Abstract
More and more, cultural institutions employ city and museum tours to encourage visitors to explore their
collections. However, most of them have many limitations for the end-users and lack true
contextualization and personalization. Recently, a tendency to use open data to feed such tours can be
observed. Museums are enriching their collections with Linked Open Data (LOD), which offers new
opportunities as well as challenges for city and museum tours. Utilizing a subset of the LOD Cloud
containing cultural heritage of Amsterdam, AmsterTour is an ongoing research project aimed to develop a
mobile city tour guide for this data subset that generates personalized tours. We found that despite the
limitations that the LOD subset entails, it has the potential to become an excellent source of information
for a mobile city tour guide. We have identified interesting links between the collections, and found a way
to overcome the difficulty of ranking links with a four-point ranking method, which can be adapted and
used for other LOD collections. In a focus group of end users, we identified what is most important and
most interesting for them in a mobile tour application. Based on their opinion and a data analysis a user
interface for AmsterTour was designed, which was qualitatively evaluated and improved. We evaluated
the improved version with an online survey on flexibility and interface elements, which showed that we
have designed an easy-to-use user interface that supports flexibility for the user interaction with
AmsterTour, of which users thought that the features helped them to easily customize a tour to their
preferences. We have designed a promising application that can bring the power of LOD to the general
public.
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1. Introduction

As we can see by the advent of online cultural collections, organizations in the cultural heritage domain are more and more going online. This is not only to preserve the cultural heritage by digitalizing the fragile collections, but also to reach out to a wider audience. As a result of this ‘onlinization’, many collections discover the advantages of establishing links between the items and participate in aggregated portals such as Europeana\(^1\), which enables people to explore the digital collections of Europe's museums, libraries, archives and audio-visual collections. New types of interactions are also explored online, and where the focus has recently shifted to mobile platforms, mobile tours both inside and outside of museums are taking a flight.

Nowadays, it is not enough to just put collections online. Organizations need to provide new approaches to support searching and browsing through their collections. Semantic Web technologies have recently been explored to facilitate this process. In this process, it is important that the collections are published and connected in a structured way, for which a set of best practices known as Linked Data was developed. Bizer \textit{et al.} (2009) explain that Linked Data is about using the web to create typed links between data from different sources. These typed links are in the form of RDF. The Resource Description Framework (RDF) is a framework for representing information on the Web (Klyne & Carroll, 2004) that allows the information to be read automatically by computers, which enables data from different sources to be connected and queried. The framework prescribes that links between data are in the form of triples that consist of a subject, object and a predicate. The object provides information on the subject, and the predicate denotes the relation between the two. The goal of Linked Data is to create both syntactic and semantic interoperability. The Linked Open Data (LOD) project\(^2\) is the most visible example of Linked Data, which aims at making data freely available to everyone. When the project started, it was mainly concerned with converting online resources to RDF format, and setting links between the triples. Nowadays, the Linked Open Data project is a large web of data with 295 data sets consisting of 31+ billion RDF triples interlinked by 500+ million RDF links, and is ever expanding.

As the cloud of Linked Open Data is very large in size and covers many domains\(^3\), it has potential to be used for many interesting cross-domain applications. However, finding exploitable and useful links in a large query space as the cloud is a very complex task, especially when using domain-specific data sets such as cultural heritage in combination with general data sets such as DBpedia\(^4\). As a result of the semantic enrichment of collections, many links can be discovered, but the search space is very complex. Consequently, problems such as ranking and relevance become crucial. In order to oversee the data and exploit interesting links, a local subset of the most interesting domain-specific data sets can be more useful. Linked Open Data from the local museums and city archive might be more feasible to build applications on, rather than trying to find and exploit links between many, different cross-domain data sets.

Researchers from the Web & Media group at the VU University have collected digital cultural heritage collections from the Amsterdam Museum\(^5\) (De Boer \textit{et al.}, 2012), Wikipedia State Monuments\(^6\),

\(^1\) http://www.europeana.eu/
\(^2\) http://www.w3.org/wiki/SweolG/TaskForces/CommunityProjects/LinkingOpenData
\(^3\) http://richard.cyganiak.de/2007/10/1od/imagemap.html
\(^4\) http://dbpedia.org/
\(^5\) http://www.amsterdammuseum.nl/
\(^6\) http://nl.wikipedia.org/wiki/Lijst_van_rijsmonumenten_in_Amsterdam_Centrum
Amsterdam City Archive\(^7\) and Sound and Vision Open Beelden\(^8\), which are stored in RDF\(^9\). Using this local subset called ‘Plaatsen van Betekenis’ (Significant Sights), which can be seen as a ‘mini’ web of Linked Open Data, the VU research group aims to create applications on top of the cultural heritage data. Plaatsen van Betekenis is an activity intended for the Amsterdam Museum to be more active in places and platforms outside the physical form of the museum building\(^10\). Research on the VU University is currently focusing on a mobile application, as yet called AmsterTour, which is a mobile city tour guide that provides historical and cultural information from the Plaatsen van Betekenis collections and generates personalized tours through the city of Amsterdam.

Tour applications are not a new phenomenon. However, most of them are rather static as they do not, or only limited, allow the user to personalize or adjust the tour in real-time. This causes frustration by the users as they are, for example, not able to select the time they would like to spent following the tour or not able to alter the tour by adding and removing waypoints. Also, besides using GPS to determine the context little adaptation is happening. The lack of true contextualization and personalization are limitations that can possibly be overcome by the use of Linked Open Data. The data sets are rich sources of information that can easily be changed and extended independent of the application. A tour application as AmsterTour can be personalized by allowing the user to set certain constraints for the tour independent of the data, where the links between data items allow for contextualization of points of interests in a tour. On the other hand however, the large quantity of available data makes finding exploitable and useful links a very complex task.

To illustrate how AmsterTour would work in practice, we provide a scenario that describes how an example user would use the application.

Jack, a 32 year old tourist from England, is in Amsterdam for the first time in his life. He is amazed by all the interesting architecture but is clueless about the history of, and the relationships between buildings. He would like to learn more while walking through town, and downloads the AmsterTour application to his smartphone at a nearby tourist information office. When standing in front of a building he really likes, he checks his smartphone where detailed information about the building is presented. Jack checks the ‘related’ page to see which buildings are related, and lets the app create a route past these buildings. As he has already visited one of the buildings, he easily deletes it from the tour. As darkness falls halfway through the tour, Jack decides to call it a day. However, it is still a half hour walk to his hotel, which is time he would still want to spend purposeful. He adds a constraint to the tour by indicating the place he wishes to end, so the tour completes near his hotel.

The goal of this research was twofold. Firstly, we searched for solutions that allow for more personalization and adaptation to dynamic context (beyond just location), and for coping with preferences such as tour time, tour length and tour topic in the AmsterTour application. The goal was to support the user in achieving optimal flexibility while creating and following the tour. Secondly, we searched for solutions that allow the user interface to present the right information and related information without overwhelming the users, which also reflect the potential of links provided by the LOD. As the LOD creates many options and increases complexity, we searched for solutions to determine relevance to user and context, and consequently determine the ranking of locations and objects. We aimed to provide innovative ways to 1) describe the current location, 2) provide links to related locations, 3) explain the

\(^7\) http://beeldbank.amsterdam.nl/
\(^8\) http://openbeelden.nl/
\(^9\) http://semanticweb.cs.vu.nl/pvb/home
\(^10\) http://www.plaatsenvanbetekenis.nl/english-summary/
relationships to the current location, and 4) adjust tour constraints in real-time and adjust the current tour on the fly.

In this case study, we researched if our data-approach can be generalized, i.e. if it is applicable to other LOD collections.

Within the research goals, we were concerned with the following research questions:

1. Which aspects of the Plaatsen van Betekenis Linked Data require ‘adaptation’ and support ‘data dynamics’ in the user interaction with a mobile city tour guide? These aspects can be divided in three categories, which are aspects related to:
   a. The types of collections (e.g. museum objects, archive videos, etc.);
   b. The types of LOD data sets selected in the application (type of information);
   c. The links between the LOD data sets.

