User experience requirements and interface design for the TouristHub trip planning platform

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Abstract. This paper outlines the user requirements and the design of the interface components and the interactions of the TouristHub web-based trip planning platform that aims to assist travelers in planning personalized trips. The paper concentrates in the research challenges and the methods used to elicit information from users and other stakeholders and thus construct a set of functional requirements for guiding the design of the platform. It also summarizes a number of use-cases and presents in detail the interface components of the TouristHub trip planning platform.

Keywords: trip planning; tourist trip design problem; interface design; interaction design; interface components.

1   Introduction

In the last few years, travelers and in particular tourists turn to web-based online trip planning platforms to consolidate the required processes and information for planning a trip [1–3]. In this regard technology takes an active role in the tourism industry, which makes travel planning and the promotion of tourism products more efficient. Trip planning online web platforms essentially are recommender systems which enable travelers to combine information, typically scattered across different online resources, in order to facilitate the planning of all aspects related to a typical trip, including: to identify interesting destinations, book transfers and accommodation, arrange day-by-day visits to attractions and activities, etc. [4].

Several factors play an important role for the design of trip planning platforms [5, 6]. These range from trip solving, route planning and navigating, recommending locations and services, to promoting offers and facilities related to the trip.

An additional significant aspect is the interaction with the interface of the platform. In particular, how design and development choices at a conceptual level, affect platform use and, therefore, decision making from the user standpoint [7, 8]. Some factors influence how users interact and experience platform content and offered services, including: the implementation of user-machine interactions and how these take place

at a physical level (i.e. interacting with different devices); the design of the graphical user interface; the modeling and presentation of the user preference controls and how these correspond to platform functionality; the visualisation techniques used for presenting data. These combined with the functionalities and features users expect from a trip planning platform [9], can potentially construct a framework for defining the requirements that provide a better tourist travel and trip planning experience.

The objective of this article is to briefly present similar platforms and online services for trip planning, present the research and design methodology used for this project and outline the user requirements and the design of the interface components and the interactions. The paper concentrates in the research challenges and the methods used to elicit information from users and thus constructing a set of functional requirements for the design of the platform. It also summarizes a number of use-cases and outlines the interface architecture of the TouristHub trip planning platform.

The paper is structured as follows: Section 2 gives a brief introduction to trip planning and the related web-based online services. Section 3 presents the TouristHub project objectives and gives a brief analysis of the platform's main features. Section 4 discusses the methodology and research steps followed for this project, describes the research with stakeholders for collecting and defining project's design requirements, provides an overview of the use cases and presents TouristHub's system overview, architectural components and interaction sequence. Section 5 presents in detail the design of the interactions, information and interfaces. Last, Section 6 concludes our work.

2 Trip planning and web-based online platforms

From a user perspective, trip planning is a dynamic activity that requires travelers to discover, categorize and make decisions by evaluating a substantial amount of information [10, 11]. It mainly interests people who aim at planning personalized itineraries but also local tourism operators and businesses that focus in promoting their tourism products and services through destination marketing [1, 12].

Commercial online platforms are web-based recommender systems that incorporate a number of functionalities, including location-based POI recommenders, tour routing, day-by-day schedules and guidance, etc. [4, 13]. These platforms request from the user to enter a set of simple parameters, such as destination and date, in order to initiate trip and route planning. The recommended plan can be later modified according to user's preferences. They typically support several means to configure the automatically proposed trip including various types of filtering and clustering algorithms that are incorporated depending on the user's input. They also offer access to a number of complementary services such as accommodation and transportation that are closely related to the realization of the recommended plan.

3   TouristHub: Project Description

This research work is carried out in the context of the TouristHub research project [14]. The focus of the project is to integrate today's fragmented online services aimed at visitors of tourist destinations (search / booking of tickets and accommodation, car rental, organized activities, etc.), which are offered individually by independent providers. This fragmentation makes it difficult to design a complete vacation package that includes solutions for all the key parameters of a tourist trip (accommodation, transport, places to visit, activities, catering, etc.). TouristHub is designed as an online 'one-stop' platform providing a comprehensive suite of tourism services, targeting both visitors of tourist destinations as well as other 'stakeholders' of the tourism value chain, such as tourism / travel agencies, other tourism businesses (catering, entertainment, retailers, etc.), tourism policy makers. In more detail, the main features of platform are:

- Design of comprehensive, personalized vacation packages which include recommendations for accommodation, transportation, organized activities, sightseeing, etc, including options for booking / buying.
- Delivery of promotional offers for local products and services by tourist businesses to tourist customers with an appropriate profile, when in proximity to the physical business site.
- Ability to re-use the platform's functionality in tourist / travel agency websites through affiliate programs.
- Assistance of tourism policy makers in data analytics.

The personalized vacation package design service of TouristHub comprises a solver which deals with a complex combinatorial optimization problem; essentially, a problem case in the family of the so-called tourist trip design problems (TTDP) [15]. The solvers of TTDP problems are typically heuristic algorithms that design tourist tours (one tour for each day of stay at the destination) which include visits in a series of points of interest (POIs), aiming at maximizing the tourist's 'profit' (i.e. satisfaction) perceived by the overall tour. TTDP problems involve many parameters and constraints (travel dates, opening hours of POIs, preferred means of transfer between sights, etc.) and belong to the class of NP-hard problems, i.e. very complex computation problems.

