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Evaluating Cartographic Communication in Croatian National Parks: User Perceptions of Pictograms

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Abstract: This study examines the understanding of tourist maps in Croatian national parks, emphasizing a user-centered approach to enhancing cartographic design, the tourist experience, and map readability. Although tourist maps are widely used, there is limited research evaluating these cartographic products, particularly in terms of their comprehensibility and effectiveness in communicating spatial information. To address this gap, we examined existing cartographic materials published by Croatian national park authorities in line with recognized cartographic standards. An online questionnaire, completed by 132 participants of varying ages and educational backgrounds, was used to evaluate the understanding of Point of Interest (POI) pictograms. The results obtained within both gap analysis and needs assessment underscore the need for user-centered improvements in cartographic communication and provide a foundation for the development of more effective map designs tailored to user needs.

Keywords: tourist map; user-centered design; cartographic evaluation; map symbology; POI; pictograms; national parks

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1. Introduction

Maps are a fundamental tool for communication, enabling people to understand, describe, and shape their environment [1]. Among the different types of maps, touristic maps play a crucial role in supporting tourism activities worldwide [2]. They are specifically designed to help tourists organize their activities and fulfill their informational needs [3]. Touristic maps represent a distinct and complex category within cartographic design, requiring special consideration of the principles and processes involved [4].

As the field of contemporary cartography continues to evolve, understanding the methods and strategies for effectively communicating spatial information has become a primary focus [5]. This communication depends largely on how information is structured and processed cognitively by users [6]. Touristic maps are particularly challenging as they must serve multiple purposes for a wide range of users [7]. With a well-designed map, tourists can discover attractions beyond the most popular sites, navigate unfamiliar spaces with ease [8,9], and explore less-known areas, thereby contributing to the local economy. On the other hand, poorly designed maps can lead to confusion, causing tourists to miss out on important sites [8,10]. As global travel trends increasingly emphasize the exploration of nature areas outside one's home country, the role of touristic maps in shaping such experiences has become even more significant [11]. Despite their importance, existing cartographic products of Croatian national parks show significant shortcomings in design and usability, such as missing or incomplete legends or lack of scale. Similar problems are seen on maps of other protected areas like nature parks. These weaknesses make it

more difficult for tourists to use the maps effectively, which affects the overall quality of their visit. This has created a growing need for optimized and user-friendly map designs that cater to a diverse audience. As the demand for touristic maps rises, improving their usability and design becomes a critical aspect of cartographic practice.

In recent years, the development of contemporary maps has shifted towards user-centric approaches, emphasizing the role of the user in shaping the cartographic message [12]. This aligns with the agenda set by the International Cartographic Association (ICA), which stresses the importance of user-centered design (UCD) studies in enhancing the quality and impact of cartographic products [5,13–16]. According to ISO Standard 9241 [17], usability is defined as the degree to which a product can be used by specific users to achieve specific goals with efficiency, effectiveness, and satisfaction. The most common method for usability assessment is through user testing. Within the field of cartography, UCD involves incorporating user feedback throughout the design process to ensure that the final product is more effective and user-friendly [18–20]. This iterative approach relies on a combination of methods to continuously assess and refine designs using real users feedback, rather than relying on hypothetical assumptions. In both academic research and practical applications, the focus of UCD studies is primarily on the process itself. Numerous studies have explored the UCD process within the context of cartography [14,21–28]. Their experiences suggest that involving actual end-users throughout the design process was crucial in shaping the system. Sedlmair et al. [29] describe a structured, multi-stage approach for conducting design studies, identifying three key types of research contributions:

- problem characterization and abstraction (initial stages),
- validation of visualization design (final stages), and
- reflection on the design process (post-completion).

Roth [13] identified domain gap analysis as a key stage in the initial phase of the iterative cycle. This analysis aspires to evaluate existing practices and identify unmet needs associated with the use of touristic maps in a specific area, forming a key part of the gap analysis phase. This phase, along with the needs assessment, plays a critical role in converting user insights into functional and non-functional requirements, forming a key part of the design process.

Research Aim and Methodology

The design of touristic maps merits scientific investigation due to the variety of factors involved, including the choice of scale, the appropriateness of cartographic symbols and text, the layout of graphical elements, and the representation of transportation and tourism infrastructure [30]. The aim of this study is to adopt an innovative UCD approach within the initial stages of the map design process by integrating key concepts from previous studies in cartography [16,31,32] and visual analytics [33–36]. The main objective is to gain insights into the users' perspective on understanding touristic content in general, and POI pictograms in particular, by applying a new approach within the UCD process. Therefore, the goal is threefold: to evaluate current visualization and provide an analysis based on theoretical knowledge and guidelines; to assess the evaluation of pictograms provided within the dataset to gain insights into users' perception; and to provide the needs assessment study, which emphasizes what objects on touristic maps are considered more or less important.

A domain gap analysis covers only one problem domain and is not able to address all possible uses of maps and visualizations. Therefore, this research focuses on only one set of touristic maps. Following recommendations for a structured UCD approach, this research prioritizes formative evaluation methods [21]. Expanding the needs assessment to a gap analysis requires an additional background to identify agitations. Therefore, the initial

phase of the research focuses on a detailed analysis of existing touristic maps, particularly analog cartographic representations of national parks in the Republic of Croatia. These maps, provided by the relevant institutions, offer a basis for analyzing current practices and identifying opportunities for improvement. Adding these sources is a valuable preparatory step for the needs assessment that can identify new ways of approaching design [13]. This analysis will be guided by established cartographic principles and communication strategies. The second aspect involves conducting a needs assessment to identify user requirements for touristic maps. Participants with diverse characteristics, such as varying age, gender, and experience, will be involved in an online survey to gather insights into user preferences. This study aims to use these insights to enhance the design of cartographic products, ensuring that they better meet the needs of modern tourists and improve the overall usability of touristic maps.