2. What user interface could support optimal flexibility for the interaction of users with a mobile city guide, and which (reusable) elements would be necessary, with respect to:
   a. Finding a location of interest;
   b. Presenting detailed information of locations and objects;
   c. Presenting links between a location and related objects and related locations;
   d. Presenting overviews of locations and objects;
   e. Adjusting the tour real-time (e.g. adding a new location of interest, changing time constraints, changing final destination, etc.).

2. Background

We provided an overview of the current status of cultural heritage LOD and applications that make use of LOD, in order to identify the developments and shortcomings in using LOD. Furthermore, we analyzed several mobile tour applications and explored the topic of user adaptation for mobile city guides, serving as a basis for the user interaction design of AmsterTour.

2.1 Cultural Heritage LOD

As a result of the ‘onlinization’ of the cultural heritage domain, many organizations discover the advantages of establishing links between the items and share their collections as Linked Open Data. Here we described several examples of these projects that also involved the creation of a user interface that allows users to view and in some cases, interact with the collections.

Europeana is one of the largest collectors of cultural heritage data. “It enables search and discovery in more than 17 million items by collecting metadata from approximately 1,500 cultural institutions across Europe” (Haslhofer & Isaac, 2011, p. 1), and is growing every day. The user interface is constructed in a way that it is easy for users to find what they are searching for. It provides auto-complete options and easy search result filtering options. Unfortunately, there are quite many broken images, which is very inconvenient especially for the similar content section. Due to the short load times and an easy to use interface, it is a useful search interface in which users can explore the available objects, although the sheer amount of items is overwhelming.

The British Museum was the first arts organization from the United Kingdom to put their collection online as Linked Data\textsuperscript{11}. They provide a SPARQL endpoint and a layman-friendly user interface for (advanced) users.

\textsuperscript{11} http://collection.britishmuseum.org/
search. The search results page shows a small image and little, unorganized information for each result. The detailed view on the other hand is much more human readable, and also provides links to objects. Related to this project, Kamura et al. (2011) describe the development of a museum collection search system called Linked Open Data for Academia (LODAC) Museum in Japan. The LODAC Museum identifies and associates artists, artworks, and museum information from some different museums to provide integrated data that are published as Linked Data with the SPARQL endpoint. A keyword search option is also provided\(^{12}\), though the detailed object view is not very human readable.

The MultimediaN N9C Eculture project\(^{13}\) is a portal that provides access to a relatively large set of key cultural heritage collections in The Netherlands. The portal allows for cross-collection search and browsing. It provides an auto-complete function and several search options that allow the user to cluster search results in different ways. Most interesting is the ‘local view’, which is the detailed view of an object. This view provides a large image and a selection of the most important properties of the object, and links to the full view and the original page. This allows the user to find more detailed information of the object.

### 2.2 Cultural Heritage LOD Applications

The previous examples show that cultural heritage institutions are more and more getting their data online in a machine-readable format, and try to link data items with each other. This allows for more specific search, but the development of useful applications is still falling behind. We do see that more and more efforts are made to make interesting applications on top of Linked Data for normal users. For LODAC, several applications have been developed that display the collection’s content on a map. The purpose is to give an overview of what is located where, but the applications are rather raw, as if it is just a data dump on a map. The detailed view of a location in the Yokohama Art Spot app\(^{14}\) seems to be more interesting, as it provides information on the location and links to Flickr photos.

The CHIP (Cultural Heritage Information Presentation) project\(^{15}\) is a project that not just semantically enriched the data of the Rijksmuseum Amsterdam\(^{16}\), but also implemented an artwork recommender, a web-based virtual tour wizard, and a PDA-based mobile tour (Wang et al. 2008). These applications utilize a personal profile, wherein the user’s interests and tours are saved. Using the artwork recommender, the user can rate artworks and topics. Meanwhile, the application provides recommendations for other artworks based on the semantic constraints from the user. The user can put restrictions on the recommendations, such as ‘do not include recommendations based on material’. The tour generator allows the user to create a tour through the Rijksmuseum based on the user’s favorite artworks, or the recommendations. It is also possible for the user to create an own tour, by clicking ‘add to tour’ on each artwork of their choice. In the mobile application, the user is also able to select temporal constraints in changing the time and number of artworks in the tour.

To challenge developers to create applications using (Linked) Open Data, the competition Apps voor Nederland\(^{17}\) (Apps for the Netherlands) was launched. In this competition, several developers aimed for an application in the cultural heritage domain. Most noticeable are the two applications that provide

\(^{12}\) [http://lod.ac/](http://lod.ac/)

\(^{13}\) [http://e-culture.multimedian.nl/](http://e-culture.multimedian.nl/)

\(^{14}\) [http://lod.ac/apps/yas/](http://lod.ac/apps/yas/)

\(^{15}\) [http://chip-project.org/](http://chip-project.org/)

\(^{16}\) [http://www.rijksmuseum.nl/](http://www.rijksmuseum.nl/)

\(^{17}\) [http://www.appsvoornederland.nl/](http://www.appsvoornederland.nl/)
information on the state monuments of the Netherlands\textsuperscript{18}, een dagje Velsen\textsuperscript{20} (a day in Velsen) and Vistory\textsuperscript{21} - an interactive historical video application.

Van Aart et al. (2010) explored the use of location-aware mobile devices for acquiring knowledge from cultural heritage information repositories. Given a particular location of the user, cultural heritage Linked Open Data and the technology and constraints of a mobile device, Van Aart et al. were able to create an application that provides dynamic information in favor of a classical travel guide. The researchers present a user interface design where a combination of location, heading and facet-based filtering provides the user with an annotated augmented reality view on points of interest. They conclude that the interplay of sources from the LOD cloud, Wikipedia and cultural heritage data can provide a very rich, machine-processable knowledge base about a certain topic. Van Aart et al. found that their “semantic crawling” method is a major improvement over the current state of the art applications, as not only labels of points of interest near a given location can be shown, but also background knowledge associated with the location.

2.3 Mobile Tour Applications

In order to gain insight on mobile applications that are similar to AmsterTour, we described several applications that make use of data sources other than Linked Open Data.

Several applications use GPS to determine the user’s location and present information that is useful at that point. For example, LaBelle (2011) describes a tree tour application that directs a tour participant from one campus tree to another while providing information about each tree. To direct the user from tree to tree, photos of each stop and cues are provided to help users locate the tree using objects in the physical environment as reference points, such as lampposts, walkways and buildings. The use of ‘augmented reality’ markers (arrows, circles) to highlight directions helps orient users relative to each specific tree. A map of the tour allows the user to see where the trees are located and shows the tree names. Each tree icon is linked to a tree repository where the user can view the comprehensive list of trees found in all tours. The application was evaluated by users that completed several tree stops and answered questions about their experience. The results show that the application was easy to use, with an effective navigation. Overall, the users were interested in the application but would like to see a wider range of content. Another application similar to AmsterTour is Amsterdam 1572\textsuperscript{22}, which allows the user to travel to the past and discover the history of the city of Amsterdam. The application uses GPS to locate the user’s position on the map of old Amsterdam, displaying information about historical places as the user visits them.

As strongly stated by Idea.org (2012), “the vast majority of museums are totally ignoring mobile apps.” In their survey, they found that the reasons for this are mainly their lack of experience, the fact that it is not a priority and the high cost. Mobile apps and social media are considered ‘marketing’ expenses, as opposed to tools to educate and inform the public. It does get easier and cheaper for cultural organizations to make mobile tours (Idea.org , 2011). Idea.org provided an overview of vendors along with several examples of tour applications.

