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Research on Skiing Apps Based on Flow Theory - Centred on User Needs -

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Abstract

Skiing, as a highly challenging and enjoyable outdoor activity, can stimulate users' positive emotions and immersive experiences, and the design of skiing apps plays an important supporting role in this. With the increasing number of ski related apps on the market, users' demand for mobile apps to assist in optimising their sports experience is also growing. This study selected four skiing apps as research objects according to the Google Play download ranking. These include Exa Ski Tracker, Ski Tracks, Slopes: Ski & Snowboard, and Skill: Ski & MTB. Taking the nine elements of the Flow Theory as the research benchmark, we distributed 177 questionnaires to users, and finally collected 172 valid questionnaires. The questionnaires were analysed using the Kano Model. The Better-Worse coefficient was used for reliability and validity testing to reduce the limitations of the results. The users' flow experience and demand for app functions resulting from the use of the app during skiing were also investigated. Finally, we proposed improvements for the four skiing apps based on our analysis results to better facilitate the flow experience of skiing enthusiasts, satisfy user needs, and enhance the overall sport experience.

Keywords: *Skiing Apps，Flow Theory，Kano Model，User Need*

1. Introduction

Skiing originated in Norway and spread in the mid-19th century. After World War II, it became a popular hobby among the middle and elite classes. With the development of the economy and the increasing popularity of outdoor sports, skiing has become popular among the masses [1]. The global number of skiers has been fluctuating between 323 million and 389 million [2]. In the era of modern information and communication systems, the use and development of mobile apps, as an emerging and rapidly developing field, have a positive impact globally [3]. To help users achieve a better skiing experience, skiing apps can enhance user experience by perceiving their own emotional state and adjusting self-efficacy in a timely manner [4]. The "Flow Theory" indicates the connection between optimal experience and optimal state, stating that "people are cognitively efficient, positive, and happy at the same time [5]." During exercise, flow occurs when the brain and body are fully immersed, making it the optimal experience during exercise [6]. In

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order to stimulate users' positive emotions and immersive experiences, the demand for mobile apps to assist in optimising sports experience is also increasing [7]. The purpose of this study is to use the nine elements of Flow Theory as research benchmarks to make optimisation suggestions to enhance the guidance of the users' state of flow, and to improve the sport experience based on users' needs for skiing apps.

When conducting a survey on Google Play, it was found that when searching for "skiing" related mobile apps, there were ski-themed game apps, travel apps for winter snow and ice events, and ski resort weather apps. To ensure consistency in the attributes of the research subjects, this study ranked the top four downloads of skiing apps in the "sports" category on Google Play, namely Exa Ski Tracker, Ski Tracks,

Slopes: Ski & Snowboard, Skill: Ski & MTB, which are the four ski apps used as the research objects. As shown in Figure 1, Exa Ski Tracker is an offline ski tracking app [8]. Ski Tracks is an award-winning app suitable for everyone from complete beginners to seasoned professionals [9]. Slopes: Ski & Snowboard is a all-in-one skiing app for both skiing and snowboarding holidays [10]. Skill: Skill & MTB is an app for recording moves, tracking progress and competing with other users [11].

	Exa Ski Tracker	Ski Tracks	Slopes: Ski & Snowboard	Skill: Ski & MTB Tracker
APP				
Downloads	1000000+	500000+	100000+	50000+

Figure 1. skiing apps research object

The research methods of the four studies are as follows:

firstly, by conducting preliminary research on relevant books and papers both domestically and internationally, the nine elements of Flow Theory were determined as further research benchmarks.

Secondly, the Kano Model was illustrated and a dual-factor questionnaire based on Flow Theory as the benchmark was generated. An online survey for users of Exa Ski Tracker, Ski Tracks, Slopes: Ski & Snowboard, Skill: Ski & MTB was then conducted.

Thirdly, based on the results of data analysis, we summarised the users' needs for skiing apps and proposed optimisation suggestions.

2. Theoretical Background

2.1 Understanding of Skiing Applications

Mobile apps, as software applications developed for small wireless computing devices, are widely used in our daily lives due to their mobility and ease of use [12]. Skiing is a high-risk sport that is influenced by dynamic factors such as weather, snow conditions, snow flow, and cable car operations [13]. During skiing, skiing mobile applications can store and analyse sports data in real time, record skiing distances, and provide information such as weather and ski trail conditions, helping skiing enthusiasts better adapt to environmental changes dynamically, thereby enhancing the safety and experience of sports [14]. Therefore, it is necessary to continuously enhance the functionality of skiing apps to assist users in obtaining a better experience in skiing.

