TouristHub: User experience and interaction design for supporting tourist trip planning

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***Abstract*—In this paper we present the design of the interactions and the user experience of a web platform that aims to assist travelers in planning personalized trips based on personal user preferences and constraints. The paper emphasizes the design challenges and the methods used to elicit information that led to the outline of design requirements. It also presents the design considerations and the prototyping processes from low to high fidelity prototypes of the user interfaces.**

Keywords: trip planning; tourist trip design problem; user experience; interaction design; interface design.

I. INTRODUCTION

Trip planning is a complex process that interests both travelers who aim at planning a personalized itinerary, and local tourism operators and businesses who focus in promoting their tourism products and services through destination marketing [1], [2].

In the past, travelers approached trip planning by mixing traditional and electronic means for compiling information (guidebooks, websites, word of mouth and social media), as well as by using personalized electronic tourist guides (PETs) and various trip planning software tools. In the last few years tourists heavily rely on online trip planning software platforms [2]–[4]. In this regard technology undertakes an active part in the tourism industry, which makes travel planning and the promotion of tourism products a lot easier than ever before. Platforms that combine all relevant information about a specific area and thus allow the promotion, creation and scheduling of personalized tourist itineraries bring forward significant advantages for all involved stakeholders.

Trip planning online web platforms essentially are recommender systems which enable travelers to consolidate 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. [5]. They also act as a tool to promote destination marketing and support the local tourism sector.

A number of key topic issues arise in the design of such platforms [6], [7]. One of the most critical ones relates to user interaction, i.e. how design and modeling choices affect the actual platform use and, therefore, decision making [8]. Several factors influence how users interact and experience platform content, including: the implementation of user-machine interactions; the design of the 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 objectives of this article is to review the state-of-the-art in trip planning s/w tools, with respect to both commercial tools and research prototypes; provide a critical analysis of the key challenges involved in the design process of trip planner platforms; report on the methods used to elicit design requirements and discussion of the prototyping process for such tools, using as a case study the trip planning platform developed in the context of an ongoing research project [10], [11]; provide insights in designing interactions and user interfaces with user experience.

The remainder of the paper is structured as follows: Section II presents the TouristHub project objectives and gives a brief analysis of the platform's main features. Section III provides a review of related research projects and the main features and functionalities of commercial platforms. Section IV provides a summary of the design guidelines and the framework which constitute the background of our research. In particular, it discusses research issues related to the development of design guidelines specifically targeted for the design of our tourist trip planning platform. Section V is about the methodology and research steps followed for this project. Section VI describes the research with stakeholders for defining project's design

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requirements. Section VII summarizes the processes for designing interactions and establishing the expected user experience. Last, Section VIII concludes our work.

II. Project Description

This research work is carried out in the context of the TouristHub research project [10]. 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) [12]. 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.

III. Related Work

In this section we provide a review of related research work and projects ranging from personalized tourist guides, to mobile applications and web platforms.

Personalized electronic tourist guides assist travelers in creating tailor-made tourist routes according to a list of personal preferences including interests and requirements about their visit such as arrival and departure dates, accommodation, POIs, etc. The main functionalities of PETs are to recommend POIs, to generate a route for them based on custom algorithmic approaches, and to offer customizability over the results in order to provide a better user experience in terms of user needs and preferences [13]. These guides are based on a variety of architectures, therefore, their implementations differ depending on the actual infrastructure used. In terms of end user / traveler interface, they provide a mix of desktop and mobile native application setup.

Lately, online approaches are also designed [14] based on advanced smart tourism technologies for trip planning [3]. These web-based software technologies offer trip planning functionality and incorporate a set of basic capabilities similar to PETs by generating personalized trip guides while also advancing the overall user experience towards an enhancement of travel satisfaction. What differentiates current platforms from PETs is a result of multiple factors including, the advances offered by modern technologies and the additional functionalities afforded in terms of software, service, hardware and networking, as well as because of the emergent approaches in designing systems and interfaces.

