Towards the Development of a Smart Tourism Application Based on Smart POI and Recommendation Algorithms: Ceutí as a Study Case

Joanna Alvarado-Uribe[1(✉)], Andrea Gómez-Oliva[2,3], Germán Molina[3], Miguel Gonzalez-Mendoza[1], María Concepción Parra-Meroño[2], and Antonio J. Jara[4]

[1] School of Engineering and Sciences, Tecnologico de Monterrey, Carretera Lago de Guadalupe Km. 3.5, Col. Margarita Maza de Juárez, 52926 Atizapán de Zaragoza, Estado de México, Mexico
{A00987514,mgonza}@itesm.mx

[2] Universidad Católica de Murcia (UCAM), Campus de los Jerónimos, Guadalupe, 30107 Murcia, Spain
mcparra@ucam.edu

[3] HOP Ubiquitous S.L., Calle Luis Buñuel No. 6, Ceutí, 30562 Murcia, Spain
{andrea,german}@hopu.eu

[4] University of Applied Sciences Western Switzerland, 3960 Sierre, Switzerland
jara@ieee.org

Abstract. Nowadays, major industry, government, and citizen initiatives are boosting the development of smart applications and services that improve the quality of life of people in domains such as mobility, security, health, and tourism, using both emerging and existing technologies. In particular, a smart tourist destination aims to improve both the citizen's quality of life and the tourist experience making use of innovation and technology. In this way, the main idea of this work is to develop a smart application focused on improving the tourist experience. The application will be based on a new concept called Smart Point of Interaction (Smart POI), the user experience research in this area, as well as a Smart POI recommendation algorithm capable of considering both user preferences and geographical influence when calculating new suggestions for users. For the experimental phase, two scenarios are considered: a simulated story and a real-world environment. In the real-world scenario, the town of Ceutí will be the first scope while for the simulated scenario, a database will be generated through surveys. As a first result, the points of interest, the target audience, and the features that will constitute the database representative of the user profile have been defined according to the real-world scenario in Ceutí. Moreover, the incorporation of an explicit feedback mechanism for the Smart POIs has been proposed as an initial approach to address user preferences.

L. Barolli and T. Enokido (eds.), *Innovative Mobile and Internet Services in Ubiquitous Computing*, Advances in Intelligent Systems and Computing 612,
DOI 10.1007/978-3-319-61542-4_92

1 Introduction

Walk up and use anything [17] is an assumption driven by a new technology developed by Google called as Physical Web [17]. The physical web together with the increase in the use of mobile devices, global position system (GPS), and Web 2.0 technologies has caused that the users share enriched information on the Web - like their experiences - through, for example, location-based social networks (LBSNs) [23]. Therefore, major initiatives, such as SmartSDK [19] and CitySDK [4], are boosting the development of smart applications and services that improve the people's quality of life in domains such as mobility, security, health, participation, and tourism, using this type of technologies.

The scope of this approach intends to follow one of these areas: tourism, where the term of smart tourist destination is key. A smart tourist destination is defined as an open area that makes use of innovation and technology to ensure sustainable tourism development with the aim of improving the citizen's quality of life as well as the tourist experience [1]. Thus, since its main purpose is to improve both the citizen's quality of life and the tourist experience, the development of a smart application for anyone (resident or visitor) who wants to know a certain place, it is relevant to this domain. As a consequence, a tourism recommendation approach is proposed.

Hence, a major issue to be faced is recommending new places where users might be interested based on their personal preferences as well as their geographical context. Such an approach follows the stated problem for the point-of-interest (POI) recommendation, i.e. the issue of providing personalized recommendations for places, such as restaurants and movie theaters [13,23]. Although recommender systems have been widely approached from different state-of-the-art models, POI recommender systems have just emerged recently [23]. Since, on the one hand, the rapid development of new location-based technologies leads to new opportunities as well as challenges that can be addressed in several application domains. In particular, this approach will deal with the Google's Physical Web technology [17], currently implemented in a device called Smart Spot [8,18]. A technology that has not been previously addressed in the tourism sector. On the other hand, the decision process for a user to choose a POI can be influenced by numerous factors, such as personal preferences, geographical considerations, and user mobility behaviors [13,14,23]. For example, user preferences represent a relevant issue for this work since this feedback is implicit. Thus, the need to implement a recommendation algorithm in an application for tourism that considers the user preferences and, in addition, the geographical influence is even more relevant.