\textsuperscript{18} http://www.appsvoornederland.nl/apps/rijksmonumenten-nl
\textsuperscript{19} http://www.appsvoornederland.nl/apps/rijksmonumenten-info
\textsuperscript{20} http://www.appsvoornederland.nl/apps/dagje-velsen
\textsuperscript{21} http://www.appsvoornederland.nl/apps/vistory-the-interactive-historical-video-app
\textsuperscript{22} http://www.parool.nl/parool/nl/38/MEDIA/article/detail/3173945/2012/02/11/Routeplanner-van-vier-eeuwen-oud.dhtml
The use of a location-awareness in a mobile application is connected to a fundamental issue of proactiveness (Lanir et al., 2011). Should the system keep the user in control all the time and only respond to user requests, or should the system take initiative and propose its services when needed? Lanir et al. performed a study in which museum visitors were approached to try out an interface of a mobile museum guide. Three different interfaces were employed; menu-based (most choice), simple (single choice) and proactive (no choice). The researchers found that visitors felt less in control when using the proactive interface than when using a passive interface, and in general a large majority preferred the menu-based interface guide, indicating choice is an important factor in the user interface.

### 2.4 User-adaptation for Mobile City Guides

Previously described applications offer little user-adaptation and personalization options. Ardissono et al. (2011) recently analyzed the matter of personalization in cultural heritage, and identified that despite some progress and interesting results that came with Web 2.0, the cultural heritage industry has yet to adopt real personalization. While mobile guides are now commonly used in cultural heritage settings and social web technology is spreading fast, personalized services are not. Ardissono et al. advise that, while there is room for continuing experimentation with new ideas and new technology, the real issue is to support realistic scenarios for real visitors and users in daily interactions with cultural heritage.

Takeuchi & Sugimoto (2009) described a user-adaptive city guide system, which adapts shop recommendations to the user’s location history. Using the loss of GPS signal to determine when the user goes indoors, the coordinates are stored to be able to determine frequented shops. Recommended shops are shown on a map, using a ‘metal detector’ interface to guide the user to the shops. Beeping sounds are emitted when the user is within a certain distance of a recommended shop. Beeping sounds do not require the user to be looking at the screen to be noticed, so the user can walk around and be alarmed when there is a shop nearby which may match their preferences. Takeuchi & Sugimoto also provide a pointing mode where users can point their mobile devices to find out the directions in which many recommended shops are located, by listening to the beeping intervals. The evaluation showed that the metal detector interface in combination with the GUI freed the user from looking at a screen all the time, but on the other hand occasionally distracted and irritated the users with the beeping sounds. Many conventional systems that list closest nearby shops, also allow some level of manual user customization, such as letting the user specify which types of shops they are interested in. However, the extra user interaction may become a nuisance, something the system from Takeuchi & Sugimoto avoids by using location awareness to adapt to the user.

Another user-adaptive city guide is described by Hill & Wesson (2010), who identified to which extent adaptive user interfaces can improve the effectiveness and user satisfaction of a mobile tourist guide. The researchers used an existing, positively evaluated, static mobile tourist guide to extent with user-adaptive features, grouped in the three categories 1) information adaptation, 2) interaction adaptation and 3) visualization adaptation. The results of the evaluation showed that an adaptive user interface can provide several usability benefits for mobile tourist guides, specifically in the areas of ease of use, usefulness and satisfaction. Several participants described adaptations linked to the GPS as the most positive aspect. Very high usefulness and satisfaction ratings were recorded for automatically adjusting the level-of-detail based on the zoom level, which adapts automatically according the current speed of the user. The issue of controllability was identified in the evaluation, which is in agreement with the findings of Lanir et al. (2011). Users want to have options to alter the interaction adaptations; as in being able to edit their user profiles, being able to do manual tweaks or corrections to learned preferences, and allowing to enable or
disable adaptive features. Also, adaptation features that are not as immediately noticeable as others (such as automatic filter adjustment) can negatively impact perceived control and should be clarified.

2.5 Conclusions
This overview showed that cultural heritage LOD is a growing field that has potential, even though the large amount of data could pose a problem. Intuitively, this might be the explanation why the development of applications has yet to emerge. The analysis of mobile tour applications showed that applications are limited in terms of adaptation and contextualization, where the challenge is to support realistic scenarios for real visitors and users. User-adaptation can be beneficial in terms of usability, provided that the user should always feel in control.

3. Approach
In order to answer the research questions and to receive a maximum amount of feedback during the research, a small cyclic approach to the interface design was employed. The goal was to quickly gather information from the data and receive input from end-users before translating the results to an interface design. This interface design was evaluated and improved based on the feedback before being evaluated for a second time. The early focus on users and tasks as well as employing an iterative process are traditional, and have become design principles in the field of user interaction design.

3.1 Information Gathering
The information gathering process consisted of three phases, namely data analysis, scenario creation and a focus group discussion.

Firstly, the Plaatsen van Betekenis Linked Data was analyzed to determine what data and relationships between data are useful and meaningful for a mobile city tour guide application. We identified which data and relationships are interesting, and found matching paths in the graph. We then identified if and which of these relationships are sensible to use and give several examples.

Secondly, based on the previous analysis and related applications, scenarios were created to identify goals and requirements for users interacting with a mobile city guide.

Thirdly, the data analysis results and scenarios were discussed in a focus group of end users, to identify what is most important and most interesting for them in a mobile city tour guide application.

3.2 Interface Design
Based on the results from the information gathering process, the functionalities requirements of the mobile city tour guide user interface were described, and the user interface was designed representing a mockup of the AmsterTour application.

Next, the interface mockup was qualitatively evaluated to see what improvements could be made in the design. This evaluation was in the form of a think-aloud walkthrough performed with several end users.

The feedback of the think-aloud walkthrough was used to create a second, improved version of the user interface. The second version was evaluated on the five points of research question two. Flexibility is
defined in four ways, to see if the interface mock-up is 1) appreciated by the users, 2) effective in performing tasks, 3) efficient in terms of interaction time, and 4) usable and quickly learnable for first time users.

4. Data

Researchers from the Web & Media group at the VU University have collected digital cultural heritage data from the Amsterdam Museum, Wikipedia State Monuments, Amsterdam City Archive and Sound and Vision Open Beelden. This local subset called Plaatsen van Betekenis (Significant Sights) contains information on different kind of collections, and is stored in RDF. In this section we described what information these collections contain and performed an analysis to see what links are present, in order to identify which aspects of the data require ‘adaptation’ and support ‘data dynamics’ in the user interaction with the AmsterTour application (research question one).

4.1 Types of Collections and Information

The collection of the Amsterdam Museum contains information about museum objects that are related to Amsterdam. The total collection counts more than 70,000 objects, of which only five percent is permanently shown in the museum. The vast majority of the collection is stored in depots and is sometimes used for exhibitions in other museums. The collection includes object metadata on 73,000 objects, a concept thesaurus with 28,000 concepts of different types, and a person thesaurus with 67,000 persons that are consolidated from the object metadata fields. Predicates in the object collection are related to acquisition, accompanying texts from within the museum, current location, dimension, documentation, exhibition, location history, maker, material, description, production and reproduction. The concept thesaurus is a list of concepts that is used to describe the collection of the Amsterdam Museum. The majority of these concepts are related to geographical locations, with other frequently occurring concepts include subjects, dimensions, object names, materials, motifs, techniques, occupations and events. The person thesaurus contains creators, annotators, reproduction creators and institutions. Some persons in this thesaurus can also be considered locations, such as Felix Meritis.

An example of an item in the Amsterdam Museum collection is a painting of the arrival of Napoleon in Amsterdam\(^2\). The information present includes acquisition date and method, texts from the museum, associated persons, subjects and motifs, dimensions, documentation, locations in the museum, maker, material, object name and category, production and reproduction and an image. Not all objects contain this amount of information; a showcased ship camel for example\(^2\) does not include museum texts, maker or associated persons, subjects and motifs.

The State Monuments collection from Wikipedia contains an overview of state monuments in the city of Amsterdam. From the total amount of 7,385 state monuments, 7,240 monuments are listed in the data set. Two percent of the monuments have been lost in the data conversion process. The collection contains images of the state monuments, and information with predicates including address, architect, year built, area, latitude and longitude, map url, object name, description and number, original function and CBS text. The CBS text is a classification scheme from the Centraal Bureau voor de Statistiek (Statistics Netherlands). Most of the monuments are described as residences (6,599), other categories

\(^2\) [http://purl.org/collections/nl/am/proxy-37932](http://purl.org/collections/nl/am/proxy-37932)

\(^2\) [http://purl.org/collections/nl/am/proxy-15382](http://purl.org/collections/nl/am/proxy-15382)
include public buildings, churches and mills. 265 monuments have an architect listed, of which 59 have the value “unknown”, and 814 monuments have their building year listed.