2.2 Understanding Flow Theory Concepts

Flow Theory was first proposed by Csikszentmihalyi in 1975. Flow is a positive psychological state in which an individual focuses on the pleasure and self-efficacy gained from an activity [15]. Skiing, as an adventure sport accompanied by speed, requires a high degree of concentration and immersion [16]. Skiing apps assists users to improve their concentration and self-efficacy by focusing their awareness and goals, while facilitating information dissemination and interactivity among users [17]. This study identified nine elements of Flow Theory based on current relevant research information as shown in Table 1: challenge-skills balance, merging of action and awareness, clear goals, direct and timely feedback, concentration on the task at hand, sense of control, loss of self-consciousness, transformation of time, and automaticity of the experience.

Table 1. Preliminary Study on Flow Theory Elements

Author	Title of paper
Patrick Boudreaua, Susan Houge Mackenziea, Ken Hodge	Flow states in adventure recreation [18]
Kim, Tae-Woon	Structural Relationship between College Level Ski Physical Activity Classes Fun Factors, Flow and Exercise Adherence [19]
Diane Ruth Barras	Flow experiences of participants in adaptive skiing programs [6,20]
Sırrı Cem Dinç, Mustafa Demircan	Investigation of the Relationship Between Dispositional Flow State, Sensation Seeking and Ski Resort Preference of Skiing and Snowboarding Participants [21]
Yang Yingmou(양영모)	(The) fun factors of skiing and snowboarding and the impact of sport commitment on the life satisfaction [22]

2.3 Concept and Understanding of the Kano Model

The Kano Model, proposed by Professor Noriaki Kano, is an investigative tool used for classifying product user needs and analysing improvement priorities, aiming to measure the relationship between user needs and satisfaction [23]. Through the study of quality theory, the Kano Model proposes a two-dimensional cognitive model that combines subjective and objective aspects of satisfaction and dissatisfaction as an alternative to the traditional one-dimensional method of quality identification. The x-axis of the Kano Model represents the level of functional satisfaction, while the y-axis represents the subjective satisfaction of consumers [24]. According to the Kano Model, quality elements are classified into five categories: Must-be Quality (M Quality), One-dimensional Quality (O Quality), Attractive Quality (A Quality), Indifferent Quality (I Quality), and Reverse Quality (R Quality). M Quality is a need that must be met, and if it is not fulfilled, user satisfaction will significantly decrease; O Quality increases user satisfaction proportionally with the level of functionality provided; A Quality will strongly satisfy users when provided, but will not have a significant impact when not provided; I Quality has no effect on user satisfaction; R Quality is a demand that the user does not want [25]. The yellow straight line can be seen as the one-dimensional mass, while the purple curve represents the attracting mass, the yellow dashed line is the reversing mass, the red curve is the must mass, and the dashed line of the circle is the irrelevant mass, as shown in Figure 2.

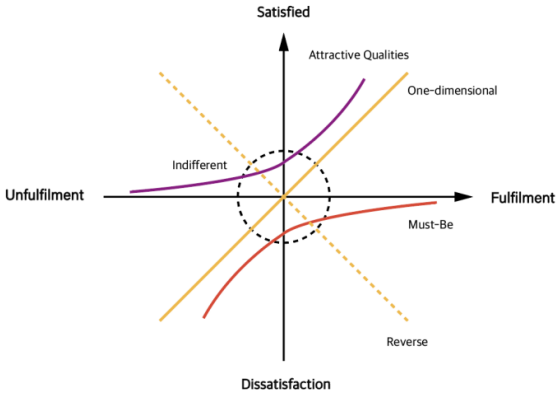

Figure 2. Kano Model

3. Survey design

3.1 Evaluation Methods for Skiing Apps Flow Theory

As shown in Table 2, the quality elements of the ski app user requirements were categorised and further tested according to The Kano Model of Quality.