4   Research and Design Methodology

For the purposes of this project we followed a user-centered design approach, based on goal-directed process for designing and developing the TouristHub platform [16]. This research was accompanied by an iterative design process within a formative evaluation framework where experts evaluated functionality against a set of design requirements. Our research, design and evaluation were based on the general phases of user-centered design and involved the specification of: *Context of use* and the identification of potential users, *Requirements* and the identification of stakeholders' goals

that must be addressed, an *Iterative Design* of several solutions based on concept and prototype development, and the *Formative Evaluation* with expert users.

4.1 Research for defining design requirements

To define requirements, we adopt an approach based on object-oriented analysis and design with UML. The aim is to model the problem domain and produce strictly defined user requirements, which in turn will facilitate the next phases of the design process where detailed design and production of prototypes will take place. In this context, user needs are explored within a requirements analysis framework based on user grouping and data collection methods. In addition, use cases are identified on the basis of their verbal descriptions using user-system alternations. This will support the design team to identify user interactions and consequently the appropriate user interface components that need to be designed.

In particular, the requirements analysis methodology used in TouristHub, as presented in Figure 1, utilizes the above approaches and includes the following steps [17]: (a) preparation of system's request report; (b) requirements gathering; (c) definition of functional and non-functional requirements; (d) use cases; (e) definition of initial problem domain model.
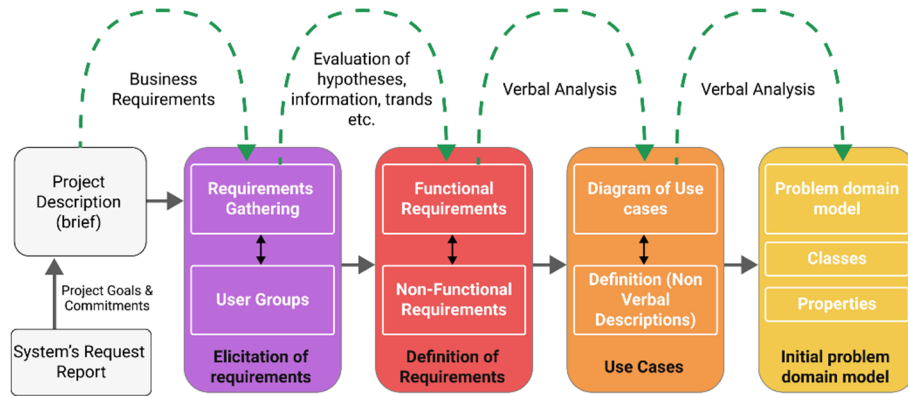

Fig. 1. Requirement analysis methodology for the TouristHub project

At the project's initiation phase, the system's goals, values and other commitments were obtained from the report describing the system's request. At the second stage of research we heavily relied in collecting and documenting information from potential users by recording their existing beliefs, attitudes, and behaviors. End-user requirements were collected through an online questionnaire and interviews. The Requirements Investigation Questionnaire comprised five (5) main sections, each of which contained several research questions as stated below. The sections were related to: (a) demographics (4 questions), (b) travel and holiday profiles (usual options or preferences) (9 questions), (c) online travel and tourism services (2 questions), (d) vacation packages (5 Questions), (e) personalized tourism services (4 questions).

The questions followed a 5-point Likert scale (1: Almost never - 5: Almost Always). In addition, some of the questions included an (optional) open answer text field. The questionnaire was completed in anonymous fashion, although it was possible for respondents to provide contact details (many did). The questionnaire was distributed to a targeted group of users, identified by the project partner's networks. The number of valid questionnaires received were 108. At a later stage, after the questionnaire sessions were complete, fourteen (14) respondents were selected to be interviewed, in order to interpret and further elaborate on their answers.

4.2 TouristHub Functional Requirements

The functional requirements of the TouristHub platform were generated from business and user requirements. Business requirements were described in the approved technical annex of the project and are not discussed in this paper. User requirements were gathered with questionnaires and interviews with user groups identified from partners' networks. Functional requirements were modelled from the user perspective with UML use cases. This section presents the elicitation of user requirements and their specification in terms of UML user cases.

4.3 User requirements gathering

The requirements gathering questionnaire consisted of five segments about: demographics, profile about trip and travel, use of online trip and travel services, preferences about holiday packages and personalization. All questions were modelled into a five-point Likert scale. Most questions allowed respondents to insert comments, if they wanted to; many did so for some of their answers. The questionnaire was distributed online for the period of approximately one month to approximately 500 users identified from the project partners' network. A number of 108 valid questionnaires were analyzed. The participants were 47% men and 53% women. In addition, 14 interviews were made (7 women).