Internet technologies have impacted the travel and tourism industries in a profound way [15]. The use of smartphones initiated a paradigm shift in content delivery and service access from users. In turn, functionalities of web browsers (HTML5) are continuously enhanced to act as thin or thick clients to cloud-based services and thus offer rich capabilities that assist the development of online smart tourism applications and services. These include a number of advances such as offline application caching, client-side database storage, geolocation support (GPS, A-GPS, WiFi-positioning, cell triangulation), multimedia playback and streaming, augmented reality, etc. [16]–[18]. Cloud-based recommender systems for trip planning enable data availability, data redundancy, information security and accuracy [19]. They are scalable and expandable software services using internet technologies that allow personalization, real-time functionality and synchronization of trip planning data across multiple contexts of use [20].

In addition to solving the TTDP, current platforms provide a consistent user experience to their users across devices and contexts of use in complex and challenging scenarios. Current platforms that provide a complete tourist trip planning experience, implement recommendation mechanisms, real-time tour planning and routing, as well as day-by-day trip planning, how-to-get-to-POI directions and promotions of relevant services.

Existing trip planning systems have been developed either with as research prototypes or as commercial platforms. Here we review both the commercial platforms that are freely accessible on the web as well as those in scientific literature. Based on search criteria that include the keywords "tourist", "trip planning", "user experience", "interaction design" and "user interface" we collected more than 50 papers from Scopus and Google Scholar database and selected 18 for our review. Accordingly, we identified 12 websites from commercial platforms and reviewed the user experience and interaction design of four (4), those closely related to the criteria we developed for comparing tourist trip planning online platforms and services (see Section IV).

Research papers that deal with user experience, interaction design and tourist trip planning can be divided in three major categories: those with focus on identifying functionalities of trip planning recommender systems [9], [21], [22]; those that develop methods and frameworks for creating and evaluating interactivity of trip planning applications [8], [22]–[29]; research works that review, present and evaluate implementations of tourist trip planning recommenders, platforms and applications [5], [20], [30]–[36].

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. [5], [37]. 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.

IV. Design Guidelines and Framework

User experience and interaction design in online trip planning does not only relate to the layout of the user interface of a typical website. It is a complex activity which involves several user tasks, from organizing and planning a trip to receiving route guidance and recommendations in real-time. Therefore, for the analysis of the design of such platforms, a focus on these expected functionalities of the trip planning activity must also be incorporated to inform the design process. For this reason, based on desktop research and literature review of related research papers, we compiled a set of expected functionalities and guidelines that will assist us to develop design guidelines specifically targeted for the design and development of our tourist trip planning platform.

1) *Expected Functionalities of Trip Planning Platforms*

According to Vansteennwegen and Souffriau [9] the planning functionality users expect from a platform to afford includes: *Personal interest estimation* which quantifies the interest of a tourist for a recommended POI, service or activity. *Selection and routing* to automatically present a route based on user data and preferences such as current location, destination, timeframes and constrained schedules. *Mandatory POIs* that represent "must see" destinations based on the preferred route/trip. *Dynamic recalculation* of the trip and route in real-time in the case of deviation from the one originally designed. *Multiple day decision support* to enable planning that spans several days of stay at the destination. *Opening hours* of facilities and services related to POIs. *Budget limitations* based on the preferred maximum and minimum amount of money the users are willing to spend. *Max-n Type constraints*, i.e. allowing users to specify the maximum number of certain types of POIs (e.g. art galleries), per day or for the whole trip. *Mandatory types* of, at least one, destination POIs to be included based on specific user preferences (culture, sightseeing, entertainment, leisure, etc). *Weather dependency* in order to consider weather forecast. *Scenic routes* in order to consider following proposed routes with high scenic interest by calculating short deviations from initial plan. *Hotel selection* to automatically support accommodation services. *Public transport* to automatically support route planning by proposing multiple types of transport means (public transport, car, walk), calculate distance and time as well as cost when travelling among different POIs. *Group profiles* to enable trip planning functionality for groups of people with different and possibly conflicting interests, personal preferences and constraints.

2) *Guidelines from Cognitive Load Theory*

It is important to note that while the list of expected functionalities that a tourist trip planning platform should afford, remains open-ended, there is a limit to the presented information and the cognitive load that a system should pose to its users during the actual interaction [38]. Following a user-centered paradigm in designing interactive systems and services, the information that can be elicited from the users must remain minimum, especially during the initial stages of interaction where users try to familiarize themselves with the platform.