An example of a monument is the Vondelkerk\(^{25}\). All mentioned information is present, apart from year built. The same applies for this collection as for the Amsterdam Museum; not all information is present for all monuments. For the American Hotel\(^{26}\) for example, no image, architect, original function nor year built is available.

The Amsterdam City Archive collection contains the historical documentation of the city of Amsterdam. This collection is historical-topographic and contains millions of maps, drawings and prints, a library and extensive audio, film and photo archives. Plaatsen van Betekenis contains a subset of this archive called the Beeldbank City Archive. This subset contains a selection of the images of the Amsterdam City Archive. This selection contains 282,563 images with metadata about Amsterdam, accompanied by a list of 8,000 persons. The predicates in the collection include date, document type (photo, print, drawing etc.), origin, year, location, description, rights and several predicates related to the roles of the creator (e.g. architect, photographer, painter). Apart from this image collection, a list of persons is available.

An example of a document is a photograph of fishermen along the Amstel by Aart Klein\(^{27}\). It contains all described information, including a description and a role that not all documents have, for instance a drawing of the Heiligeweg 19\(^{28}\).

The Sound and Vision Open Beelden collection contains open video footage from the Sound and Vision institute. The video archives are not specifically about Amsterdam, and contain 1,655 videos and metadata. Predicates that are used for each video include abstract, attribution name, creator, date, datestamp, description, extent (describes the duration of the video), language, license, medium, source, subject and title. Around half of the videos (765) are subject of the predicate ‘spatial’, which contains a country or a city as object. Based on the spatial predicate we can say that about 130 of these videos are about Amsterdam.

An example of a video is the Arrival of Sinterklaas in Amsterdam\(^{29}\). The abstract is a summary of the video, and other information includes the date, subject, spatial information and links to the video file in different formats.

We arranged the subject of the items in the Plaatsen van Betekenis collections into a classification (table 1). The ordering is based on the number of items corresponding to the categories. Next to the listed items, Plaatsen van Betekenis also contains persons with different roles and geographic locations. The City Archive does not contain a predicate indicating the subject of the item, and the descriptions are hard to categorize as they are not keyworded. The City Archive contains documents depicting persons, locations, buildings, events and objects (in no particular order). The type of document is the only clear distinction, which can be categorized in order of frequency into Photos, Building Plans, Prints, Drawings, Maps and Picture Postcards.

\(^{25}\) [http://purl.org/collections/nl/rijksmonumenten/proxy-5907_Vondelstraat_120A](http://purl.org/collections/nl/rijksmonumenten/proxy-5907_Vondelstraat_120A)


\(^{27}\) [http://purl.org/collections/nl/stadsarchief/proxy-290534](http://purl.org/collections/nl/stadsarchief/proxy-290534)

\(^{28}\) [http://purl.org/collections/nl/stadsarchief/proxy-98020](http://purl.org/collections/nl/stadsarchief/proxy-98020)

From this taxonomy, we derive the item categories in Plaatsen van Betekenis that are dominant in the collections. Most of the documents, events and museum objects are related to Religion, Construction, War, and Citizenship.

Table 1. Taxonomy

<table>
<thead>
<tr>
<th>Museum Objects</th>
<th>Buildings</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religion</td>
<td>Residences</td>
<td>Second World War</td>
</tr>
<tr>
<td>Orphan Care</td>
<td>Individual Objects</td>
<td>Exhibitions</td>
</tr>
<tr>
<td>Emblemata</td>
<td>Public Buildings</td>
<td>Openings</td>
</tr>
<tr>
<td>Travels</td>
<td>Churches</td>
<td>Jubilee</td>
</tr>
<tr>
<td>Trades and Professions</td>
<td>Parts of Buildings</td>
<td>Children</td>
</tr>
<tr>
<td>Cartography</td>
<td>Road and Waterworks</td>
<td>Factories</td>
</tr>
<tr>
<td>Sports and Games</td>
<td>Charities</td>
<td>Women</td>
</tr>
<tr>
<td>Literature</td>
<td>Catering Establishments</td>
<td>Construction</td>
</tr>
<tr>
<td>War</td>
<td>Agricultural Buildings</td>
<td>Military</td>
</tr>
<tr>
<td>Shipping</td>
<td>Defensive Structures</td>
<td>Memorials</td>
</tr>
<tr>
<td>Jubilee</td>
<td>Mills</td>
<td>Winter</td>
</tr>
<tr>
<td>Science</td>
<td>Castles and Manors</td>
<td>Harbors</td>
</tr>
<tr>
<td>Food</td>
<td>Church Components / Objects</td>
<td>Football</td>
</tr>
<tr>
<td>Medicine</td>
<td></td>
<td>Airplanes</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>Fairs</td>
</tr>
<tr>
<td>Pigeon Sport</td>
<td></td>
<td>Clothing</td>
</tr>
<tr>
<td>Heraldry</td>
<td></td>
<td>Museums</td>
</tr>
<tr>
<td>Criminality</td>
<td></td>
<td>Leisure Activities</td>
</tr>
<tr>
<td>Citizenship</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2 Types of Links

In this section we described the analysis of present links in the collections, between the collections and to other collections outside of Plaatsen van Betekenis.

4.2.1 Links within Collections

The Amsterdam Museum, City Archive and State Monuments collections each have a separate RDF graph for persons in their collection. In this way, information on persons can be found by following the link
to this graph. For example, the predicate ‘maker’ in the Amsterdam Museum leads to the information page of a person in the person graph. The print ‘the official municipal brothels’ has a maker predicate that leads to the person Harry van Kruijningen, where we find 35 other triples with this person. The Amsterdam Museum person graph has, if known, information stored on birth and death date and place, nationality and occupation. This information is linked to other objects and persons in the collection. For instance, the year 1778 is used as birth date but also as production date for museum objects. The person graphs for the City Archive and the State Monuments are less extensive, only containing respectively a foaf:name predicate and a label predicate.

Apart from the person graphs, the Amsterdam Museum has a separate concept graph. This list of concepts is used to describe the collection of the Amsterdam Museum and uses the Simple Knowledge Organization System (SKOS) as a representation. Predicates such as broader, narrower and related allow for organization of the concepts. Triples are for instance ‘apostel skos:related heilige’ (‘apostle skos:related saint’), and ‘duif skos:broadere vogel’ (‘pigeon skos:broadere bird’). The pigeon is used as ‘content subject’ and ‘content motif’ describing museum objects. In this way, links to broader, narrower and related terms can lead to more information on similar concepts.

4.2.2 Links between Collections

There are currently no links between the collections. To illustrate this, we take Jan Wils as an example. In the State Monuments collection, Jan Wils is present in the person graph as ‘Jan Wils (architect)’. He appears in seven triples as an object with the predicate architect. The seven monuments are related to the Olympisch Stadion, of which he was the architect. In the City Archive collection, Jan Wils is also listed in the person graph, and appears in one triple as an object with the predicate role-architect. The document is the building plan for Stadionplein 22-24, of which Jan Wils was the architect. Jan Wils is also listed in the Amsterdam Museum concept graph as Wils, Jan, and linked as an associated person and content person name to a coin in the collection. All links between Jan Wils and objects reside inside a collection. There is, for example, no foaf:sameAs link between the person graphs nor a link from one person graph to an object in another collection.

Apart from organizing knowledge, another component of SKOS is Mapping, which is intended to provide a vocabulary to express matching (exact or fuzzy) of concepts from one concept scheme to another. Subjects in the collections have predicates with literals as object. For instance, a triple from the City Archive looks like ‘subject - predicate - “WO II”’. SKOS mapping finds matches between the literals and the concepts in the Amsterdam Museum concept thesaurus. These are not actual links as of yet, but can be made rather easily. The actual linking is not yet performed due to the fact that it will not be perfect. The possibilities and constraints are illustrated below.

