



# Facilitating hikers' mobility in protected areas through smartphone app: a case of the Hoge Kempen National Park, Belgium

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## Abstract

Visitor mobility in protected areas is often a challenge as manual map reading and finding a route consume the time. This paper presents a digital tool that provides valuable information for both the visitors and the managers of protected areas. The app provides assistance to users to generate, access, and record hiking routes within the protected area. A route planner was created to generate user-specific alternative routes taking into account the user's preferences in terms of distance, preferred landscape, level of accessibility, etc. The app also provides the users with basic information on the park, including captivating points, typical flora, and fauna. Moreover, visitors and park management can communicate with each other through exchanging messages and suggestions. The pilot validation test performed with 20 participants and real-time test from 68 park visitors revealed that all the functionality of the app is in order and the app enhances the mobility experience of the user within Hoge Kempen National Park. Furthermore, regular use of the app from users will generate rich data that is valuable for visitor management purposes, for example, the number of trips per day, the average duration of visits and popular segments.

**Keywords** Smartphone app · Protected areas · Tourism · Mobility · Hiking route

## 1 Introduction

In the last few decades, it has been observed that tourism has become an important industry with enormous economic impacts. The information collected by the World Travel and Tourism Council (WTTC) from more than 180 countries states that the tourism industry has contributed \$7580.9 billion, which is equivalent to 9.8% of the global gross domestic product (GDP). It is worth mentioning that this industry has also created job opportunities for 276,845,000 people, which is equivalent to 9.4% of the total global employment. Future predictions are also made regarding the contribution of employment and economics. As per predictions, the economic contribution will rise to an estimate of \$11,381.9 billion in the future, and there will be an increase in jobs up to 356,911,000 by 2025 [18]. When discussing tourism, the role of mobility

can never be ignored. Effective mobility is an important aspect to be managed for tourism, also in protected areas.

In many studies, it has been observed that control over mobility activities affects the visitor's experience [11]. Mobility is considered an essential component of nature-based tourism [9].

Protected areas (PAs) are defined by the International Union for Conservation of Nature (IUCN) as “clearly defined geographical spaces, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” [7]. The management of the protected areas aims to regulate tourism activities and their effects on the environmental, social, and traditional values of an area [8]. For the managers, it is necessary that they first understand the behavior and trends adopted by tourists. McCool [10] in his study pinpoints that the management of tourism in the protected areas contains plentiful adjustments between two goals [10]: (1) the key values that form the basis for preservation needs to be protected and (2) giving access to tourists to appreciate and praise those values [16]. The management of the protected areas comprises of planning and consolidation of mobility measurements [6]. An elegant

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mobility network enhances the visitors' experiences through guidance, by ensuring time-saving, safety, and by the provision of detailed information about the route [14].

In past rigid routes that were available for years and rarely updated, it is assumed that these routes can be against the preferences of tourists. That is why the tourists explore their own ways, and they make off-trail routes. Although the technical reasons for walking off-trail can be broadly understood (Root & Knapik 1972), the reasons reflect the differences between levels of knowledge, morality, or experience among visitors (Smallwood, Beckley, & Moore, 2012). The increase in desire from visitors about self-service movement, as well as the goal of protected areas to reduce the costs through automation, is considered the basic reasons for the infusion of technology in facilitating the managers and tourists [15]. In most of the wilderness areas, the connectivity is increasing and it is moving towards infinite limits of connectivity. Few of the researchers assume that with the advancement in technology, there is potential to change nature-based experiences and to make the visit naturally meaningful (Shultis, 2012; Borrie, 1998). This study aims to introduce a digital tool, the "Hoge Kempen National Park (HKNP) app" and is focused on the description of usage and advantages of this app. This digital tool in the form of a smartphone application will help the tourists to plan their journey in an organized way. Mobile apps may enrich, regale, and provide guidance, tracking them back to routes via pop-ups, and visitors may feel safe. However, there are some cons as well as it can distract visitors, obstruct the ability to immerse into nature, and visitors may lose time to communicate with friends (Halpenny & Priebe, 2014).

The paper is structured into six sections, the first section deals with the brief introduction and problem statement. Section 2 is about smartphone apps and the added value of the development of the app for the case study. The third section is about the current situation of mobility within Hoge Kempen National Park and the need for the development of HKNP app. In Section 4, the different functions of the app are explained with some screenshots from the app, so that it is helpful for the readers to understand the app. The fifth section explains the research methodology, the techniques that will be used to collect and analyze the data in the near future. The final section discusses the conclusions and future of the HKNP app.

## 2 Smartphone apps and HKNP app

In a study related to the usage of smartphone apps in protected areas, it is found that consumers' behavior to use a smartphone app is directly influenced by their attitude, the extent of entertainment, and perceived control mechanism [17]. (Hong & Tam, 2006) identified that the intention to use a smartphone app is also influenced by the tourist's desires, interests, conflicts, perceived usefulness, value, and peer pressure [3]. It has

also been observed by Tsai that individuals' attitude toward technology and intention to use it have a positive correlation. Finally, it is also stated that other factors like perceived usefulness, ease in using the multiple features of the app, and entertainment attraction have a positive effect on attitude [17].

There is a wide range of mobility apps that provide guidance to visitors at their destinations. For example, Citymapper is a multimodal trip planning app that provides the function of finding the fastest route with the multimodal public transport network, i.e., metro, train, bus, ferry, light rail, taxi, car share, bike share, and walking. Commuters can make a decision based on the preferences given by the app about minimum time consumption. Similarly, Moovit combines real-time data from the transport network with live information from the user community. Another app that is related to the customization of walking speed, the maximum distance that one desires to walk, provides walking routes with feasible accessibility. There are also many other apps as well, i.e., TripGo, TripView, and stop announcer (Transport for NSW, 2019).

Bundle of apps has been developed for hiking and live tracking, but still, the examples of apps in protected areas are less common; likewise, at the moment, there is no fully operational app for the Hoge Kempen National park. It would be of worth mentioning here about a couple of examples from the real world. Chimani offers free mobile apps to help users to discover all 417 National Park Service units, including historical parks, seashores, preserves, and lakeshores. Chimani Yellowstone National Park app was created for the most popular national parks based on attendance. This application is extensive, focusing on every aspect of a visitor's experience in the park including hiking trails, park amenities, audio and auto tours, museum and prime wildlife viewing locations, geolocation maps, park event schedules, leave no trace guidelines and a safety section, and sunrise and sunset times [1]. The usage of smartphone applications in protected areas can help in assembling and analyzing data related to preferred destinations [2]. A smartphone app provides quality onsite experience to visitors, and it is also beneficial from a business perspective [5]. The usage of a smartphone app is expected to determine and find solutions for challenges that have persisted. Few of these challenges are assessment of the impact of tourism, understanding of mutual relations between visitors and nature, monitoring, and analyses of mutual interactions of tourists doing other activities at the points of interest ([12]; Moscardo, 2011).

In comparison with the existing mobility apps and to enhance the visitors' experience within the national park of Belgium, a digital application named "HKNP app" is developed by the Transportation Research Institute (IMOB) of Hasselt University in Belgium, to facilitate and monitor mobility within the Hoge Kempen National Park (HKNP) in Belgium. The app will be utilized to gain insights in the hiking behavior within the Hoge Kempen National Park and to

facilitate the users to improvise their hiking trajectories. The HKNP app is a kind of unique app as it provides mobility services within the park to the visitors and also to the routine users with the addition of functionality of statistical analysis, that enables the visitors to develop a kind of comparison or their routes. The data collected from hikers using the HKNP app can also be analyzed to support various managerial tasks, for example, to deduce visitors' attraction points, stopping places, deviations from the route, and opinion/satisfaction regarding the protected area. This data can be used to understand the behavior and mobility patterns of visitors. The interpreted data can be used for the purpose of policymaking and management. There are some similarities and dissimilarities of the HKNP app with already developed apps highlighting all those differences would justify the development of this app. The table shows the fundamental differences between multiple apps.

The main distinction of the HKNP app is the availability of qualifiers selections for making a route as per desire of visitors, the second distinction is the statistical analysis of already made routes, and another characteristic is the bi-directional communication of visitors with management and vice versa. The working of different functionalities of the app is discussed in detail in Section 4.

It can be seen in Table 1 that the Golden Gate and Yellowstone app do not contain the functionality of qualifier selection, route registration, statistical analysis, and bi-directional communication among visitors and park administration. Similarly, it can be observed that the other apps mentioned in Table 1 lack at least two and a maximum of four functionalities. However, these missing functionalities are incorporated in the HKNP app to formulate a one combine mobile application. The addition of these necessary functionalities is based on the need for mobility and the current situation in HKNP. The current situation of mobility within HKNP and hiking problem are mentioned in Section 3.