The user-centered design principles associated with improved human performance [38], should be also considered for the user interaction design. Therefore, the design of the interactions should leverage from users' experience, knowledge, and engrained behavioral patterns. It could also adapt to users' behavior and preferences and provide support to users' natural and flexible multimodal communication patterns. In order to minimize system errors due to unintentional interactions, the design of the interfaces should transparently guide users' input. Moreover, the design of the interactions should minimize cognitive load associated with user content manipulation and input. Implementing interactions based on users' existing experiences, rather than attempting to introduce new ones is also considered a good practice that simplifies interaction flow and amplifies usability. The design should also incorporate representational mechanisms as part of the interaction techniques (e.g., linguistic, diagrammatic, symbolic, numeric). Of primary importance it also to minimize cognitive and sensory load associated with peripheral complexity of system output, for example unnecessary features and functionalities that distract users' attention when interacting. Finally, the design should focus on minimizing interruptions coming from distracting system features or explicit system interruptions (pop-ups, overlays, unnecessary tasks etc.), which weaken users' ability to focus, comprehend and interact with the important information presented through the user interface.

B. *Usability and interactivity guidelines in trip planning systems*

Following the set of guidelines proposed by Pu et al. [24] for evaluating usability and interactivity of recommender systems, Pugacs et.al. [8] compiled a framework, which is based on seven criteria, in order to compare and evaluate the functionality of interactive route planning applications in tourism. These criteria are defined on a two-level distinction, tour-related and POI-related preferences. Criteria such as total trip time, budget and means of transport belong at the tour level, while user preferences about the destination or specific

point locations belong at the POI level. They also identify that there are certain preferences that can possibly correspond to both levels such as time constraints, or temporal restrictions for visiting individual POIs. The seven criteria for preference elicitation in interactive tour planning can be summarized as follows:

1) C1 – Flexible expression of preferences is about avoiding rigid schemes for preference elicitation from users and thus allow users to enter data without restrictions posed by the interface. The platform should respond even in the case that data is entered in a different input order than expected. In the case of trip planning, mandatory POIs and category preferences can be elicited from the users in an incrimental fashion rather than requiring them up-front. At the tour level, the platform should only require the destination and trip duration, leaving other more specific user preferences to be elicited at a later step.

2) C2 – Example-based reference elicitation is about using simple examples that either facilitate novice users in gaining fluency with the core platform functionality, or providing them with ideas in the case that they are uncertain about their choices regarding tour planning. At the POI level the platform suggests POIs to be included to the planned trip while at the tour level the platform suggests a number of alternative pre-built tours.

3) C3 – Preference lookahead is a recommender mechanism that proposes to users alternative new preferences that can possibly expand the currently selected trip scenario. At the POI level the platform is suggesting a list of POIs from different categories not previously explored while at the tour level it compiles a partial tour that can be further customised by the users themselves.

4) C4 – Conflict resolution is about indicators that the platform can implement through its interface in order to alert the users for potential conflicts that occured because of their preferences or the active constraints. At the POI level the platform should indicate the specific POIs that are affected as well as the specific platform rules or mechanisms that are violated. At the tour level the platform should explain to the users the reasons that make the current tour impossible exist and provide them with suggestions to solve the conflict.

5) C5 – Trade-off transparency is a criterion that aims at providing awareness to users about conflicts related to their preferences that in turn affect the quality of the proposed recommendation. At the POI level for instance it should present budget vs. quality indications for different POIs. At the tour level it should offer a good overview of the difference in terms of budget, transportation and categories.

6) C6 – Result presentation is a criterion associated with the complexity of the displayed content for each user request and is related to the context of use. At the POI level the presented POIs should follow responsive design guidelines so as to adapt to specific devices. The same applies at a tour level where only one complete tour can be shown on mobile devices while several can be presented on a desktop computer setting.

7) C7 – Explanations are about providing basic information that, in a simplistic way, reveal to the end user the mechanisms implemented by the recommender system. For example, at the POI level, through the interface the platform should present the corresponding preferences that influence the selection, by visualising POI scores and highlighting mandatory POIs. At the tour level the platform should provide visual cues about the preferences that influenced the specific recommendation.

C. Incorporate user emotional response

As the interaction progresses and based on fact that the demand for more functionality increases the interface should respond accordingly in order to afford user needs and requirements. This minimally affective behavior along with the traditional HCI usability and accessibility design practices, establishes important qualities of user experience (UX) as it contributes in the improvement of the user's personal attitude towards the platform.