2. Materials and Methods

2.1. Case Study: National Parks

There are 444 protected areas of Croatia, encompassing 9% of the country [37]. National parks are vital public resources for the conservation of valued ecosystems and species, protecting many of the preeminent natural, cultural, and recreational resources [38]. In Croatian legislature, they are defined by Article 113 of the Law on Nature Protection [39] as "... a vast, largely unaltered area of land and/or sea of exceptional and multiple natural values, includes one or more preserved or slightly altered ecological systems, and is primarily intended to preserve the original natural values". There are eight national parks in Croatia: Plitvice lakes, Krka, Sjeverni Velebit, Risnjak, Paklenica, Brijuni, Mljet, and Kornati. Each of them is maintained by a separate institution; these institutions represent a unified group of touristic locations and are overseen and funded by the Ministry of Economy and Sustainable Development, which provides centralized oversight and expertise. The Ministry published an Ordinance on the Unique Visual Identity of Nature Conservation in the Republic of Croatia [40] for the purpose of promoting nature protection and a system of interpretation and signaling of protected areas in the Republic of Croatia [41], as well as standards [42] for their use. The purpose of defining a unique visual identity is to achieve general recognition of the nature protection system. Even though these guidelines do not obligate their usage on maps and cartographic products, they provide an interesting view on the produced visualizations and their uniformity, as well as guidelines for their interpretation. Due to their uniformity, they can be seen as a group of touristic attractions that offer similar activities to a compact group of visitors and create cartographic products in the same manner, for the same purposes.

2.2. National Park Maps Analysis

2.2.1. Data Acquisition

The selected maps were both general and tourist maps provided by national park organizations. They constitute a representative sample of maps providing tourist information about the national parks in Croatia. However, it is important to note that these maps are not professional cartographic products but rather materials created primarily for informational purposes by national park institutions. They were obtained by contacting these institutions via email and telephone. The number and form of products provided are summarized in Table 1. Data collection took place in July 2024, when the tourist season was already underway, institutional services were operating at full capacity, and their products were prepared for distribution (including any seasonal updates or modifications). The institutions were asked to provide any analog cartographic product, in printed or in digital form. All of them provided data digitally, and several of them sent their analog products

via post (Mljet, Paklenica and Plitvice lakes). Table 1 shows the total number of provided maps and brochures or other publications used by the institutions. However, some items were not suitable for analysis because (a) they were not published by the institutions, or (b) they lacked cartographic visualization of the area.

Table 1. Distribution of cartographic products provided by the national park institutions.

	NP Brijuni	NP Kornati	NP Mljet	NP Paklenica	NP Risnjak	NP Sjeverni Velebit	NP Krka	NP Plitvice Lakes
Maps	4	1	4	16	2	6	3	15
Flyers and brochures	11	1	2	2	0	0	2	3

The cartographic product pool is endless. There are many forms and ways of displaying Earth's surface, and the possibilities for its visualization are endless. Since the format and number of given displays is diverse, it was decided that analysis and comparison would be conducted on one map per park.

The selection of one map was not an easy task. The criteria for selection were maps with good resolution, which cover the whole park area, were published by the national park institution, had the newest date of publication, and were displayed in large format at the entrance to the park. Also, not every map provided was useful. For example, NP Paklenica provided a lot of maps in jpg form that were not readable due to poor resolution. Also, many of them were part of the management plan of the institution. These maps were also excluded since their purpose was not touristic but more internal.

2.2.2. Methodology for Map Analysis

After the map selection, maps were reviewed according to the cartographic design guidelines. The evaluation method followed the guidelines by ESRI [43] and Frangeš et al. [44]. The available maps were analyzed according to Frangeš [45,46]. The elements of the cartographic content on the map covered by the analysis are summarized and presented in the Section 3. Maps that were included in the analysis are available as Supplementary Materials, together with a detailed analysis in written form for each map.

The analysis included basic map elements, i.e., title, representation area and orientation, content, scale, projection data, map format, legend, map graphics, author (producer) and production date, publisher and circulation, data sources, and miscellaneous map elements. It was decided that pictograms alone would not be included since each of the maps analyzed included a different set of symbols that was not uniform. The selected maps were evaluated as comprehensive cartographic products, rather than isolating specific elements such as pictograms. This approach ensured that the initial evaluation focused on the overall design and usability of the maps rather than on the variability in specific cartographic symbols.

2.3. Online Survey for User Input

This aspect of the proposed gap analysis involved a needs assessment to identify user requirements for touristic maps in order to investigate how tourists, i.e., users of these cartographic products, see them and their content. Most of the thematic content on the touristic maps was shown by point symbols [47]; therefore, their design and usage are crucial for the effective use of touristic maps [48]. The most effective cartographic symbols are considered the ones whose importance is clear to the user [49]. Pictograms should be interpreted correctly without prior learning or using a legend and were found to be the most effective non-linguistic information that everybody understood [50]. Due to this advantage,

they are usually included in maps for beginners and occasional users, such as tourists [51]. Considering that mentioned, they were the main object of the user test within this research. The conducted questionnaire incorporated pictograms based on the initial analysis—all pictograms used in this phase were derived from the Croatian national park maps provided by the official institutions. Based on their location and environment, Croatian national parks can be divided into three groups. The first group are island national parks: Brijuni, Kornati, and Mljet. The second group are mountain ones, like Sjeverni Velebit, Risnjak, and Paklenica. Third group are the Plitvice lakes and Krka, as the most visited national parks in Croatia, both located on the river with lakes, waterfalls, and exquisite nature. Therefore, the selection of pictograms included in the survey was also distributed according to the groups mentioned, which are further detailed in the following section.

