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EVALUATING SKI RESORT INVESTMENT PROJECTS: ADAPTING TO NEW CLIMATIC CHALLENGES

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Abstract

Climate change is significantly impacting ski centers in Central Europe. Warmer winters are leading to less snowfall and more rain, which can result in lower revenues for these resorts. To address this challenge, implementing technologies like higher-capacity ski lifts and artificial snowmaking systems has become necessary. This paper, evaluates a specific investment project in the southern region of Czechia. By analyzing historical data, current market prices of technology, and financial forecasts, I assess the potential investment in new technology. The results indicate that investing in such technology could effectively mitigate the effects of climate change on ski centers.

Keywords: Financial analysis, budgeting, free cash flow, financial forecasting, artificial snowmaking system, ski center, climate change.

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Introduction

Czechia's borders are surrounded by mountains where summits reach approximately 1,000 metres above sea level. Such mountains, together with the climate of Czechia, used to provide rich snowfall approximately from December to March. Those favorable conditions allowed for the establishment of a skiing culture, tradition, and history that in Czechia reaches back to the beginning of the 20th century (Kulhanek 1989). Ski centers, usually located in the mountains, are favorite places where people like to spend Christmas or winter holidays, which span over most of the winter months. This usually provides ski centers with sufficient demand, which is, however, conditioned by the snow depth.

The ski center where I had the opportunity to pursue an internship faces challenges similar to those at other resorts impacted by climate change. Situated in the mountains of southern Czechia at just under 1,000 meters above sea level, the area is highly popular during the summer months. However, the winter season is crucial for the company's revenue generation. Currently, the company operates several slopes and ski lifts. It holds lease contracts for the longest slope in the area, which unfortunately lacks an artificial snowmaking system and is serviced by an outdated, low-capacity ski lift. The company is now considering potential investments to upgrade this facility.

Although the site remains operational, inconsistent snow conditions in recent years have hindered its performance. In this thesis, I analyze a potential investment in this slope that aims to establish a stable snow layer through artificial snowmaking and to increase capacity with a new ski lift, thereby enhancing revenue. To thoroughly understand the company's financial position, I analyzed the financial statements of its two organizational units. I began with an examination of the core business unit's financials, and secondly, the financials specific to the slope where the proposed investment would occur. The purpose of this thesis is to evaluate whether the company should proceed with the investment based on financial viability and potential returns, which were analyzed in the final section of this paper. The goal was to estimate the free cash flow to the firm from the investment.

Objectives of an internship

The internship had two main objectives. The first was to gather robust data to support an investment decision in new technologies, such as a new ski lift and snowmaking system. The second objective was to gain insights that would be valuable not only for the immediate investment decision but also for other aspects of the company's operations. Data gathering for construction projects can be quite challenging; therefore, one of the model's objectives is to provide sufficient flexibility to project different scenarios. The company's goal was to obtain an initial assessment of the investment's profitability before allocating additional funds to further investigate the idea, which can be quite costly. Based on the gathered data and literature review, several hypotheses that the company's management had suspected were confirmed.

Literature review

Climate Change

Worsening snow conditions are affecting most ski centers at lower altitudes, which are more sensitive to temperature increases; this negative effect has intensified in recent years. The total amount of precipitation is projected to become increasingly variable (International Panel on Climate Change, 2023). Consequently, it is becoming more difficult for ski resorts to rely on natural snow conditions, rendering them highly dependent on snow-making systems. The average temperature in Czechia rose by 1.1°C between the periods 2001–2015 and 1961–1990, which is considered the base period for other comparisons. However, the temperature differences are not uniform across all parts of the country and do not affect the mountainous regions as significantly. Temperature increases are more pronounced in winter and summer compared to autumn and spring, further negatively impacting snow conditions. The Czech Ministry of the Environment also warns about the risks posed by climate change and identifies winter sports as especially vulnerable. A study conducted by the ministry predicts a shortening of the winter season by approximately 4–6 weeks with a temperature increase of 1°C; this translates into a risk of lower revenues. An additional risk posed by climate change is the availability of water resources needed for snow-making systems. Another implication is that tourists may shift from ski centers with less favorable snow conditions to those with better snow quality. Proposed mitigations for the aforementioned risks include investments in new technologies, which are fairly capital-intensive and require careful financial planning. This implies an opportunity for ski centers that successfully implement technologies allowing them to adapt to climate change (Ministerstvo Životního Prostředí, 2019).

Economical aspects of ski resorts

Ski resorts are typically located in mountainous regions distant from cities. These areas often offer limited economic opportunities. Tourism in such regions can be a source of local development by attracting visitors with various activities (Briedenhann and Wickens 2003). Therefore, not only do the owners of ski resorts benefit from the investment, but the activities can also be beneficial to the entire area in the long term. In this sense, ski lifts have an infrastructural characteristic; their presence enables the development of other activities. Similar findings are mentioned in a report from KPMG, which concludes that ski centers create significant value and, in the Czech Republic, contribute 0.6% of the national GDP. They also contribute to job creation and to adjacent industries such as hospitality and retail. For every single Czech crown (CZK) spent in the ski resorts (meaning directly for the ski lift), customers spend another 7 CZK on additional services (KPMG Česká republika 2014).