Therefore, the main objective of this work is to develop a Smart POI recommendation algorithm able to consider both user preferences and geographical influence when calculating new suggestions for users. In addition to the recommendation algorithm, an application under the Progressive Web App [6] approach and based on the user experience research is addressed to incorporate the proposed algorithm for then achieving the purpose of developing a smart application to contribute to the goal of a smart tourist destination [1]. In order

to test this development, two scenarios are considered: a simulated story and a real-world environment. In the real-world scenario, the town of Ceutí will be the first scope while for the simulated scenario, a database will be generated through surveys.

The rest of this article is organized as follows. Section 2 presents a brief introduction to the concepts related to the recommendation approach as well as the technology used. Subsequently, Sect. 3 provides the proposal of this work and Sect. 4 the methodology to carry it out. Finally, Sects. 5 and 6 show the results obtained so far and the preliminary conclusions, respectively.

2 State of the Art

Definitions and features related to the traditional and POI recommenders will be introduced. In addition, both the Point of Interest concept and the Point of Interaction conception, as well as the difference between these concepts will be explained.

2.1 Traditional and Point-of-Interest Recommendation Algorithms

POI recommendation systems will be addressed in a detailed manner due to the algorithm will be proposed for this development could follow this approach given the similarity of its features.

Firstly, it is necessary to introduce the definition given for a personalization system with the aim of emphasizing the importance of developing a recommendation algorithm. Therefore, according to Amoretti et al. [2] a personalization system can be intended as a computer-based application that learns the user behavior to generate and manage his/her profile, since, in accordance with this profile, the system can provide suggestions about only products or items relevant to him/her from a repository (recommendation) or can support other applications/services in adapting to the characteristics of each user. Consequently, these systems can be used in several contexts. For this article, two types of systems are considered: traditional recommendation systems and POI recommendation systems.

On the one hand, in a traditional recommendation approach, the user generally provides his/her preferences by explicitly giving ratings to the items, such as books, movies, music, among others [23]. Therefore, user preferences [20,23] are a common characteristic presented in traditional recommendation systems.

On the other hand, the objective of POI recommendation is to model the users' visiting preferences and recommend to a user the POIs in which she/he may be interested, but has never visited [7,24]. Some authors who have addressed this type of recommendation are mentioned below. For the tourism scope, Meehan et al. [15] proposed an intelligent context-aware recommender system to provide appropriate suggestions for tourists. The recommendation of new POIs in regions rarely visited by the user was addressed by Zheng et al. [26]. Yuan et al. [24] tackled the problem of time-aware POI recommendation to suggest a

list of POIs for visiting at a given time. In the same way, Li et al. [11] considered the ratings and their corresponding time stamps on LBSNs to recommend new POIs. Zhang and Wang [25] presented a model that deals with location, time, and social information simultaneously for the successive POI recommendation process. Other works that have provided a POI recommendation algorithm based on LBSNs were presented by Ye et al. [22], Liu et al. [12], and Xingyi et al. [21].

Finally, it is noteworthy that the POI recommender systems have the following unique features: geographical influence, frequency data and sparsity, and social influence [13,23]; since this proposal will deal with geographical influence and frequency data and sparsity. A brief description of each feature is given below.