2.3.1. Data Collection

We utilized an online questionnaire as our data collection instrument. This approach was chosen for its effectiveness in reaching a diverse group of participants while ensuring their anonymity, thereby promoting the collection of more authentic responses. Questionnaires are usually considered as a method to generally collect quantitative data [20], but they can contain questions aimed at qualitative data gathering, depending on the evaluation's context.

Additionally, recent academic studies on pictograms in tourist areas have also employed online questionnaires, supporting the relevance of this method [11,50]. This study was conducted during August 2024 using Microsoft Forms. An online link to access the questionnaire was sent via e-mail to the national park institutions, nature park institutions, and biggest touristic agencies. Also, printed flyers with a QR code for easy access to the survey were sent via post to the national park institutions.

2.3.2. Participants

A total of 132 participants took part in the study, consisting primarily of adults from Croatia (n = 81) and other parts of Europe (n = 43), all of whom voluntarily agreed to participate. The participant selection aimed to include a broad range of individuals, rather than focusing on a narrowly defined target group with specific needs [52]. This approach was intended to inform the development of designs that are more universally accessible and appealing. The age range of the entire participant group spanned from 18 to 64 years, with most of the participants aged between 25 and 34 years (45%). One participant identified as non-binary, with 64 male and 67 female participants. Based on insights from Dowse and Ehlers [53], questions about education levels were incorporated into the questionnaire to assess the distribution of educational backgrounds among our respondents. The educational background of participants was categorized as follows: 15.91% finished high school education, 24.24% obtained college or university diploma, 7.58% completed undergraduate studies, and 52.27% obtained a master's degree or higher. Approximately the same ratio of participants were experienced in GIS, maps, and other spatial tools as those that were not experienced.

At the beginning of the questionnaire, the participants were introduced to the purpose of the survey, together with a privacy statement indicating how the data would be processed.

2.3.3. Questionnaire

The questionnaire began with a set of questions focused on demographic characteristics, such as age, gender, educational background, and home country. Also, the participants were asked to subjectively evaluate their level of expertise in using Geographic Information Systems (GIS), maps, or other spatial tools. As noted by Ghayas et al. [54], recognition rates

for visual representations can vary depending on the users' memory and are influenced by previous knowledge. Therefore, a differentiation between expert users (high level of experience) and novices (low level of experience) was conducted. Approximately the same ratio of participants was experienced in GIS, maps, and other spatial tools as those not experienced.

Pictogram comprehension was evaluated using both open-ended and closed-ended questions [55,56]. The questions were clearly defined and designed to maintain an optimal level of complexity. Most of them were open-ended, reducing the rigidity of the responses and providing participants with greater freedom to express their thoughts and ideas.

The questions differed in their role. From nine questions related to pictogram comprehension, two of them were related to a decision between the preferable symbol of certain meaning, asking "Which symbol best represents a certain object?", and last two questions were open-ended questions related to "most important" and "least important" symbols and objects on a touristic map. These questions were meant to influence the content of future maps and determine which of the most common symbols is preferable among participants, i.e., the wider population. For each of the remaining five questions, the participants were asked: "What do you think this pictogram means?" or "Assign a symbol to its meaning". Close-ended questions provided several predefined response options, while open-ended questions allowed participants to respond freely. An answer was classified as correct if the participant's interpretation matched the intended meaning of the pictogram [11] as represented on the original map from which it was taken; otherwise, it was classified as incorrect.

The mentioned questions related to pictogram comprehension contained pictograms derived from different national park maps within the different park groups, as follows:

- Question 1 contained pictograms from the NP Krka map (group 3).
- Question 2 had a pictogram from the NP Brijuni map (group 1).
- Question 3 showed pictograms from the NP Kornati map (group 1), NP Krka map (group 3), NP Risnjak map (group 2), and NP Mljet map (group 1).
- Question 4 contained a pictogram from the NP Sjeverni Velebit map (group 2).
- Question 5 showed pictograms from the NP Plitvice Lakes map (group 3), NP Sjeverni Velebit map (group 2), and NP Mljet map (group 1).
- Question 6 showed a pictogram from the Sjeverni Velebit map (group 2), but this symbol was visible on all other maps (in slightly different forms).
- Question 7 showed pictograms from the NP Risnjak map and NP Sjeverni Velebit map (group 2), mainly because the maps in this group are smaller scale than the other ones and show more accommodation objects than maps of larger scale.

This approach ensured the inclusion of a variety of pictograms from different park types in the survey. At the end, the participants were also provided with the possibility to give subjective evaluations of the questionnaire and were given the option to comment freely on the research. The questionnaire is provided as Supplementary Materials.

3. Results

3.1. Results from Map Analysis

The analysis of touristic maps from various Croatian national parks revealed several inconsistencies and areas in need of improvement (Table 2). Across all the maps analyzed, key cartographic elements such as map legends, scale, projection information, and symbol clarity were found to be inconsistently applied or missing altogether, limiting their effectiveness for users.

Table 2. Comparison table between Croatian national park maps.