Regarding the participants profile, we report on the following characteristics:

- Half of the participants (50%) were in the age group 41-50, another large percent (42%) were in the ages of 31-40, and fewer (6%) were in the 18-30 age group and a few (3%) within 51-65 years old.
- Most participants (52.6%) reported that they travel mostly 3-5 times per year, while another 44.7% travel 1-2 times a year, and the rest travel more than 5 times per year.
- Many participants reported that the average duration of their trips is 4-7 days (89.4%).
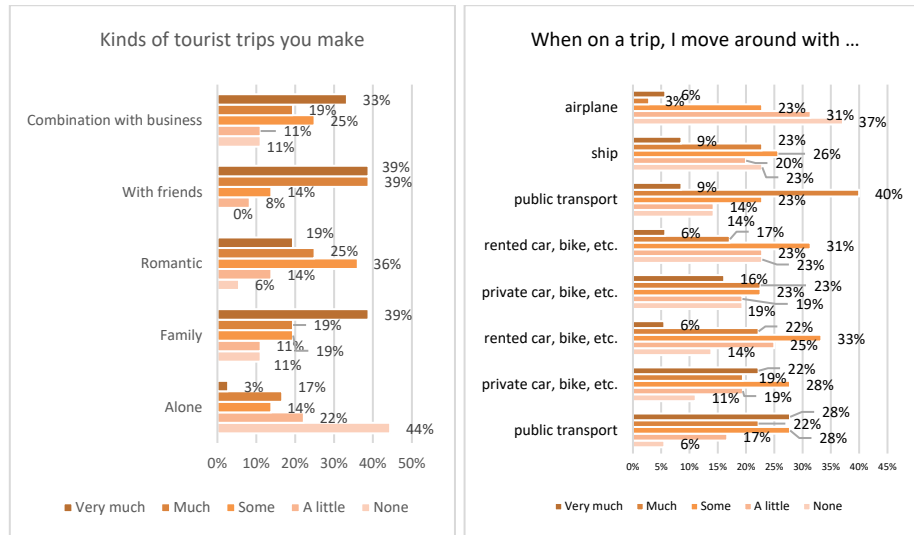- Most participants make business trips (78.5%) which last 1-4 days.
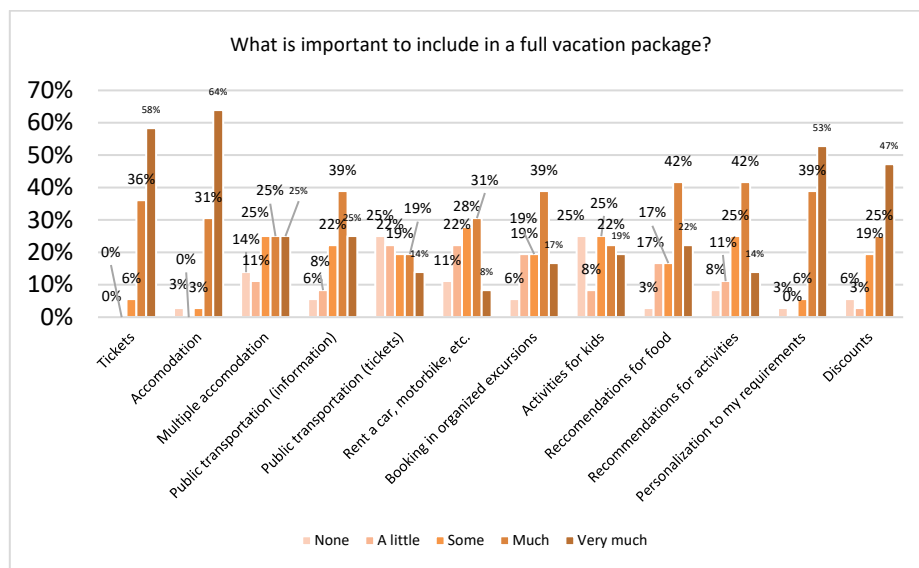
Fig. 2. Travelers' visit preferences

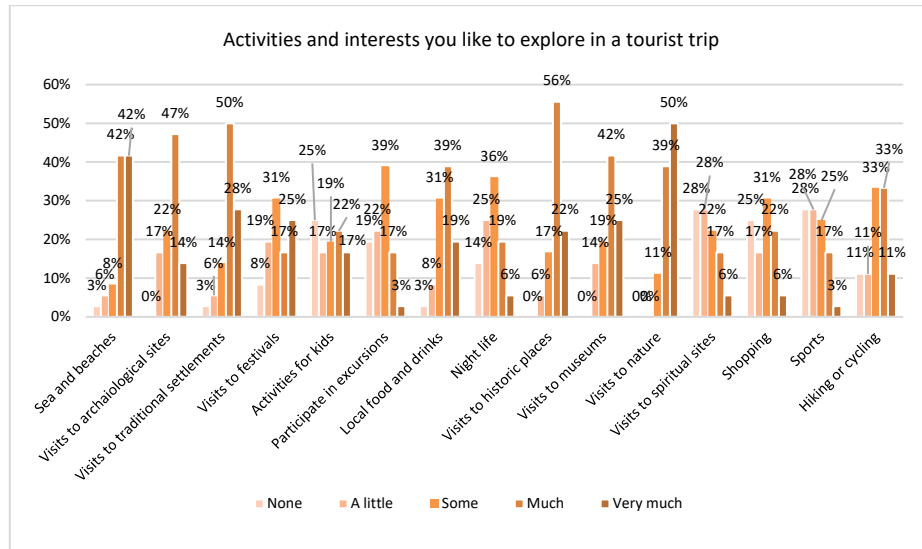**Fig. 3.** Traveler's vacation package preferences