Profitability drivers

Geographical characteristics can significantly influence the attractiveness and profitability of ski resorts. Falk and Steiger (2020) evaluate profitability factors in ski lift operations in Austria, which is an essential consideration when investing in ski infrastructure. The size of the resorts allows companies to benefit from economies of scale and therefore perform better. The second most significant driver of profitability is the presence of neighboring resorts, which tend to have better results due to benefits like joint ski passes and the overall higher attractiveness of the area. Another impactful aspect is the elevation of the ski resort (Falk and Steiger, 2020). Similar conclusions are drawn by Moreno-Gené et al. (2018), whose paper shows that large ski resorts achieve higher profitability. Moreno adds that generally, ski resorts are a low-profitability industry, ranging approximately from 7% for large resorts to 3% for small ones (measured as return on assets) (Moreno-Gené et al., 2018). Based on the categorization of the KPMG study, which is better suited to the Czech environment, the analyzed resort is medium-sized and would therefore appear somewhere in the middle of the profitability spectrum. The slope where the analyzed ski center is considering placing its investments lies approximately 1 km from the main ski slope and could increase the overall attractiveness of the area as a whole (KPMG Česká republika, 2014). The slope where the analyzed ski center considers placing its investments lies approximately 1 km from the main ski slope and therefore could increase the overall attractiveness of the area as a whole. A study by Damm, Köberl, and Prettenthaler (2014) analyzing the impact of future climate conditions on investments in snow-making technologies identifies increasing costs, implied by rising temperatures, as a main risk. Specifically, this results in higher energy costs, driven by increased consumption and higher prices per MWh due to the energy crisis caused by gas shortages. The study also highlights the vulnerability of low-altitude ski resorts. Low altitude in this case is defined as a ski center situated at a mean of 1,320 meters above sea level (Damm, Köberl, and Prettenthaler, 2014). That is approximately 300 m higher than the ski resort analyzed in this paper. The authors warn that an additional risk to profitability could be the rising decline in the number of visitors due to overall decreasing snow depths. A possible solution to remain profitable is an increase in ticket prices (Damm, Köberl, and Prettenthaler, 2014)."

Financial evaluation of investment

Before starting any investment evaluation or budgeting process, a company should define the investment outcomes and goals it wants to achieve. The company's overall strategy should be reflected in these goals, which should ultimately align with the fundamental objective of any corporation: creating value for shareholders (Allen, Brealey, and Myers n.d.). An ultimate measure for evaluating any investment is its ability to generate future cash flows. Generated cash flows represent the value created by the company, which, as mentioned earlier, is the ultimate goal. We can either measure free cash flows to the firm (FCFF), i.e., money available to all investors of the company—both debt holders and equity holders—or free cash flow to equity (FCFE), which tells us how much cash is available to equity holders after servicing debt obligations. Other measurements can be influenced by accounting methods and do not provide a fully clear picture of company operations.

Equation 1: Free cash flow to firm

$$Free\ cash\ flow\ to\ equity = Net\ income - (Capital\ expenditures - Depreciation) - Change\ in\ noncash\ working\ capital + (New\ debt\ raised - Debt\ repayment)$$

Equation 2: Free cash flow to firm

$$Free\ cash\ flow\ to\ firm = Operating\ income * (1 - Tax\ rate) - Capital\ expenditures + Depreciation - Change\ in\ noncash\ working\ capital$$

In order to evaluate cashflows in time internal rate of return (IRR) can be used. Investment projects should be accepted if IRR exceeds company’s hurdle rate. (Damodaran 2012)

Data collection and analysis

Artificial snow making system - technology introduction

An artificial snowmaking system consists of four main components. Firstly, a water pump operates under high pressure to push water through pipelines to snow cannons. These cannons then disperse the water into the air, where it freezes and turns into snow. Therefore, the ambient temperature must be at or below zero degrees Celsius for the snowmaking system to function effectively. Lower temperatures enhance the efficiency of the system. A reliable water source is a crucial element, given the system's high water consumption. The company owned a small water reservoir, which was insufficient for its needs. In 2023, the company built an additional reservoir that fully meets the requirements of current operations and can also be utilized for the analyzed investment. Therefore, no additional investment in water sources is necessary.

Climate risk in local context

The literature review suggests that the most significant risks are the implications of climate change. To examine this thesis, weather data from a meteorological station located in the vicinity of the ski resorts were analyzed. The goal of the data analysis was to observe trends in weather dynamics in terms of natural snow depth and its influence on snowmaking technology, due to its aforementioned technical limitations. Firstly, snow depths were reviewed. To assess when there is sufficient natural snow depth, data were clustered based on the number of days and snow depth in each year from 1960 to the present to provide a long-term context (Figure 1). The graph, to a certain extent, confirms the conclusions of the reports from the literature review. From 2014 until 2023, we can observe that there is generally a low number of days with sufficient snow depth.