	Brijuni	**Kornati**	**Mljet**	**Paklenica**	**Risnjak**	**Sj. Velebit**	**Krka**	**Plitvice Lakes**
Title	YES	YES	YES	NO	YES	NO	NO	YES
Multilingual title	NO	YES	YES	NO	YES	NO	NO	YES
Position of the title	GOOD	BAD	GOOD	NO	GOOD	NO	NO	GOOD
Map dimension (size)	60 × 47 cm	42 × 30 cm	63 × 93 cm	15 × 21 cm	46 × 30 cm	21 × 30 cm	15 × 21 cm	103 × 56 cm
Map orientation	NORTH	NORTH	NORTH	NORTH	NORTH	NORTH	NORTH	WEST
North arrow	YES	YES	YES	NO	YES	YES	NO	YES
Scale (value)	1:30,000	1:100,000	1:15,000	1:40,000	1:80,000	1:20,000	1: 20,000	1:30,000
Scale (format)	YES Graphic	NO	YES Graphic	NO	YES Graphic	YES Numeric	NO	YES Graphic
Map format	60 × 47 cm	42 × 30 cm	68 × 98 cm	15 × 21 cm	48 × 33 cm	21 × 30 cm	15 × 21 cm	106 × 66 cm
Contour interval	NO	NO	5 m	5 m	NO	10 m	NO	NO
Altitudes and depths	NO	NO	YES [m]	YES [m]	YES [m]	YES [m]	NO	YES [m]
Nomenclature	NO	NO	YES	NO	NO	NO	NO	NO
Projection	NO	NO	YES	NO	NO	NO	NO	NO
Ellipsoid	NO	NO	YES	NO	NO	NO	NO	NO
Coordinate grid	NO	YES	YES	YES	NO	YES	NO	NO
Map content settlements	NO	NO	YES	YES	YES	YES	YES	YES
Map content roads	NO	NO	YES	YES	YES	YES	YES	YES
Map content water bodies	NO	NO	YES	YES	YES	YES	YES	YES
Map content relief	NO	YES	YES	YES	NO	YES	NO	YES
Map content vegetation	NO	YES	NO	NO	NO	NO	NO	NO
Map content geographic names (toponyms)	YES	YES	YES	YES	YES	YES	YES	YES
Legend	YES	NO	YES	NO	YES	NO	YES	YES
Legend completeness	NO	NO	YES	NO	YES	NO	NO	YES
Legend categorization	YES	NO	YES	NO	NO	NO	YES	YES
Legend multilingual	YES	NO	YES	NO	YES	NO	NO	YES
Map graphics difference between symbols on the map vs. legend	YES	YES	YES	YES	YES	NO	NO	NO
Map graphics text position and style	BAD	BAD	GOOD	BAD	GOOD	BAD	GOOD	GOOD
Map elements positioning	GOOD	BAD	GOOD	BAD	BAD	BAD	GOOD	GOOD
Graphics density	GOOD	BAD	GOOD	BAD	BAD	BAD	GOOD	GOOD
Generalization	GOOD	BAD	GOOD	BAD	BAD	BAD	GOOD	GOOD
Author	YES	YES	YES	NO	YES	NO	NO	NO
Printing and copyrights	NO	NO	YES	NO	NO	NO	NO	NO
Publisher	NO	YES	YES	YES	NO	NO	NO	NO
Publication date	NO	YES	YES	NO	NO	NO	NO	NO

Table 2. *Cont.*

	Brijuni	Kornati	Mljet	Paklenica	Risnjak	Sj. Velebit	Krka	Plitvice Lakes
Sources	NO	NO	YES	NO	NO	NO	NO	NO
Additional data	YES	YES	YES	NO	YES	NO	NO	NO
Map frame	NO	NO	YES	NO	YES	NO	NO	YES
Inserted map	YES	NO	YES	NO	NO	NO	NO	YES
Expanded map	NO	NO	NO	NO	NO	NO	NO	NO
Index or list of objects	YES	NO	NO	NO	NO	NO	NO	NO

For instance, the Brijuni National Park map features a digital orthophoto background, but it lacks explicit cartographic representation of settlements, vegetation, and relief. While the map includes a legend for 24 symbols in multiple languages, several important map features, such as the ferry line and certain paths, are not represented in the legend. Additionally, the geographical names are presented in a white font that does not follow their contours, making them difficult to read.

The Kornati National Park map also shows significant deficiencies, particularly in the absence of a legend and scale. The lack of clear graphical elements and a proper frame further detracts from the map's usability.

The Mljet National Park map provides more details compared to the other maps. The map represents settlements, road lines, hydrography, and relief using contour lines, and it is complete and readable.

The National Park Paklenica map presents a particularly challenging example, as it lacks a title, scale, legend, and projection information altogether. The map contains several symbols, such as park entrances, which are not explained. This makes navigation and interpretation particularly difficult for users. Almost the same is valid for the Sjeverni Velebit National Park map.

Similarly, the Risnjak National Park map lacks critical features such as relief representation and grid lines. Although a legend is provided for 22 symbols, inconsistencies in symbol size between the map and the legend reduce the map's clarity. The map also lacks a frame and explanatory text, further limiting its usefulness.

The Krka National Park map represents settlements using point symbols of varying sizes, likely corresponding to population size, yet these symbols are not clearly differentiated in the legend. Educational trails and bicycle routes are also not represented within the legend.

Finally, the National Park Plitvice Lakes map provides a good graphical density of the map. Some labels, such as lake names, are difficult to read due to inconsistent font sizes. Shading of the relief appears to be overwhelming in certain areas, detracting from the overall visual balance.

3.2. Results from the Questionnaire—Pictogram Comprehension

According to ISO Standard 9186 [56], the minimum criterion for the interpretation accuracy of pictogram comprehension to be considered acceptable is an interpretation accuracy of 67%. The analysis of correct responses (Figure 1) revealed that only four pictograms were accurately interpreted by more than 67% of all the participants. Seven pictograms were not interpreted correctly.

