% of the total number of ski lifts in Poland), including 88 aerial lifts, with a total length of 169.0 km and a transport capacity of 370,381 people per hour (Table 4). In 2023, the same ski destinations had 396 ski lifts, including 89 aerial lifts, with a total length of 166.4 km and a transport capacity of 373,621 people per hour. In the years 2020–2023,

the number of ski lifts decreased in 5 ski destinations, increased in 5, and was unchanged in the remaining 16. The largest declines were in Bukowina Tatrzańska (4), Karpacz (2), Korbielów (3), and Zawoja (4). The biggest growth in ski infrastructure occurred in Tylicz, where a new six-person chairlift was built in 2022.

Contemporary development directions of ski resorts in Poland

The most important development directions of Polish ski resorts in the 2010s and early 2020s include the following:

- modernisation and construction of new ski lifts and aerial lifts;
- broadening the offer to encompass the summer season, particularly for cyclists and families with children;
- offering skiers the possibility to use the ski infrastructure at many resorts via a single ski pass;
- use of special price discounts on the purchase of ski passes outside the high season;
- use of the latest interactive tools for attracting customers;
- high concentration of tourist traffic in some localities;
- development of infrastructure for tourists travelling by camper van.

The biggest modernisation investment in the 2010s was the development of the Czyrna-Solisko Ski Resort in Szczyrk (known as Szczyrk Mountain Resort since 2014). This intensive modernisation began in 2017; it included building a new snowmaking system along with a 100,000 m^3-capacity reservoir, a 10-person gondola cableway and three 6-person chairlifts, modification of the downhill ski runs and construction of a car park for 700 cars (https://www.szczyrkowski.pl). The value of the investments completed in 2017–2018 amounted to €54.3 million.

In the years 2011–2020, 43 cableways were constructed in Poland, including 30 in the Carpathians, 10 in the Sudetes, 2 in highland areas and 1 in the lake districts. Many of these were modern chair lifts, mainly 4- and 6-person, with heated seats and wind shields (Photo 1). In this period, modernisation work was also done on short unsupported platter lifts and handle tows on magic carpets. In the Carpathians alone, 40 such lifts were installed.

To improve their economic viability, ski resorts are expanding their offer to include the summer season. Among the 303 ski resorts, 66 (21.8%) are open to tourists in summer. These resorts are in 49 different localities. In total, 54 lifts are open outside the winter season, including 48 aerial lifts, comprising 7.0% of all such lifts in Poland. The summer offer of ski resorts in mountain areas is aimed at walkers, cyclists and families with children, while in highland and lowland areas and in the lake districts it is mainly towards families with children. Adaptations to ski areas to attract tourist traffic in the summer season include building one-way mountain bike runs, so-called singletracks, closed tracks with moguls and so-called pumptracks; setting out bike trails and nature trails; and building sled runs, tubing tracks (for use with tyres), viewing towers (Photo 2), theme parks such as miniature parks, children's playgrounds, rope parks, mountain railways, and animal enclosures.

A new trend in the development of ski resorts in Poland's mountain areas is the construction of bike parks (Photo 3) – that is, downhill bike trail complexes, also known as MTB (*Mountain Terrain Bike*) trails – and combining the offer for skiers with the offer for mountain bikers. The people managing ski resorts believe that once the

winter season is over, their customers switch from skis or snowboards to bikes. The summer offer in these resorts is therefore aimed at the same target group as the winter offer. In recent years, an increasing number of resorts have begun specialising in ski-and-bike offers. In 2021, there were 23 in Poland, including 15 in the Carpathians and 6 in the Sudetes. Some have even changed their name to draw customers' attention to the fact that they are no longer winter-only resorts, but year-round resorts, and that their infrastructure is designed for both skiers and cyclists; for example, Skolnity Ski & Bike Park in Wisła (Silesian Beskids). These resorts also offer year-round passes for use of the ski infrastructure in winter and the bike infrastructure in summer. The first such pass in Poland, launched in December 2020, was the Pingwin Pass Ski & Bike (https://grupapingwina.pl).