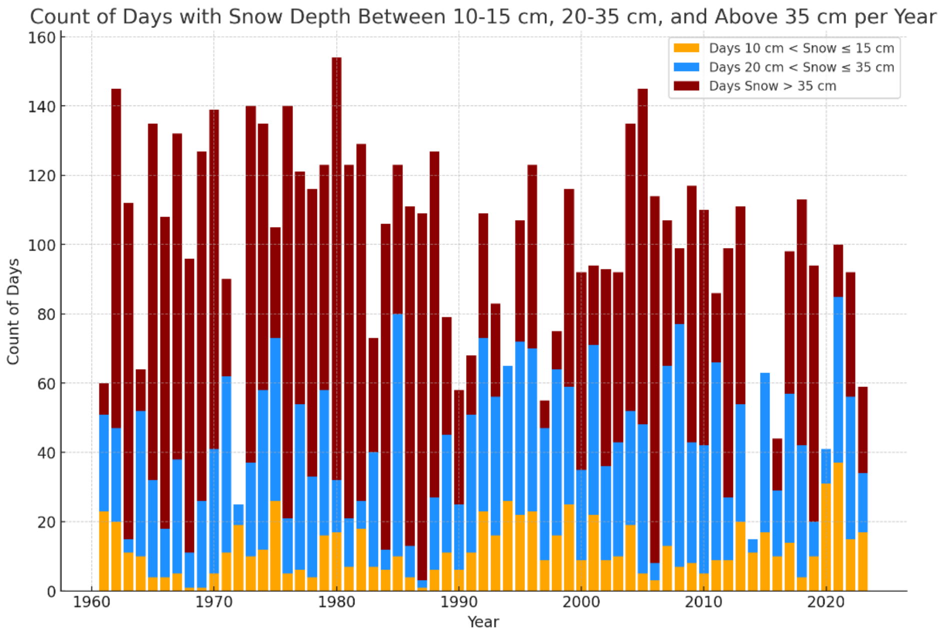

Figure 1: Snow depth overview from meteorological station located nearby – 1960 - 2023

Data source 1: Český hydrometeorologický ústav

The graphs indicate that especially in the last 10 years, there has been a lower number of days with at least some snow depth. We can assume that the minimum snow depth required for running the ski resort is 35 cm (company estimate). We observe that in the period from 2013 to 2023, there were four years when it would not have been possible to run the ski lifts for more than 60 days, which is already a fairly short season. This is the same result as for the entire previous period (1960–2012 inclusive). The graph also shows extreme years such as 2014, 2015, and 2020, when there was not a single day with snow depth exceeding 35 cm. The weather data clearly indicate that if similar conditions persist or even worsen, operating ski slopes without a snowmaking system in the analyzed locality would be highly volatile and would negatively affect revenues. The most efficient way to operate the snowmaking system is to produce as much artificial snow as possible during November and December, creating sufficient snow reserves for the whole season. Running the system in later months is more costly due to increased costs for personnel, electricity, and other expenses.

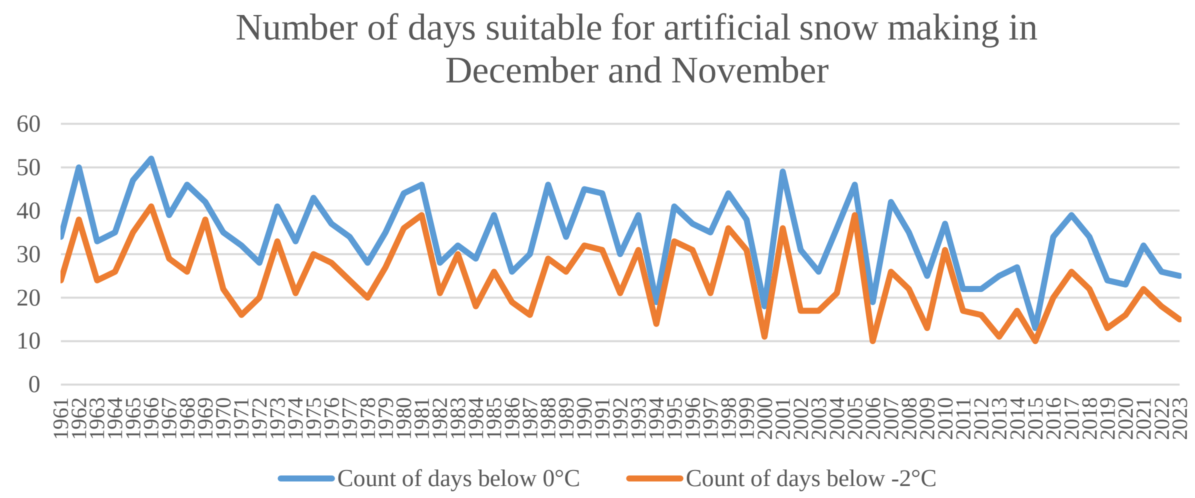

Figure 2: Number of days when snow making system can run

Data source 2: Český hydrometeorologický ústav

Figure 2 demonstrates that, overall, the trend of days when the snowmaking system could run, at least to some extent, is decreasing. The company indicates that it needs approximately 20 days to produce a reasonably safe amount of snow for the season. We see that there were years when the average temperature was below -2°C for only 10 days, which is not sufficient at all, especially considering that at this temperature, the snowmaking system is not very efficient. To summarize the findings, even in the last decade, there were years when the artificial snowmaking system would not have been able to fully meet the ski resort's needs. If we accept the assumption that the poor weather conditions in the years 2013–2023 are a result of climate change, we must confirm that it indeed poses significant risks to the business. There can be years when even the new technologies would not mitigate the situation.