Fig. 4. Travelers' activities and interests when on a tourist trip
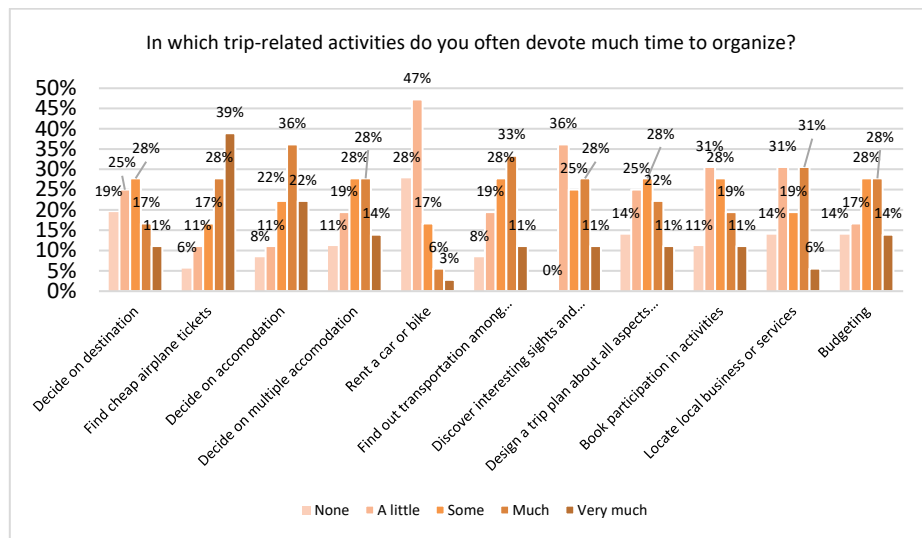

Fig. 5. Travelers' trip related activities and time to organise

The survey on user requirements investigated several issues about user preferences on travels and trip planning (Figures 2-5) such as types of trips and duration, whether the participants use online travel services, tourist guides and trip planning services, their preferred means of transportation within a destination, preferred types of activities, whether they would pay for a trip plan or package, etc.

The most important conclusions from the requirements survey and interviews can be summarized as follows:

- Participants visit a lot of sites around one or two destinations; they don't often change accommodation but move from/to it, during the day.
- Most participants move with public transport or rented car.
- Most participants use various online services for tourist planning, but they do not often use existing tourist planning platforms and recommendations.
- The most important elements of a tourist package are tickets, accommodation and personalization of preferences about trip planning, activities and costs.
- Most participants would book most elements of a vacation package, especially if there was increased demand or if it was cheaper. "I would pay for something I can't afford to miss, for example the Disneyland, and not for something I could replace."
- Most participants argued for some flexibility in booking activities and sightseeing, e.g. "I might want to sleep more or stay more at a place and alter my day plan."
- Most respondents would like mobile access to the tourist planning platform through a responsive web site, and "not another mobile app".

4.4 Overview of the TouristHub use cases

The modelling of functional requirements included UML use case diagrams, presented in Fig. **66**, and tabular, textual descriptions that were analyzed from the user perspective in the form of alternations between actions of the user (or another actor) and responses of the system (or a subsystem). Each use case description allows the writeup of user scenarios and the design of simple mockups. The functional requirements of the TouristHub platform consist of these use cases and their textual descriptions.
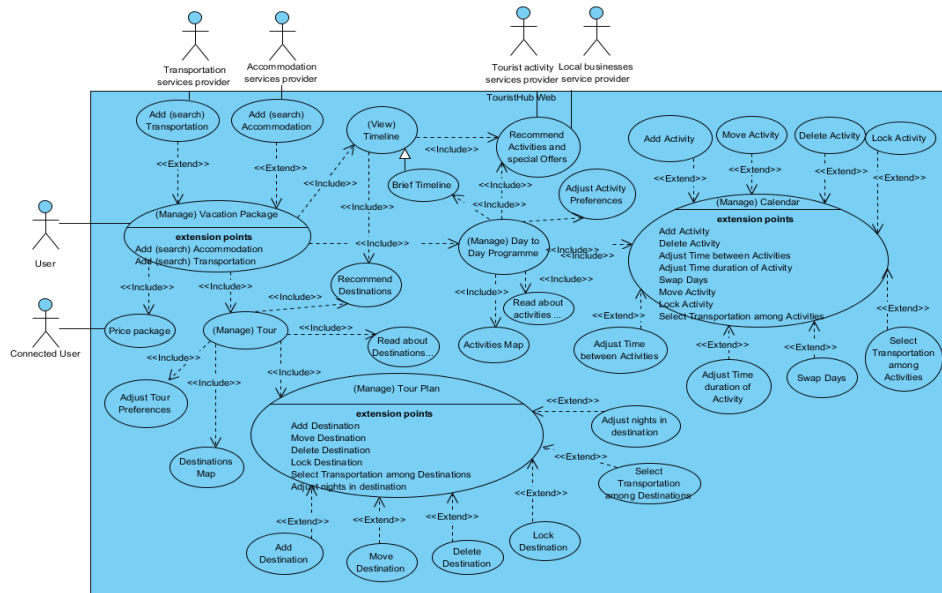
Fig. 6. UML use case diagram of the TouristHub platform

The TouristHub Web is the central point of user access to all trip planning services and it follows responsive design principles to allow access from mobile devices. The main areas of functionality of the system include:

User connection.