In the 2010s, owners of certain Polish ski resorts located in the same region or locality began to combine their offers in the form of joint ski passes. The first such initiative appeared in the 2011/2012 winter season in Wisła and Ustroń (Silesian Beskids), and in localities in Podhale. The 'Wiślański skipass' included six ski resorts in Wisła, the 'Ustroński skipass' operated in four resorts in Ustroń, and the 'Tatry Ski' pass was valid for five resorts in Białka Tatrzańska, Jurgów and Kluszkowce (Krzesiwo, 2014). In subsequent years, similar solutions appeared in other tourist localities and regions in the Carpathians and Sudetes, and joint ski passes were combined; for example, the 'Wiślański Skipass' with the 'Ustroński Skipass' in 2012, and the 'Tatry Ski' pass with the 'Góral Skipass' in 2018. Additional resorts also joined existing initiatives. In 2021 in the Carpathians, there were five joint passes: 'Tatry Super Ski' in the Podhale region, 'Wiślański Skipass' and 'Szczyrk Wspólny Skipass' in the Silesian Beskids, 'Krynica.ski' in the Sądecki Beskids and the 'Pingwin Pass' in resorts belonging to one owner but located in different regions. In the Sudetes, meanwhile, skiers could choose from the 'SkiPass Zieleniec' in the Orlickie mountains and the 'eSkipass' in the Śnieżnik Massif. The largest of these initiatives is the 'Tatry Super Ski' pass, which in 2021 operated in 13 localities, including 11 in Poland and 2 in Slovakia. It included 19 ski resorts, and gave access to 90 ski lifts and cableways with a total transport capacity of 106,979 people per hour, as well as 106 downhill ski runs with a total length of 73.3 km (Krzesiwo, 2023).

To generate more revenue, ski resorts use targeted activities and marketing strategies in the form of pre-season and post-season ski pass discounts, as well as dynamic pricing. Increasingly, potential customers are encouraged to purchase passes online before the skiing season or in the low season by offering them lower prices for time-limited or season ski passes that they can use in the high season. A new strategy still rarely used in Polish ski resorts is dynamic pricing. Szczyrk Mountain Resort in Szczyrk was the first and so far only ski resort in Poland to use this marketing strategy to manage demand in order to combat the seasonality of tourist traffic in the winter season, increase revenue and maximise profits. From the 2019/2020 winter season, it abandoned fixed ski pass prices; its prices now depend on various factors, including the volume of tourist traffic in the resort on a given day, the pass purchase date, the current weather, and the type of season (low or high). This form of pricing strategy allows administrators to increase traffic on days when interest in skiing is low, and reduce the number of people in the resort as well as increase the level of comfort on days when tourist demand is high. Another product that aims to attract tourists out of the high season is 'freeski' offers; these consist of adding free ski passes to overnight stays in accommodation venues participating