Analysis of historical financials

For the purposes of this paper, the company's following organizational units were analyzed: the Main Unit and the Old Unit. The Main Unit is currently the primary source of the company's revenues. It includes several ski lifts and two slopes with a total length of approximately 2 km. The Main Unit is equipped with a snowmaking system and has a fairly high capacity of 5,000 persons per hour. This categorizes the unit as medium-sized based on the KPMG study methodology (KPMG Česká republika 2014). In 2023, an investment in a new water source was completed, freeing the company from limitations related to water requirements. The Main Unit is also operational during summer when the ski lift transports pedestrians or cyclists. Figure 3 clearly indicates that the main winter revenue stream is the sale of ski-lift tickets, which accounts for approximately 90% of revenues. Other revenues come from advertising or leasing buildings or land, which are fairly negligible in comparison. The winter of 2020/21 is an outlier, during which all ski lifts had to be closed due to COVID-19 restrictions.

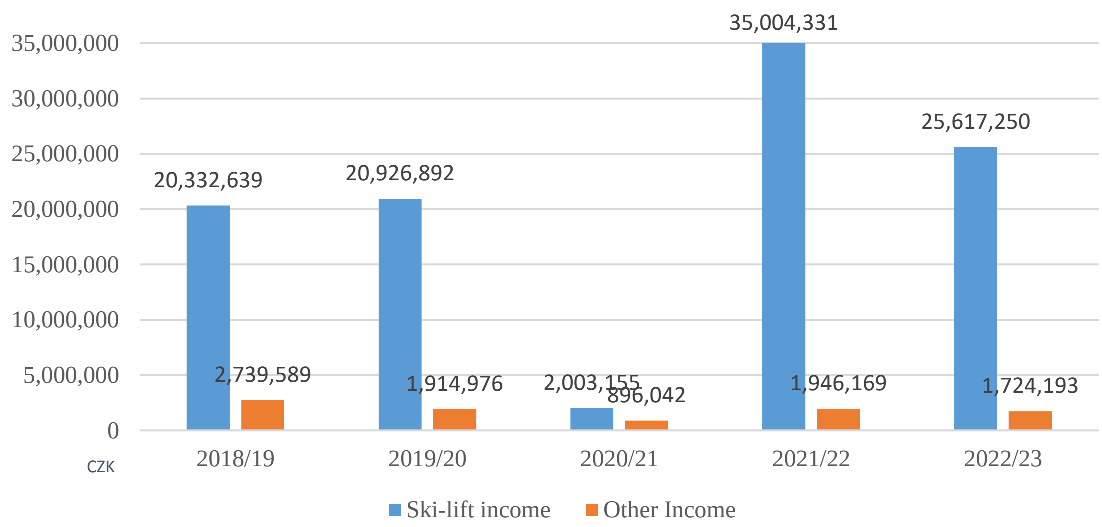

Figure 3: Winter revenues of the Main unit

Data source 3: Company's financials

Summer revenues are minor in comparison with winter, as Figure 4 illustrates. The company relies on the winter season, and even if the summer season were extremely good, it cannot be expected to fill the gap of winter revenue drops, at least not with current operations. Other income is fairly constant, even though we have to take into account that the summer season (April to October) is longer than winter (November to March).

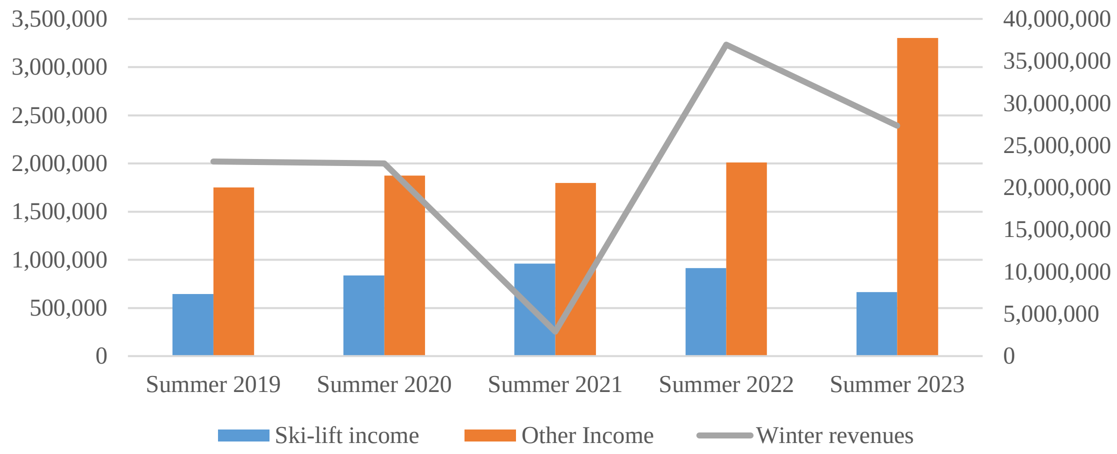

Figure 4: Summer revenues in comparison to winter

Data source 4: Company's financials

In terms of profitability, winter significantly drives the company's performance. Net income margins oscillate between 46% and 60% in winter, while in summer, even EBITDA margins are deeply negative, as can be observed in Figure 5. However, we should consider that a certain amount of operating expenses connected to winter operations is spent in summer. Unfortunately, it was impossible to distinguish these in the reporting.