- Geographical influence is based on the Tobler's First Law of Geography, which states that *Everything is related to everything else, but near things are more related than distant things*. In other words, it is most probable than users prefer to visit nearby locations rather than distant ones and users may be interested in POIs surrounded an attractive POI for them due to geographically proximate POIs are most likely to share similar characteristics [13,23].
- Frequency data and sparsity is mainly caused because a user does not express explicitly his/her preferences by providing ratings to the items, as in a traditional recommender system. Hence, in a POI recommender system, the user preferences are reflected and inferred by the frequency of check-in for locations, which are often transformed to a user-location check-in frequency matrix. Nevertheless, the frequency data presents a large range compared with ratings (that generally are numerical values between 1 and 5) since frequency can start from once to hundreds of times for some locations. Likewise, this produces a sparse population in the user-location check-in frequency matrix, which leads to a bigger challenge for POI recommendation [13,23].
- Social influence is based on the assumption that friends share common interests as well as opinions. Therefore, traditional recommender systems have combined social relationships with ratings to successfully improve the quality of recommendation. However, in POI recommender systems, previous studies have shown that around 96% of users share less than 10% common visited interests, indicating that a large number of friends does not have the same preferences in terms of POI. Thus, although this feature is beneficial for traditional recommender systems, it has limited effects on user's check-in behaviors for POI recommender systems [23].

2.2 Point of Interest and Smart Point of Interaction

The introductory concepts about Point of Interest and Point of Interaction will be addressed. Likewise, the difference between these concepts will be explained.

A Point of Interest (POI) is defined as an interesting place for the user [23] while a Smart Point of Interaction (Smart POI) is a smart interaction point between users (citizens and visitors) and a Smart Spot (a beacon) [8,18]. Hence, the two main differences from a Smart POI and a POI are the following: (1) the

Smart POI does not necessarily represent an interesting place for the user and (2) the Smart POI provides a smart interaction between the possible points of interest for a user and the user. Restaurants, tourist spots, stores, and movie theaters [13,23] are examples of POI and these can be instances of the Smart POIs. Such a relationship can be seen in Fig. 1.

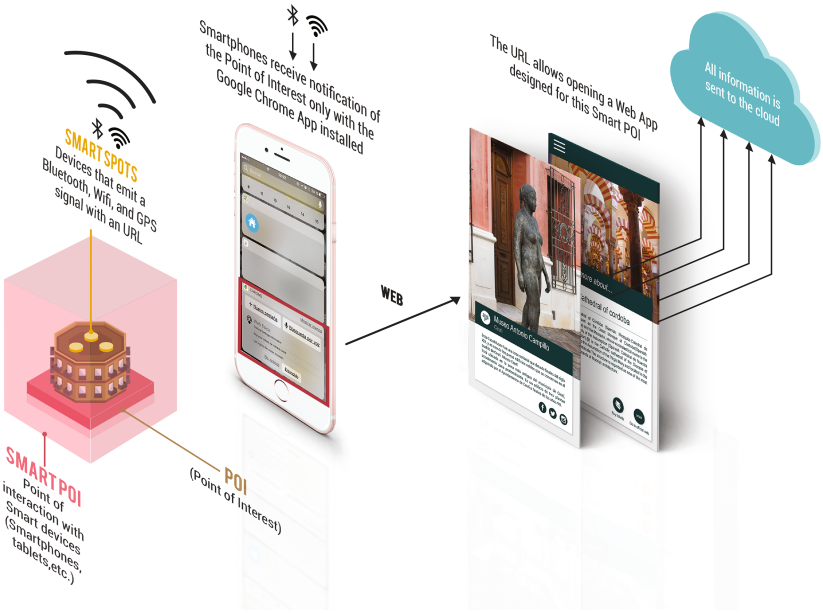

Fig. 1. Schema of relationship between the Smart POI and the POI

3 Description of the Smart Tourism Application Approach

On the one hand, the proposal objective and the real-world application scenario will be described. On the other hand, the recommendation algorithm that is intended to be implemented in the proposed application and the experimental scenario that intends to be overcome with this development will be introduced.

The main objective of this work is to develop a Smart POI recommendation algorithm able to consider both user preferences and geographical influence when calculating new suggestions for users. Therefore, according to Yu and Chen [23], this proposal could belong to the following two approaches: approach based on pure check-in data and approach based on check-in data and geographical influence. This double participation is due to the fact that, on the one hand, a first version of the algorithm is intended to develop which only considers the user preferences to provide a recommendation, establishing that such data are composed of the ratings given to an entity by a user - assumption based on

the characteristics of the technology used in this platform. Thus, a traditional recommendation approach has been proposed as the first solution. On the other hand, an extended version of the first proposed algorithm is intended to carry out in order to incorporate information related to the feature defined as geographical influence [13,23].