Tourist Hub users may be connected or not (anonymous). Connected users will have access to the full functionality of the platform, which can also provide better recommendations in this case.

Search for vacation package.

The user can search and book for accommodation and transportation for one or more destinations (within the same trip). The user can insert various preferences and constraints gradually including traveling persons and their ages, budget limits, etc. Furthermore, users can also provide preferences about activities and styles. The search process gradually develops a vacation package for the user, which includes detailed schedule and activities, as well other recommendations, considering user preferences and constraints.

Manage tour plan.

The user can manage the tour plan at two levels of detail: for all days (overall) and for a single day. When managing the tour plan, the user mainly manages different destinations of the tour and transportation connections with emphasis on public transport.

Manage calendar.

The user can manage the activities per day in more detail than that of the tour plan. In the calendar the user manages the details of the package with emphasis on activities.

For management of other tour plan and calendar, for each user-initiated change, the system must re-calculate the plan or calendar according to all related constraints. If the activity cannot be set exactly as the user requires (e.g. due to transportation unavailability) the system must be able to find a close alternative.

4.5 TouristHub system overview, architectural components and interaction sequence.

The TouristHub platform is a web service that can be accessed from a web browser through its responsive interface. The system overview, as presented on Figure 7, consist of the user interface, a trip planning engine, a route planning engine and a database.
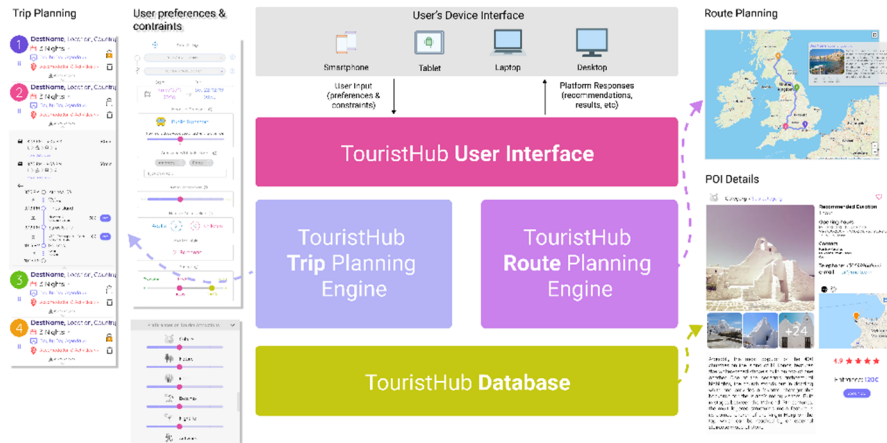

Fig. 7. TouristHub Platform Overview

The high-level sequence diagram of the TouristHub platform presented on Figure 8 depicts main interactions among architectural components. This sequence diagram describes how and in what order the various objects of the platform function. The main components are, the TouristHub User Interface (UI) which represents the front-end interface that the users experience; the TouristHub Trip Planning Engine which is responsible for handling user requests that refer to the planning and customization of a trip plan; the TouristHub Route Planning Engine which is responsible for handling route related requests (i.e. route directions either between subsequent stop-overs where the user stays overnight, or among POIs included in a daily plan); the TouristHub Database which is responsible to handle all database queries.
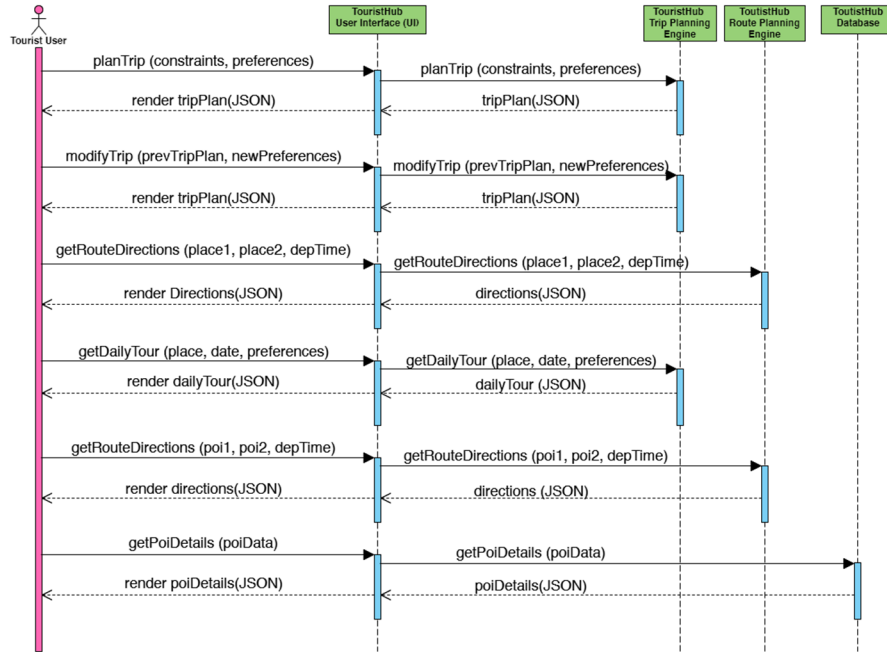
Fig. 8. TouristHub UML sequence diagram