Profitability analysis - Summer	Summer 2019	Summer 2020	Summer 2021	Summer 2022	Summer 2023
Revenue growth		13%	2%	6%	36%
EBITDA margin	-182%	-137%	-85%	-171%	-124%
EBIT margin	-284%	-238%	-180%	-254%	-188%
NI margin	-284%	-238%	-180%	-254%	-188%

Figure 5: Summer of Main unit

Data source 5: Company's financials

Main unit: winter revenue drivers	2018/19	2019/20	2020/21	2021/22	2022/23
Ski lift reveneus	**20,332,639**	**20,926,892**	**2,003,155**	**35,004,331**	**25,617,250**
Days of operations	114	84	9	110	85
growth %		*-26%*	*-89%*	*1122%*	*-23%*
Number of tickets	88,411	76,959	6,112	91,156	59,310
growth %		*-13%*	*-92%*	*1391%*	*-35%*
Per day					
Revenues per day	178,356	249,130	222,573	318,221	301,379
growth %		*40%*	*-11%*	*43%*	*-5%*
Avg. # of tickets per day	776	916	679	829	698
growth %		*18%*	*-26%*	*22%*	*-16%*
Avg. ticket price	230	272	328	384	432
growth %		*18%*	*21%*	*17%*	*12%*
Revenue contributions sources					
Additions form increase in daily revenue		8,068,142	-2,230,775	860,835	-1,852,597
Additions from increase in number of days		-5,350,695	-18,684,725	22,479,854	-7,955,530
Uncategorized		-2,123,195	1,991,763	9,660,486	421,045

Figure 6: Operational data of Main unit in context of revenues, CZK

Data source 6: Company's data

The company kept increasing the average ticket price by an average of 17% during the entire analyzed period, as Figure 6 illustrates. The year 2021/22 was exceptionally well-performing, also due to travel restrictions in reaction to COVID-19, as Czech tourists were mainly looking for ski resorts within the country's borders. The main takeaway from Figure 6 is that the biggest contribution to revenues is the number of operational days, as we can see in the bottom part of the chart. An exception to this is the 2019/20 season, where the number of tickets was record high, and the price increase was the second highest. However, in all other years, this is the case, most visibly in 2020/21, where one simply cannot do much with only nine operational days.

Figure 7 shows the distribution of individual OPEX items as a percentage of total OPEX. The main cost items of the ski center are employees, maintenance, other operating expenses, and, since 2021, utilities, whose prices have increased significantly. These items represent approximately 75% of total OPEX in the last two analyzed years, which are considered the most relevant for two reasons: they are the most up-to-date, which is important since inflation in Czechia was 15.1% and 10.7% in 2022 and 2023, respectively (Český statistický úřad 2024). Secondly, 2019/20 was an outlier in which the company tried to reduce costs as much as possible.

Year	2018/19	2019/20	2020/21	2021/22	2022/23
Total revenues	23,072,228	22,841,867	2,899,198	36,950,508	27,341,443
Total OPEX	-8,417,146	-9,895,958	-6,166,987	-12,939,732	-13,044,734
% of total OPEX					
COGS	0%	0%	0%	0%	0%
Advertising	12%	11%	4%	10%	8%
Advisory	0%	0%	0%	0%	0%
Employees	22%	25%	34%	20%	22%
Insurance	2%	0%	0%	0%	0%
Maintenance	16%	13%	7%	12%	10%
Operating expenses	20%	20%	23%	20%	20%
Rentals	8%	8%	13%	5%	7%
Travelling, transportation	10%	8%	0%	8%	8%
Utilities	7%	12%	19%	23%	22%
Other expenses	3%	2%	1%	2%	2%

Figure 7: OPEX item distribution on total OPEX

Data source 7: Company's financials

To a certain extent, OPEX is flexible. The graph demonstrates that the company is able to increase or reduce expenses in response to revenue performance. The company also had available the income statement for the Old Unit, which, however, was operational only in 2018/19 and was loss-making. Since then, the company has still maintained the unit and incurs certain fixed costs, but it generates no revenues. Therefore, it is investigating options to either invest in the unit or shut it down completely.

The Old Unit has the longest slope in the area, with an old ski lift of very low capacity (363 persons per hour) located approximately 1 km from the Main Unit. The Old Unit is the subject of potential investment. Geographically, the unit has the longest slope in the area and would be touristically attractive if operational. The Old Unit is also close to the new water source, which would be sufficient for both units.

Investment analysis

There are two investment options for the Old Unit: either to only build a snowmaking system (as described above) and use the old ski lift with low capacity, or to build both a snowmaking system and a new ski lift with increased capacity. In the text below, we will analyze each option.

Technology data collection and CAPEX assumptions

Based on technical requirements, a request for quotation was created. The main considerations were the current infrastructure (existing water source) and the limitations of the electrical connection to the grid. Additional important inputs were the geological studies that the company already had for the evaluation of ski lift requirements. Requests for quotation were sent to selected suppliers. Based on the received offers, the best ones were selected. This provided inputs for the CAPEX evaluation in the financial model. The quotes received were indicative; the company assumes that further price reductions would be possible. However, for the purposes of the financial model, a more conservative approach was chosen. Additionally, installation works tend to surprise investors with unexpected costs; therefore, the company preferred to include a reserve of 5% of the total equipment cost. Building projects are assumed to have three main stages. The 'Ready-to-build' phase focuses on the preparation of all designs and plans needed before construction begins. The next stage is construction, where all the equipment is installed and built. The last phase focuses on testing whether the technology works properly. It is short; however, the results of the tests are a condition for the last share of payments to suppliers. The assumed timeline is that from ordering to the start of full operation, it would take two years. For simplicity, the time for obtaining building permits is not considered.