Table 2. Kano evaluation table

		Answers negative questions				
Answering positive questions		Be very satisfied	Satisfy	neutral	Be unsatisfied	Be very unsatisfied
	Be very satisfied	Q	A	A	A	Q
	Satisfy	R	I	I	I	M
	neutral	R	I	I	I	M
	Be unsatisfied	R	I	I	I	M
	Be very unsatisfied	R	R	R	R	Q
A (Attractive need), O (One-dimensional need), M (Must-be need), I (Indifferent need), R (Reverse need), and Q (Questionable results).						

3.2 Development of the Survey Questionnaire

As shown in Table 3, each question requires a two-way choice, which will result in a corresponding demand. If the users have different attitudes, the referred demand does not exist. If the users have a consistent attitude, the referred demand exists. The respondents' survey responses have 5 levels [26].

Table 3. Sample Questionnaire

Elements of Flow Theory	Questions	Be very satisfied	Satisfy	neutral	Be unsatisfied	Be very unsatisfied

Challenge-skills balance	There is a demand for this feature.					
	This feature is not required.					
Merging of action and awareness	There is a demand for this feature.					
	This feature is not required.					
Clear goals	There is a demand for this feature.					
	This feature is not required.					
Direct and timely feedback	There is a demand for this feature.					
	This feature is not required.					
Concentration on the task at hand	There is a demand for this feature.					
	This feature is not required.					
Sense of control	There is a demand for this feature.					
	This feature is not required.					
Loss of self-conscious ness	There is a demand for this feature.					
	This feature is not required.					
Transformation of time	There is a demand for this feature.					
	This feature is not required.					
Autotelic experience	There is a demand for this feature.					
	This feature is not required.					

The objective of this survey was to conduct an online questionnaire targeting users who have used the four skiing apps: Exa Ski Tracker, Ski Tracks, Slopes: Ski & Snowboard, and Skill: Ski & MTB. A total of 177 responses were collected, of which 172 valid responses were retained for substantive analysis after excluding incomplete or problematic questionnaires.

3.3 Demographic Characteristics

Table 4. Summary of demographic characteristics

Feature Classification	Gender		Age Range					Total Skiing Distance Recorded by the App				
	Male	Female	Less than 20	20-30	30-40	40-50	More than50	Less than 100 KM	100-200	200-300	300-400	More than 500KM
Total Sample Size 172	62.6%	37.4%	11.05%	34.88%	29.07%	29.07%	17.44%	27.3%	29.2%	21.2%	13.3%	9%

As shown in Table 4, the demographic characteristics of the respondents are summarized based on Gender, Age Range, and Total Skiing Distance Recorded by the App.

4. Case Analysis

4.1 Analysis Results of the Kano Model of Exa Ski Tracke APP

Table 5. Kano evaluation table (a)

Features/Services	A	O	M	I	R	Q	Results
Challenge-skills balance	7.56%	60.47%	11.63%	19.77%	0.00%	0.58%	O
Merging of action and awareness	6.40%	18.60%	52.91%	20.93%	1.16%	0.00%	M
Clear goals	5.81%	55.23%	8.14%	29.07%	1.74%	0.00%	O
Direct and timely feedback	50.58%	15.70%	8.72%	22.67%	2.33%	0.00%	A
Concentration on the task at hand	8.72%	22.67%	52.33%	13.95%	2.33%	0.00%	M
Sense of control	13.37%	25.58%	45.35%	13.37%	2.33%	0.00%	M
Loss of self-consciousness	8.14%	34.30%	6.98%	50.00%	0.58%	0.00%	I
Transformation of time	9.88%	27.91%	46.51%	15.70%	0.00%	0.00%	M
Autotelic experience	4.65%	25.00%	52.91%	16.28%	1.16%	0.00%	M

Here's the revised paragraph with the quality labels replaced:

As shown in Table 5, the expected attributes in Ski Tracks are direct and timely feedback M Quality and concentration on the task at hand M Quality; the must-be attributes include challenge-skills balance O Quality, merging of action and awareness O Quality, clear goals O Quality, and sense of control O Quality; the attractive attributes are transformation of time A Quality and autotelic experience A Quality; and the indifferent attribute is loss of self-consciousness I Quality.