From the user perspective the TouristHub Trip Planning Engine makes use of a number of factors to plan a trip. This acts as a trip recommender system that requests some basic data from the users including Trip Data and User Preferences.

Trip Data can be described in terms of:

- Arrival Location, where the trip will start from,
- Departure Location, where the trip will end to,
- Trip Dates indicate the arrival / departure dates, therefore, the total trip duration,
- Number of Stopovers indicate the number of in-between stops that the user is willing to accommodate,
- Means of Transport indicates preference for using either to Public or Private transportation.

User preferences can be outlined in terms of:

- Vacation Style includes: Culture, Nature, Food, Beaches, Nightlife, Activities, Historical Places, Religion,
- POIs preferences indicate user preference on particular POI categories (e.g., museums, archaelogical sites, monuments, nature, etc)
- Budget data represents a rough indication of the budget the user is willing to spend (Economy, Moderate, Luxury).

5 Interactions, Information and Interface Design

Emphasis was given on a number of interface design strategies for interface design and layout. For the purposes of this project, the design team followed interaction design practices according to the guidelines given by Responsive Design and Material Design for the web and the mobile responsive interfaces of the platform. Based on the Information Architecture and Information Design that the research team provided, interaction and interface designers considered the following factors in designing interactions and structuring the interface: general interaction/interface design goals, organization of interface elements, ordering and categorization of data and content, navigation flow, interface aesthetics and visual style, typography, dimensions of interface elements and webpage sizes for the different scenarios, web user interaction styles based on well known design guidelines that provide familiarity in terms of web experience. Special importance was given to the *Search, User Preferences* and *Route planning components* as they represent the main user interaction with the platform.

5.1 Interface Design and Interactions

A number of interface concepts have been designed and prototyped. The aim of the early (low-fidelity) and late (high-fidelity) concept prototypes was to confirm that the proposed design concepts complemented the use case scenarios. The prototypes enabled the design team to determine whether the proposed concepts were usable matched the mental models of the users and reflected the conceptual models of the designers.
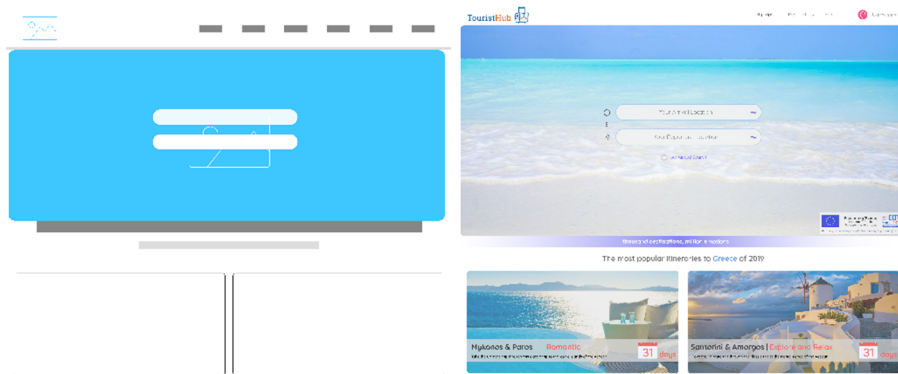

Fig. 9. Wireframe and high-fidelity representation, respectively, of the TouristHub main interface

The low-fidelity prototypes in the form of wireframes are presented on left of Figure 9 and were used at the early stages of the concept development. These had low visual fidelity and no content or interactivity. The purpose was to support early experimentation mainly by evaluating the organization of interface elements, the ordering

and categorization of data and content, provide information architecture validity, and assist on the screen layout design that followed at a later stage.

The next prototyping stage included the construction of high-fidelity prototypes. These were visually identical to the final concepts and included all interface elements, spacing, rendered graphics, etc. The prototype content essentially simulated the existence of the actual content that will appear in the final design, thought it was static. During the final prototyping stage interactivity components were designed to simulate actual interactions and respond to basic user testing scenarios.

5.2   User Interface Templates, Components and Interactions

In order to speed up the design process the design team developed the TouristHub UX/UI kit. This worked as a reference point for all collaborators in the design and development teams. It included the User Interface Templates, Components and Interactions. From this kit a shareable group library was also assembled in order to give to everyone in the design and development team access to the reusable UI elements. The structure of the library included interface elements of various types: arrows, avatars, banners, buttons, color reference palettes, dropdowns, footers and headers, forms and settings, icons, modals and alerts, sliders, tabs, toasts and tooltips. It also included higher level components such as destination components, location components, route components, navigation components, simple and advanced search components, and user preferences components.