The proposal of the recommendation algorithm approach is based on the characteristics that the Smart POIs have as well as on the initiative of the town council of Ceutí. From the characteristics of the technology, Smart Spots allow the user to have physical interactions between him/her and a possible point-of-interest by basing on the Physical Web technology [17]. A unique feature distinguishing a POI recommendation from a traditional item recommendation [23]. Regarding the town council of Ceutí, a town belonging La Vega Media area in the Región de Murcia in Spain, the ministers seek to innovate in methods of dissemination and protection of their heritage in order to contribute to the creation of new experiences in inhabitants and visitors. Therefore, considering these two bases, in addition to the POI recommendation algorithm, an application under the Progressive Web App [6] approach and based on the user experience research is addressed to incorporate the algorithm proposed for then achieving the purpose of the town council of Ceutí: to be a smart tourist destination [1].

According to the above, the following specific experimental scenario has been proposed for the application: Felipe is a citizen from Murcia interested in art. Thus, he loves to travel to different places to know mainly their museums and monuments. However, Felipe spends time searching for what monuments and museums he will visit on his next trip because according to the type of art he likes is how he decides what other tourist sites will include in his tour. On the other hand, sometimes Felipe decides that he will visit only one particular area of the city. Hence, Felipe would like to have an application on the mobile that provides suggestions about possible sites of interest to him within a certain geographical area. As an expected result is that the application developed in this work and the technology deployed for it can be adopted everywhere that aims to become a smart tourist destination [1].

4 Methodology

In order that this application accomplishes with one of the major challenges of smart cities - promote solutions that represent an improvement in the lives of its citizens in aspects of mobility, quality of life, security, and sustainable development [16], this work is been based on the conjunction of two areas: Computer Science and Social Sciences. From the computational point of view, the research, development, and implementation of the recommendation algorithm, as well as the tourism application, is addressed, while from the social perspective, the research, analysis, and definition of the user experience are approached. Such activities are described in a general manner below.

1. **Study the synergy between the recommendation algorithms and the field of application.** For this first activity, a review of the state-of-the-art

about the traditional and POI recommendation algorithms will be carried out. Similarly, a brief survey of the related work that addresses the proposal and application of the POI recommendation algorithms in both tourism scenarios and other POI topics will be performed. Finally, according to these reviews, the data model and the algorithm approach will be defined.

2. **Carry out the first approach with a traditional recommendation algorithm.** The first phase that is intended to test is the application of an algorithm widely used in the traditional recommendation systems with the rating information obtained from the scope of this work.
3. **Study the application scenario in Ceutí.** In order to able to have an approach to the profile of the potential visitors, who will compose the target group of this work, as well as the sites that will be considered as point-of-interest, a series of activities is proposed to carry out. It is important to mention that some of the proposed activities have already been addressed and, thus, reported in Sect. 5.
   a. **Determine the POIs.** This activity aims to determine which places in Ceutí will be considered in the deployment of the application. On the one hand with the objective of implementing the Smart Spots in each of these places and on the other hand, with the purpose of adopting them as possible points of interest for the users of the application.
   b. **Define the target audience.** After delimiting the key physical points for this project, the following activity intends to determine the possible users of the application. This phase has two purposes: the first one is to know the general profile of visitors to Ceutí (and therefore, possible users), and the second one is to support the learning process of the proposed recommendation algorithm through these profiles.
   c. **Know the target audience.** This task has the objective of designing a survey that helps to build a database of the profiles and preferences of the possible users of the application. In such a way, this database will be part of the local testing environment developed to experiment with the proposed recommendation algorithm before it is incorporated into the tourism application.
   d. **Distribute the survey to a pilot target audience.** This activity aims to publicize the survey designed to a group of potential users of the application for the purpose of receiving an implicit and explicit feedback from them. This will help to know the level of clarity of the questions included as well as detect any problem that may prevent the respondent from successfully completing the questionnaire.
   e. **Re-design the survey.** This task has the objective of analyzing the feedback provided by the pilot target audience to improve the content of the survey and thus, obtain the information that is really expected from the participants.
   f. **Disseminate the final survey.** It is intended to send the digital survey by e-mail to different groups of people who meet the appropriate percentile as well as publish it on different social networks to obtain the

participation of people external to Ceutí. Also, it is intended to expand the field of dissemination by delivering paper surveys in the locality.

g. **Analyze the results of the survey.** Once all the surveys have been gathered, the data collected on paper will be integrated into the corresponding data analysis platform to export a single data file with the entries. It is also intended to examine such entries to better understand the audience for who the final product will be elaborated.

