Quo vadis?: Persuasive computing using real time queue information

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ABSTRACT

By presenting tourists with real-time information an increase in efficiency and satisfaction of their day planning can be achieved. At the same time, real-time information services can offer the municipality the opportunity to spread the tourists throughout the city centre. An important factor for success is if we can influence tourist day planning. Therefore we studied how tourists could be persuaded to change their planning with real-time information services. This was done by providing the tourists with real-time sensor data about the queue length at the Van Gogh museum in Amsterdam. Two groups of tourists were interviewed about an application that was able to show the queue length at the museum. One group of tourists was interviewed while in the process of planning their day, and one group was interviewed while they were waiting in the queue. Results showed that the information about the queue length and information to visit alternative tourist attractions were trusted by both of the groups. Furthermore, the tourists were very inclined to change their route and plans for that day based on the queue length.

Categories and Subject Descriptors

H.1.2 [**Information Systems**]:User/Machine Systems – *Human information processing*

General Terms

Measurement, Experimentation, Human Factors.

Keywords

Persuasive Computing, Measuring Queue Length, Sensor, IoT, Planning behaviour.

1. INTRODUCTION

With the emergence of open data, more and more information is available to developers to create new innovative services as cities are opening up their datasets. However, the majority of these open datasets contains data that is often not updated more than once a day or week. For the majority of the datasets, such as a dataset containing the location of public buildings, this is sufficient. But to be able to create systems such as context aware recommender systems, real-time information is needed [1]. Real-time information can be used to create new information services for decision makers and end-users. However it is still unclear what the effects of these information services can be on the behaviour of people. We took tourists information services as a case and investigated the possibilities of real-time information services. For this study we took the CitySDK open data platform as a base for our study to build our information services on.

In the European project CitySDK eight cities across Europe have joined their forces to create a new standard for open data across Europe. New (and existing) data services are combined into one Service Development Kit (SDK). In this study, we looked at the possibilities of using real-time data in the CitySDK platform. We investigated the effect that real-time information services can have on the day planning of users when they are presented with real-time information about the queue length at a museum. For the study, a sensor network was created which measured the length of a queue. This is done in collaboration with the Van Gogh museum where we placed sensors to measure the queue length.

Research by Oh et al. [5] shows that presenting tourists with real-time information increased their efficiency and their satisfaction of their day planning. Brown et al. [2] show how the behaviour of visitors of a theme park can be influenced by providing them real-time information, such as waiting-time, and giving them incentives. In both of these studies the importance of prediction is stressed. Alternatives should be given to the user, especially at popular and preferred locations. To complement this research, our application can show to the user what the best times to return to a certain venue are based on previous queue length. We will be testing this system within the city centre of Amsterdam and will use tourists as participants for our study.

In this study we will answer the following research question: *Can we persuade tourists to change their day planning, when visiting a city, by presenting them with real-time information about the queue length?* Furthermore, we will investigate whether the real-time information has a different effect on the day planning of tourists that are already standing in a queue and those who are still have to plan their day. We expect that tourists who are still planning their day are more likely to change their planning based on the real-time queue length than the tourists that are already in the queue.

2. BACKGROUND

2.1 Smart Tourism

With the new technical developments within Smart Cities and the Internet of Things come great possibilities for better and improved information services for tourists. While the possibilities are clear [3], there is still a lack of case studies in a city setting to investigate these technologies and its effects. Furthermore, Gretzel [5] concludes that there is a need to research the impact intelligent

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systems can have on the socio-technical systems in which they exist. It is relevant to see how tourists will interact with the real-time information that smart systems in a city will present to them and how this can influence the behavior of tourists.

2.2 Real-time information

Real-time information systems can be used as an input for context aware recommender systems. Research shows how many information services do not use information about the current context in their services[1][4]. For example, the weather, day or season could be of influence on what can be presented to the user.

When presenting users with real-time information, it is important to take into account several aspects. Brown et al [2] emphasize how prediction is an important aspect of real-time information services. In their research, people visiting a theme park were persuaded to change their behaviour based on real-time information about the queue times. It showed that it was difficult to persuade people to not go to their preferred location. Even when they were presented with real-time information about the queue and bonuses. The solution that was argued in their research is presenting the users with predictions based on the real-time queue data, to give them an alternative time to return to their preferred location.

Additionally, Oh et al. [5] explain another aspect of real-time data called overreaction. Overreaction occurs when too many people use the service and instead of a positive effect, it will trigger a negative effect. The real-time is biased because everyone will go to that location at the recommended time. This means that the prediction model would need to be adapted accordingly. However during this study we will not have enough users to experience this problem, it is important to keep it in mind during the design process. Kramer et al. [3] have shown that there is a demand for spontaneous deviations from tourists' intended route. In their research, users using a tour planner application showed to accept the given route, but they also tended to ignore the plan and deviate from the route when they saw something interesting along the route. This is interesting for our research because this indicates that as long as we present users with something interesting for them, they are more inclined to accept our recommendations.

2.3 Waiting line

To a certain extent, people do not mind waiting in a queue [4]. It creates a certain expectation which, as long as the expectation is met, is not considered problematic. Unfortunately, during peak-time, queue times are so long that the expectations do not meet the actual experience at the museum. This results in visitors leaving with a negative feeling about the museum. In addition, queue members suffer from a lack of information in their environment [6]. They are unsure on how long the waiting time will be, and are uncertain as to how crowded it will be once they are in. Furthermore, they are often unable to estimate accurately the number of people in the queue or the time they have been there. These are all aspects that can be improved by better information services.

3. METHOD

Interviews were conducted with tourists in Amsterdam at two different locations. The interviews were created to investigate whether tourists can be persuaded to change their route based on the real-time information presented to them and if their opinion differs when they are already in a queue or not.