User Interface elements.
The UI elements, presented in Figure 10, have been designed in order to be reusable across the different use cases and device-oriented scenarios (e.g. desktop, web-responsive, mobile etc). There are two main aspects related to the design of reusable components: a) The Master Element, which defines the properties of the Element, b) The Instance, which is a copy of the Master Element that be easily reused in different cases. Elements are sharable among the different scenarios and together with Interface Templates have been stored to the sharable library. It is important to note that in order to accelerate the design process, Element Instances are linked to the Master Element, so that any changes made to the Master Element be propagated to all related element Instances. This functionality has been provided by the Figma interface design tool [18] and added flexibility in the process of applying changes to the design.
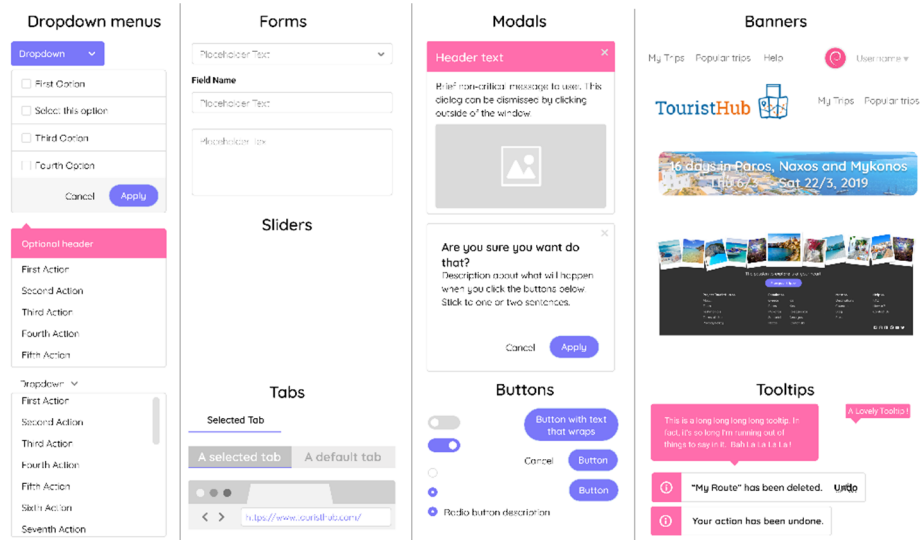
Fig. 10. A sample set from the user interface elements used in TouristHub platform

Search component.

Many recent studies of user's search behavior online reveal that users initially tend to search using the simplest query they consider at the time [19, 20], and if they fail to find what they look for, it is probable that the quit searching and possibly never return to the website [21]. It is important to note that the way the interactions take place and their timing are crucial for both the user and the system. While users are interacting with the interface the trip planning engine has to perform a number of expensive computations at the background. Therefore, timing is a very important aspect as the interface, in order to be acceptable, must respond in close to real time without stressing the planning engine. The Main Search Component has been designed with balance between simplicity and functionality in mind. Initially the search component is presented as an autocomplete form where users can input arrival and departure locations (presented on the left on Figure 11). Gradually, as the user inputs constraints and preferences and gets in return basic feedback from the system, the interface evolves to provide more interface elements (Advanced Search Component) that in turn request more input from the user without frustrating him/her.

The SearchTab Component is then accompanying the user in the respective pages that follow and provide full functionality for customizing and altering the initial preferences and constraints (presented on the right on Figure 11).
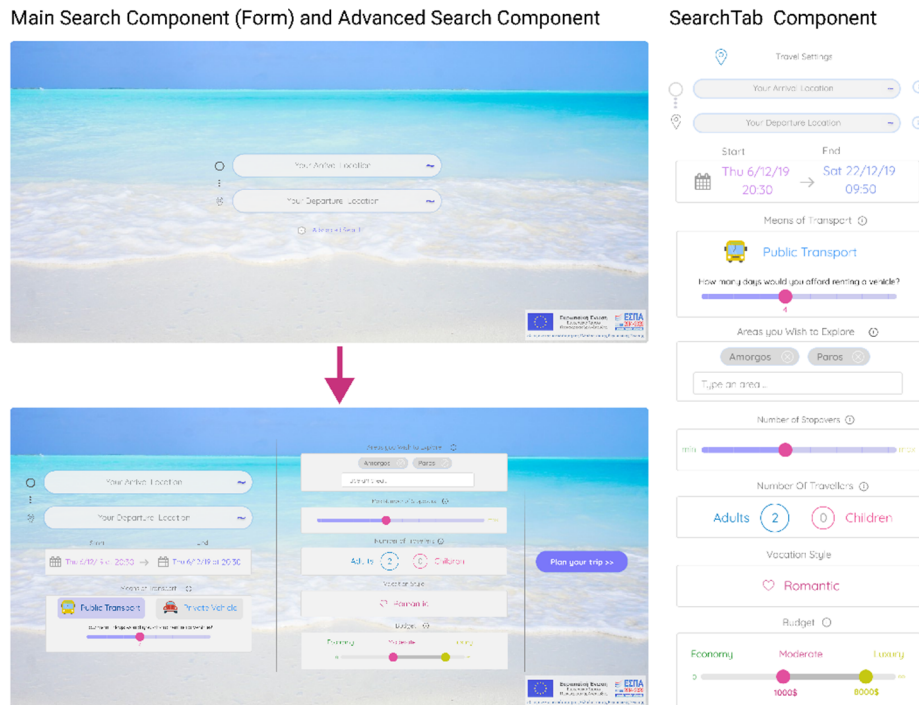
Fig. 11. Main Search and Advanced Search Components (left). SearchTab Component (right)

User Preferences component.