### 3 Current situation and hiking problems in HKNP

Among various components of tourism, nature-based tourism in protected areas is increasing and growing evidently. For many countries (Australia, Kenya, Nepal, New Zealand, Tanzania, Costa Rica, and Botswana), nature-based tourism is a key component of their most important export industry, tourism (Eagles, 2003). Visitors have various expectations regarding their visit to natural areas. It can be assumed that the motivation of visitors can be different according to their background and cultural values. It has been observed in a few studies that the launch of mobile ICT (smartphone applications) in wilderness areas reduces the park visitor's perception of risk and enhances the risk-taking activities (Holden, 2004; Martin, Pracheil, DeBoer, Wilde, & Pope, 2012). In view of this,

1. Currently, visitors while walking into the Hoge Kempen National Park (HKNP) use brochures/maps that are available at the entry gates of the park. These maps can be purchased at the entry gate of the park or either visitor can find them online. The cost of the map is 2.5 euros/gateway. So, if somebody wants to purchase a map for the complete park, he/she has to pay 15 euros in total. It is observed that most of the time, the visitors do not prefer to pay for maps and walk without maps. These brochures (paper-based maps) comprise of available routes having different information (i.e., distance, waymarkers, average time to complete the route, availability of different points of interest on particular route, accessibility to disabled people, existence of stairs, flora and fauna, availability of cycles, connecting routes, routes with dog course, background landscape map, approximate parking location, and brief detail about the point of interests). Currently, the visitors in HKNP are using brochures, but

**Table 1** Comparison of functionalities of National Park apps with HKNP App

| Apps/characteristics          | Golden Gate | National Mall | Chimani | Yellowstone | Wikiloc | HKNP |
|-------------------------------|-------------|---------------|---------|-------------|---------|------|
| Qualifiers selection          | X           | ✓             | ✓       | X           | X       | ✓    |
| Recording a route             | X           | ✓             | ✓       | X           | ✓       | ✓    |
| Levels of accessibility       | ✓           | X             | X       | ✓           | ✓       | ✓    |
| Points of Interests           | ✓           | ✓             | ✓       | ✓           | ✓       | ✓    |
| Statistical analysis          | X           | X             | X       | X           | X       | ✓    |
| Alerts/notification           | ✓           | ✓             | ✓       | ✓           | X       | ✓    |
| Communication with management | X           | X             | X       | X           | X       | ✓    |

✓: Represents the availability of the function in the relevant app

X: Non-availability

Source: Authors' own verification from different apps

these also need to be purchased first, visitors have to hold a lot of pamphlets, papers, and wrapper, which is not convenient normally and especially in bad weather. The visitors require unique experience, comfort, safety, and guidance to accomplish their journey.

2. The limitation of the paper-based map is the non-availability of the current geographical location of the visitor; paper maps are limited to a certain scale and do not contain all the detailed information. The same is the problem with the visitors of HKNP; there are numerous different tracks that exist on the ground; once the visitors deviate from the proposed route from brochures/maps, it becomes difficult to navigate to the way back and way forward, as visitors always have limited time and such a situation creates panic among visitors that causes in devaluation to the visit of the HKNP.
3. At the moment, there is no tracking of visitors, which places are most preferred by the visitor, where they tend to stay more and how long they spend within the park? There are no guided tours in HKNP; the trajectories are made at the individual level. Current location function and data stored at the background help the administration in locating the visitors' location using coordinates. Currently, the park administration has no tool to calculate the number of visitors visiting the park.
4. At the moment, the park does not have an emergency response system to facilitate the visitors, for example, in case of fire, bad weather, and track closure, the only way to disseminate the information is via website or radio. But, there is no direct way to contact the visitors, to disseminate information directly especially to routine users. Similarly, if the visitors are stuck into a problematic situation inside the park, for instance, because of fire and attack by wildlife, the only way to get assistance is through a general response system.
5. The maps point to the estimated location of parking, in HKNP, which is also not precise. But, this is the case for the users who have already borrowed a map. All the other visitors have to found a nearby parking space.
6. Similarly, the current park does not have a specific mechanism to collect/store data (number of tourists, preferred routes, time spent, deviation from the routes, duration of stay, etc.) regarding tourists coming to the park. As protected area destinations strive to increase their share of the international and national tourism market, it becomes important to understand why people travel and why they choose a specific destination (Oh, Uysal, & Weaver, 1995).

The aforementioned problems and issues provide the basis for the development of HKNP app. The HKNP app along with the amalgamation of additional functionalities that were found missing in various apps (as mentioned in Section 2) also resolves the abovementioned current mobility issues in HKNP.

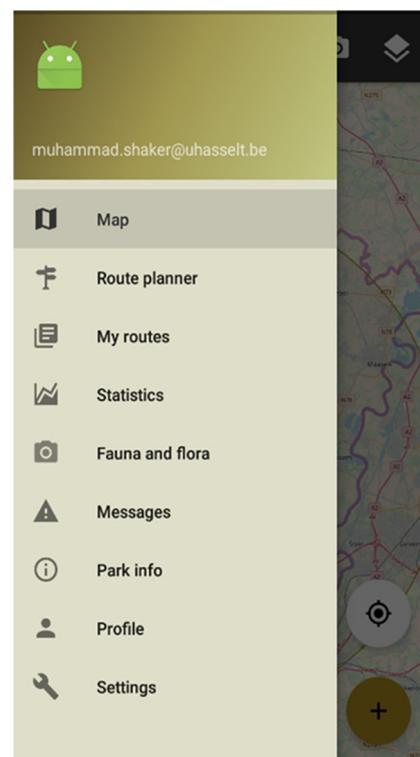
The app provides its users with one combine tool for all the six gateways of the park rather than purchasing maps separately for all gateways. Similarly, the HKNP app provides solutions for all other problems.

## 4 Functionalities of the HKNP app

The app has multiple functionalities. Each function is useful for the tourist, for the park management, or for both. The two most important functionalities are (1) create routes taking into account visitors' personal preferences and (2) register routes while hiking. The purpose of the app is to facilitate the hikers to explore the national park in an effective way with a bundle of facilities and guidance. Figure 1 displays the list of all the functions of the HKNP app, the usage, and their explanation can be found in the next sections.

### 4.1 Map of the park

One of the functionalities of the HKNP app is a map. This map function (Fig. 2) comprises of the boundary of the Hoge Kempen National Park with some detailed information like land use, road network, and regional boundaries. Other relevant information like entry points, parking spots, restaurants, picnic places, viewpoints, photo location, chapel, boardwalk, and play areas can be added as a layer over the map. The addition of multiple layers, i.e., parking spots, restaurants,

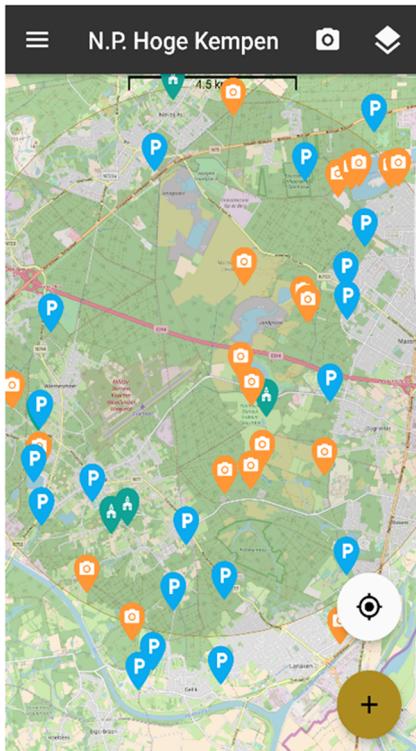


**Fig. 1** List of different functions of the app



**Fig. 2** Map of the Hoge Kempen National Park

and chapels, pinpoints the location of these points, as can be seen in Fig. 3. The map function is necessary for the navigation point of view within the park. The purpose of the app is to



**Fig. 3** Map comprising layers of parking spots, restaurants, and chapels

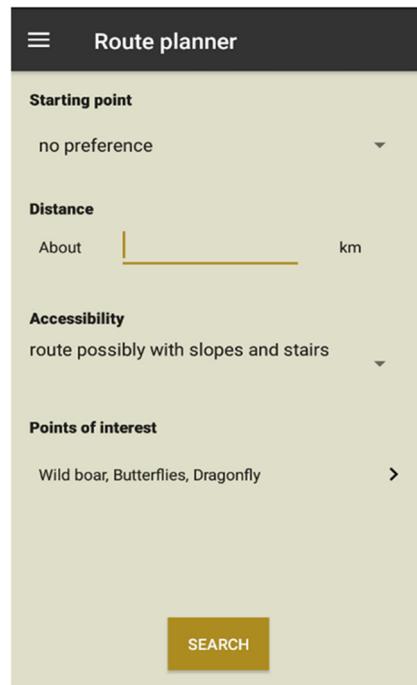
help the tourists, to make their journey more efficient by following the navigational pane.