Interesting links can be established through SKOS mapping. For instance, ‘spatial’ from Open Beelden, ‘location’ from City Archive and ‘address’ from State Monuments can be linked to the concept thesaurus, making documents, objects and videos related to a specific location easily retrievable. As the thesaurus is

30 http://purl.org/collections/nl/am/proxy-2838
31 http://www.w3.org/2004/02/skos/
32 http://purl.org/collections/nl/rijksonmonumenten/p-Jan_Wils_architect
33 http://purl.org/collections/nl/rijksonmonumenten/p-Jan_Wils_architect
34 http://purl.org/collections/nl/stadsarchiefJan_Wils
35 http://purl.org/collections/nl/stadsarchief/proxy-247362
36 http://purl.org/collections/nl/am/p-24172
37 http://purl.org/collections/nl/am/proxy-37214
not complete, many literals will not match on a concept in the graph. The location ‘De Ruijterkade’ in the City Archive has many documents linked to it, but as it does not exist in the thesaurus, it will not be linked. If then only the thesaurus and its links are used for an application, documents related to ‘De Ruijterkade’ will never be used.

For subjects the mapping is more difficult, as the City Archive does not have a specific subject predicate. Consequently, the description has to be used and because the literals are long and complex, this will require manual labor. The State Monuments CBS categorization and original function contain literals that are not recognized by the SKOS mapping due to its format, but could be linked to the thesaurus manually. The ‘subjects’ of Open Beelden on the other hand, can easily be linked to the thesaurus with SKOS mapping.

Apart from location and subject, there are no concepts that are similar across all four collections. Next to concepts, the linking of persons such as Jan Wils across the collections would be beneficial for finding documents, objects and videos related to a specific person.

4.2.3 Links to Other Collections

Several links exists from the Amsterdam Museum collection to other Linked Open Data sources outside of Plaatsen van Betekenis. Around 3.500 links have been established, including 143 places linked to GeoNames38, 1.076 persons linked to ULAN39, 34 persons linked to DBpedia, and 2.498 concepts linked to AAT-Ned40.

GeoNames is a geographical database that has information on all countries and contains over eight million place names. ULAN is the Union List of Artist Names, a structured vocabulary of artist names and biographical information. DBpedia is structured information from Wikipedia, and AAT-Ned is the Dutch version of AAT, a thesaurus for architecture, art and cultural historical collections.

4.3 Implications

Plaatsen van Betekenis includes a variety of collection types that requires the application to be flexible in presenting different kinds of data items, as they range from videos to museum objects. The information from these heterogeneous sources can be presented in either a homogeneous or a heterogeneous way. Presenting information from different collections alternately can have confusing consequences for the user. In the focus group discussion, it is determined which collection is most suitable to focus the AmsterTour application on and to what extent the Open Beelden videos are useful in this context.

In presenting the information to users, it is important to realize that many values are missing or incomplete. For instance, when presenting information on a state monument we cannot rely on being able to present the architect and the year built as they are only present for a limited amount of monuments. One option is to limit the search space to objects that only contain the desired attributes, which leaves out possible very interesting objects. Another option is to include all objects whether the desired attributes are present or not. To not severely limit the number of objects, we chose to include all objects but prefer objects that have more of the attributes suited for the context in which they are presented. Consequently, the user should not have to deal with the problems and be presented empty information fields and red crosses where pictures are not available. At the same time, the tour should not stop or behave

38 http://www.geonames.org/
39 http://www.getty.edu/vow/ULANSearchPage.jsp
40 http://www.aat-ned.nl/home
unexpectedly due to missing or incomplete information. Missing and incomplete values is not limited to Plaatsen van Betekenis Linked Data only, but typical for all Linked Open Data. As the data resides in a web environment that has an open nature by default, the information is uncontrollable for the application maker. Data can be moved, changed or removed without the application maker knowing. While the separation of application logic and data is also one of the strengths of Linked Open Data, it does mean the application has to deal with the imperfections that come with the open nature.

The number of links to data sets outside of Plaatsen van Betekenis is rather limited; therefore it is troublesome to rely on retrieving information from these sources in the context of AmsterTour. The user interface needs to be adaptive due to missing and incomplete data from Plaatsen van Betekenis. Dealing with other sources as well increases the chance of errors and has limited added value for the users due to the small number of links, therefore these are not used in the design of AmsterTour.

Currently, no links exist between the data collections within Plaatsen van Betekenis. SKOS mapping can improve findability of related items, but relying on the links created through mapping will leave out items that are not linked for whatever reason. A spelling mistake or one missing value can cause the mapping to fail and therefore cause the link to not be created, which implies manual labor is necessary to create links. The application will have to reason to a certain extent to determine what links are to be followed and what links are not to be followed. This can either be indicated explicitly or inferred by using RDFS reasoning. From all the data items and (possible) links, we question what is actually of interest for users of a mobile tour application, which is discussed in the focus group (chapter 6). Ideally, there are many options to choose from at each location of interest on where to continue or to alter the tour. These options can for example be based on year or period, function, style or person, as depicted in figure 1. A tour can be created based completely on preferences of the user beforehand, created from scratch and completely altered based on user input as locations are visited, or anything in between. In chapter 7, we described the approach chosen for AmsterTour and which links would therefore need to be created to optimally make use of the data and provide a meaningful experience to the user.

**Figure 1. Application rationale**
5. Scenarios

Different scenarios of how people would interact with a tour application built upon the Plaatsen van Betekenis data can be identified. As different users have different preferences for using a tour application, possible scenarios are quite divergent. We provided several scenarios covering several types of interaction with AmsterTour.

5.1 Types of Tourists

McKercher (2002) defines different types of cultural tourists, integrating the two elements centrality and depth of experience along a continuum to produce a conceptual model:

The importance (or centrality) of cultural tourism can be the main reason someone chooses a destination, but it can also play a lesser role. Likewise, depth of experience will be variable, ranging from a shallow, superficial or sightseeing experience to a much deeper, learning orientated experience. (p. 32)

The scenarios are influenced by the five types of cultural tourists as described by McKercher:

1. The purposeful cultural tourist, high centrality and deep experience;
2. The sightseeing cultural tourist, high centrality and shallow experience;
3. The casual cultural tourist, modest centrality and shallow experience;
4. The incidental cultural tourist, low centrality and shallow experience;
5. The serendipitous cultural tourist, low centrality and deep experience.

Different types of tourist interact with a mobile tour application in different ways. Ideally, the application supports all kinds of scenarios.

5.2 Tourist Scenarios

The purposeful cultural tourist (on the spot)

Tourist Chen is on a fourteen-day European trip and wants to visit Amsterdam. He is interested in Rembrandt and would like to have a three-hour comprehensible Rembrandt-themed tour through Amsterdam. In the AmsterTour application, he enters his interests and generates a tour which takes him past interesting locations and houses related to Rembrandt, as well as into the Amsterdam Museum and the City Archive.

The purposeful cultural tourist (beforehand)

Jeroen, a 43 year old biologist, is planning to make a trip to Amsterdam. Even though he has been there before, he has never seen the city through a tourist point of view. This time, he wants to visit several places of interest and actually see the beauty of Amsterdam’s historic heritage. Beforehand, he searches the Internet for places he would like to visit. He reads about several churches, some museums and looks through the digital archive of the Amsterdam Museum. He ends up with a list of six places he would like to visit, and starts up the AmsterTour application in which he creates a tour along these places. Based on suggestions from the application, he finds out about another church he did not find in his Internet search. Pleasantly surprised, Jeroen adds this church to the tour. Now everything is set up, he cannot wait to make his trip to Amsterdam the next weekend.
The sightseeing cultural tourist
Nick, a 32 year old radio disk jockey from England, is in Amsterdam with his wife to celebrate their 5 year wedding anniversary. They want to find their own way through the city, exploring the town without the help of a guide. Feeling that they lack information on certain sites, they download the AmsterTour application to learn about the sights they are visiting. When they stand in front of Olympic Stadium, they use the application to view information and historic images of the sight.