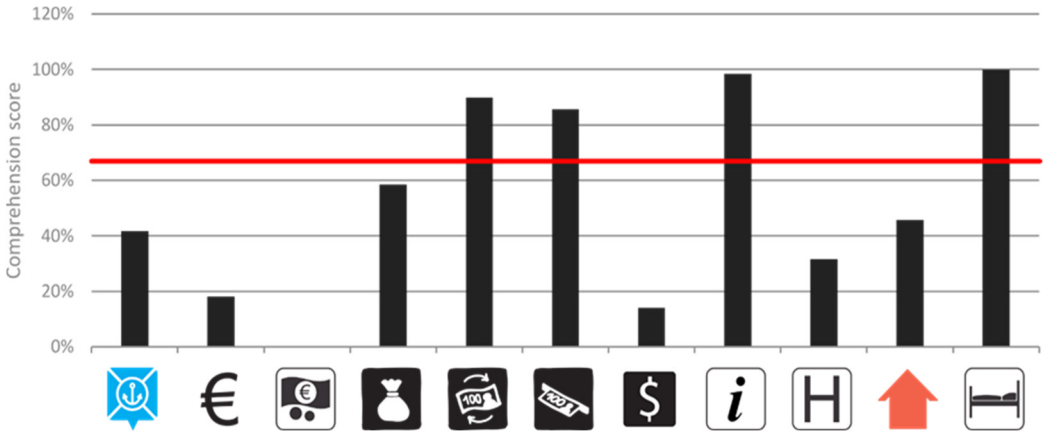


Figure 1. Distribution of the correct interpretations of the pictograms (from left to right: anchorage; ATM; ticket sale; bank; exchange office; ATM; ATM; information office; hotel; mountain lodge; accommodation). The red line indicates a 67% minimum criterion for successful interpretation.

The open-ended responses were categorized based on their thematic content. For example, "hotel", "motel", and "hostel" are distinct POIs but fall under the broader category of "accommodation". To classify the provided answers, general content categories were created. The classification criteria were based on available map sources, the content of contemporary tourist maps, and existing studies [44,57]. They differed from question to question: the idea was to obtain a comprehensive review of different POI categories, so each question involved pictograms from different categories.

The questions were analyzed according to the correct answers, expertise level, gender, and age. However, it was clear that the distribution of answers did not vary meaningfully across different gender or age categories; therefore, it was decided that these variables would no longer be emphasized. The distribution was analyzed statistically by separating the responses into groups based on gender (e.g., male, female, other) and age categories (e.g., age ranges), and by summarizing the responses for each group using descriptive statistics (e.g., mean, median, frequencies).

The first question was related to assigning the correct meaning of the presented symbol. To this, 42% of answers were correct (anchorage), 40% of participants chose port, and 4% did not answer the question. However, we notice that a higher number of non-experienced participants chose the correct answer, anchorage (n = 30), in comparison to experienced ones (n = 25) (Figure 2).

It should be considered that the survey was provided in English language and the majority of participants do not come from English-speaking countries. This problem was considered in advance and addressed by enabling a translation option within the questionnaire. However, it could still be a limiting factor for question comprehension (particularly applicable to this question).

In the next question the participants were asked was what the euro sign means. They were given four options, with the possibility for their own input. The correct meaning, assigned to this symbol on the original map from which it was derived, is ATM, and only 18% of participants chose this answer. This indicates that the meaning of the symbol is not clear; since it is just a euro sign, maybe the most intuitive interpretation would be money currency, which was chosen by 33% of participants. However, this interpretation cannot only be related to the possible meaning of the symbol on the map, and was therefore not considered applicable. For the rest of the answers, 30% of participants thought it represented the exchange office, 9% indicated it as a bank, and 10% of answers were vague and unclear. Notably, among the participants identified as experienced map users, 71% of them selected the ATM as the correct answer.

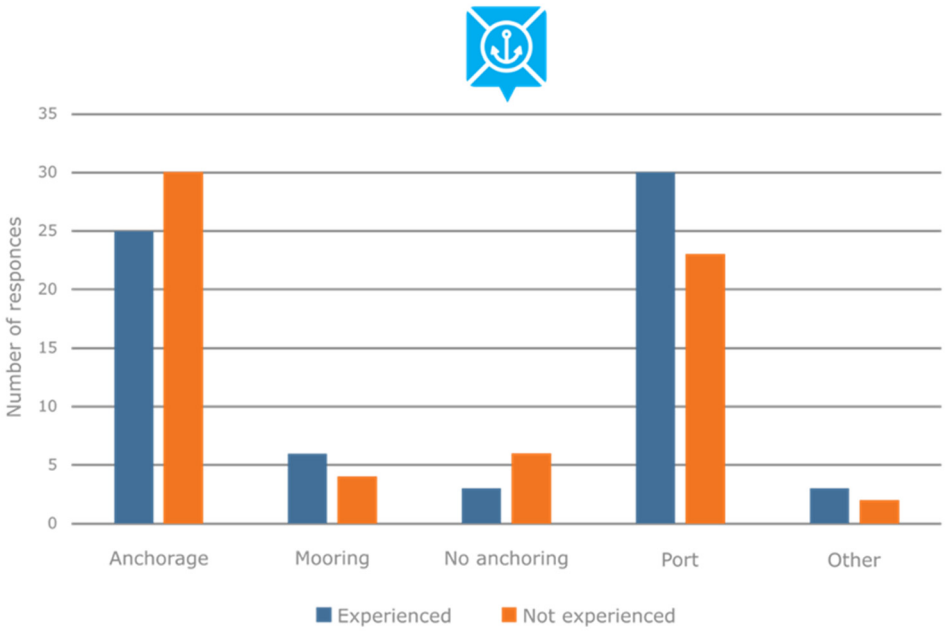


Figure 2. Results of answers for symbol derived from Brijuni National Park map.