It is not always convenient to make a hiking route by using a paper map; sometimes, it is even more difficult when the scale is small. The app will offer a digital map of the proposed route, as well as the walked/registered route so far. Moreover, zooming is possible.

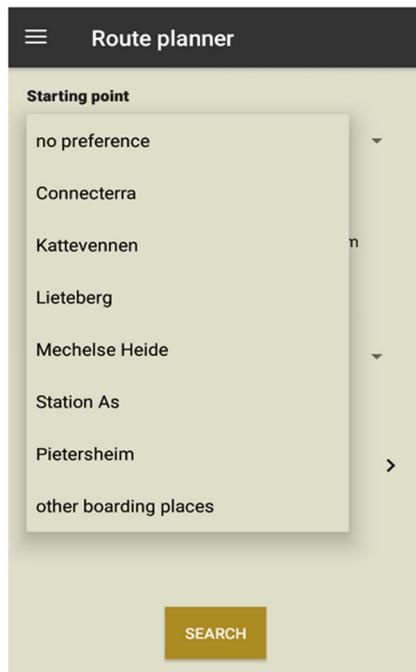
#### 4.2 Route planner

For visitors, it is not always convenient to move within protected areas, especially when they are unfamiliar with the natural area or if they want to explore new aspects. The effective mobility in an organized way is ensured by the HKNP app's functionality "route planner." The route planner allows the hiker to plan its trip, in advance before entering the park or on the spot. It comprises four constraints, 1–3 are hard constraints and the 4th is a soft constraint. The user can make a preference for these constraints and select an appropriate route for hiking. These four constraints are preferred starting point, distance, level of accessibility, and points of interest (Fig. 4). The first search criterion is the starting point. The user can select one of the mentioned entrance gates as a starting point from where he/she wants to start his/her journey (Fig. 5).

Once the hiker has selected its starting point preference, the second step is to select the distance. The visitors can select the approximate number of kilometers as per their desire, e.g., if a visitor wants to take a hike of 5 km (Fig. 6), the app will propose routes containing all the qualifiers and a distance varying between 4 and 6 km approximately.

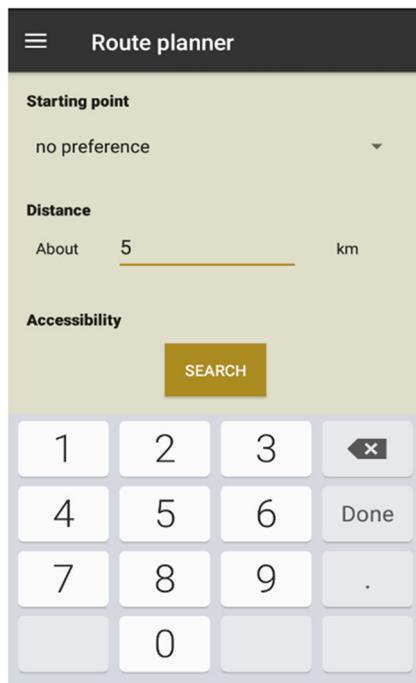


**Fig. 4** Selection of preferences



**Fig. 5** Selection of starting point

The third step in the route planner is about the pathway preference, which is related to the characteristics of the surface. The levels of pathways differ within the park, that is why the accessibility level is divided into four fundamental categories: (1) paved roads without slopes and stairs, flat terrain, (2) both paved and unpaved tracks but without slopes and stairs, (3) tracks with slopes, and (4) routes with slopes and stairs.



**Fig. 6** Desired distance

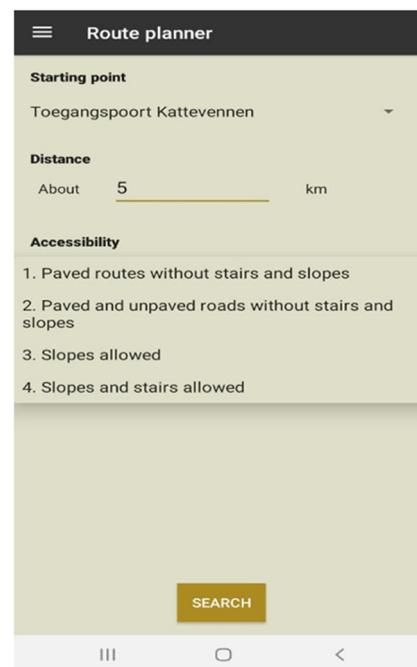
The user is free to choose the accessibility factor according to its interest and capability (Fig. 7).

The fourth step is a soft constraint related to the selection of points of interests (POIs). The users can select one or multiple POIs from the given list (Fig. 8). These POIs are a pond, spoil tip, brook valley, dragonfly, wild boar, picnic benches, thematic trails, etc. The natural landscape comprises of the forest, water reserves, green fields/meadow, and heath. Other points of interest contain lookouts, boardwalks, photo locations, picnic spots, and cafes (Fig. 8). So, it depends upon the hiker's preferences to select multiple options.

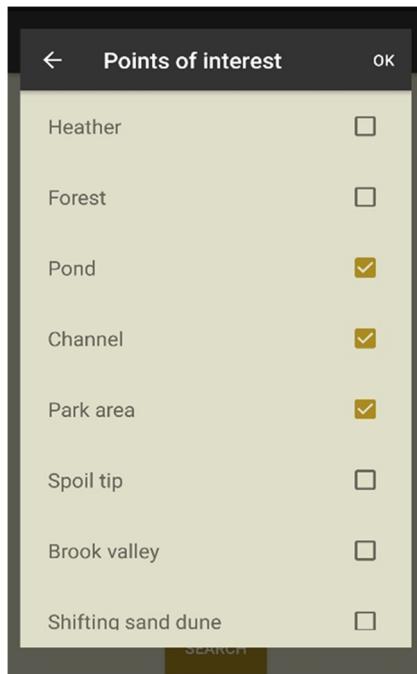
Once all the four criteria of the route planner are complete, the user is offered a list of multiple possible routes, including details regarding their main characteristics and their trajectory (Fig. 9). One can select and save the most preferred route and start the journey. The functionality of the route planner develops the route according to the tourist's interests and preferences. Being a hiker, it is the ultimate desire to explore more within limited resources and limited time. This function of the app will help the visitors of the park to save time and take a walking route that suits them best.

#### 4.3 Recording a route

Hikers can record their routes in the park. They can walk and record a random route as well as a route proposed by the app. There are two ways to register a route: you start hiking a saved search result (the recording starts automatically) or you start hiking a random route and press play. In the second case, the map will show the current location, and layers can

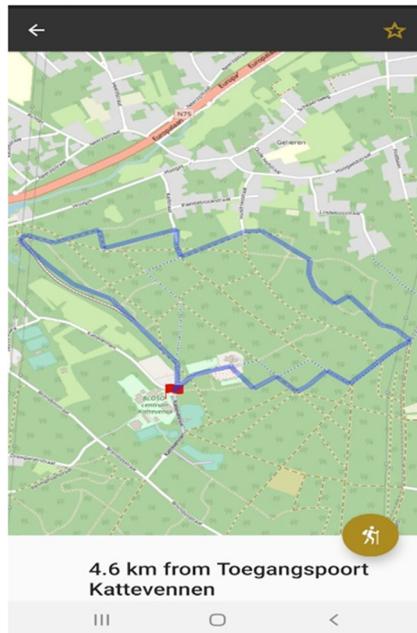


**Fig. 7** Selection of accessibility level



**Fig. 8** Tab for selection points of interests (POIs)

be added showing points of interest. And in the first case, the selected hiking route is shown on the map as well. When the hiker approaches a junction, a pop-up screen appears, indicating the correct waymarker. At the end of the hiking trip, the user can assess the route and share his/her experience on social media. During the hiking, the HKNP app screen displays the proposed route and an additional layer which shows the traveled route in the form of waymarkers. The visitors can also add layers for all the selected points of



**Fig. 9** Proposed route by the HKNP APP

interest over the proposed route. The current location of the tourist and colored shape waymarkers appear per segment during the route.