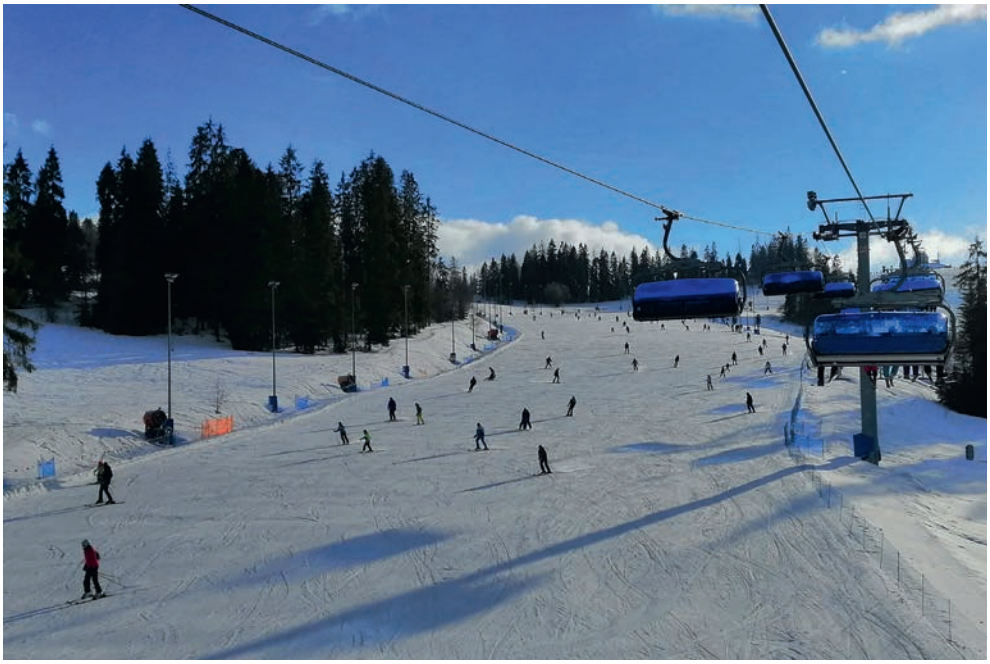
in a partnership programme. This type of offer is usually valid from the date ski resorts open up to Christmas Day, and from the end of the school winter holidays to the end of the skiing season. This type of promotion is used, for example, by Szczyrk Mountain Resort in Szczyrk, Czarna Góra Resort in Sienna, and resorts affiliated to the 'Wiślański Skipass', the 'Pingwin Skipass' and the 'Zieleniec Skipass'.

Innovative solutions aiming to attract customers and retain their loyalty include new interactive tools; the number of resorts using these tools grows every year. One of the most important such tools is a professional website containing such features as live camera feeds from the slopes, information on the current weather, the thickness of the snow cover and the ski lifts and ski runs that are open, and the possibility to buy ski passes online. The loyalty tools commonly used by ski resort administrators are Facebook, Instagram, YouTube and TikTok. Among the other interactive solutions for skiers and snowboarders are mobile applications that can be used to check the live camera feed on the slopes, the number of ski runs completed, the number of kilometres covered and the maximum skiing speed. Users can check the weather, conditions on the slopes, the availability of ski lifts and ski runs, and accommodation and other services on offer in a given locality; they can also buy a ski pass.

An unfavourable phenomenon that has been noticeable in recent years in Poland is the concentration of tourist traffic in selected localities and ski resorts, caused by overall competitive pressure on a small and average scale. Large resorts have invested in innovative solutions and thus strengthened their market position, attracting crowds of tourists. This results in overcrowding (Photo 4) and a range of other related problems, including an increase in environmental pollution, a worsening of internal transport accessibility, and a resulting drop in tourists' level of satisfaction with their stay. Examples of ski destinations that have maintained a strong competitive position over the past 10 to 15 years, and in which tourist traffic is concentrated in the winter season, are Białka Tatrzańska, Krynica Zdrój and Wisła in the Carpathians, and Karpacz and Duszniki Zdrój in the Sudetes. In recent years, Szczyrk has also joined this group. Meanwhile, there are many small enterprises with low economic viability that do not have sufficient funds for further development.

An entirely new phenomenon in Polish ski resorts is the development of infrastructure for tourists travelling by camper van. The COVID-19 pandemic triggered interest in caravanning among Poles en masse; car parks in some ski resorts in the 2020/2021 winter season were full of this type of vehicle. Three Carpathian and two Sudeten skiresorts are fully equipped to accommodate camper vans: Master-Ski in Tylicz, Słotwiny Arena in Krynica Zdrój, Rusiń-Ski in Bukowina Tatrzańska, Dzikowiec in Boguszów Gorce and Lądek Zdrój in Lądek Zdrój. Electricity, water and sewage services are provided free of charge to people with valid ski passes, while in resorts in the Sudetes, a fee is charged for the use of camper van parks. In addition, in some resorts, for example Kotelnica Białczańska in Białka Tatrzańska, JurgówSki in Jurgów, Laskowa-Ski in Laskowa, Wierchomla in Wierchomla, Tylicz.ski in Tylicz, and Jaworzyna Krynicka in Krynica Zdrój, tourists travelling by camper van can connect their vehicles to the electricity supply for no additional fee (https://polskicaravaning.pl).