The casual cultural tourist
Rachel has to stay in Amsterdam for a day due to problems with her transfer plane ticket. While she is stuck in the city, she would like to see some of the culture. Using the AmsterTour application, she creates a two-hour tour through the city center. At the first location, the Oude Kerk, she decides she wants to see more buildings like this. Rachel changes the tour to include more churches, dropping other locations originally included in the tour. After seeing the Nieuwe Kerk and the Westerkerk, she gets tired and decides to go shopping nearby.

The incidental cultural tourist
Wendy, a 21 year old student from Groningen, is planning to do her masters’ study in Amsterdam. Before making the decision, she would like to see if Amsterdam is a town she would enjoy for several years. Alone and kind of helpless, she uses the AmsterTour application to create a tour through town. She follows the given directions and memorizes some of the streets and places she visits. Wendy is barely interested in the cultural and historical information given by the application, and mostly just reads the names to learn the locations of points of interest.

The serendipitous cultural tourist
Tourist Lukas from Germany is in Amsterdam for the first time in his life, and has no idea where to go and what to visit. At a nearby tourist information office he finds out about the AmsterTour application and downloads it to his smartphone. As he has no clue on what he would like to see, he lets the application create a tour only entering the restriction of using well-known locations only. Lukas trusts the application and follows the tour. In the end, he feels like he got a good feeling of the city and its points of interest.

In the focus group discussion, we determined which scenarios are most common and therefore important to support.

6. Focus Group
In the context of the research, a focus group meeting was held on the 3rd of May 2012 to get input from end users with regards to the use of the Plaatsen van Betekenis Linked Data and the flexibility in interaction with a mobile tour application. A focus group is typically a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs and attitudes towards a product, service, concept, idea, or whatnot (Henderson, 2009). Questions are asked in a group setting where the participants are free to talk with each other. The participants had no prior knowledge of the topic before the start of the discussion, and they were given just enough information to answer and discuss the questions (with the intention to prevent a bias and to keep the discussion as open as possible). The concept of Linked Data was deliberately not explained not to bias the thoughts of the participants.
6.1 Participants
The focus group consisted of six Dutch people with different professional backgrounds, a limited knowledge about Amsterdam, and none of them currently living there. Three age groups were represented (in the range of 21 to 68): two participants around 20, two around 40 and two around 60 years old. Each age group consisted of a male and a female. Only one participant (male, age 42) owned a smartphone.

6.2 Goals and Tasks
The overall goal of the focus group discussion was to get input from end users with regards to their expectations of the types of information personalization and presentation, as well as their perception of flexibility and adaptation in terms of interaction. Below, we provided the set of concrete goals for the focus group, which are related to the research questions:

1. Data
   a. What type of collections do users find interesting in the context of a mobile tour?
   b. What type of information do users find useful in the context of a mobile tour?
   c. What type of links in terms of relatedness would users like to see in the context of a mobile tour?

2. User interaction and flexibility
   a. What are typical criteria to determine points of interest in a given context (e.g. travel companions, the weather, etc.), and what is important in navigating to points of interest?
   b. What is important to know about a point of interest and in the presentation of the information? Is this always the same, or does it change? Is it dependent on the initial interest specification from question 2a?
   c. What do users consider a related item? What information is important in the presentation of related items?
   d. What is important in presenting tour overviews? What would an overview be used for? Are there different situations when different things are important in overviews? Do they differ depending on the tour content?
   e. What is important in adjusting the tour with regards to flexibility; length, walking distance, number of locations, add/remove locations, etc.? How often would such adjustments be used?

The described goals were used as a guide for the focus group discussion that consisted of four parts. In the introductory Part I, the participants indicated their previous experiences with following tours and formed scenarios for exploring a city that served as a base for all tasks. The goals related to the user interaction and flexibility are covered in Part II and the goals related to the data are covered in Part III. Part IV consisted of closing questions where the participants reflected on the discussed content. For some questions, the participants worked together with a partner of the same age to get to a collaborated answer. The specific contents of the discussion are described in Appendix A.

6.3 Results
The main results that came from the focus group are that 1) current tours are too static and impersonal, 2) people are willing to take time beforehand to make a tour personal, 3) people would like to have options for change in case of unexpected events, 4) waypoints in a tour should be tangible, such as existing buildings, and 5) any information available in the application should be presented on demand only.
In this section we described the results per part of tasks. The numbers in parentheses indicate prominent results that are summarized in the next section, 6.4.

**Introduction (Task Part I)**
The participants indicated their previous experiences with following tours, which included city tours, museum tours, sightseeing boat tours, cave tours and tours in palaces. Following these tours had positive sides such as the added value due to extra information, good programs, interesting sites and an amusing atmosphere. However, there were issues with time by either by staying in one place too long or too short and the tours were rather impersonal (1).

The participants wrote down keywords indicating terms related to exploring a new and exploring a familiar city, which were quite similar with recurring terms such as ‘discovering’, ‘walking’ and ‘hotel’ (2). Differences occurred in terms that were mentioned for a familiar city including ‘wish list’, ‘recognizance’, ‘specific search’ and ‘focused view’, which were not mentioned for a new city. This means that the process of exploring stays the same, but the planning and content is different. This comes back in the scenarios the participants created that also appeared to be very similar. In all scenarios three phases could be identified, namely finding information, planning and executing (2). The group with participants of around 40 years of age specifically added an evaluation phase at the end, in which they would evaluate if the trip would be worth doing again or not, and indicate points for improvement. As we saw in the keywords, the only difference between the scenarios for exploring a new city and exploring a familiar city is the more specific information search during the planning phase in the latter case. That is, the selection procedure of places to visit is more detailed.

The participants best fit the purposeful cultural tourist (beforehand) tourist scenario. They could see a use for the sightseeing and casual scenario, but the other scenarios from chapter 5 did not come forward during the discussion. We cannot conclude that the other scenarios will never occur, however they might be less forthcoming. This implies that an application should provide or support the planning phase as described by the participants. The importance of planning for tourists is also emphasized by Yu & Chang (2009), who also note that there is still a lack of personalization in context to meet the interests, preferences, and devices of individual tourists.

**Interaction (Task Part II)**
The participants formed goals for a mobile application that support their scenarios for exploring a city, which were related to the execution phase only. They indicated that the information finding and planning phases would preferably be done at home. Based on the goals that were formed in groups of two, a shared ranked list of main functionalities for a mobile tour application was created, where the actual content of the tour was not discussed at this point: 1) information on points of interest, also inside of museums and other buildings, 2-3) navigation while walking and possibly public transport, which was considered useful but dependent on the city, 2-3) information on events, which is information on current activities or festivities in the city that might influence the tour or the participants’ interests, and 4) suggestions for related waypoints to add to the tour (5).

Information on service providing agencies, such as emergency services, police, tourist information, postal office, banks, etc. was specifically mentioned to be very important to have as a function when visiting a city (5). When something happens, this is urgent information to know and therefore very important. It would give the participants a feeling of safety that with one push of a button the necessary information can be found. Other functionalities that were considered interesting but not main functionalities are information on busy spots, weather information and a translator.
The trade-off between the application doing things automatically and the participants guiding it with their own choices is considered to be goal-dependent and should be adjustable at all times. Generally, the participants want to be in control where pull-information is preferred, and a personal profile could indicate what information should be pushed at all times (8). This is in agreement with Lanir et al. (2011).

**Presentation (Task Part II)**

For the function *navigation*, a map view with route overlay is preferred. This is a familiar concept and considered most useful. Other options such as voice guidance and a street view overlay are not the preferred way of navigation.

Participants indicate that they would like to take the time beforehand to indicate their preferences in order to find points of interest, as this is something that would generally not change (3). Next to personal preferences, it is also appreciated if the application could show where the generally important points of interest are. What is of interest would also depend on the group composition and the length of the stay.