#### 4.4 My routes

One of the functionalities of the HKNP app is “my routes,” providing information about three categories of routes, i.e., favorites, featured routes, and history of routes (Fig. 10).

- The favorites represent the catalog of preferred/saved routes; a user can add routes from the proposed list of search results, by having a click on the steric icon of the selected route.
- The featured routes are also known as the seasonal routes which are promoted by the park administration.
- The third category of my routes is the history of routes. The history includes the routes recorded/registered by the tourist in the past.

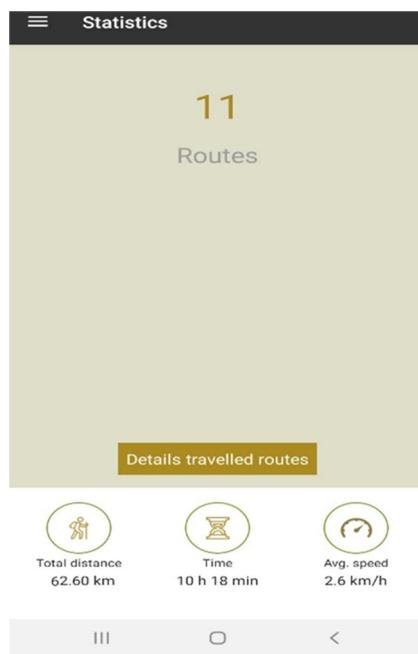
The routes saved in favorites and history can also be deleted by the user.

#### 4.5 Statistics

The related statistics about the traveled routes can be found in the statistics section of the HKNP app. The statistics comprise of the total distance traveled, the hiking time, and the average

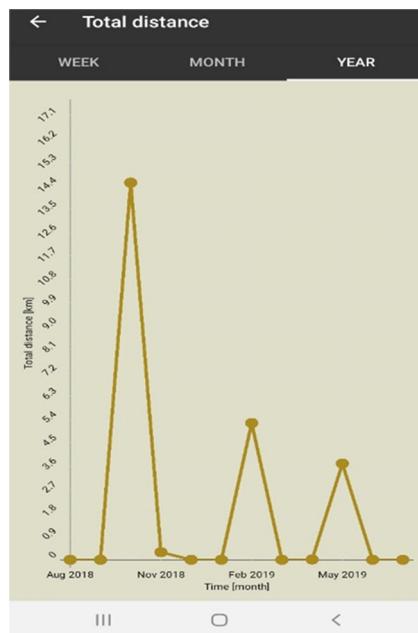


**Fig. 10** Different categories of saved routes



**Fig. 11** Different statistics with measurements and units

hiking speed of the individual (Fig. 11). This part is very fruitful for frequent users as they can analyze the improvements in their traveled distance, time, and/or average speed. Once the route is completed, the statistics are deployed into this section, and users can easily compare and improve accordingly. As far as the analysis is concerned, the user can make a comparison between all routes traveled, a comparison of distance, time, and speed of the latest route with the routes of the last (three) months to 1 year (Fig. 12).



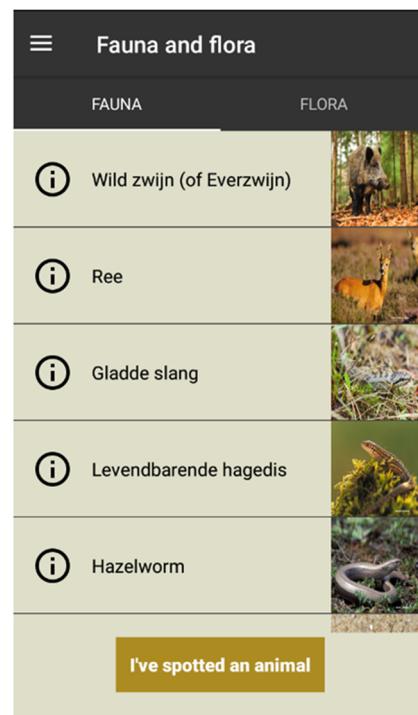
**Fig. 12** Total distance traveled

#### 4.6 Flora and fauna

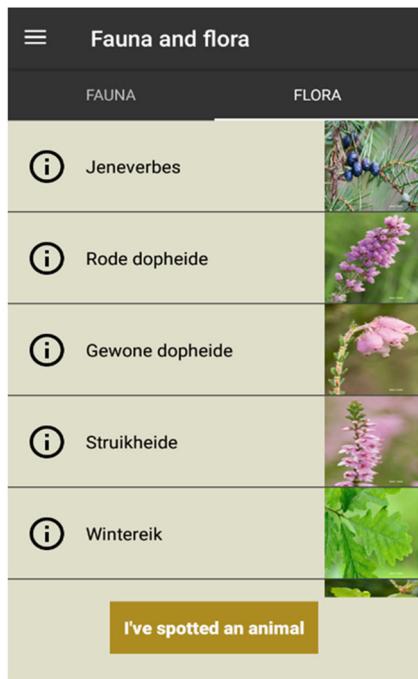
The app also contains information about the flora and fauna. At the moment, there are two tabs in this function of the app: fauna on the left and flora on the right. The fauna includes details about the animals, i.e., picture, description, the surrounding location where these animals are often found, and other important information like a family group, etc. The fauna includes the aforementioned information for the wild boar, roe deer, smooth snake, viviparous lizard, hazel worm, sand beetle, natterjack toad, swallowtail butterfly, nightjar, and saddle grasshopper (Fig. 13). The other part of this function comprises of flora, which contains information about plants, trees, and flowers. In the HKNP app, the flora part contains data related to juniper, red heath, common heather, heather, holm oak, *Quercus robur* (pedunculate oak), bell gentian, gale, and pine (Fig. 14). If the hiker comes across an animal, the app provides the opportunity to take a picture and save it to the list of the respective animal. In case the user is interested and not sure about the found species, (s)he can send that picture through the HKNP app to the staff of the HKNP to ask for the name and description of that particular flora or fauna (Fig. 15). The user can also share the picture on social media like Facebook, Twitter, etc. (Fig. 16).

#### 4.7 Messages

All kinds of information can be communicated to the user, and (s)he can also communicate back to the management of the

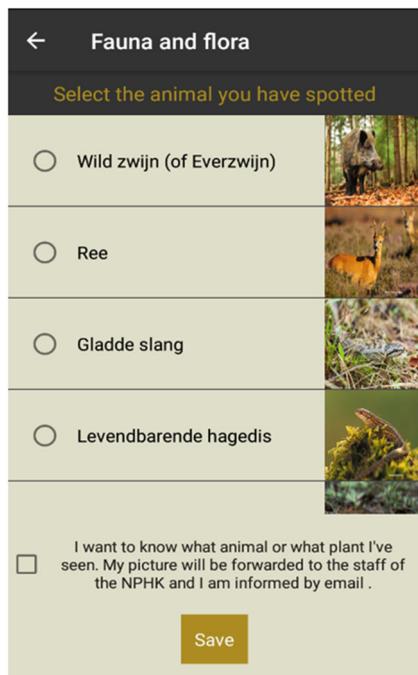


**Fig. 13** List of different animals (fauna)

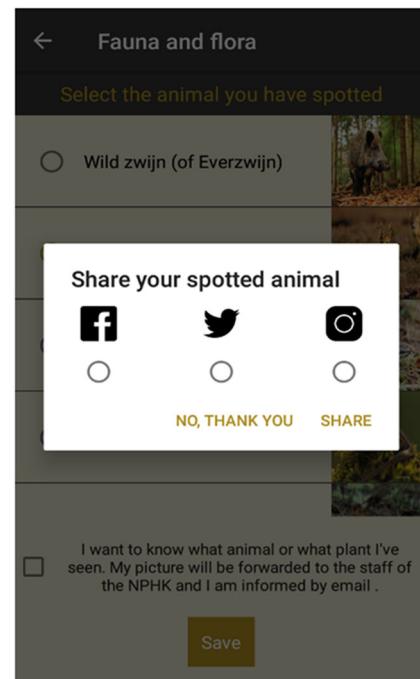


**Fig. 14** List of different plants (flora)

park. The messages will contribute to the communication between the park and the hikers (and vice versa). Possible messages are fire in the west area—please evacuate, something is wrong, alert, attention: bad weather warning, and heavy rain forecast (Fig. 17). The user can also give some feedback and suggestion themselves. The GPS location and time of the message are automatically sent to the staff of HKNP (Fig. 18).