The following question involved a set of five pictograms in black and white (Figure 3), all related to financial institutions and/or objects. They were asked to assign a meaning to each of the symbols in an open-question form. Around 70% of answers were given to this set of symbols (73%, 73%, 74%, 74%, 70%, respectively). There was no difference in answers between the experienced and non-experienced participants.

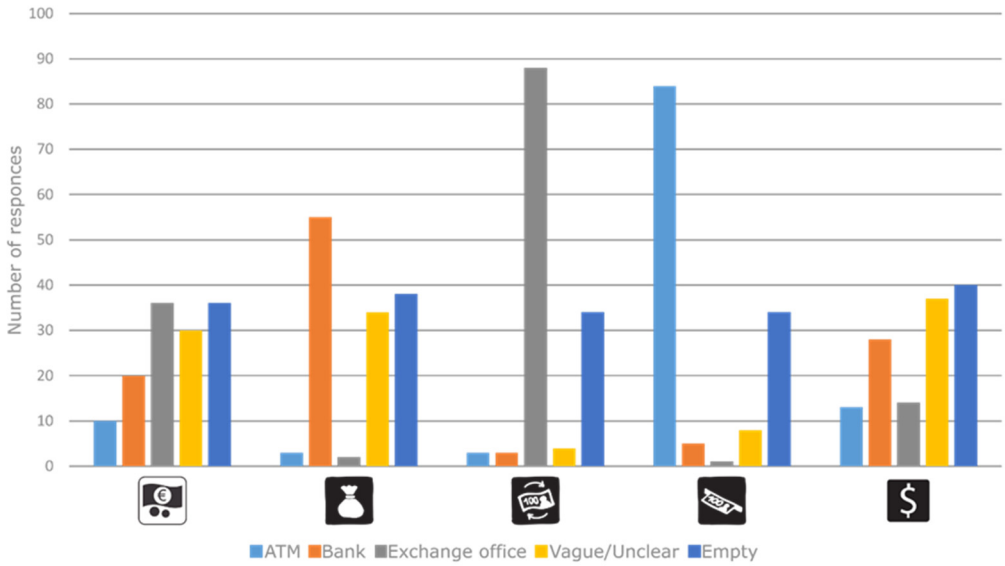


Figure 3. Financial pictograms (from left to right: ticket sales; bank; exchange office; ATM; ATM).

The first symbol (on the map from which it was derived) is the ticket sales office, which none of the participants answered. The highest number of answers was exchange office (n = 36), followed by vague and unclear answers (n = 30), bank (n = 20), and ATM (n = 10). Vague and unclear answers refer to responses that describe the visual appearance of a symbol rather than its intended meaning or provide generic terms not directly associated with the symbol's function. For example, responses such as "money bag", "safety", "vault" or "treasure" were categorized as vague or unclear. The following three symbols were derived from the same map, Plitvice lakes National Park map. The first one (second symbol in the set) indicates the bank, which presented 59% of given answers. However, 36%

of given answers were vague and unclear, mostly not specific to one meaning but also describing what the symbol shows and not its meaning. Nevertheless, several answers in the vague category of answers were in line with the meaning of the symbol (i.e., money, money bag, golden coins, save, saving bag, treasure, vault), but were categorized this way because the answers were closer to a symbol description and not its meaning. The following symbol (third in the set) should represent the exchange office, which was answered correctly in 90% of given answers. The fourth symbol represents an ATM, which was correctly answered by most of the participants (n = 84). The last symbol of the presented set should also represent an ATM. However, mixed results were displayed. With the lowest answered rate (70%), 40% of the answers were vague. The other answers were distributed as follows: bank 30%, ATM 14%, and exchange office 15%.

The next question included the pictogram with a small letter "i" in the center of the symbol. This pictogram was included in the questionnaire since it has been distributed among a large number of touristic maps but with different meanings assigned to it. The question was close-ended, with four possible answer options. Here, 98% of participants answered the question correctly, while 2% of incorrect answers (reception) were given by non-experienced participants.

The last question included a set of three pictograms (Table 3), all related to the accommodation. It was an open-ended question, so the answers pool was diverse. The response percentage was 84% for the first symbol, 80% for the second, and 76% for the third symbol.

Table 3. Categories of accommodation and number of responses per category.

	Category	Experienced	Not Experienced	Total
	Hospital	29	37	66
	Hostel	0	3	3
	Hotel	22	13	35
	Other	4	1	5
	Vague/Unclear	2	0	2
	Accommodation	28	20	48
	Direction	25	29	54
	Other	2	1	3
	Apartment	5	6	11
	Hotel	15	10	25
	Rooms to rent	5	14	19
	Accommodation (general)	23	22	45

The correct meaning assigned to the first symbol in this set is hotel, which was only 27% of given answers. Further, 50% of respondents answered hospital, and it was mostly chosen by non-experienced participants (56% of hospital answers were non-experienced). Hotel was chosen by mostly experienced participants (n = 22). The second symbol in this group was surprising: 41% of answers indicated direction and only 36% of answers were assigned to some type of accommodation or gave a general meaning of accommodation. However, experienced participants mostly opted for accommodation answer, and most of the non-experienced answers were assigned to a meaning of direction. The correct meaning of the symbol on the map from which it was derived is mountain lodge. The last question in this set had a wide meaning: accommodation. Of the answers provided, only 34% of responses were "accommodation", but in general, almost all answers were assigned to some kind of accommodation (i.e., hotel, apartment, rooms to rent).