4. **Define the categories of the points of interest.** In a synergy between the part dedicated to developing the algorithm and the part dedicated to delimit and understand the target audience for the practical case of Ceutí, the different categories that describe the POIs will be defined.
5. **Study the data collected from the point of view of the algorithm.** In this task, it is proposed to carry out the preprocessing of the data collected through the surveys in order to standardize the data to the format and type of value required by the recommendation algorithm. Therefore, this process is intended to be automatically incorporated into the development of the application.
6. **Propose the recommendation algorithm approach.** This activity aims to define the approach of the algorithm, considering that such an algorithm should deal with at least two of the three features defined for the POI recommendation systems: frequency data (check-in) and geographical influence.
7. **Develop the recommendation algorithm.** At this point, the first test phase had to be carried out (Task 2). Therefore, according to the analysis of such results and the research performed in phase 3 of this methodology, this phase intends to incorporate the new considerations defined to support the first feature established for this algorithm: frequency data. Subsequently, the inclusion of features and concepts related to the modeling of geographic information will be addressed. Likewise, the built-in concepts will be tested in order to deliver the first algorithm that will be implemented in the application for the end-user.
8. **Design the smart tourism application.** Based on state-of-the-art research about information, management, and tourist recommendation applications, a design for a web application will be contemplated in order to accomplish the needs of the target audience and contribute to improving the tourist experience by turning the place into a smart tourist destination [1].
9. **Deliver the application to potential tourists.** This activity aims to deliver the application developed to a select group of potential users. This is intended for such users experiment with the application and at the same time, provide a feedback about its design and performance. This feedback will help to improve both the algorithm and the application itself.

5 Results and Discussion

The purpose of this section is to provide the lessons learned as well as the analysis of the considerations taken so far to carry out the proposal described in this article.

5.1 Tourism Ecosystem in Ceutí: Definition and Analysis

The first activity that was done for the approach of this project, from the point of view of the user experience, in cooperation with town council of Ceutí and tourism office representatives, was to determine points of interest that would be incorporated into this first pilot project. During this phase of the project, an issue was found. That is, firstly, it was determined that the points of interest would be composed of a mixture between the heritage of the town and gastronomic places. However, during the selection of these points arose a problem by determining which gastronomic sites would be incorporated. For this reason, the selection of the points of interest was delimited to only the heritage of the town. As a result, 16 points - the most representative of the heritage of Ceutí - were defined as points of interest for this project.

After defining the points of interest, the following step was to define the target audience. Therefore, a research has been carried out to define this target audience, who will support to build the database through a survey where the 16 points of interest defined will be rated by them. For this scenario, the target audience is constituted by travelers to the town of Ceutí. However, due to the scarcity of information about this audience, it has been necessary to start from the number of visitors to the central area of the Región de Murcia, given Ceutí belongs to this region in addition of Las Torres de Cotillas, Totana, Molina de Segura, Alcantarilla, Aledo, Alhama de Murcia, Lorquí, and Librilla. Thus, the figures of tourists to the central area of the Región de Murcia, who do not necessarily spend the night, from January 2016 to January 2017 are the following: Residents in Spain: 3,437 (86.4%) and Non-residents in Spain: 542 (13.6%) from 3,979 people [9].

In the detailed study of the resident audience in Spain, information about the place of residence of visitors to Ceutí was not found. Therefore, some interviews were conducted with town council representatives, who have participated in the different cultural activities of this area, in order to obtain this missing information. During these interviews, a key factor was determined when selecting the target audience of Ceutí: a high percentage of Spanish visitors is from the Región de Murcia itself. As a consequence, for this research, it was decided to work with the population of the Región de Murcia as the total number of the visitors to Ceutí, residents in Spain.