**Fig. 15** Adding a picture and send email to inquire



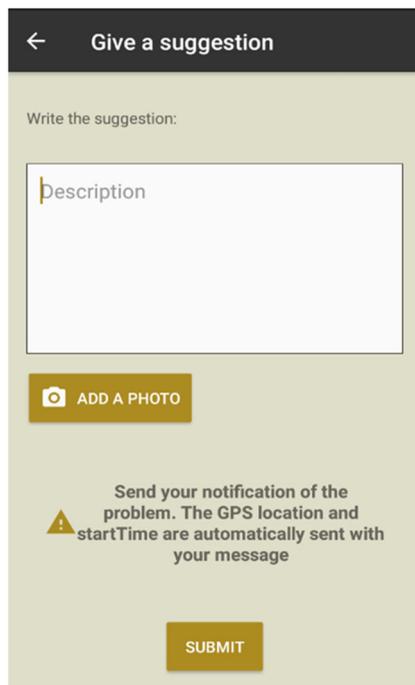
**Fig. 16** Save and share picture of flora and fauna on social media

#### 4.8 Park info

Hoge Kempen National Park is located in the province of Limburg in the East of Belgium. The HKNP was inaugurated in 2006 and covers six municipalities. The area of this national park is approximately 5700 ha, with a large diversity of habitats, including heathlands [4]. Hoge Kempen National Park's highest part has a height of 100 m. The highest part of the park



**Fig. 17** Display of different warning messages



**Fig. 18** Process to give suggestions

was developed by debris brought from the river Meuse by the Ardennes during the last ice ages. The era of coal mining changed the landscape and the way of life in the Hoge Kempen. The landscape is populated by a large variety of species. More than 7000 species find a home in the National Park. The park has six main entrance gates and around one million tourists visit the park every year. The park comprises of 210 km of hiking tracks, cycling, and horse riding tracks [4].

The Hoge Kempen National Park clearly has a positive effect on Limburg's economy. As per minimal estimate, it can be estimated that this park has a direct effect on the tourism sector. In 2013, 1,022,350 people visited the National Park; in comparison with the year 2005, there was a 47.5% increase in the number of visitors. The number of stay-over tourists has increased by 32% in the last 8 years since 2005. The direct turnover at the entrance gates also increased by 258.2%—the total direct turnover amounts to at least €23 million per year ("National Parc Hoge Kempen," 2019).

The park info function of the app provides the users with detailed information about the main gateways in the Hoge Kempen National Park, being Connecterra, Kattevennen, Lieteberg, Mechelse Heide, Station As, and Pietersheim. Furthermore, the layout map of HKNP and the contact information of the park administration are also included in the park info section (Figs. 19 and 20). Let us consider that one wants to know more about Kattevennen, by further proceeding into this icon, the app will display the famous POIs of Kattevennen, i.e., the recreational facilities such as the visitor

center Cosmodrome, the minigolf, the educational planets hiking trail, the playground, the nearby city park, catering, and bike rental (Fig. 21). More detailed information comprises of tariff details, opening hours, and contact information can also be found. The purpose of assimilating all the information within the HKNP app is that the visitors may find it convenient to know all the details about the protected area. However, if the visitor is still concerned about something, (s)he can always find relevant information on the website provided in the app or (s)he can make a phone call to a staff member of HKNP. The information to contact the HKNP staff is also attached to the function of the park info and can easily be found.

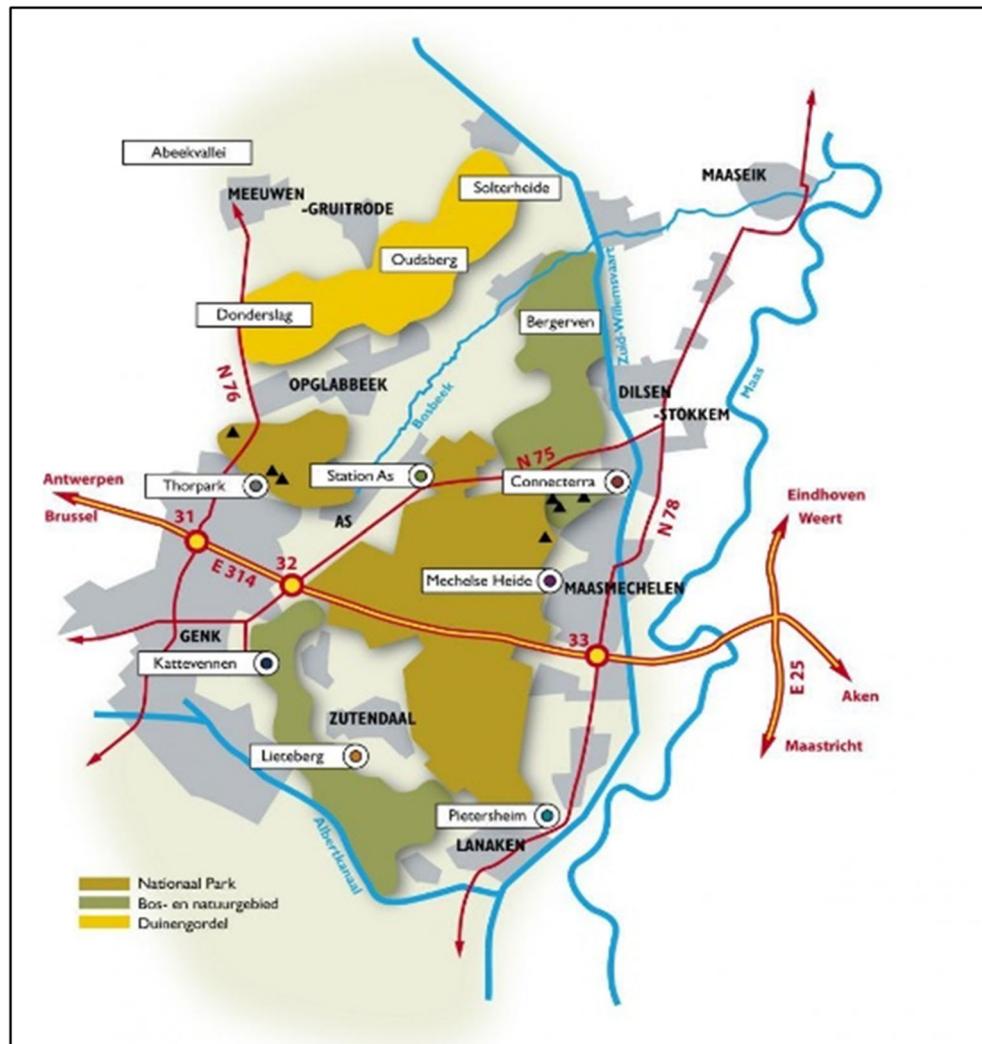
#### 4.9 Profile

It is mandatory for all users to create their profile. The user's profile includes details such as name, date of birth, gender, country, postal code, and email address of the user. The user also chooses a password to ensure security, which can be changed at any time.

#### 4.10 Technical details

The app comprises of an algorithm that determines the suggestion for several routes, also calculates the score for each route, and then makes the comparison of different routes based on its qualifiers (preferences or choices made by the users). Each of the qualifiers is given a particular score which is defined according to the suitability and relevance of the selected option. Once all the qualifiers obtained a score, the scores of all the qualifiers are accumulated. The route that gains the highest score appears on top of the proposed list and other routes follow respectively. After the determination of qualifiers and scoring, the algorithm presents one or more routes to the users. The route is constructed by finding a circuit (connecting to the starting point) in the network that involves as many segments as possible defined with a "preferred label." While defining the route, the circuit is managed in such a way that it aims to avoid crossing any link multiple times. The circuit only uses those links that meet the pathway level (accessibility) requirement, points of interest, and having a feasible length. When the route starts, the circuit is presented to the user using colored shape waymarkers, and these colored waymarkers are the shortest possible sequence of segments. Also, the network access is not guaranteed in the park; hence, all required data is downloaded to the phone, and the route-advisor algorithm is also run by the phone. On average, the algorithm takes around 2–3 s to find the feasible route as per desired qualifier.