Photo 1. Six-person 'Pasieka Express' chairlift in the Kotelnica Białczańska Ski Resort in Białka Tatrzańska



by K. Krzesiwo

Photo 2. Viewing tower in the Słotwiny Arena Ski Resort in Krynica Zdrój

by Ł. Krzesiwo

Photo 3. Infrastructure for mountain biking in the Mosorny Groń Ski Resort in Zawoja

by K. Żuławiński

Photo 4. Huge queue for the cableway in the Szczyrk Mountain Resort in Szczyrk

by P. Krzesiwo

DISCUSSION

This paper is the first work to date to present the state of ski infrastructure across the whole of Poland. There is, therefore, a lack of comparable material that, when combined with the numerical data in this article, would allow for analysis of changes in ski tourism infrastructure. Such an analysis was conducted by Krzesiwo (2021) for the Carpathians. It may be supposed that in the remaining regions of the country, similar processes have taken place, affecting the development of ski infrastructure. In 2012–2020, the number of localities in the Polish Carpathians with areas dedicated to downhill skiing fell by 22.9%, and the number of lifts for transporting skiers up slopes dropped by 8.2%. Although the total number of ski lifts declined, the number of aerial lifts grew by 44.4%, and the transport capacity increased by 15.5% (Krzesiwo, 2021). There was also an improvement in the quality of preparation of downhill ski runs. The number and length of runs with snowmaking capabilities grew by around 15%, and floodlit runs enabling skiing after dark increased by around 12% (Krzesiwo, 2023). The Carpathians, therefore, have seen a development of ski infrastructure; however, this has been primarily in the quality of facilities.

In 2020–2023, the development of downhill skiing infrastructure in Poland definitely slowed down. During this period, the number of ski lifts at the 26 largest ski destinations decreased by 2.0%, and transport capacity increased by only 0.9%. This was an extremely difficult time for the tourism industry due to restrictions caused by the COVID-19 pandemic in 2020 and 2021 and the outbreak of armed conflict between Russia and Ukraine in February 2022. Significantly lower revenues for ski resorts in the winter season 2020/2021, amounting to 10–35% of the levels of the previous winter, as well as the migration, economic and energy crises in 2022 and 2023 due to the war in Ukraine, halted costly investments in ski infrastructure. In some large ski resorts, only handle tows and magic carpets were installed for people learning skiing or snowboarding. On the other hand, those managing single, short, and non-invested ski lifts, for which there had already been no demand in earlier years, decided to close their businesses.

The principal issue that leads ski lifts to close is high costs, including the maintenance and servicing of lift equipment; the costs of implementing innovations and new investments in modern ski lifts, aerial lifts and efficient snowmaking systems; and the costs of snow production and maintaining snow cover on the slopes. Other contributory factors include disputes and lack of agreement between landowners and ski resort operators over conditions for the lease of land to be used for skiing. A further reason is the drop in tourist demand in some localities due to the lack of modernisation of ski infrastructure or marketing activities to attract customers, as well as competition from expanding ski resorts (Krzesiwo, 2021).

The operators of ski infrastructure in Poland are mostly Polish family-run businesses and cooperative initiatives connected to local communities and their individual capital. The need to improve the quality of services and build new infrastructure results in the owners of ski resorts being highly indebted for many years. In 2019, the average cost of building a four-person chairlift was around 25–30 million złoty (€5.5–6.5 million), while the average time for the return on investment was around 10 years. The high financial outlays in ski infrastructure are a serious challenge for many enterprises in the ski industry (Krzesiwo & Mika, 2023).