Consequently, it was established that the survey would be non-probabilistic and by clusters due to the target audience is hard to identify and the sample is a pilot study [10]. Hence, the population was divided into four age groups: <18, 18–30, 31–50, and >50, which also have been separated into women and men. Subsequently, these data were considered to define a margin of error that ensures the building of a database representative of the possible users of the application. As a result, it was established that the margin of error would be set at 6.75%, therefore setting the representative sample at 200 people, of which: 173 people to be surveyed must be resident travelers in Spain (86.4%) and 27 people to be surveyed must be non-resident travelers in Spain (13.6%).

On the one hand, due to the complexity of defining clusters of the non-resident audience, the 27 corresponding surveys will be collected globally and not by clusters with the help of the town council of Ceutí to locate the potential affluent public. On the other hand, with the aim of dividing the resident travelers in Spain into clusters, the conclusions obtained in the interviews were considered to define the total number of residents in the Región de Murcia older than 18 years old as the target audience. Therefore, according to this data, the following clusters have been defined:

- Target audience: 1,157,527 - 100% [3]
  - First cluster: 18–30 years old
    - **Men:** 111,587 - 9.64%, **Women:** 107,836 - 9.32%
  - Second cluster: 31–50 years old
    - **Men:** 250,590 - **21.65% Women:** 231,068 - 19.96%
  - Third cluster: >50 years old
    - **Men:** 213,321 - **18.43%, Women:** 243,125 - 21%

As a result, taking into account that 173 surveys have been allocated for this audience, the following figures are proposed to have a representative database:

- – First cluster: 18–30 years old
  - **Men:** 17 surveys, **Women:** 16 surveys

  Second cluster: 31–50 years old
  - **Men:** 37 surveys, **Women:** 35 surveys

  Third cluster: >50 years old
  - **Men:** 32 surveys, **Women:** 36 surveys

With regard to the design of the survey, this is constituted by four blocks. The first section allows knowing some personal data of the respondents, such as age range, gender, occupation, study degree, and place of residence, in order to be aware of the user's profile. Then, a series of questions of a technological nature are presented to know if the user uses them in their tourist experiences. Subsequently, some questions are included to know what tourist relationship has had the user with the Región de Murcia and Ceutí. Finally, the 16 points of interest in Ceutí are exposed for the user to rate according to the possible interest he/she might have towards them.

In the same way, the development of the survey has been structured in Google Forms[1] to facilitate its dissemination and, similarly, has been edited in the English language to be able to survey the target non-resident audience. Likewise, this survey is planned to disseminate on paper between local sites in Ceutí in order to reach as many participants as possible. Current versions of these surveys are available in the URLs provided as footnotes - Spanish[2] and English[3] version.

Finally, a pilot test of the survey is planned to carry out with 10 residents in Spain and 2 foreign people with the purpose of improving the survey to obtain the expected information of the respondents.

[1] https://www.google.com/intl/en/forms/about/.
[2] https://goo.gl/VrC0ve.
[3] https://lnkd.in/dzqVyJD.

5.2 Recommendation System

From the technological and computational point, it is emphasized that the Smart Spot constantly emits signals to the mobile devices of the users [8], which entails an issue for the algorithm. From the POI recommender systems approach, the user preferences are reflected and inferred by the frequency of check-in for locations [13,23]. Then, since the user's smartphone can receive all the signals that the smart spots emit, the user's interaction (check-in) with the Smart POI does not necessarily indicate interest in that place, but only that the user is close to that place. Therefore, a way to really get user preferences through the application had to be defined. The first solution that arises is based on the traditional recommendation systems approach: to have explicitly the ratings for the items (by treating POIs as items) [23]. As a consequence, it is defined to incorporate into the application the evaluation based on the 5-star rating system since it is the online explicit feedback mechanism that allows collecting more feedback [5].