3.3. Results from Questionnaire—Importance of the Objects on a Touristic Maps

The last two questions were intended to give insights into people's preferences. These were free form, open-ended questions with a number of answers. In total, 1320 objects were named in questions regarding the most important objects on touristic maps, and

396 objects in answer to the least important objects on touristic maps. Answers with "don't know" answers were marked as empty. It was noted that each participant named different numbers of objects, and in different orders. To evaluate the data based on the order in which objects were mentioned, the importance of objects by considering both frequency and mention order can be applied. It is possible to assign different weights to objects based on their mention position. For example, the first mentioned object might be the most important for the respondent, so it receives a higher weight than the second mentioned object. This approach is known as weighted scores [58], and it was applied to the results of these questions.

The content on the touristic maps can be divided into separate categories. The general categorization would be Accommodation, Food and Beverage, Shopping and Markets, Financial Services, Transportation, Health and Emergency, Leisure activities, Tourism activities, and Public services. Some objects that fall within these categories were heavily chosen (like restrooms within the most important objects selection) so they were included in the analysis as individual objects. Another often-mentioned concept is the location where the viewer is currently located, which was also included as a separate category. Table 4 shows the result of questions related to the most important objects on touristic maps, divided by object categories, experience levels, and weighted values. It should be noted that the division of respondents into experienced and inexperienced groups was not applied in the calculation of weighted scores.

Table 4. Results for most important objects on touristic maps.

	Experienced	Not Experienced	Count	Weighted Scores
Tourism activities	58	50	108	861
Transport	45	31	76	576
Food and Beverage	37	34	71	563
Restrooms	16	21	37	312
Accommodation	20	13	33	275
Finance	20	14	34	272
Other	11	13	24	177
Leisure activities	14	7	21	173
Shopping	7	11	18	135
Health	8	7	15	121
Tourism activities	58	50	108	861
Food and Beverage	37	34	71	563

Based on the results, there were no significant differences between experienced and non-experienced participants. Both experienced and non-experienced participants selected "Tourism activities" the most (58 and 50, respectively), followed by "Transport" and "Food and Beverage", which may indicate that these categories are universally considered important for tourists. "Restrooms" were highly valued, implying that they are essential for the tourist experience even if not mentioned by everyone. "Accommodation" and "Financial institutions" have similar levels of importance reflected in their weighted scores. "Leisure activities", "Shopping", and "Health" were less attractive considerations for tourists since they were among the least selected by both groups, possibly indicating lower perceived utility or importance in these categories. The categories with the highest weighted scores were the same as those with the highest total mentions, indicating that these objects were frequently mentioned and often in higher-priority positions (i.e., mentioned first or second). For example, "Tourism activities" had the highest count and weighted score (861), followed by "Transport" (576) and "Food and Beverage" (563). "Location" and "Health" had the lowest weighted scores, supporting the finding that these categories are not prioritized by either participant group.

The data suggest that essential amenities (like tourist attractions, transportation, and food) are prioritized by both experienced and non-experienced tourists and should be

clearly emphasized on the tourist maps. However, experienced users seem to place slightly more emphasis on infrastructure; therefore, maps for seasoned tourists could highlight these features more prominently. This alignment of object count with weighted scores supports using these results to prioritize map design elements according to user importance.

Table 5 shows the result of the questions related to the least important objects on touristic maps, divided by object categories, experience levels, and weighted values. As mentioned before, there was a slight difference between the object categories selected as the most important and least important objects on a touristic map. This was influenced by the participants' answers. In this analysis, restrooms were accounted for within Public services category.

Table 5. Results for least important objects on touristic maps.

	Experienced	Not Experienced	Count	Weighted Scores
Public services	15	15	30	81
Food and Beverage	6	10	16	44
Tourism activities	7	6	13	38
Leisure activities	3	7	10	27
Finance	6	3	9	26
Accommodation	7	2	9	25
Transport	3	5	8	21
Other	4	3	7	21
Shopping	5	1	6	18
Health	2	2	4	11
Public services	15	15	30	81
Food and Beverage	6	10	16	44

For the least important objects on a map, "Public services" had the highest total count (30) and weighted score (81). Interestingly, both experienced and non-experienced participants selected this equally (15 each). This suggests that while public services are acknowledged, they may not be seen as essential compared to other primary needs. "Food and Beverage" appeared with a relatively high count (16) and weighted score (44). This may indicate that, for certain participants, food options are considered more of a secondary feature, possibly because more significant food establishments are already highlighted elsewhere. The "Leisure Activities" category shows a divergence between experienced (3) and non-experienced (7) participants, with non-experienced participants selecting it more. "Transport" has a relatively low importance, just like "Accommodation" and "Financial institutions". "Shopping" and "Health" have limited appeal among tourists, suggesting that they are not a primary focus for most visitors in the touristic environment. These categories may hold limited significance for participants, either because they are considered low priority or because they are perceived as less relevant for a tourist experience.

The least important categories indicate that secondary services like "Public Services" and "Food and Beverage" are acknowledged but not critical to the overall tourist experience. "Health services" and "Shopping" might be seen as specialized needs that not all tourists consider necessary. "Transport", "Accommodation", and "Financial institutions", interestingly, are low on both counts and weighted scores, possibly indicating that for this group, they are either assumed to be readily available or unnecessary for a localized experience. There are differences between experienced and non-experienced participants, with non-experienced individuals favoring leisurely options. This can inform map designs by distinguishing between core amenities and secondary or less impactful features, tailored to user needs.