The User Preferences Component provides a simple mechanism to customize constraints and preferences related to both Organised Activities and Tourist Attractions. The Organised Activities Component is a tabbed component that provides functionality for customizing the organized activities. As such it offers the ability to set dates and budget, as well as capabilities to book an activity or cancel. Tourist Attractions Component appears in the form of sliders so as to provide a quick and easy to understand interface for the user. The slider bars are based on the Material Design guidelines for discrete sliders and reflect a range of non-numeric values of the form: not-interested – very much interested.

Route Planning Component.

The Route Planning Component, presented on Figure 12, offers the core functionality for planning and customizing proposed routes. It assimilates a number of different mechanisms in one component and it is based on two sub-components the Destination Component and the Navigation Directions Component. Its basic functionality is to present a number of stopovers in the form of timely ordered destinations. The Destination Component displays the destinations name and details, the duration of the visit and also affords a Day by Day Agenda, Accommodation and Activities, lock and delete mechanisms. The Navigation Directions Component is presented as an expand-

able component and provides basic navigation guides and affords the booking of tickets on the displayed transportation services.
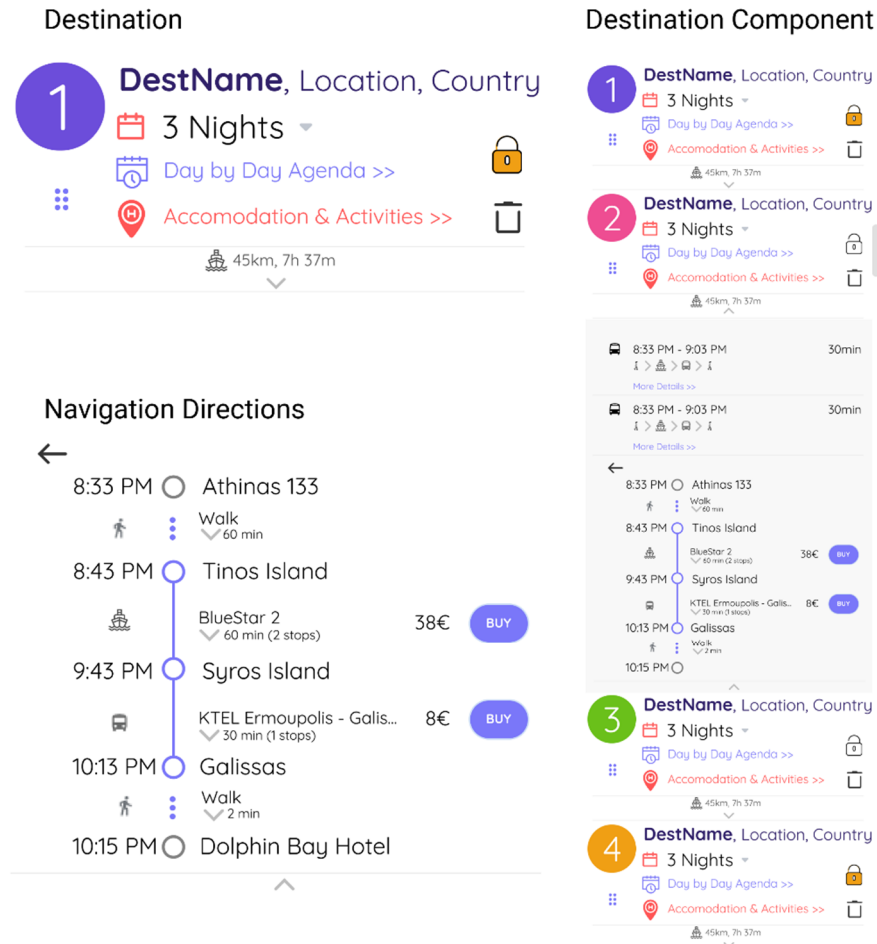

Fig. 12. Destination Component, Navigation Directions Component and Route Planning Component.

6 Conclusion

This paper presented the user experience requirements and interface design for the TouristHub, an interactive tourist trip planning platform. The paper provided a brief review of the related concepts to trip planning and presented in detail the research decisions taken for the design of the platform. It focused in describing the research challenges and the methods used to collect information from users and other stake-

holders and provide research findings that led to the outline of design requirements. It also presented the interaction and interface design considerations and provided a brief overview of the various components that structure the main skeleton of the user interface.

7 Acknowledgments

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