The high costs of producing snow and maintaining snow cover are caused by changes in climate and unstable weather conditions in winter (Scott et al., 2006). Damm, Köberl et al. (2014) estimated that these costs are from €10,000 to €30,000 per hectare annually. This includes the cost of electricity, labour costs and ensuring an appropriate supply of water. Administrators of Polish ski resorts point out that due to the approximately 300% rise in the price of electricity in 2023, these costs are skyrocketing and may prove prohibitive for some firms.

In the 1990s and 2000s, the principal adaptive strategy for dealing with the changeability of the climate in Poland was snowmaking. Today, snowmaking equipment is standard for ski resorts, with almost 90% of downhill ski runs in Poland equipped with snowmaking capabilities. As indicated by Steiger and Mayer (2008), the increase in the use of snowmaking equipment should not only be ascribed exclusively to climate change; tendencies in tourism, prestige and competitive advantage also contribute. Nowadays, a distinguishing feature of a ski resort is not the very fact of having a snowmaking system, but its quality, manifested in its efficiency, low energy consumption and environmental friendliness.

In the 2010s, the climate change adaptation strategies of many ski resorts concentrated on marketing activities and diversification of the product offer. In order to reduce the sensitivity of the business model to temperature fluctuations and escape from the 'trap' of the seasonality of revenue, ski resorts are developing in the direction of multifunctional use. According to Walters and Ruhanen (2015), to attract tourists outside the winter season and thus increase the profitability of their business activity, resorts should invest in attractions and amenities that offer elements of emotion and adventure, as well as the possibility for rest and relaxation. In Polish ski resorts, tourist attractions are being created for the summer season, such as bike parks, viewing towers, year-round sled runs, themed attractions, outdoor events and others. While at present, such activity is only seen in one-fifth of ski resorts in Poland, in the face of high and rising fixed costs, many resorts will change from a one-season profile to a year-round activity.

Falk and Steiger (2020) proved that the commercial success of ski resorts depends mainly on their size, with an increasing number of connections between ski lifts and ski runs with neighbouring ski areas, and a growing number of projects in the form of joint ski passes. Although this process is not new – it has been in operation in the Alps since the 1980s – from the early 2000s, it grew in strength, even on an international scale (Falk, 2017; Tuppen, 2002). In Poland, the first initiative of this kind appeared in the early 2010s, but in recent years, such activity has grown in size and scope. The idea of physically connecting neighbouring ski resorts and creating joint ski passes will, in the future, be replicated in other Polish tourist localities and regions. It is presumed, however, that not many new solutions of this type will appear. They will instead be replaced by the fusion of solutions, with additional ski resorts joining existing projects.

To increase their profitability, many ski industry enterprises are introducing discount programmes; these are an effective tool in the strategy to combat seasonality. According to research conducted by Sainaghi et al. (2019), after Livigno, in Italy, offered a free ski pass out of the high season in selected accommodation facilities, over 10 years the number of stays in hotels increased by 108%, and the number of skiers by 248%. In turn, Falk and Scaglione (2021) demonstrated that a considerable reduction in the price of season ski passes in Switzerland led to a 31% increase in overnight stays by Swiss tourists. The discounted price was not, however, effective in attracting foreign guests.

One strategy for increasing the profitability of ski resorts and reducing fluctuations in tourist demand is innovative pricing tactics in the form of dynamic ski pass prices (Haugom & Malasevska, 2018). Malasevska et al. (2017a) indicated that in Norwegian ski resorts, the number of daily visitors is significantly affected by weather conditions, the day of the week and public holidays. Therefore, if their approach to ski pass pricing was more dynamic and based on weather forecasts, ski resort operators could considerably increase their revenue (Malasevska et al., 2017b).

Nowadays, the most common sources used by current and potential customers to gather information on ski resorts are the opinions of friends and family, as well as the Internet. As a channel for the flow of information, the Internet is of particular importance in conducting image and promotional activities. Internet marketing is one of the cheapest and most effective forms of marketing. For this reason, it is vital that ski resorts pay close attention to their websites and social media profiles, as well as trying to ensure that the most popular platforms related to skiing feature as many articles as possible about their resorts (Krzesiwo, 2018).