V. Research and Design Methodology

The current research, design and development practices in interaction design and usability engineering provide a pluralistic multi-methodological framework in designing and developing trip planning platforms and their interfaces. For this project we followed a user-centered design approach, based on goal-directed process for designing and developing the TouristHub platform [39, p. 2010]. This research was accompanied by an iterative design process within a formative evaluation framework where experts evaluated functionality against a set of design requirements (see TABLE II). Our research, design and evaluation were based on the general phases of user-centered design and involved the specification of:

a) Context of use, where we identified potetial users, what they will use the platform for, and under what conditions they will use it.

b) Requirements, where we identified any stakeholder goals that must be addressed for the product to sucessfully fullfill user needs and goals.

c) Design solutions, where we iteratively designed and built concept prototypes ranging from low-fidelity to high-fidelity that simulate the final platform functionality in terms of user interfaction, visual design and workflow.

d) Evaluation, where we planned and performed usability tests at various levels throughout a formative evaluation process. At this stage, we performed in-lab evaluations with expert users based on high-fidelity prototypes.

VI. 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 [40]: (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.

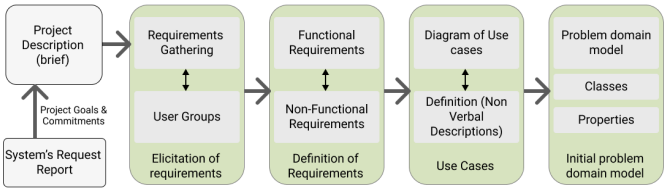

Figure 1. Requirement analysis methodology for the TouristHub project

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.

A. Elicitation of user requirements - Results

Based on the questionnaire sections the results were as follows.

a) Participants: The sample was random and balanced between male 47% and female 53%. Half of the respondents (50%) were between 41-50 years old, while 42% were between 31-40 years old. A small percentage of respondents (6%) were between 18-30 years old and a 3% were between 51-56 years old. It is emphasized that there was no prior focus on a particular demographic profile. Finally, 7 men and 7 women participated in the interviews.

b) Travel / vacation habits and preferences: The vast majority of the respondents travel for vacation, 3 to 5 trips per year, (52.6%) or 1 to 2 trips (44.7%). The average duration range from 3 to 4 days (44.7%), or 5 to 7 days (44.7%). However, there is also a 7.9% who stated that their average vacation trip takes 1 to 2 weeks. Respondents also reported that they travel for business (78.5%). Most participants prefer to travel with friends (81%), family (51%) and combine vacation with business trips (52%). Activities that interest respondents where related to: "Sport" (28% very much, 25% sometimes), "Wine / Gastronomy" (17% very much and 36% sometimes) , "Walk & Sightseeing" (31% very much and 25% sometimes). Other activities mentioned, during the interviews, were camping and training. Most respondents stated that the prefer to use *one* accommodation and visit the nearby destinations instead of changing hotels.

c) Online travel and tourism services: The majority of participants responded that they were looking for information online (86%), with about half of them (53%) using travel online services or software applications. A 47% make use of travel guides, while about one third of the respondents (29%) prefer them in the form of a mobile application. The 97% of respondents pre-plan their vacations.

d) Vacation packages: Most respondents consider accommodation as an important feature (64% high importance, 31% average importance), ticket services (58% high importance, 38% average importance) and vacation personalisation (53% high importance, 39% average importance). Other things they considered as important include, moving and getting guidance within a specific region (25% high importance, 39% average importance), suggestions for activities (42% high importance, 25% average importance), suggestions about food and entertainment activities (42% high importance, 17% average importance). On a multi-answer question regarding difficulties they spot in dealing with vacation packages, 67% of the respondents found difficult to balance vacation package cost in terms travel and accommodation expenses, and 58% to decide which accommodation service is more suitable for their trip. Subsequently, during the interviews they also raised concerns about trip planning procedures, accommodation selection and matching with a tour and scheduling of day-by-day activities.

e) Use of personalized tourism services: Regarding the online booking feature, all respondents (100%) answered positively about accommodation and ticket booking online. The majority would also rent a car (58%) and book for sightseeing services (52%). Most respondents would like to be able to sync data with their mobile phone (66%), be able to perform modification in the future (66%), as well as receive e-mail notifications (58%). With respect to the personalized mobile application services, respondents favored significantly the following: information on in-area travel options (79%), POIs (74%), hotel booking (66%), cancellation or change

alerts (63%), search for organized activities (61%) and map of the area (61%).