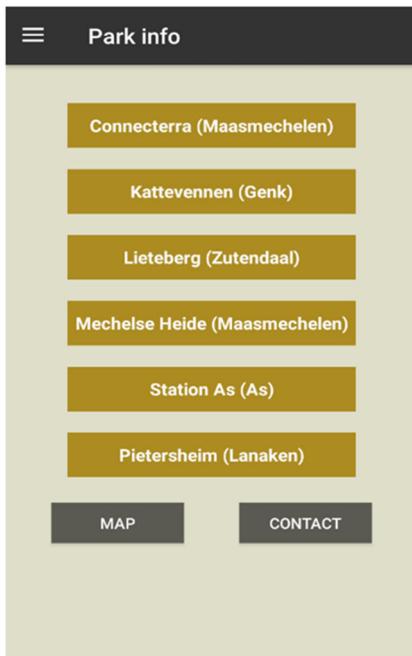
**Fig. 19** Map of the Hoge Kempen National Park (“National Parc Hoge Kempen,” 2019)



## 5 Methodology and research framework

The HKNP app is currently in use of experimental work to collect data from a test audience and real park visitors about the working of the app. The research methodology will be followed as follows:

1. Before launching the app to the common public, the first step was the detailed evaluation of user-friendliness and functionalities by an internal research community.
  - (a) The respondents were inquired about all the functions of the app
  - (b) The questionnaire contains questions, e.g., (1) Did the proposed route fulfill all the requirements, i.e., starting point, distance, pathway levels and points of interest (POIs)? (2) Was it convenient for you to find the registered routes from the section “My routes”? etc.
- (c) Other important attributes are also included in the questionnaire to determine the impact of the HKNP app on the mobility pattern, i.e., the added value of the app, social characteristics purpose of trips, and connection to nature.
- (d) The questionnaire contains responses in the form of “Yes,” “No,” and comments/remarks.
2. The questionnaire was being distributed to the internal research community, and responses were collected using Qualtrics (an online tool for questionnaire distribution and data collection).
3. A couple of important changes were made based on the comments and suggestions made by the research community, for example, addition of multiple layers on route and range of distance qualifier was also adjusted.
4. After the internal evaluation of the app, the evaluation of the app was carried out in coordination with the rangers of the park. Their opinion (gathered through another survey) is appreciated very much as well.



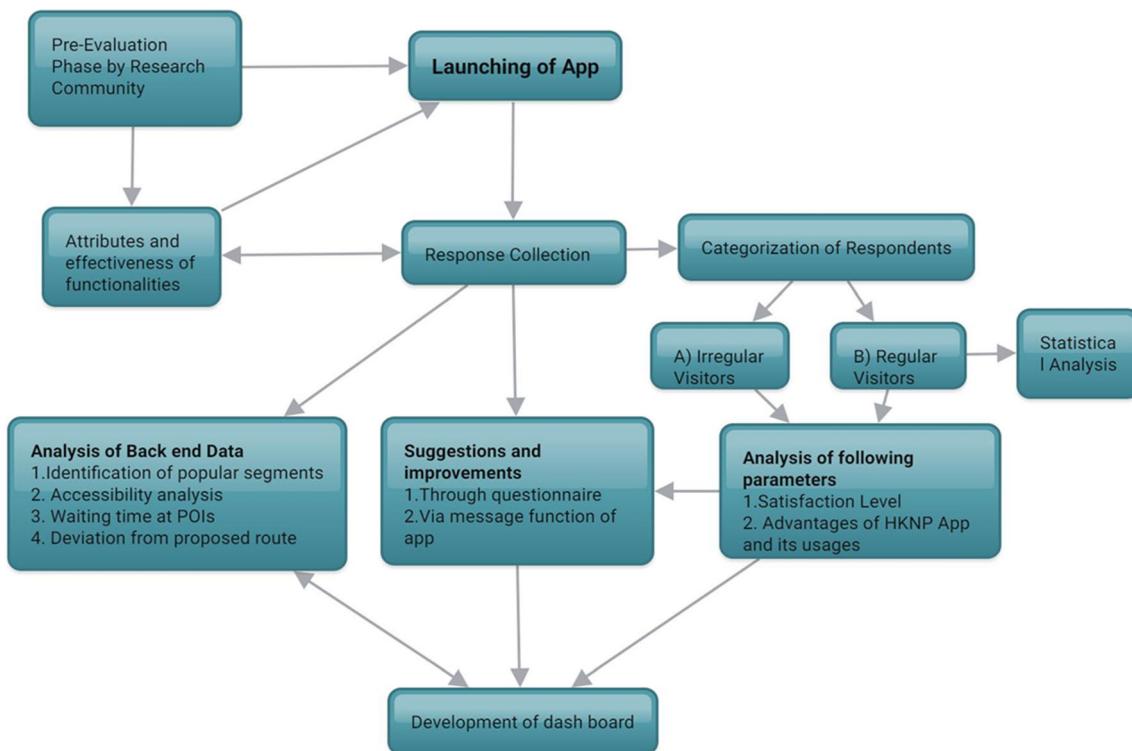
**Fig. 20** Information on different gateways to the park

5. Later on, the promotion was enhanced, and the response was collected from the general public to determine the added value to the visitors. Some of the responses are mentioned in Section 6.5.
6. Then, the questionnaire was distributed to the general public, and real-time experience of users was recorded via (1) responses collected through questionnaires and (2) traveled route information stored in the backend.



**Fig. 21** Display of points of interest of Kattevennen

7. The second part of the research is to analyze the traveled route information. Once the user travels around the park, the route information (i.e., route deviation, time to complete the route, and stopping places) is stored in the backend. The respondents will be categorized into two categories: (1) regular visitors (those who visit the protected area either daily, weekly, or monthly) and (2) irregular visitors (those who visit the park once a year). The purpose of the categorization of users is to identify visitors' behavior towards smartphone technology, assessment of adaptability to the app, identification of the number of users, and statistical analyses of time and speed for regular users. The detailed framework of the methodology is visualized in Fig. 22.
8. As the user starts its journey, the trajectory is saved and other data related to soft and hard constraints, e.g., points of interest, preferred distance, starting points, and desired pathway levels, are also stored at the backend. The following steps will be carried out to analyze the mobility pattern of hikers
  - (a) The traveled route information of various hikers recorded at the backend in the form of trajectories, points, lines, or polygons will be converted to shapefiles using coordinates.
  - (b) These shapefiles will be used in GIS and the traveled trajectories of different routes will be overlaid on satellite images to determine the mobility pattern, i.e., most preferred start points and segments, and deviations from the proposed route.
  - (c) The mobility patterns will be later used to predict the future routes, and weights to the qualifiers will be assigned as per the significance of preferred qualifiers by the hikers.
  - (d) Other parameters, i.e., traveled time, stopping time, and speed, will also be added to the shapefiles of traveled routes. These attributes will determine hikers' interests and the reasons behind stays. The results from the analysis can be utilized to improve the cleanliness, beautification, and infrastructure developments of stopping points.
9. The users are able to send their suggestions. The suggestions/messages (users can take a picture of flora and fauna and can also suggest the management to improve the cleanliness, quality of hiking, and beauty of the park) will be observed in detail, and practical solutions to necessary actions will be devised into future policy.
10. The last step is the development of a dashboard for park management. The dashboard will give a visual overview of the key indicators with respect to the usage of the app.



**Fig. 22** Detailed framework of the methodology

## 6 Pilot testing of HKNP app

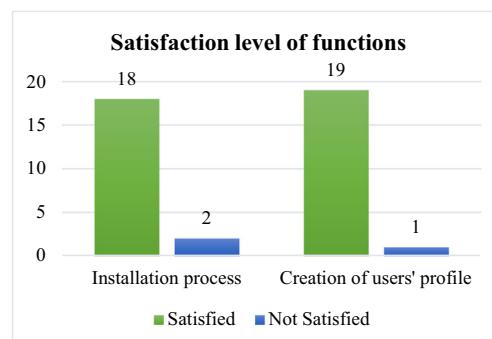
Before launching an app to the large public, it was found necessary to have detailed pilot testing so that hidden issues may be resolved. The HKNP app was shared among the internal research community and the students of masters in mobility, the University of Hasselt. The test users were given a brief explanation about the different functions of the app. Around 20 respondents took part in the pilot testing phase. The users were dropped at all the entry gates of the Hoge Kempen National Park, so that the utility of the app may be checked from all the access points. The test users were asked to test the app individually with different routes (routes of their own desire based on their preferred qualifiers). In order to estimate the utilization of the HKNP app from the test users, a questionnaire was prepared and was distributed among the test users/respondents. The expected response was based on the working of the different functionalities and overall satisfaction level of the app. The detailed analysis of the results obtained using the HKNP app is mentioned in Section 6.

### 6.1 Installation process and creating the desired route

The first question was about the installation process and making a profile using the HKNP app. The users were asked to highlight if they face any kind of distortion during the process of installation. Indeed, the stats show that 18 out of 20 respondents stated that it was quite convenient for them to install the

app on their smartphones. However, upon further clarification from the respondent, it was mined that there was some problem with the phone or either they missed some steps from the installation process. Secondly, it was also not difficult to create a profile as only one of the respondents did not feel comfortable while creating a profile (see Fig. 23).