Operating expenses

Operating Expenses Estimation

Three approaches were used for the estimation of operating expenses (OPEX):

1. Company Technical Personnel Estimates: Values based on the expertise and projections of the company's technical staff.
2. Historical Financial Analysis: Values derived from analyzed historical financial data.

3. Bottom-Up Approach: Calculations based on the technical specifications of each item.

Snow system	
Transportation	CZK
Snow groomer	
Consumption per hour [l]	35
Avg daily use [h]	2
Price per liter	36.07
Season days	100
Total cost per season	**252,490**
Utilities	CZK
Electricity consumption	**572,471**
Employees	CZK
Number of employees	10
Avg salary	36,663
Total cost	**366,630**
Insurance	CZK
% of CAPEX	0.09%
Yearly insurance Cost	**25,856**
Rental	CZK
Current 5y average	182,635
Currently some of the lands no	10%
Yearly rent	**200,898**
Maintenance	CZK
as % of CAPEX	1%
Yearly maintenance	**290,520**
Operating expenses	CZK
% of total OPEX	**20.50%**
80% of OPEX	1,708,865
Remaining 20% of OPEX	**440,651**
Depreciation schedule	
Lifetime	20
Depreciation/year	**1,452,601**

New Ski lift + snow system		Note
Transportation	CZK	
Snow groomer	CZK	
Consumption per hour [l]	35	Average consumption of current snow groomer
Avg daily use [h]	2	Assumes that slope is groomed once a day
Price per liter	36.07	Source: Ministerstvo prumyslu a obchodu
Season days	100	Revenue estimtae
Total cost per season	**252,490**	
Utilities	CZK	
Electricity consumption	**766,940**	Calculated separately
Employees	CZK	
Number of employees	12	Company estimate
Avg salary	36,663	Source: Czech statistical office
Total cost	**439,956**	
Insurance	CZK	
% of CAPEX	0.09%	Avg. of tendered offers
Yearly insurance Cost	**79,392**	
Rental	CZK	
5y average of Churanov	182,635	Contract in place
Currently some of the lands not use	10%	Price not fixed, increase assumed
Yearly rent	**200,898**	
Maintenance	CZK	
as % of CAPEX	1%	Indicated by supplier
Yearly maintenance	**892,049**	
Operating expenses	CZK	
% of total OPEX	**20.50%**	Based on historical financial where Operating expenses were constant as % with regards to total OPEX
80% of OPEX	2,631,725	
Remaining 20% of OPEX	**678,621**	
Depreciation schedule		
Lifetime	20	Technical specifics
Depreciation/year	**3,007,644**	

Figure 8: Yearly OPEX overview

Electricity consumption was calculated separately, based on current electricity prices and the power output of the technologies involved. Electricity prices mainly depend on the power output defined by technical specification of suppliers and number of hours used during the season. All OPEX items are assumed to increase over time due inflation.

Cost savings

The cost estimation assumes certain cost savings due to economies of scale. For example, it is assumed that there will be no additional spending on advertising, as both the slopes of the Main Unit and the newly opened slope will be promoted with the same budget. Additionally, there is no anticipated investment in a new snow groomer, since one groomer can service both units.

Working Capital

The company assumes an investment of 100,000 CZK in working capital each year in both scenarios.

Revenue estimation

The base revenue estimations were derived from the revenue drivers of the Main Unit. Firstly, future revenues of the Main Unit were estimated based on the average ticket price and the number of tickets sold per day. The company believes that future price increases are possible, despite the worsening overall economic situation in Czechia. This assumption is supported by the fact that surrounding ski centers have higher pricing. It is assumed that ticket prices will grow by 5% per year for 10 years until 2033; thereafter, they are assumed to grow at the rate of inflation.

The number of tickets sold per day is assumed to remain at the historical average of 779. The number of operational days is assumed to be 100, representing the full length of the main season and deemed achievable with the snowmaking system. Revenues estimated for the Main Unit are then adjusted for the capacity factor of the old ski lift or the new ski lift. The capacity factor is defined as the proportion of the lift's capacity relative to that of the Main Unit.

Furthermore, revenues are adjusted for evening skiing permits, which are offered on the Main Unit slopes but are not considered for the Old Unit. The company estimates that evening skiing accounts for 10% of total Main Unit sales. The operational lifetime of the investment is assumed to be 20 years, during which the technologies should function without the need for significant additional investments.

$$Annual\ Revenue = Average\ Ticket\ Price * Tickets\ sold\ per\ day * Count\ of\ operational\ days * Capacity\ factor * Evening\ skiing\ adjustment\ factor$$

Equation 3: Annual revenue calculation breakdown for purposes of future estimates

Results

Investing only in the snowmaking system results in a negative internal rate of return (IRR) of -2.88%. The assurance of 100 operational days with a low-capacity ski lift does not compensate for the capital expenditure (CAPEX) of the investment. Even though the project shows a slightly positive free cash flow to the firm, the net operating profit after tax is negative, and the investment would not pay back over the 20-year period. Therefore, pursuing this investment is not advisable. Conversely, investing in both the snowmaking system and a new ski lift yields a positive IRR of 14.43%. This result is plausible and favorable. To provide context, a review paper by Moreno-Gené et al. (2018) indicates that profitability for better-performing ski resorts is around 7% (measured as return on assets). However, as mentioned earlier, revenues are highly sensitive to the number of operational days. Additionally, the elasticity of demand in response to price increases could be questioned, even though previous years' data suggest minimal impact. A sensitivity analysis was conducted to examine the effects of these factors on the IRR; the results are shown in Figure 9.