B. Design Requirements

The design requirements have been introduced at the research phase. These include functional (functions that the system should perform) and non-functional (features that afford usability and effectiveness of the entire software) design requirements [41] and can be summarized as follows:

TABLE I. FUNCTIONAL AND NON-FUNCTIONAL DESIGN REQUIREMENTS

Requirement Type	Requirement Description
Functional	1. Authentication mechanisms a. System Sign-up b. System Authentication Mechanisms Sign-in, Sign-out, Automatic Sign-in through other services such as Google, Facebook etc c. Password Recovery d. Automatic Sign-In e. Sign-Out 2. Trip plan package management a. Creation of a "Trip Plan" b. Customization of Trip Plan through "Trip Preferences" c. Filtering based on criteria d. Save the Trip Plan for future use 3. Vacation Package creation and management a. Create vacation package b. Vacation package price estimation c. Search and include "Accommodation facilities" per stopover d. Change preferred "Means of Transport" e. Timeline overview of planned trip (detailed view and condensed) f. Recommendations for "Activities" and "Special Offers" g. Manage day-to-day schedule h. Activities calendar i. Add "New Activities" j. Adjust "Activity Preferences" such as Duration of activity, time between activities, lock, move in time and delete activity k. Provide "Activities map" l. Detailed description and a list of available activities m. Presentation of activities nearby n. Presentation of Today's Activities o. Rating of Activities p. Adding content for activities (i.e. photos) q. Provide calendar and afford management of day-to-day schedule through it r. Alter the linear character of a trip by swapping calendar entries s. Select means of transport among activities t. Destinations Map and visualization of trip stops on it u. Recommendations for destinations with special interest based of preferences v. Add "New Destinations" w. Adjust "Destination Preferences" such as delete, lock, move destination x. Adjust Nights in Destination y. Select means of transport among destinations 4. Saving vacation package a. Print, email and share the Trip Plan b. Confirm Reservation c. Pay for a Reservation 5. Vacation Package a. View Vacation Package b. Manage c. Sync d. Vacation Activities e. Activities Calendar f. Activities Nearby g. View Today's Activities h. Rate Activities i. Add Activity Photos j. Share activities on social networks and other k. Special Offers 6. Notifications (real-time push notifications, email) a. Wish list b. Forward list Activities to e-mail c. Delete Activities
Non-Functional	1. Responsive Design for device compatibility (desktop, mobile, smartphone, tablet) 2. Cross platform compatibility (independent to OS) 3. Multilingual ability 4. Follow Current Usability Guidelines 5. Performance (real-time response, low footprint) 6. Automatic updates 7. Connectivity 8. Use of hardware sensors

To represent these requirements, we constructed a set of 56 Use Cases which can be divided into four functional areas:

- Sign-up or sign-in: nine (9) use cases,
- Create a user query: three (3) use cases,
- Manage vacation package: thirty-two (32) use cases,
- Booking of a package (save and book): twelve (12) use cases.

These have been presented in the form of the following TABLE III which represents an example of the Activities Map:

TABLE II. EXAMPLE OF USE CASE FORM

Identifier	UC3.10
Name	Activities Map
Description	The system displays an activity map of a single day. Each activity is located at a suitable point on the map. If the user chooses to view an activity, the POI is expanded to present a photo with a summary, as well as a time duration, start and end date, and a detailed description link.
Events Flow	1. The user looks at the map and selects an activity. 2. The system shows a brief description of the activity with a link to a detailed description. 3. End of UC
Alternative route	Not available
Classes	Activity.geolocation Map
Priority	High
Interface Components	Composite List view or Grid view about Activities
Version	0.2

C. TouristHub architectural components and interaction sequence

The sequence diagram of the TouristHub platform presented on Figure 2 depicts the interaction between objects in a sequential

order. 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.