The respondents were asked to create the desired route as per the selection of their own qualifiers (entry gate, level of accessibility, points of interest, and desired distance). During the test phase, the respondents deployed at different entry gates were further intimated to create a route using the route planner function of the app. Once the respondents selected the desired route, they were supposed to make a journey as per the planned route is given by the app. Based on the overall experience of the route traveled as per the planned route is given by



**Fig. 23** Satisfaction level of the installation process and creation of users profile using the HKNP App

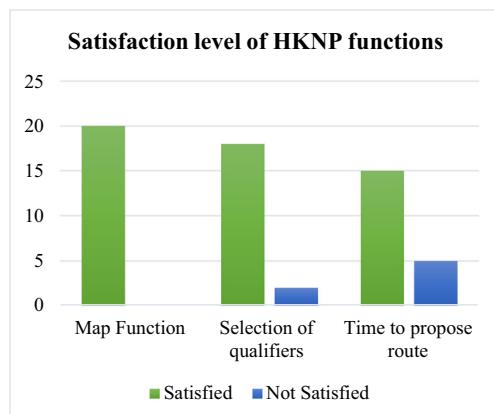
the app, the respondents were asked to intimate the satisfaction level of this functionality of the app. The respondents were asked to indicate either they were satisfied with the navigation system of the app using map function; it was interesting to know that almost all the respondents were satisfied with the map function of the app. Around 95% of the respondents were also satisfied with the selection of different qualifiers. It is estimated that once the user selects the desired qualifiers, the app generates the proposed routes within 3 seconds of the request made. Fifteen out of 20 respondents stated that the route was proposed within 3 seconds (see Fig. 24).

However, it can be concluded for the remaining 5 respondents, based on their remarks, that there might be compatibility issues of the app with the phone that app took a bit longer than the average time.

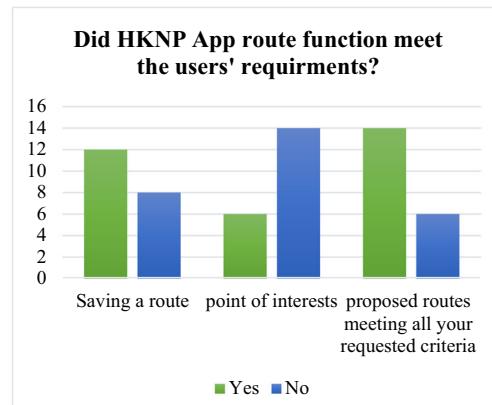
## 6.2 History of the routes and statistics function

The app proposes a route and based on these routes, the user can make a journey if the user finds the route as the best route he/she can register/save those routes. Once the routes are saved, it is more convenient to use those routes again rather than again completing steps in the route planner. Almost all the respondents were satisfied with the functionality of registering a route (see Fig. 25 and Fig. 26).

The most important function of the HKNP app is the statistical analysis using the HKNP app. The users can estimate and improve their average speed, traveled distance, and time function not only for one trajectory but also for all the traveled trajectories made in last week, months, or even in last year. The respondents were asked to highlight whether the app recorded different parameters, i.e., average speed. The respondents were asked to respond whether it was easy for them to understand the statistics and were they able to make a kind of comparison for their route. Figure 27 shows that 90% of the respondents stated that the app recorded the average speed, time, and distance. The response about the comparison of the routes is different as 45% of the respondents stated that they



**Fig. 24** Satisfaction of different functions of the HKNP app

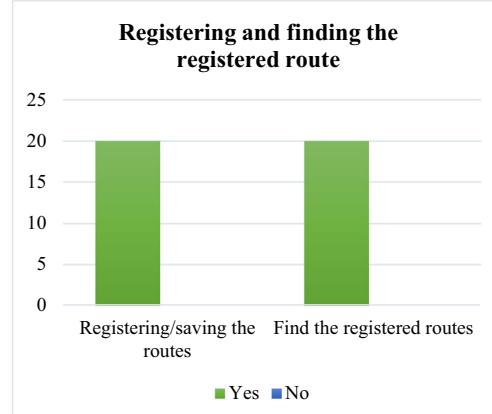


**Fig. 25** Did the HKNP app meet all the requirements while making a route?

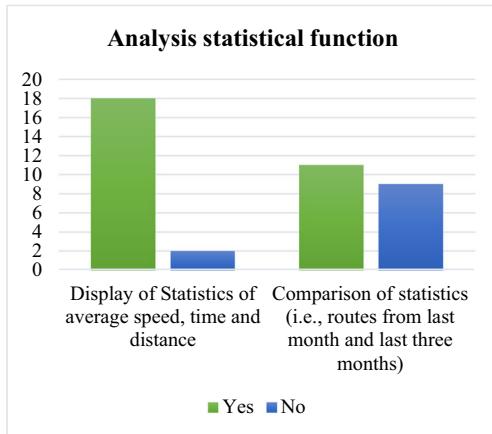
were not been able to make a kind of comparison of their routes, it is because of the fact that they used the app only one time. And for the purpose of comparison, the user needs to have at least two routes traveled using the app.

## 6.3 Sending/receiving messages, flora, and fauna information

The app has the functionalities that users can receive the messages from the managers' organization; at the same time, they can also send the messages back to the management. It was observed that 65% of the respondents said "yes" that they were able to send or receive the messages. However, it is worth mentioning here that to utilize the function of sending a message, the user is supposed to have connectivity with the internet. The respondents were also satisfied with the information provided about the six gateways of the park. Around 85% of the respondents stated that the information about the different parameters (i.e., point of interests, activities, or attraction, entry fees (if applicable), management contact for all six gateways) was helpful (see Fig. 28). The respondents were asked if there was detailed information (availability, approximate location, season, and volume) about the flora and fauna. It is quite



**Fig. 26** Registering the traveled route for future use

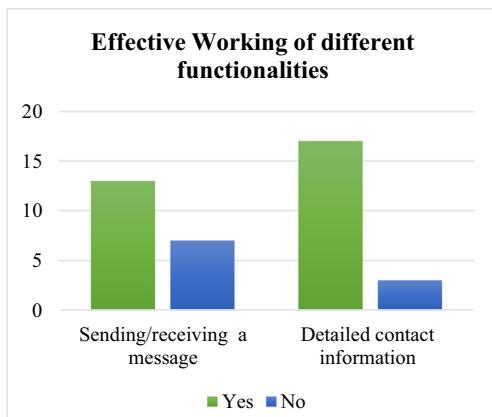


**Fig. 27** Analysis of different parameters using statistical function of the HKNP App

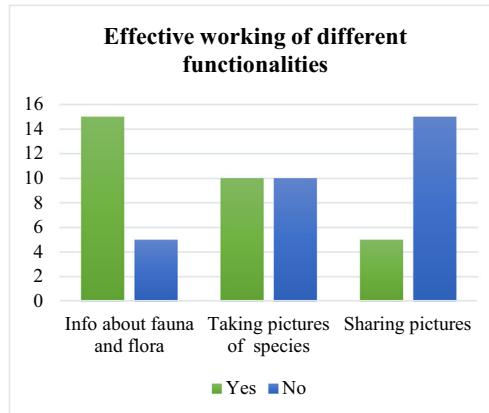
valuable to mention here that the users' perception about the contact information of the park was satisfactory as 75% of the respondents stated "yes" in response to the question asked. The app also provides the option to take the picture and share it on social media. The respondents were able to take the picture; however, only few were able to upload due to internet connectivity (see Fig. 29).

#### 6.4 Performance testing

From the users' point of view, 85% of the respondents were feeling comfortable using a smartphone while hiking or traveling around the park. There was a fifty-fifty response about the accuracy of the navigational pane. However, around 80% of the respondents stated that the app also consumes a battery when the mobile data is turned along; in other cases, the scenario is different. The users can also utilize the other apps along with HKNP. It would be of worth mentioning here that 18 out of 20 respondents stated that they were able to use other smartphone apps at the same time as they were using the park app (Fig. 30). In the end, 90% of the respondents agreed with the statement that the app will enhance the hiking experience (Fig. 30).