4.2 Analysis Results of the Kano Model of Ski Tracks APP

Table 6. Kano evaluation table (b)

Features/Services	A	O	M	I	R	Q	Results
Challenge-skills balance	13.37%	29.07%	40.12%	15.70%	1.74%	0.00%	M
Merging of action and awareness	11.05%	20.93%	48.84%	18.02%	0.58%	0.58%	M
Clear goals	8.14%	29.65%	43.60%	18.02%	0.58%	0.00%	M
Direct and timely feedback	6.98%	54.65%	5.23%	30.81%	2.33%	0.00%	O
Concentration on the task at hand	7.56%	57.56%	7.56%	23.26%	3.49%	0.58%	O
Sense of control	11.05%	24.42%	50.00%	12.79%	1.74%	0.00%	M
Loss of self-consciousness	0.58%	38.95%	8.72%	51.16%	0.58%	0.00%	I
Transformation of time	48.26%	33.14%	5.23%	13.37%	0.00%	0.00%	A
Autotelic experience	41.28%	31.98%	9.30%	16.28%	1.16%	0.00%	A

As shown in Table 6, the M Quality attributes in Ski Tracks are direct and timely feedback and concentration on the task at hand; the O Quality attributes include challenge-skills balance, merging of action

and awareness, clear goals, and sense of control; the A Quality attributes are transformation of time and autotelic experience; and the I Quality attribute is loss of self-consciousness.

4.3 Analysis Results of the Kano Slopes:Ski&Snowboard APP

Table 7. Kano evaluation table（c）

Features/Services	A	O	M	I	R	Q	Results
Challenge-skills balance	8.72%	52.91%	7.56%	28.49%	2.33%	0.00%	O
Merging of action and awareness	6.98%	21.51%	58.72%	11.63%	0.58%	0.58%	M
Clear goals	8.14%	25.00%	48.26%	18.02%	0.00%	0.58%	M
Direct and timely feedback	48.26%	0.00%	5.23%	45.35%	1.16%	0.00%	A
Concentration on the task at hand	10.47%	30.23%	45.35%	13.37%	0.58%	0.00%	M
Sense of control	7.56%	47.67%	0.58%	43.02%	1.16%	0.00%	O
Loss of self-consciousness	44.19%	30.23%	7.56%	17.44%	0.00%	0.58%	A
Transformation of time	9.30%	52.91%	11.05%	26.16%	0.58%	0.00%	O
Autotelic experience	11.05%	0.00%	76.16%	11.63%	1.16%	0.00%	M

As shown in Table 7, the M Quality attributes in Slopes: Ski & Snowboard include challenge-skills balance, sense of control, and transformation of time; the O Quality attributes include merging of action and awareness, clear goals, concentration on the task at hand, and autotelic experience; and the A Quality attributes are direct and timely feedback and loss of self-consciousness.

4.4 Analysis Results of the Kano Model of Skill:Ski&MTB APP

Table 8. Kano evaluation table（d）

Features/Services	A	O	M	I	R	Q	Results
Challenge-skills balance	8.14%	18.60%	50.58%	21.51%	1.16%	0.00%	M
Merging of action and awareness	11.63%	47.67%	12.21%	27.33%	1.16%	0.00%	O
Clear goals	8.14%	52.33%	9.88%	27.33%	1.74%	0.58%	O
Direct and timely feedback	50.00%	20.93%	12.79%	14.53%	1.74%	0.00%	A
Concentration on the task at hand	12.21%	30.81%	43.60%	12.21%	1.16%	0.00%	O
Sense of control	9.88%	34.30%	48.26%	6.98%	0.58%	0.00%	M
Loss of self-consciousness	10.47%	29.65%	43.60%	14.53%	1.16%	0.58%	M
Transformation of time	7.56%	29.65%	48.84%	12.21%	1.74%	0.00%	M
Autotelic experience	5.81%	53.49%	6.98%	32.56%	1.16%	0.00%	M
Challenge-skills balance	8.14%	18.60%	50.58%	21.51%	1.16%	0.00%	O

As shown in Table 8, the M Quality attributes include merging of action and awareness, clear goals, and autotelic experience; the O Quality attributes include challenge-skills balance, concentration on the task at hand, sense of control, loss of self-consciousness, and transformation of time; and the A Quality attribute is direct and timely feedback.