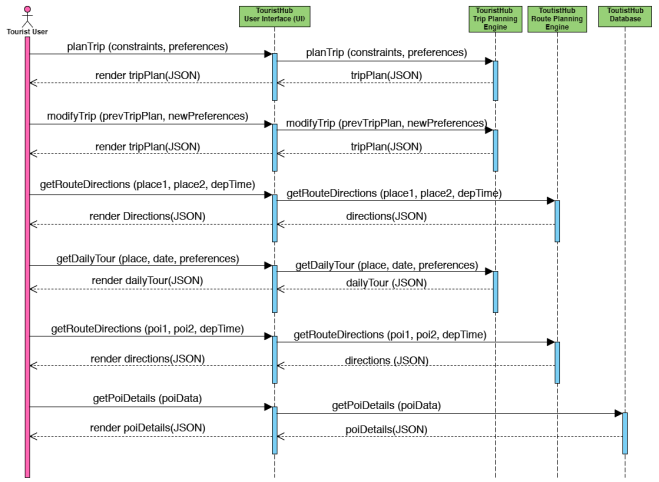

Figure 2. TouristHub UML sequence diagram

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.

1) ***Trip Data*** can be described in terms of:

a) *Arrival Location,* where the trip will start from,

b) *Departure Location,* where the trip will end to,

c) *Trip Dates* indicate the arrival / departure dates, therefore, the total trip duration,

d) *Number of Stopovers* indicate the number of in-between stops that the user is willing to accommodate,

e) *Means of Transport* indicates preference for using either to Public or Private transportation.

2) ***User preferences*** can be outlined in terms of:

a) *Vacation Style* includes: Culture, Nature, Food, Beaches, Nightlife, Activities, Historical Places, Religion,

b) *POIs preferences* indicate user preference on particular POI categories (e.g., museums, archaeological sites, monuments, nature, etc)

c) *Budget data* represents a rough indication of the budget the user is willing to spend (Economy, Moderate, Luxury).

VII. User Experience and Interaction Design

A. Prototypes

Based on the guidelines and requirements presented in the previous sections we designed a number of concepts and depending on the phase of design and development, those ranged from low-fidelity prototypes to high-fidelity ones (Figure 3).

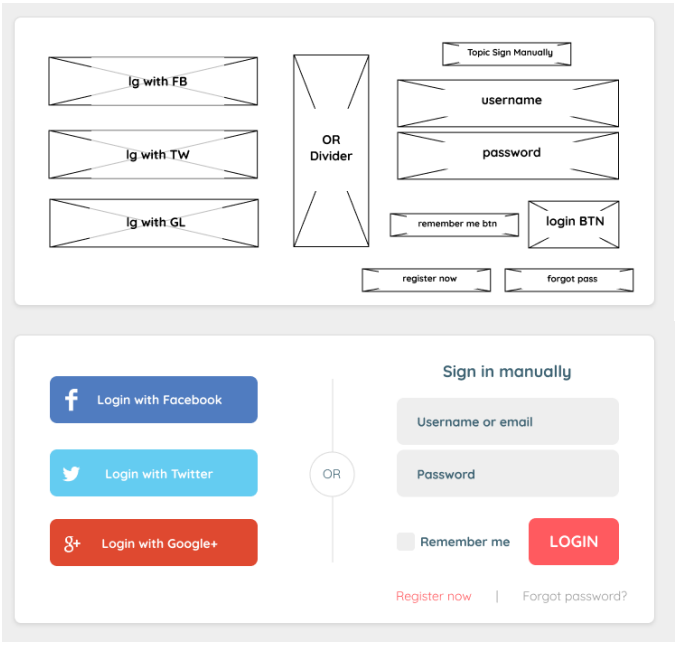

Figure 3. Wireframe and high-fidelity representation, respectively, of the TouristHub Social Login Widget

The purpose of the prototyping was to ensure that the proposed design concepts worked as intended by the descriptions outlined in the use case scenarios. Moreover, the prototypes helped 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.

The low-fidelity prototypes in the form of wireframes 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 element placement, information architecture validity, and screen layout design.

The main part of concept development focused on the design of high-fidelity prototypes. Those prototypes 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. Finally, all interactivity components were designed to simulate actual interactions and respond to basic user testing scenarios.