**Fig. 28** Effective working of the different functions of the HKNP App



**Fig. 29** Effective working of the different functions of HKNP the app

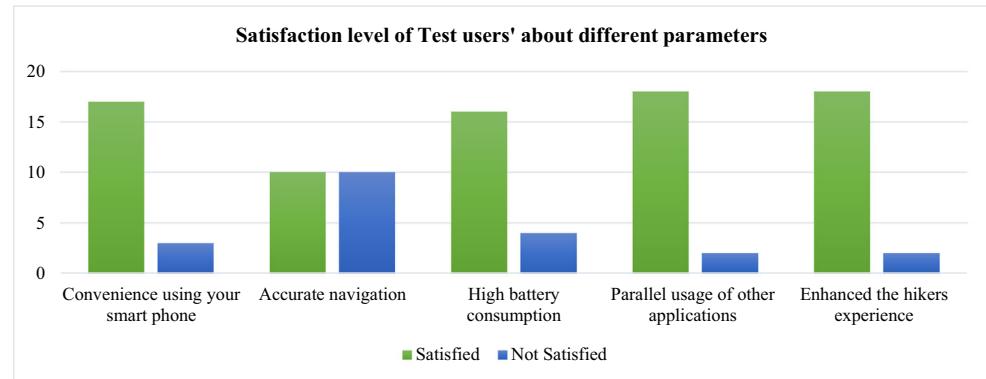
#### 6.5 Added value of the HKNP app

As mentioned in Section 5, another survey was carried out from the general public in which the app was used by the visitors. In total, 68 real visitors from the park participated in the research. The respondents were asked various questions using Qualtrics; the questions were about the functionalities of app, in addition to that few more questions regarding the added value of the app. The results of the questions are as mentioned. The respondents were asked: did you find the app as an added value for the experience of your visit to the national park? They were supposed to select "yes" or "no." It would be of worth mentioning here that 62% of the respondents considered the app an added value to their visit to park and 38% selected no. In another question, they were asked: do you think that using an app will disturb your connection to nature? Almost 48.5% of respondents stated yes, and 51.5% of the respondents stated that using the app will not affect the connection to nature. Around 70.5% of the respondents agreed on the point that app will enhance the mobility within the park; however, 29.5% did not agree with the statement that using the HKNP app will enhance the mobility within the park. The respondents were also asked another question: would you recommend the app to friends? The interesting fact is that 64.7% of the respondents stated that yes, they would recommend the app to their friends; however, 35.3% of the respondents stated no. The graphical presentation of the abovementioned results is shown in Fig. 31.

## 7 Discussions

An overall analysis of the results gives the impression that the working of different functions of app is in order. However, there are some issues that need to be resolved, for example, points of interest (POIs). The POIs are something that exists within the park and that has been executed into the app as per data given by the park management. The inclusion of the

**Fig. 30** Performance testing of HKNP app



maximum number of POIs with short distance cannot be made possible as the POIs are at various geographical locations having a distance between them, because the respondents want to explore as many as POIs within short distances. However, these POIs are nearby and sometimes, they are far away/at a longer distance. Indeed, the users have to enhance the distance qualifiers to a certain limit where he/she can find all the desired point of interests. The HKNP app contains all the POIs that are available within the park. The app has its unique function that users can compare the route parameters (average speed, time, and distance). Statistics function is much useful for the routine visitors, as they can improve the hiking experience.

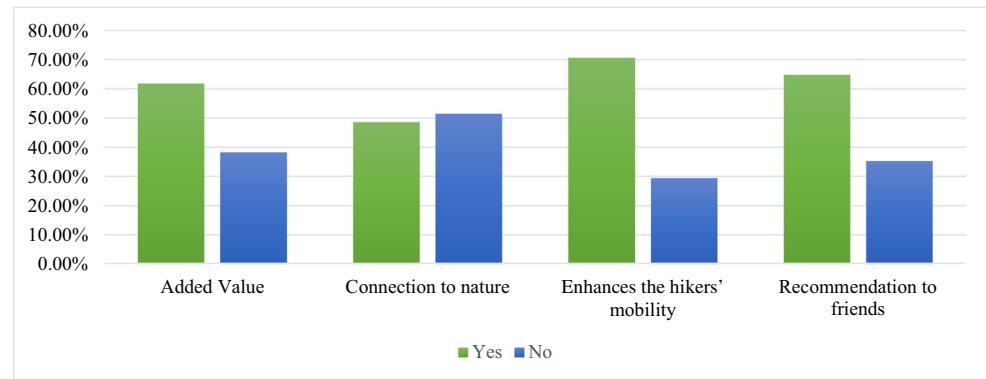
There were a couple of issues highlighted by the users, for example, there was a problem of sending a message to the management. The problem was because of the fact that they need to connect to internet; in other cases, the app users will not be able to convey the messages/suggestions to the management. Similarly, to share the pictures of different species on social media and also with the park management, the users need to be equipped with internet facility. It would be good to discuss here that respondents feel comfortable with the working of app, and they also felt convenient while making the trajectory using the app. However, the accuracy of the planned routes can be improved further, but for this purpose, there is a need to check/compare the available routes. The app works without connectivity to the internet except for few functions as

mentioned earlier, the mobile data. So, it is better to use the app without connectivity to mobile data as the app drains more battery with mobile data. Further, as per responses, the app did not crash at all; the app was working fine with different smartphones with having android versions. The respondents also considered the app an added value for their visit to the park, and more than half of the respondents also admitted that usage of the app will not disconnect them from nature.

## 8 Conclusions

Increasing demand for tourism, especially towards protected areas, requires a huge amount of attention to the mobility aspects within and around the protected areas. Management organizations are continuously working to facilitate visitors by developing a bundle of policies. But, their policies/strategies collapse when there is a conflict between the proposals by the management and desires of the visitors. To solve the conflict between these two aspects, the HKNP app has been developed. The app not only facilitates the visitors by providing them the best suitable routes comprising detailed information like points of interest and respecting the desired pathway levels and time. There is also a solution for the management to propose and plan policies in accordance with the visitor's interests. The app will provide an interface to collect the data about the visitors' trajectories. The data collected through the

**Fig. 31** Response collected from the visitors regarding added value of HKNP app



real-time information of the traveled route and selection of desired qualifiers can be utilized for future policies. Similarly, the management can communicate with the visitors and use this tool to gather feedback.

In comparison with other apps like Citymapper and Moovit, the HKNP app provides a route proposal for hiking for the visitors while moving within the park. The app proposes a variety of routes, and hikers can make a choice according to the availability of qualifiers. The users can get advantages of this app without having access to mobile data. The main beneficiary of the HKNP app is the hikers, as the app will serve as a guiding tool to complete the route in a planned way. The app facilitates the hikers to locate the points of interest in an advanced way so that time is saved. One of the advantages which is not inculcated in other mobility apps is a comparison of statistics. Hikers can analyze their average hiking speed, duration of one trip, and total distance covered. The function of statistics allows the hikers to improve their hiking abilities. Hikers can also share their trips and pictures of flora and fauna on social media. The combination of these aspects makes the HKNP app unique. There are multiple apps that provide the mobility facility and information about the flora and fauna but these applications are designed separately either for mobility or for other park features. The HKNP combines various parameters like efficient mobility, statistical analysis, bi-directional communication, and detailed information about flora and fauna. It is assumed that for the user perspective, it is easier to operate one app for different queries, rather than using multiple apps which is not convenient and might be vulnerable to the battery of the smartphone.

The managers can overview the trips per date and can estimate the frequency of the users, average traveled distance, duration of the trip, and variance from the route, await points (kind of attractions where people use to stay a lot), points of interest, and also the trajectory of routes. The data collected through the app will also provide information to develop and prepare an aggregated heat map of popular await points and will highlight the location of newly spotted flora and fauna. The suggestions and responses by the visitors will help the management to analyze and improve the quality of hiking trails, cleanliness of the park, the beauty of the walks, and signage. One of the advantages of using this app is that the managers can always communicate with visitors for park announcements, emergency alerts, event management, response to flora and fauna identification, etc. In the future, it is expected that the app will be connected to a web-dashboard which will offer useful insights. In addition to this, the pilot validation test of the app can be considered successful, and learning from that experience will be incorporated into the app for its further improvement.

The app is currently developed for the Hoge Kempen National Park (HKNP), Belgium. The scope of the app is expected to be broadened based on the acceptance level by

the visitors. In the future, the app is expected to have an inclusion of difficulty levels such as challenges to cross the hurdles/physical barriers within the park. The app is expected to be integrated with health parameters so that the users can also analyze their health parameters, i.e., heartbeat rate, intensity, and calories burned. At the moment, the app is only developed for android so the iOS version of the app will be soon developed as well. Finally, if needed, the geographical boundaries of the app will be enhanced, and a similar app for other protected areas can be developed. So, indeed, the future of the app will be “one App solution” to the hikers with a richness of information offering a richness of insights.

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