5. Results and Discussion

The identification of quality elements in the Kano Model uses a qualitative approach by selecting the category with the highest frequency as the quality attribute for that indicator, which results in certain limitations. Thus, the Better-Worse Satisfaction Index method is introduced to examine the relationship between indicators and satisfaction. The "Better" index represents the degree to which a quality element enhances user satisfaction, typically greater than 0, with higher values indicating increased satisfaction. The "Worse" index represents the degree to which a quality element leads to dissatisfaction, typically less than 0, with lower values indicating greater dissatisfaction. The specific calculation formula is as follows:

Better = (A+0) / (A+O+M+I)

Worse = (0+M) / (A+O+M+I) * (-1)

AcBased on the aforementioned formula, the data obtained from the survey was input into Excel, and each factor was calculated using the Better-Worse coefficient. The results are shown in Table 8.

Table 8. The Better-Worse coefficient table

	Exa Ski Tracke		Ski Tracks		Slopes: Ski&Snowboard		Skill:Ski&MTB	
Features /Services	Better	Worse	Better	Worse	Better	Worse	Better	Worse
Challenge-skills balance	68.42%	-72.51%	43.20%	-70.41%	63.10%	-61.90%	27.06%	-70.00%
Merging of action and awareness	25.29%	-72.35%	32.35%	-70.59%	28.82%	-81.18%	58.00%	-60.59%
Clear goals	62.13%	-64.50%	38.01%	-73.68%	33.33%	-73.68%	61.90%	-63.69%
Direct and timely feedback	67.86%	-25.00%	63.10%	-61.31%	48.82%	-5.29%	72.19%	-34.32%
Concentration on the task at hand	32.14%	-76.79%	67.88%	-67.88%	40.94%	-76.02%	43.53%	-75.29%
Sense of control	39.88%	-72.62%	36.09%	-75.74%	55.88%	-48.82%	44.44%	-83.04%

Loss of self-consciousness	42.69%	-41.52%	39.77%	-47.95%	74.85%	-38.01%	40.83%	-74.56%
Transformation of time	37.79%	-74.42%	81.40%	-38.37%	62.57%	-64.33%	37.87%	-79.88%
Autotelic experience	30.00%	-78.82%	74.12%	-41.76%	11.18%	-77.06%	60.00%	-61.18%

The specific analysis results of the Better-Worse coefficient are as follows.

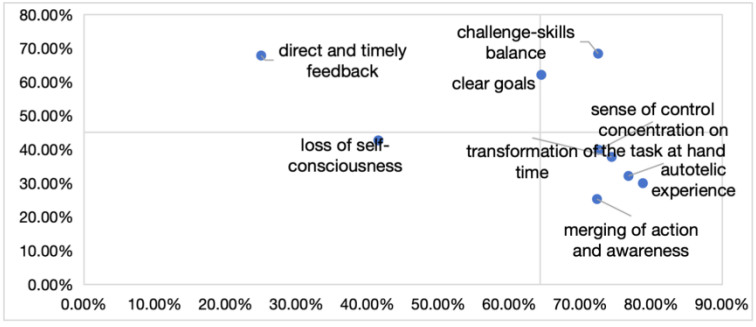

Figure 3. Analysis diagram of the Exa Ski Tracke app kano model

As shown in Figure 3, the must-be attributes, including merging of action and awareness, concentration on the task at hand, sense of control, transformation of time, and autotelic experience, represent the fundamental requirements of users and should be prioritized. The expected attributes, such as challenge-skills balance and clear goals, significantly impact user satisfaction and should be given precedence. The attractive attribute, direct and timely feedback, provides users with an unexpected delight, but its absence does not negatively affect user satisfaction.

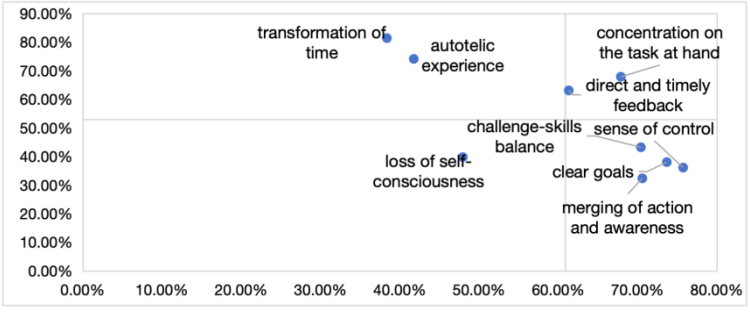

Figure 4. Analysis diagram of the Ski Tracks app kano model

As shown in Figure 4, the must-be attributes, including challenge-skills balance, merging of action and awareness, clear goals, and sense of control, represent the fundamental requirements of users and should be prioritized. The expected attributes, such as direct and timely feedback and concentration on the task at hand,