Days of operations	Ticket price increase 5%	4%	3%	2%	2%	2%
100	14.4%	13.1%	11.7%	10.4%	10.4%	10.4%
95	13.6%	12.2%	10.9%	9.6%	9.6%	9.6%
90	12.7%	11.4%	10.1%	8.8%	8.8%	8.8%
85	11.7%	10.5%	9.2%	7.9%	7.9%	7.9%
80	10.8%	9.5%	8.3%	7.0%	7.0%	7.0%
75	9.8%	8.6%	7.3%	6.1%	6.1%	6.1%
70	8.8%	7.6%	6.4%	5.1%	5.1%	5.1%

Figure 9: Sensitivity analysis of IRR for Ski lift + snow making system

The number of operating days significantly influences the IRR. A 30% reduction in operating days causes approximately a 40% decrease in the IRR. However, even in the worst-case scenario—where the ski resort operates for only 70 days and prices increase only at the rate of inflation—the IRR remains positive at 5.1%. The company indicates that it aims to accept projects with an IRR over 6%. Another major risk could stem from costs. CAPEX is substantial, and utility prices pose a risk, as mentioned in the paper by Damm, Köberl, and Prettenthaler (2014). Figure 10 illustrates the effect of increasing CAPEX and utility prices.

Electricity price increase [CZK]	CAPEX increase					
	5%	10%	15%	20%	25%	30%
2500	13.9%	13.2%	12.6%	12.1%	11.5%	11.0%
3000	13.7%	13.1%	12.5%	11.9%	11.4%	10.9%
3500	13.6%	12.9%	12.3%	11.8%	11.2%	10.7%
5000	13.1%	12.5%	11.9%	11.4%	10.8%	10.3%
6000	12.8%	12.2%	11.6%	11.1%	10.6%	10.1%

Figure 10: Sensitivity analysis of CAPEX increase and electricity prices increase for Snow system + Ski lift scenario

Even though electricity price increases to 6,000 CZK per MWh or higher were common during the energy crisis caused by Russian aggression in Ukraine in 2022, it can be assumed that companies have learned from this and have hedged prices. Even if such increases occur, the effect would not significantly damage the IRR. Errors in CAPEX estimation or unexpected events could decrease the IRR by approximately 3.8 percentage points. The worst-case scenario would lead to an IRR of 10.1%, which is still above the company's hurdle rate. The revenue estimation assumes that, although the ski resort is currently utilizing a certain share of its maximum capacity, the new ski lift would operate at the same capacity utilization rate as the Main Unit. This assumption could be questionable, since if the Main Unit's ski lift has a capacity of 5,000 people per hour and the new ski lift has a capacity of 2,400 people per hour, there would be an approximate 50% increase in capacity, potentially requiring a significant increase in visitors. To challenge this assumption, a further sensitivity analysis was conducted. The company's hurdle rate of 6% is not met in most scenarios when visits are 40% lower than at the Main Unit, which represents a substantial deterioration.

Days of operations	Decrease in New lift visits					
	10%	20%	30%	40%	50%	60%
100	12.6%	10.7%	8.6%	6.3%	3.7%	0.6%
95	11.8%	9.9%	7.9%	5.6%	3.1%	-0.1%
90	10.9%	9.1%	7.1%	4.9%	2.4%	-0.8%
85	10.1%	8.3%	6.3%	4.1%	1.6%	-1.6%
80	9.2%	7.4%	5.5%	3.3%	0.8%	-2.5%
75	8.2%	6.5%	4.6%	2.5%	0.0%	-3.6%
70	7.2%	5.6%	3.7%	1.6%	-0.9%	-4.8%

Figure 11: Sensitivity analysis of visits decrease and days of operation decrease for Snow system +Ski lift scenario