CONCLUSIONS

In 2020, ski infrastructure was found in 171 localities in Poland, mainly in the Carpathian and Sudeten mountain areas (81%). There were 769 lift devices in operation, including 119 aerial lifts, with a total length of 302.9 km and a transport capacity of 625,500 people per hour; there were 826 downhill ski runs with a total length of 445.7 km. Of these ski runs, 88.3% had snowmaking equipment and 78.6% were floodlit. The largest Polish ski destinations were Białka Tatrzańska, Bukowina Tatrzańska, Krynica Zdrój, Szczyrk, Wisła and Zakopane in the Carpathians, and Duszniki Zdrój, Karpacz and Szklarska Poręba in the Sudetes. On the basis of earlier analyses conducted in the Carpathians, it can be said that there is ongoing improvement in the quality of downhill skiing infrastructure in Poland, reflected in the growing total transport capacity of ski lifts and an increase in the number and length of ski runs with snowmaking equipment and floodlights. However, in 2020–2023, thanks to the COVID-19 pandemic and the armed conflict between Russia and Ukraine, ski resorts in Poland did not undertake investment activities in infrastructure for downhill skiing.

The actions undertaken by Polish ski resorts from the perspective of sustainable development are of an environmental, economic and social nature. The environmental aspect relates to eliminating the negative impacts of ski infrastructure and ski tourism on the natural environment, for example, by technological and quality improvements to lift and snowmaking equipment, the planned development of ski resorts, and the monitoring by some resorts of the condition of the natural environment (e.g. Kotelnica Białczańska Ski Resort in Białka Tatrzańska). Economic actions involve maintaining the profitability of ski resorts while keeping a suitable depth of snow cover, as well as improving their financial condition by creating new products and tourist attractions for the summer season. The operating model for firms managing ski resorts will, therefore, slowly change from one-season use to multiple year-round activities. To achieve a competitive advantage, many ski resorts are conducting carefully thought-out marketing campaigns, such as combining the offers of many resorts in one locality or region in the form of a joint ski pass, special discounts on ski passes out of the high season, and new interactive tools for attracting customers. Equally important are the socially oriented activities undertaken

by ski resorts, involving, above all, the employment of local inhabitants, as well as meeting the expectations of tourists to ensure they are satisfied with their stay.

Ski tourism should continue to develop, especially in traditional ski regions, as for many communities, this activity is the most important sector in the local economy and supports other forms of development (Scott, Steiger, Rutty et al., 2020; Tuppen 2002). Changes in demand at ski resorts have a direct effect on the use of accommodation facilities, rental of ski equipment, gastronomy services, retail services, and so on (Lohmann & Crasselt, 2012). For this reason, the future development of entire regions depends to a large degree on ski resorts (Falk & Steiger, 2020). Maintaining growth in specialised regions dependent on ski tourism requires active investment and marketing activities, as well as continuous monitoring and preventive action in the case of a worsening economic situation or a deterioration in the quality of tourist attractions. Ski destinations that increase their resistance to both climate instability and fluctuations in demand will achieve stable growth and a long-term competitive advantage. This can be done if they invest in multifunctional models and develop their summer season offer, as well as being able to bear the high financial outlays required for these initiatives. For this reason, the processes stabilising growth in Polish tourist destinations dependent on skiing will be of a long-term nature, amid conditions of continuous uncertainty as to revenue volumes.

Taking into account the dynamic changes taking place in tourism and the natural, social, economic and political threats to the sustainable development of ski resorts, it is proposed to conduct research on the state of ski infrastructure development in Poland at fixed intervals; on a five-year basis, for example. Current developments also raise the reasonable question of whether and to what extent ski resort managers in Poland can adapt to changes caused by the instability of climate conditions. Therefore, future research should focus on identifying the factors that are important for maintaining the development capacity of ski resorts in the context of their ability to adapt to climate change.

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