have a significant impact on user satisfaction and should be given precedence when providing services. The attractive attributes, including transformation of time and autotelic experience, offer unexpected delight to users; however, their absence does not negatively affect satisfaction. The indifferent attribute, loss of self-consciousness, indicates a low level of user concern and can be optimized and improved based on actual user needs.

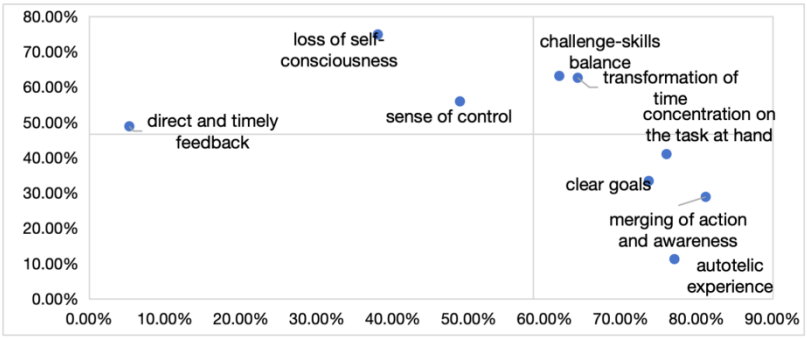

Figure 5. Analysis diagram of the Slopes: Ski&Snowboard app kano model

As shown in Figure 5, the must-be attributes, including merging of action and awareness, clear goals, concentration on the task at hand, and autotelic experience, represent the fundamental requirements of users and should be prioritized. The expected attributes, such as challenge-skills balance, sense of control, and transformation of time, have a significant impact on user satisfaction and should be given precedence. The attractive attributes, including direct and timely feedback and loss of self-consciousness, provide unexpected delight to users, but their absence does not negatively affect user satisfaction.

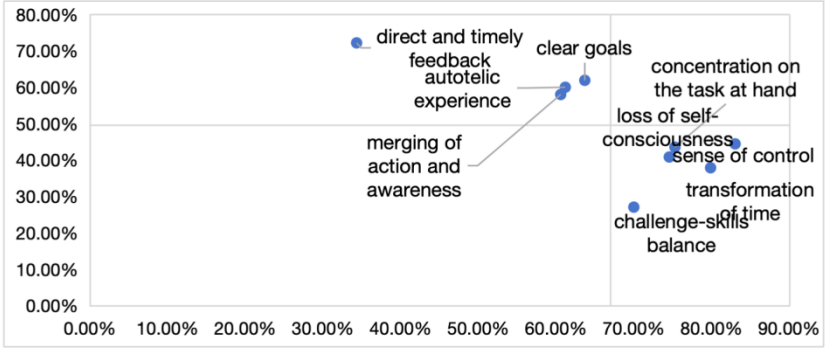

Figure 6. Analysis diagram of the Skill: Ski&MTB app kano model

As shown in Figure 6, the must-be attributes, including challenge-skills balance, concentration on the task at hand, sense of control, loss of self-consciousness, and transformation of time, represent the fundamental requirements of users and should be prioritized. The expected attributes, such as merging of action and awareness, clear goals, and autotelic experience, have a significant impact on user satisfaction and should be given precedence. The attractive attributes, also including merging of action and awareness, clear goals, and autotelic experience, provide unexpected delight to users; however, their absence does not negatively affect user satisfaction.