Similarly, because of the user's interaction with the Smart POI provides the current location of the user, which can be considered as his/her check-in, the value considered for this scenario should be clarified. Thus, it is defined that the user registration field will be constituted by the locations of the Smart POIs that the user qualifies. Subsequently, according to the review of the state-of-the-art (Sect. 2), the traditional recommendation algorithm chosen was collaborative filtering since it is the one most used by researchers to address the recommendation based on the ratings [14,23].

Finally, the vision of implementing different versions of the Smart POIs recommendation algorithm arises with the aim of providing better suggestions to users. In the first instance, this algorithm will be tested on the information collected through the surveys, and later, will be implemented in the application. Different features of the information pertaining to both users and POIs, as well as variations of the algorithms and concepts are intended to be incorporated into these versions.

6 Conclusions

This article proposes to develop a Smart POI recommendation algorithm that incorporates both user preferences and geographical influence when suggesting to the user new places to visit. Therefore, information related to the location and categories of the Smart POIs interesting to the user as well as the ratings given by him/her to these Smart POIs is considered so far. Similarly, a progressive web app approach has been chosen to design and to develop the proposed tourism application.

Finally, a research about the user experience in the tourism sector has been proposed in order to develop the application for the possible user. To this end, the points of interest, the target audience, and a database representative of the user profile have been defined according to the real-world scenario in Ceutí. It is relevant to mention that these guides, first, have been taken into account to generate the database that will be used to test the simulated story.

Thus, a survey was designed with the aim of collecting such data. This survey, in addition to supporting this proposal as a way to obtain the data of the possible user, also contributes to one of the capacities that the Internet of Things (IoT) presents to improve any sector: the collection of data about the user [16].

Acknowledgements. Joanna Alvarado-Uribe is currently supported by a CONACYT studentship as well as by a SmartSDK project funding (SmartSDK project is co-funded by the EU's Horizon2020 programme under agreement number 723174 - ©2016 EC and by CONACYT agreement 737373). The first author also renders thanks for HOP Ubiquitous and Tecnologico de Monterrey for the support to carry out this research project. In the same way, Andrea Gómez-Oliva thanks for Isabel Serna and Antonio Campillo for the facilities offered to perform the research and the Universidad Católica de Murcia (UCAM) where she is studying the doctor's degree within the industrial doctorate program. We really appreciate the collaboration and review of the people involved in the development of this project.

References

1. AENOR: Sistema de gestión de los destinos turísticos inteligentes. Requisitos. Asociación Española de Normalización y Certificación, Génova, 6, 28004, Madrid-España (2016)
2. Amoretti, M., Belli, L., Zanichelli, F.: Utravel: Smart mobility with a novel user profiling and recommendation approach. Pervasive Mob. Comput. **38**(2), 474–489 (2017). http://www.sciencedirect.com/science/article/pii/S1574119216301341
3. Centro Regional de Estadística de Murcia: Población según edad y sexo, por municipios. 2016 - murcia (región de), CREM (2017).http://econet.carm.es/web/crem/inicio/-/crem/sicrem/PU_padron/p16/sec2_sec2.html. Accessed 4 Apr 2017
4. CitySDK: CitySDK transforming digital service development with harmonized apis, CitySDK (2017). https://www.citysdk.eu/wp-content/uploads/2014/11/CitySDK-Cookbook-highres.pdf. Accessed 11 Apr 2017
5. Dooms, S., De Pessemier, T., Martens, L.: An online evaluation of explicit feedback mechanisms for recommender systems. In: 7th International Conference on Web Information Systems and Technologies, WEBIST 2011, pp. 391–394. Ghent University, Department of Information Technology (2011)
6. Google Developers: Progressive web apps. Google (2017). https://developers.google.com/web/progressive-web-apps/. Accessed 4 Apr 2017
7. Guo, L., Jiang, H., Wang, X., Liu, F.: Learning to recommend point-of-interest with the weighted Bayesian personalized ranking method in LBSNs. Information **8**(1), 20 (2017)
8. HOP Ubiquitous: Smart poi. HOPU (2017). https://storage.googleapis.com/smartcity/SmartPOI_A4_lr.pdf. Accessed 23 Mar 2017
9. Instituto de Turismo de la Región de Murcia: Viajeros y pernoctaciones según destinos en la región de murcia. Murcia Turística (2017). https://www.murciaturistica.es/es/estadisticas_de_turismo?pagina=viajeros-y-pernoctaciones-segun-destinos. Accessed 4 Apr 2017
10. Kitchenham, B., Pfleeger, S.L.: Principles of survey research: part 5: populations and samples. ACM SIGSOFT Softw. Eng. Notes **27**(5), 17–20 (2002)
11. Li, X., Xu, G., Chen, E., Zong, Y.: Learning recency based comparative choice towards point-of-interest recommendation. Expert Syst. Appl. **42**(9), 4274–4283 (2015)