In presenting information on a point of interest, there is a general consensus that the amount of information presented should be limited at first, with background information only when specifically requested (10). For the form of presentation, text with an accompanying picture is mostly appreciated, as opposed to videos due to the time it takes to watch them (11).

For the function *suggestions*, i.e. presenting related waypoints, all participants indicated that they should only be displayed when requested. They see a use for suggestions in the planning phase, as they could not have thought of, for example, a third church to include in their tour. It is important that suggestions should 1) be closely related to the original point of interest, 2) not be based on trivial information, and 3) clearly separated on what they are based on (9). Apart from using suggestions in the planning phase, the scenario of going to city X in the blind and follow a tour based on suggestions could be seen as an interesting concept.

Apart from the map, a summary of a tour, i.e. an overview, is seen as a useful feature to have while following a tour. Information that could be in the overview is total distance, tour time and need-to-know information on the waypoints in the tour such as costs or opening hours.

Candello & Pemberton (2011) analyzed the experience of being guided by a mobile guide app, and also found that users prefer short information at first and do not spent too much time absorbing information. They found that their participants did not spend a great amount of time reading the texts and observing sculptures, but that pictures where considered very useful.

**Adaptation (Task Part II)**

After discussing scenarios for exploring, how to find a point of interest and what functions an application would need to have, we questioned the participants whether they could come up adjustments they would like to be able to make to a created tour. The most useful adjustment is considered removing points from the tour. Other adjustments include changing the tour based on the weather, adding a restaurant and including other ways of travel besides walking. Summarizing, all mentioned adjustments are related to unexpected events or delays, i.e. what the participants would want to do if something would happen. In this light, suggestions on what to remove to deal with time delays would be appreciated. When a point is removed from the tour, there would be no need to insert or suggest an alternative. This could be useful if the user is planning the route at home, but not on the spot.
Collections (Task Part III)
The last task part of the discussion revolved around the Plaatsen van Betekenis data and therefore the content of the information available on points of interest.

As videos are not the preferred method of receiving information, *Open Beelden* scored worst on the ranking of collections, which was indicated by means of creating an ordering based on a small description of what the collections contain (11). The *State Monuments* collection was preferred by two teams and placed second by the third team. The *Amsterdam Museum* collection scored best by the oldest team and low by the other two teams. This collection scored low due to the fact that: “it is data from only one museum of which 95% cannot be viewed in real life”. They argued that it could be nice to see at home, but when they are in Amsterdam they would not care for the information as they could not see it in real life anyway, so only the 5% is considered interesting at that moment. As they would like to see actual items in the real world as opposed to items on a screen, the *State Monuments* collection was chosen as most interesting (6, 7).

The participants did not see that related items, whether it are objects, photos or anything, could be used to provide more information on the point of interest they are receiving information on. This may be explained by the fact that Linked Data is not a familiar concept that was not explained in the focus group. They did clearly indicate to not take relatedness in waypoint selection ‘too far’, so it can be argued that for a more info page the relatedness should be closely related to the original point of interest (9).

In terms of receiving information from different collections, participants would not care from which collection the information that is presented comes from, as long as it is relevant and available. They do would like to know the origin when the presented information demands an explanation, as for example information based on persons pops up in a churches tour. Again they mention that the amount of information presented should be limited. A short Wikipedia-like page at first is preferred, where more information should only be presented if the user specifically requests it, possibly even afterwards at home (10). It is argued that is impossible to remember all information and that most people are superficial, and would therefore not want to know very much about points of interest.

The information that is considered to be most interesting per collection is shown in table 2, ranked on terms that aggregate the properties, which the participants checked based on keywords describing them. The numbers indicate per collection how many times properties covered by a term were checked. It can be seen that based on the limited information provisioning (i.e. just the keywords), the participants consider basic properties of a collection item to be interesting, such as description and maker. As they argued, the average person would not like to see too much or deep information. Therefore, keywords that were not picked include more detailed properties such as acquisition, dimensions, latitude and longitude, rights, license and publisher. The Linked Data can be exploited by linking the properties that fall in the same term categories, for instance by linking ‘maker’ from the *Amsterdam Museum*, ‘architect’ from *State Monuments* and ‘maker’ from *City Archive* to each other.
Table 2. Most interesting information per collection, ranked on aggregating terms

<table>
<thead>
<tr>
<th>Collection</th>
<th>Amsterdam Museum</th>
<th>State Monuments</th>
<th>City Archive</th>
<th>Open Beelden</th>
<th>Totals</th>
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<td>2x</td>
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<td>10x</td>
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<td>Subject</td>
<td>2x</td>
<td>2x</td>
<td>1x</td>
<td>3x</td>
<td>8x</td>
</tr>
<tr>
<td>Person</td>
<td>4x</td>
<td>3x</td>
<td>1x</td>
<td>0x</td>
<td>8x</td>
</tr>
<tr>
<td>Date</td>
<td>0x</td>
<td>3x</td>
<td>3x</td>
<td>2x</td>
<td>8x</td>
</tr>
<tr>
<td>Location</td>
<td>2x</td>
<td>1x</td>
<td>2x</td>
<td>1x</td>
<td>6x</td>
</tr>
<tr>
<td>Origin</td>
<td>0x</td>
<td>3x</td>
<td>1x</td>
<td>not covered in collection</td>
<td>4x</td>
</tr>
<tr>
<td>Other</td>
<td>1x</td>
<td>0x</td>
<td>0x</td>
<td>3x</td>
<td>4x</td>
</tr>
</tbody>
</table>

The fact that the participants would like to see actual items in the real world implies that the application should be centered on objects that can be visited, in a city tour meaning that the objects are locations. The State Monuments collection provides tangible locations that are viewable this present day. The City Archive has photos of locations as well, although it is a limited amount of recent photos of which the scenery has changed over time. With State Monuments as central collection, the other collections can be used to gather extra information for a 'more info' page, as there is a general consensus that the amount of information presented should be limited at first and more when requested. This was also in agreement with Candello & Pemberton (2011), who found that people sought basic and brief information for points of interest. The information has to be linked to the other collections in order to include information from the other collections, which is described in chapter 7.

Closing (Task Part IV)

To end the discussion, the participants indicated they would not change their scenarios they created at the beginning. They do would want to use a smartphone to execute what they have planned beforehand, but not do the phased process in a different way. For a familiar city they would do less planning with an application beforehand, but for a new city they would still search information beforehand. It was discussed that the majority of the people does most information search prior to the trip. In the context of using a smartphone application, it means that they would make a route and planning beforehand, put it on their smartphone and change it when desired. All participants agreed on the fact that part of the trip or holiday is the pre-fun. It adds to the experience and has emotional value. Also, it was indicated that absorbing all information on the spot is too late and therefore too much to handle.
6.4 Summary
The most prominent results are listed below, with table 3 aggregating the results based on corresponding topics.

1. Previous followed tours are considered impersonal as not all sites are interesting to everyone and are time-wise limiting the user in either taking too much or too little time for a site.
2. Exploring a new or a familiar city appeared to be very similar, as all scenarios consisted of three phases: finding information, planning and execution. One group mentioned an evaluation phase at the end.
3. Pre-trip, the participants are willing to take the time and trouble to indicate their preferences to determine what is of interest, as they expect to not have to change it all the time.
4. Removing a waypoint from the tour is the most interesting adjustment to make, adding a waypoint a close second.
5. Functionalities of a mobile tour application: information on POIs, navigation, information on events, suggestions for waypoints. Information on service providing agencies, such as emergency services, police, tourist information, postal office, banks, etc. were specifically mentioned to be very important to have as a function.
6. The tour around town should consist of real, existing locations. That is, visiting a place where something important has happened but is currently not a resemblance of that anymore should not be a waypoint in the tour.
7. State Monuments therefore came out first in the ranking of the collections. Most interesting properties per collection ranked on aggregating terms are: description, subject, person, data, location and origin.
8. Primary pull information for POI info is preferred, but if the user would like pushed information they should be able to choose so.
9. Suggestions for waypoints should be displayed only on user request, and it should be made clear where they are based on. Also, suggestions should be directly related.
10. Participants would like to see only limited, short, important information on waypoints only at first. More information only presented when specifically requested.
11. Information presented as text and images is preferred, as opposed to videos which are too troublesome to watch and take too much time.