6. Conclusion and Recommendations

The features of skiing apps are closely aligned with the nine elements of Flow Theory, enhancing user immersion and engagement during skiing activities. Challenge-skills balance is achieved through personalized challenge suggestions and skill assessments, ensuring users are faced with tasks that are neither too easy nor too difficult, maintaining motivation. The merging of action and awareness is facilitated by real-time feedback, which helps users synchronize their skiing actions with awareness of their performance. Clear goals are set through measurable targets, such as skiing distance and time, which serve to motivate users and focus their efforts. Direct and timely feedback is provided continuously, allowing users to adjust their performance and maintain focus, while concentration on the task at hand is encouraged through minimalist interface designs that reduce distractions and keep users focused on their skiing experience. The sense of control is enhanced by personalized settings and real-time tracking, giving users the ability to monitor and adjust their performance as needed. Skiing apps also promote the loss of self-consciousness by immersing users in the activity, allowing them to focus solely on skiing rather than self-awareness. The transformation of time is experienced as users engage in skiing, with time feeling distorted due to the flow of the activity, which is often reflected in the apps' tracking and review functions. Finally, the automaticity of the experience is supported by the app's ability to automatically record key metrics, such as distance and speed, reducing the need for manual input and allowing users to focus entirely on the activity itself. By incorporating these nine elements, skiing apps are designed to optimize user experience, promoting greater engagement, satisfaction, and overall immersion in the sport.

The analysis results of this study indicate that there are differences in the performance of each app in meeting the users' needs for the flow experience due to the different focuses of each app in terms of functional design. The performance of various apps in meeting users' flow experience needs varies, and there

was a large difference in the perception of users' needs by different factors. Overall, factors such as "challenge-skills balance," "concentration on the task at hand," and "clear goals" repeatedly appear across apps,we demonstrate the necessity of these attributes for user experience in skiing apps.

The desired attributes of Exa Ski Tracker are challenge-skills balance and clear goals. Personalised challenge suggestions based on user performance are recommended, such as introducing a user ski skill assessment module.

The desired attributes of Ski Tracks are concentration on the task at hand and direct and timely feedback. It is recommended to optimise the design of the interface by introducing a 'simplified mode' option that focuses on the presentation of core data and reduces distractions. Feedback mechanisms should be added, such as real-time ski performance display and intelligent suggestions.

The desired attributes of Slopes: Ski & Snowboard are to challenge-skills balance, transformation of time, and sense of control. It is recommended to provide a user skill assessment function and introduce a skiing difficulty curve to help users understand how the challenge difficulty relates to their current skills. Skiing duration recording and review functions should be added to allow users to review and experience changes in time, enhancing the sense of immersion. Users' personalisation for the skiing process should be enhanced, for example by providing ski route options and a customisable skiing experience.

The desired attributes of Skill: Ski & MTB are clear goals, autotelic experiences, and the merging of action and awareness. It is suggested to add a goal function to stimulate motivation to achieve skiing goals. Providing personalised ski route suggestions and incentive mechanisms can stimulate users' intrinsic drives and enhance their spontaneous experiences. The design of the skiing experience should be optimised to reduce interruption and improve overall smoothness.

Based on the demographic characteristics of our study and emerging technologies such as wearable sensors,

we propose the following usability and accessibility improvements for different user groups.For gender differences, wearable devices like fitness trackers or smartwatches can provide more accurate physiological data to help users adjust exercise intensity and goals.For age differences, skiing apps for users under 40 can incorporate interactive and social features to boost engagement, while apps for users 40 and above could offer a safety mode that limits speed, includes rest reminders, and integrates wearable devices to monitor physiological conditions. For users with shorter skiing distances, the app could provide beginner-friendly guidance and gradual challenges. For more experienced users, advanced features like technical analysis and personalized challenges could be introduced, with wearable sensors offering detailed data to refine technique.In terms of usability, apps should feature simple, intuitive interfaces with clear tutorials for less tech-savvy users, particularly older adults or beginners, while wearable devices should ensure comfort for extended use.

This study uses Flow Theory and the Kano Model to investigate the needs of skiing app users, helping developers better understand their psychological needs during skiing activities and design and optimise functions based on these needs. It improves the sense of user experience, increases user stickiness and satisfaction, and thereby improves the market competitiveness of the apps. We propose that, in addition, the improvement strategies presented in this study also provide reference for other types of sports apps and have certain promotional value.However,the study's reliance on a small and demographically narrow sample limits the generalizability of the findings. To enhance the robustness and applicability of future research, it is recommended to increase the sample size and include a more diverse participant pool, considering factors such as age, gender, experience level, and geographic location. This would facilitate a more comprehensive analysis and ensure that the findings are applicable to a broader user base.

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