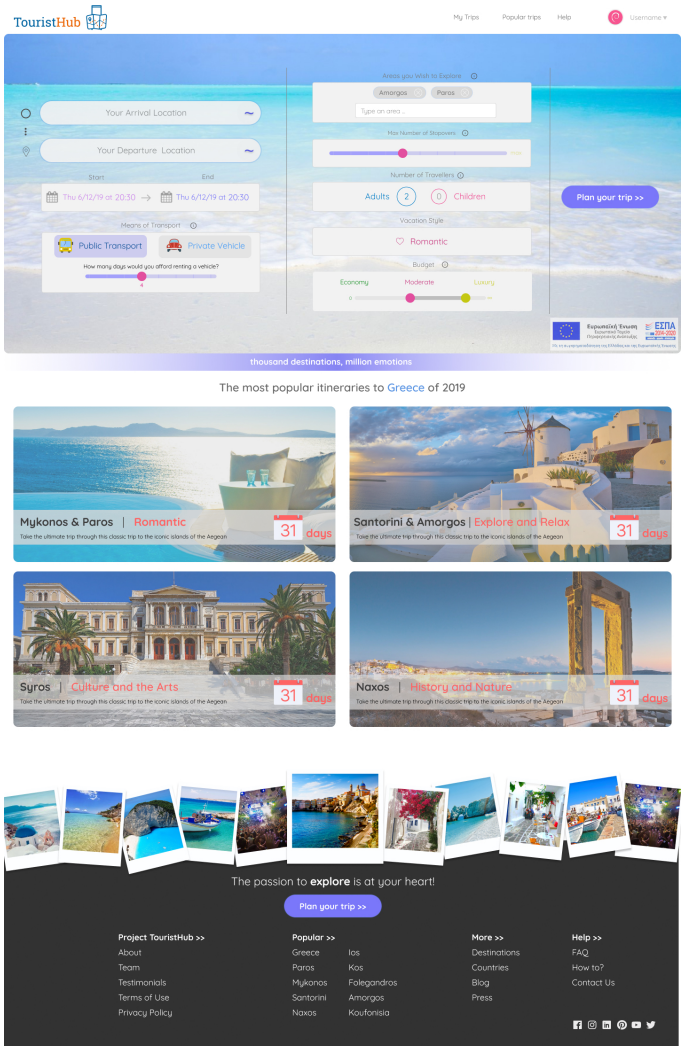

Figure 4. High-fidelity prototype of TouristHub main web interface

We followed interaction design practices for responsive design and Material Design guidelines for the web and mobile responsive interfaces of the platform.

B. *User Interface Templates, Components and Interactions*

User Interface Templates, *Components* and *Interactions* are all included to the main TouristHub UX Kit which constitute a reusable elements UI design library.

1) User Interface Templates were designed in order to simplify the conceptual design process. These templates are instances of the different interfaces (collections of components within a context of use) and are related to use case scenarios according to the organisation described earlier (see Section VI.B, TABLE III).

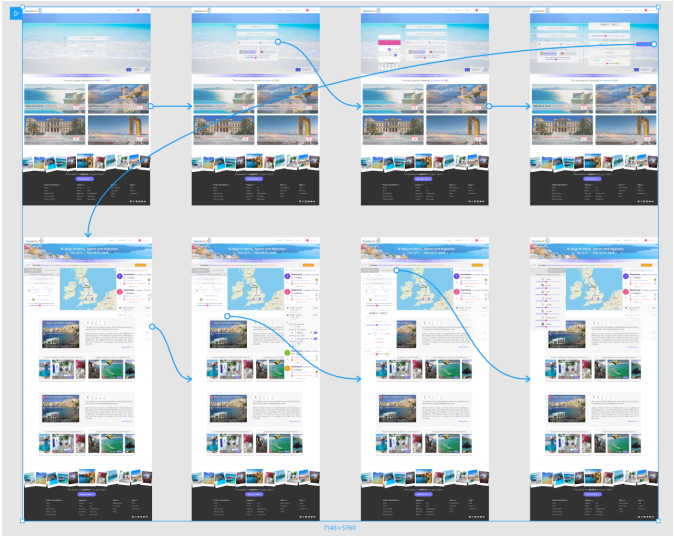

Figure 5. TouristHub high-fidelity interactive prototypes. Interactions are indicated as blue arrows and connect a Hotspot of an active element (e.g. button or icon) to a Destination