12. Liu, B., Fu, Y., Yao, Z., Xiong, H.: Learning geographical preferences for point-of-interest recommendation. In: Proceedings of the 19th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Chicago, Illinois, USA, pp. 1043–1051. ACM (2013)
13. Liu, B., Xiong, H., Papadimitriou, S., Fu, Y., Yao, Z.: A general geographical probabilistic factor model for point of interest recommendation. IEEE Trans. Knowl. Data Eng. **27**(5), 1167–1179 (2015)
14. Meehan, K., Lunney, T., Curran, K., McCaughey, A.: Context-aware intelligent recommendation system for tourism. In: 2013 IEEE International Conference on Pervasive Computing and Communications Workshops, PERCOM Workshops, pp. 328–331. IEEE, San Diego (2013)
15. Meehan, K., Lunney, T., Curran, K., McCaughey, A.: Aggregating social media data with temporal and environmental context for recommendation in a mobile tour guide system. J. Hosp. Tourism Technol. **7**(3), 281–299 (2016)
16. Gómez Oliva, A., Server Gómez, M., Jara, A.J., Parra-Meroño, M.C.: Turismo inteligente y patrimonio cultural: un sector a explorar en el desarrollo de las smart cities. Int. J. Sci. Manag. Tourism **3**, 389–411 (2017)
17. Physical Web: Walk up and use anything. Google (2017). https://google.github.io/physical-web/. Accessed 13 Mar 2017
18. SmartSDK: Smart pois: a fiware-based technology to engage users and make cities more sustainable. SmartSDK (2017). https://www.smartsdk.eu/2017/02/16/smartpoi/. Accessed 13 Mar 2017
19. SmartSDK: SmartSDK (2017). https://www.smartsdk.eu/. Accessed 11 Apr 2017
20. Xie, B., Tang, X., Tang, F.: Hybrid recommendation base on learning to rank. In: 2015 9th International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), pp. 53–57. IEEE (2015)
21. Xingyi, R., Meina, S., Haihong, E., Junde, S.: Joint model of user check-in activities for point-of-interest recommendation. J. China Univ. Posts Telecommun. **23**(4), 25–36 (2016)
22. Ye, M., Yin, P., Lee, W.C., Lee, D.L.: Exploiting geographical influence for collaborative point-of-interest recommendation. In: Proceedings of the 34th International ACM SIGIR Conference on Research and Development in Information Retrieval, Beijing, China, pp. 325–334. ACM (2011)
23. Yu, Y., Chen, X.: A survey of point-of-interest recommendation in location-based social networks. In: Workshops at the Twenty-Ninth AAAI Conference on Artificial Intelligence, Association for the Advancement of Artificial Intelligence, pp. 53–60 (2015)
24. Yuan, Q., Cong, G., Sun, A.: Graph-based point-of-interest recommendation with geographical and temporal influences. In: Proceedings of the 23rd ACM International Conference on Conference on Information and Knowledge Management, Shanghai, China, pp. 659–668. ACM (2014)
25. Zhang, W., Wang, J.: Location and time aware social collaborative retrieval for new successive point-of-interest recommendation. In: Proceedings of the 24th ACM International on Conference on Information and Knowledge Management, pp. 1221–1230. ACM, Melbourne, Australia (2015)
26. Zheng, N., Jin, X., Li, L.: Cross-region collaborative filtering for new point-of-interest recommendation. In: Proceedings of the 22nd International Conference on World Wide Web, Rio de Janeiro, Brazil, pp. 45–46. ACM (2013)