4. Discussion and Conclusions

The aim of this study was to apply an innovative UCD approach within the domain gap analysis phase to gain insights into users' perspectives on understanding of touristic

content. The findings reveal significant shortcomings in the cartographic design and usability of current Croatian national park maps, indicating areas for improvement.

The evaluation of current visualizations was conducted based on theoretical knowledge and cartographic guidelines. The analysis of these maps shows that despite being produced by official institutions, many of the touristic maps for Croatian national parks fail to meet basic cartographic standards. This is understandable, as their primary purpose is to provide general information rather than serve as specialized navigational aids. Despite adherence to established cartographic guidelines, the maps lacked certain features that would make them more user-friendly and engaging for a broader range of tourists. Issues such as inconsistent formats, varied content, and differing object categories across parks highlight a lack of uniformity. Furthermore, essential map elements such as legends, scales, and projections are often missing or inconsistently presented, limiting their usability for tourists. Nevertheless, none of the analyzed maps adhere to unified standards, underscoring the necessity for standardized and user-focused cartographic practices across national parks. These results indicate that current maps do not fully support the effective communication of spatial information, particularly when it comes to enhancing the tourist experience.

The pictogram analysis revealed significant user difficulties in interpreting cartographic symbols. Pictograms are common symbols on touristic maps since they should not require experience in their comprehension and are not restricted by language. Unlike abstract symbols, pictograms usually have some link to the object they are representing. Effective symbols must be easily distinguishable, logically grouped, and simple enough to eliminate the frequent need for legend consultation. The evaluation of pictograms provided within the dataset gained insights into user's perception and ability to comprehend their meanings without the legend. The results indicate that participants often struggled to correctly interpret the pictograms presented to them. This misinterpretation was consistent across diverse demographic groups, suggesting that the pictogram design may not fully align with users' perceptual and interpretive processes. Furthermore, it has been suggested that user's experience in map reading does not play a significant role in pictogram perception. The gap in user understanding conducted within this research suggests that the current designs fail to effectively communicate key spatial information, potentially limiting the usefulness of the maps in guiding tourists. This observation is critical, as it highlights the necessity of ensuring intuitive and universally comprehensible touristic maps.

The needs assessment component further emphasized the importance of certain map elements, with participants identifying which objects on touristic maps they considered most or least important. This feedback offers a valuable foundation for redesigning maps to better cater to user preferences and improve overall map usability. For the overall results, "Touristic activities" emerged as the most important category, with the highest overall weighted score (823). This reaffirms its central role in tourist experiences, as visitors highly value landmarks and attractions. Other high-priority elements included Food services and Transportation, while Public services, such as police stations and health facilities, were considered less critical for general touristic maps. These findings have broader implications for the design of touristic maps, suggesting that emphasis should be placed on features that align closely with user needs and priorities.

The study does have several limitations that should be acknowledged. The main limitation of our study could be the challenge of gaining conclusions from the questionnaire answers. Several factors should be considered, with some of them not being so easily eliminated. For instance, factors such as a response fatigue or participant's employment within related institutions may have influenced their answers. Furthermore, diverse cognitive and perceptual factors—such as color vision deficiency—should be considered. Another potential bias stems from the way pictograms were grouped in the questionnaire.

For example, participants failed to recognize the ticket sales pictogram, most likely because it did not necessarily align with the intended category. Additionally, in the accommodation pictogram group, some participants identified a hotel pictogram as a hospital, which did not align with the intention of the group. This could be due to wrongly grouped pictograms or the participant's lack of attention. However, these factors suggest that while the results offer valuable insights, they should be interpreted with caution, considering the potential influence of these biases.

While our study has limitations, it provides critical insights into the limitations of Croatian national park maps, highlighting the need for improved cartographic practices. The findings underscore the need for a user-oriented approach that accounts for the different ways users comprehend visual information. It has been demonstrated that the newly applied user-oriented approach, which accounts for diverse user perspectives, has been successfully applied. Even though this study does not offer specific design recommendations, it identifies a clear need for further research to improve map usability through iterative feedback and testing. These findings are significant beyond the context of Croatian national parks, offering valuable insights into the broader domain of touristic map design, such as urban tourism, heritage sites, or protected natural areas, where intuitive and standardized visual communication is essential. By addressing the observed deficiencies—such as a lack of uniformity and challenges in pictogram comprehension—future cartographic practices can better meet the needs of modern tourists, enhancing usability and user satisfaction.

In conclusion, this research contributes to the field of cartography by demonstrating the value of a UCD approach in the design of tourist maps, particularly within the context of Croatian national parks. While the analyzed maps provide basic spatial information, they do not effectively communicate information and therefore fail to enhance the overall tourist experience. Addressing these design gaps can help in creation of maps that offer a more engaging and user-friendly experience that meets the expectations of today's tourists. The newly applied gap analysis approach gained meaningful insights, highlighting several critical design shortcomings. User feedback from the needs assessment phase has pinpointed specific areas that represent a base for improvement.

These findings suggest that adopting a UCD approach can lead to better map designs by incorporating user feedback at certain stages of the design process. Future studies should continue to explore innovative ways to improve the usability of tourist maps, particularly through the iterative refinement of pictogram design and the continued integration of user feedback throughout the design process.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/ijgi14020041/s1, maps of NP Brijuni, NP Kornati, NP Krka, NP Mljet, NP Paklenica, NP Plitvice, NP Risnjak, NP Sjeverni Velebit, detailed NP maps analysis and questionnaire.

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