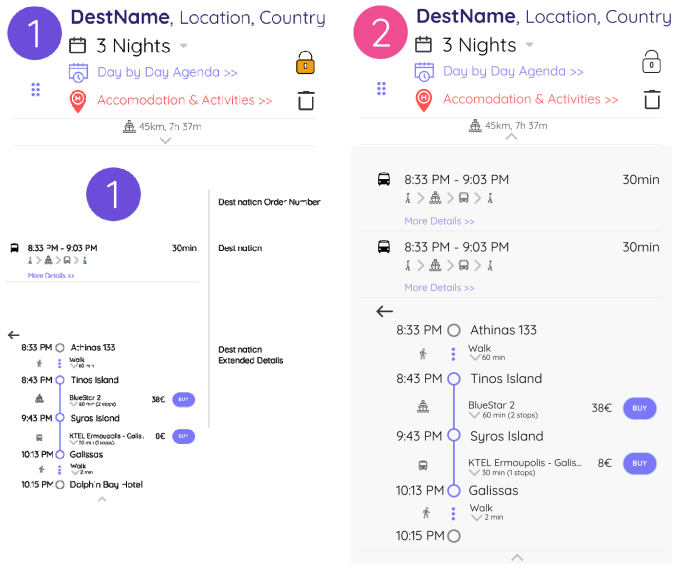

Figure 6. User Interface templates that incorporate the Destination Components

2) User Interface components consist of widgets and UI elements of all different types, including: buttons, icons, sliders, navigation, dropdown, modals & alerts, tabs, toasts & tooltips, headers and footers, search UI components, etc. Components are UI elements that 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 Component,* which defines the properties of the Component, *b) The Instance,* which is a copy of the Master Component that be easily reused in different cases. Components are sharable among the different scenarios and along with *Interface Templates* have been stored to a library. It is important to note that in order to accelerate the

design process, Component Instances are linked to the Master Component, so that any changes made to the Master Component will be propagated to all related Instances. This functionality has been provided by the *Figma* interface design tool *[42]* and added flexibility in the process of applying changes to the design.

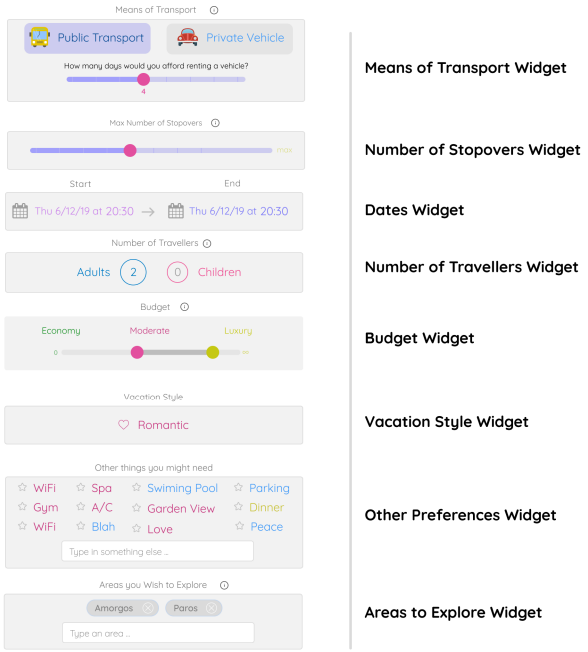

Figure 7. Complete set of User Preferences UI Widgets

3) Interactions were designed at the final high-fidelity prototypes and combined a number of interactive techniques including transitions, dynamic overlays to create multiple layers of interactive content (static), animated GIFs to represent motion designs, video elements and subtle animations. During the design of interactions we also considered interaction workflows with the variety of widgets and dynamic components as well as navigation flow and on demand content delivery.

VIII. Conclusion

This work presented TouristHub, an interactive tourist trip planning platform. The aim of the platform is to integrate today's fragmented online tourist services which are offered separately by independent tourism providers. The goal is thus to offer a one-stop trip planning with real-time routing and delivery of tourist services promotion. In this paper we presented the research steps towards the design of the interactions and the user experience. The paper provided a brief review of the related concepts and the decisions taken for the design of the platform. It focused in describing the design challenges and the methods used to collect information and provide research findings that led to the outline of design requirements. It also presented the design considerations and the prototyping processes from low to high fidelity prototypes of the user interfaces and the interactions involved.

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