3.1 Sensor system design

A sensor system was created that can measure the length of a queue. A collaboration was set up with the Van Gogh museum. The sensor system was made and was based on the Arduino framework. The system contains four different sensor nodes, a base station, and an antenna. The sensor nodes use sonic proximity sensors to detect if someone stands in front of them. They were placed on the street, along the queue line of the Van Gogh museum. The data generated by these sensors, contained the distance in cm to the closest object and the number of the sensor, was sent to the base station. The base station was located inside the museum, which detected the signal with an external antenna. This base station is connected to the internet via WiFi which enabled it to send the data to a server. This server stored this data in a MySQL database. A data adapter was responsible of sending the most recent data to CitySDK API which was then able to show the waiting time at a particular tourist hotspot. This information could be accessed and used by our mobile application to present the queue length to the users.

3.2 Participants

A total of 33 tourists, from which 51.5% were male and 48.5% female, were interviewed in two groups. All tourists that participated were foreigners. One group (N=16) consisted of tourists that had the intention to visit the city centre of Amsterdam that day, but are not yet in queue. The other group (N=17) consisted of tourists that were already in the queue at the Van Gogh museum. When tourists were asked to cooperate that were part of a group, only one tourist of that group was interviewed. The mean age of the tourists was 36.94 years (SD = 12.85), ranging from 21 to 65 years old. All participants indicated that they had experience with using technologies such as smartphones or tablets.

3.3 Interview locations

The interviews took place at two different locations. The first location was at the central train station in Amsterdam. This location is ideal to find tourists that are just arriving in Amsterdam and still are in the process of planning their day. The other location was the queue line at the Van Gogh Museum. This museum has a queue on every day of the week, making it a very suitable interview location. To not let the tourists be influenced by the time in their decision-making, all interviews took place in the morning before noon.

3.4 Interviews

Before the interview, the tourists were asked to participate in a research that investigated the possibilities to improve the information services for tourists in Amsterdam. During the interviews, general questions such as demographic information, tablet/smartphone usage and possible day plans were asked first. When a tourist did not own a smartphone or tablet, or was not planning to visit any museums, the interview was stopped. Also, questions were asked about their waiting behaviour and which variables (such as weather, cost or waiting time) were of influence whether or not they would visit a museum. After this, the tourist was presented with a mock-up application showing the dummy data of the queue at the Van Gogh museum. The dummy data was set in the application to have consistent data presented to the participants. The participants would always see the same queue length as the other, decreasing bias in answers about changing their behaviour.

The system also showed possible other places to visit other than the van Gogh museum. The application also indicated a time at which the users could best visit the Van Gogh Museum instead. After this, the interviewees were asked a series of questions on how likely they would be to follow the application's suggestions or route. In addition, questions were included regarding different real-time data sources, such as air quality, transit or traffic data.

4. RESULTS & DISCUSSION

There was no significant difference found between the 'in-queue' group and the 'out-of-queue' group. Both groups were very inclined to trust the data and change their day planning (96.9% - N=32). It seems that already seeing the queue does not have any effect on the willingness to change the day planning. This could be influenced by the fact that only tourists were interviewed that had not been waiting for a very long time, meaning that were not yet committed to the queue.

We found that the mean time that the interviewees were willing to wait in line for a museum was 45 minutes (SD=25 minutes). In addition, 84.8% (N=28) of the interviewees would go to the museum at a later time if they would know beforehand that their maximum waiting time would be exceeded. Further results show that 72.7% of the interviewees (N=24) had not planned any specific activities on certain times or days, but only had a certain amount of venues they wanted to visit regardless of the time and date.

We asked the interviewees what would influence them on their decision to visit a museum. These results can be found in table 1.

Variable	% Influenced
Weather	12.1% (n=4)
Cost	21.2% (n=7)
Waiting time	42.4% (n=14)
Exhibition	30.3% (n=10)

Table 1: Influence of variables on visiting a museum

Interestingly, the waiting time seems to the most decisive variable that influences whether tourists will go to a museum. This question was asked before the participants knew that the main focus of the interview was regarding waiting time. Other variables that the interviewees mentioned were prestige and a lack of information regarding a certain museum.

Finally, questions were asked regarding information that would be interesting for tourists besides waiting time. An overview of these results can be found in table 2. Especially, offering free WiFi is an information service that is in demand among tourists. Now, due to the high roaming costs, tourists rarely use their mobile phones while they are abroad, due to the high roaming costs.

Variable	% Influenced
Air Quality	27.3% (n=9)
Free WiFi spots	84.4% (n=28)
Real-time transport data	75.8% (n=25)
Crowded locations	57.6% (n=19)

Table 2: Interest in different information sources

5. CONCLUSION

We found that most tourists were likely to follow suggestions to change their day planning if an application would suggest an alternative. Furthermore, we found that most tourists would visit the museum at a later time if they knew beforehand that their maximum waiting time threshold would be exceeded.

We have shown that tourists can be persuaded to changing their day planning by presenting them with real time queue information. This is useful for tourists, the municipality and (popular) museums. It enables tourists to have a more efficient day in the city, while it allows the municipality to spread the tourists throughout the city. It could also help museums to spread the tourist flow over the entire day. Interestingly, compared to previous research, people were very inclined to change their day-planning even without any form of direct reward, such as a discount. Just having simple recommendations presented to them gave them enough incentive to change their day plans.

6. FUTURE WORK

Based on the results that were presented in this paper, further research can focus on improving the sensor network. It is shown that people are very inclined to change their behaviour based on the data presented. In order to create reliable data for the system to give recommendations, a more elaborate system is needed. In order to create a more sustainable network, citizen can play an important role. By giving the citizen the tools to place their own sensors, they can be empowered to create their own smart city.

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