Real option analysis

In order to better assess the uncertainty and the option to defer the investment, a real option model was calculated using the Black-Scholes methodology. As a baseline, we considered the assumptions mentioned above; however, we also implemented more pessimistic scenarios based on a paper by Mitterwallner and Walentowitz, who analyzed the decrease in snow cover days in Europe. They projected the decrease in three Shared Socioeconomic Pathways published by the IPCC (Mitterwallner et al., 2024). Furthermore, it is assumed that the financial model considers that one additional day of snowmaking produces additional 3.3 operational days, aligning with the requirement of 30 snowmaking days to achieve 100 operational days. However, the climatic constraints highlighted in the analysis limit the availability of snowmaking days to an average of 10 per month in November and December. This caps the total potential snowmaking days at 40 per season, reflecting the variability in temperature and other environmental factors observed in historical data. Four scenarios of Shared Socioeconomic Pathways yielded a range of NPVs of investment that were used for calculating the investment volatility. The baseline scenario NPV is used as the underlying asset value. The strike price is considered the deferred value of the investment, adjusted for inflation. The value of the call option is 2,464,245 CZK. That is a fairly small benefit in comparison to the project's total CAPEX, which is almost 100 million CZK. Therefore, based on the Black-Scholes model, deferring the investment is not recommended, as waiting simply does not provide sufficient benefit. The snowmaking system is efficient enough to produce enough snow in a short period to cover the ski slope to keep the area open. Additionally, the costs incurred due to additional snowmaking days do not increase rapidly enough to ruin the cash flows. Another factor for pursuing the investment is that all predictions of climate change suggest that the weather conditions will deteriorate more in the long term. Therefore, the company should pursue the investment sooner rather than later, as the chances that weather conditions will worsen might be higher later

Deffered				
Scenario	**Baseline**	**SSP1-2.6**	**SSP3-7.0**	**SSP5-8.5**
Snow Cover days decrease		-10%	-37%	-42%
IRR	13.2%	13.2%	12.4%	11.6%
NPV (6%)	55,225,965	54,814,005	48,303,277	41,366,418

Black-Scholes	
Underlying asset value (S)	55,225,965
Strike price (K)	99,982,940
Time to maturity (T)	5
Volatility (σ)	12.6%
Standard deviation of NPV	8,994,796
Mean of NPV	71,429,876
σ^2	0.0159
Risk free rate	4.00%
N(D1)	0.10
N(D2)	0.06
Value of call option	**2,464,244.81**

Figure 12: Black-Scholes model results

Methodology

Black Scholes model

Real options theory applies financial option principles to tangible investment decisions, emphasizing flexibility under uncertainty (Dixit and Pindyck n.d.). The deferred investment option allows decision-makers to delay projects until conditions improve, mitigating risks and preserving opportunities for future gains (Trigeorgis 1996). One approach to valuing an option is the Black-Scholes formula. While initially developed for financial options like stocks, it has since been adapted for use in real option analysis, which evaluates flexibility in investment decisions under uncertainty. Real options apply this framework to tangible projects, such as infrastructure investments, by treating the investment opportunity as a financial call option.

$$C = S * N(D_1) - K * e^{-rT} * N(D_2)$$

Where S is the asset value (NPV of the project), K is the strike price (deferred value of the ski lift and snowmaking system investment), r is the risk-free rate (10-year Czech government bond), T is the time until the investment is deferred (5 years before the building permit expires), and D is the cumulative distribution function.

$$D_1 = \frac{\ln\left(\frac{S0}{K}\right) + \left(r + \frac{\sigma 2}{2}\right)T}{\sigma\sqrt{T}}$$

$$D_2 = D_1 - \sigma\sqrt{T}$$

This approach enhances traditional net present value (NPV) methods by valuing strategic flexibility (Copeland and Antikarov, n.d.). Deferred investment is especially valuable in uncertain industries, allowing investors to avoid premature commitments while remaining prepared for favorable conditions (Amram and Nalin, 1999).

Proposed solution

Currently, the Old Unit is loss-making; therefore, the company should either invest in or shut down/sell the unit completely. The recommendation is to proceed with the investment in both the ski lift and the snowmaking system. The scenario involving only the snowmaking system should be rejected. The initial IRR of the proposed investment appears sufficiently high to accommodate potential estimation errors. The sensitivity analyses support this conclusion. However, there are additional aspects not covered in this study that should be analyzed before proceeding, as mentioned below.

Climate change risk

As observed, even in past years, there were insufficient days to cover the entire ski resort with artificial snow. The assumption was that snowmaking would be completed within November and December; while snowmaking could also occur in January or February, this would entail higher costs. Additionally, the assumption that winter temperatures would not be unusually warm may be optimistic, given recent trends. Therefore, the assumptions in this study should be considered cautiously optimistic in this regard.

Regulation

Obtaining building permits in Czechia is a complicated and lengthy process. Initiating construction in two years could be overly optimistic. Delays and additional costs could be incurred, potentially leading to a lower IRR.

Diversification

The company provided invaluable guidance and patient explanations of the technical nuances and dynamics of the ski lift business. The company's relationships with suppliers and industry insights significantly contributed to data collection, thereby enhancing the accuracy of the results.

ESG

Environmentally, such investments reduce the dependency on natural snowfall and mitigate risks associated with climate change, as highlighted by the Czech Ministry of the Environment, which predicts a significant shortening of the ski season due to rising temperatures (Ministerstvo Životního Prostředí 2019). Socially, these investments ensure the long-term viability of ski resorts as key employers and economic drivers in mountainous regions, contributing to community resilience (Briedenhann and Wickens 2003). As mentioned earlier, each CZK spent in the ski resort translates into 7 CZK spent on auxiliary services, which brings wealth also to other stakeholders in the area. Additionally, ski resorts represent a contribution of 0.6% to Czech GDP (KPMG Česká republika 2014).

Organization's Advisor/Tutor

Company provided me with guidance and patient explanations of technical perks and dynamics of ski-lift business. Company’s relationships and overview of suppliers was also significant contribution for data collection, and therefore increased accuracy of results.

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Figures table

Equation table