Table 3. Aggregated results based on corresponding topics

| Planning                        | Existing tours are time wise not ideal for the user and considered impersonal (1), which can be improved by allowing users to plan their tour. People are willing to plan and take time for it (2) (3). Even though people plan their tour, removing or adding a waypoint when plans change and thereby changing the tour is considered useful (4). Additionally, people want to have information on service providing agencies such as emergency services, police, tourist information, banks, etc. available at their fingertips (5). |
| Waypoints                       | Waypoints should be real, existing locations (6). This helps to explain why State Monuments is the collection of choice to center the tour on (7). |
| Information                     | People do not want to be overloaded with information. Whether it is POI info (8), suggestions (9) or an overview of the tour, it should be displayed on demand. Also, short information on POIs is preferred before presenting extensive, more complex information (10) and videos are undesirable due to the time it takes to watch them (11). |
7. Interface Design

From the data analysis, scenarios and focus group results, we derived requirements for the functionalities the interface of the application should support. The interface design that follows is implemented as an interactive mock-up to qualitatively evaluate whether it works the way we envisioned it to work. Improvements are made in a second iteration, which is further evaluated on flexibility and interface elements as described in research question two and the aspects of the LOD as described in research question one.

7.1 Scenario

To demonstrate the context in which the mockup is set, we provided a scenario in which a user is working with the AmsterTour application, which is mainly based on the preferences of the focus group participants. The scenario fits with cultural tourist types that have a modest to high centrality, i.e. the sightseeing, casual and the purposeful cultural tourist.

Bert is a first-time tourist in Amsterdam. To his own displeasure, he did not have the time to plan a tour before he traveled to the city. Yet he does want to explore the city, for which he uses the mobile application AmsterTour. Bert indicates his preferences for waypoints by selecting which types of buildings he would like to see as well as the time he has available, after which the application creates a tour. He starts walking and looks at the overview to see which waypoints are in the tour and in which order. Using the map he finds his way to the first waypoint, the Beurs van Berlage. He taps the marker and reads the available information. Bert finds this building very interesting, so he checks out the ‘more information’ page in which he finds related objects from the Amsterdam Museum, as well as historic pictures from the City Archive. He decides he wants to see a location similar to the Beurs van Berlage, and checks the suggestions page. Here, he finds another interesting monument which he adds to the tour. During the walk there, he reads the information on that monument, after which he decides it is not that interesting to him after all. Bert drops it from the tour and happily follows the rest of the tour.

7.2 Functionality Requirements

As described in the Data chapter, there are many options for a next waypoint at each location of interest. This allows for a tour created completely on the fly, using the current location of the user as a reference point to determine the next point of interest each and every time. In this way, the tour would be built up as the user visits points of interest and could take a different path at every moment in time. This is the complete opposite of a regular, standard tour which is usually completely predefined. As the focus group participants indicated, preparation is important in the overall experience of a trip. We decided to create a combination of a predefined tour and an on the fly changeable tour, which best reflects the possibilities of the data and lives up to the wishes of the average tourist. A similar serendipitous-based approach is employed by Hornecker et al. (2011).

A tour in the AmsterTour application is created based on preferences given by the user and can easily be changed by adding and removing waypoints. In this way, by allowing the user to create a personalized tour beforehand, the application offers a form of preparation which has the added value of getting the user familiar with the concepts within the tour. Also, suggestions for waypoints can be put in context as the rest of the tour and its content is already known, as opposed to an on the fly tour. This preferences-approach is also employed by Kramer et al. (2006), who showed in their field study that interest profiles of users are very diverse. This implies by elicitation of interests, very personal tours can be created.
In order for AmsterTour to be used as described in the scenario, the application should be able to 1) create a tour based on preferences, 2) deal with time constraints and push/pull options, 3) change the tour by adding/removing waypoints, 4) present information on waypoints, 5) provide waypoint suggestions, 6) provide a map, and 7) provide a tour overview. Information on service providing agencies and event information fall outside the scope of the research of using Linked Open Data in a mobile tour application and are not essential to the goal of exploring and learning about the city, therefore these functionalities will not be taken into account.

The State Monuments collection was chosen as base of the application, as suggested by the focus group participants. The Amsterdam Museum and City Archive collections were used to show the user objects and images that are related to the monuments. Due to the limited usefulness of videos in this context, the Open Beelden collection is not included in the mockup.

7.3 Mockup Design

The design of the mockup was realized as an interactive PowerPoint, and includes the functionalities as described in the previous section. Here we described the main choices in design for each feature and how the Linked Open Data is utilized for POI information in the application mockup. Several screenshots of the mockup are included in Appendix B, and the mockup itself can be found online

7.3.1 Design Choices

Application navigation
The user interaction can be divided in three parts; creating the tour, following the tour and adjusting the tour, where following and adjusting the tour are closely related. The functions associated with adjusting the tour are therefore interwoven with the functions associated with following a tour; the map, the overview and the suggestions. These are the functionalities that users would use mostly while following the tour, and are accessible through a three-button navigation ribbon. When tapped on a waypoint in one of the views, a short information page is shown with information from the State Monuments collection. A more info button leads to a page with more information as well as related information from the other collections. From the home screen, the user can create a new tour and is lead through the preferences and options. Back buttons, home buttons and shortcuts to the settings are included to allow the user to quickly navigate through the application and alter the settings at any time.

Preferences
In the preferences, we included several predicates from the State Monuments collection on which points of interests can be filtered. These are the CBS classification, building year and architect, of which the building year is aggregated in several time periods. The tour options include available time, the option to turn push info on or off and the sources for more information, in which the user can indicate which collections should be included in the related information page (in this case Amsterdam Museum, City Archive and Open Beelden). From the preferences and options, an algorithm performs a best guess in picking the waypoints for a tour. As the goal is to explore the city, the algorithm designs the tour as diverse as possible within the given preferences. That is, if the user indicated “mills, churches, defensive structures, H.P. Berlage and 19th century” as preferences, the algorithm includes at least one waypoint for each indicated preference, and, preferably, includes monuments that satisfy multiple preferences. In this mockup, three reasonably known monuments are chosen as waypoints. We have to note however, that many of the monuments are normal residences with a monumental facade.

https://dl.dropbox.com/u/4576864/AmsterTour_1.0.ppsx
Overview
The overview displays the waypoints in the tour with their name and image, and indicates which waypoint is the current location and shows an ordered to go list. On top is the current location or most nearby location. As the tour continues and the user moves to the next location, the waypoints move up and on top will be a ‘just visited’ location, then the current or most nearby location, then the to-go list. The overview also contains the option to remove each to-go waypoint from the tour, and indicates the total time and total distance of the tour.

Map
The map comprises a Google Maps\(^\text{42}\) interface, and utilizes different markers for different type of waypoints based on the CBS classification.

Suggestions
Suggestions for waypoints are related to the nearest waypoint in the tour, and are based on the architect, the original function and the building period. If any of the properties is not available, the options for suggestions are limited. In the worst case where none of the three properties is available, the CBS classification can be used to provide suggestions. Ranking of the suggestions is based on semantic distance firstly, i.e. how many predicates are matching, then within the results on geographical distance. As the number of results might be (too) high, the results can be limited. In the mockup, three suggestions for the Beurs van Berlage are displayed. There is one monument with the same architect and matching building year, and while there are five monuments with the same original function and matching building year, of which the geographically nearest two are shown.

7.3.2 LOD for POI Information
When information on a waypoint in requested, a short information page is shown with information from the State Monuments collection. This information includes the name of the monument and the corresponding image, architect, building year and original function, as indicated by the focus group participants in table 2 (chapter 6). If any of the information is not available the missing values are left out, as listing them with an empty value or ‘unknown’ is considered meaningless to the user. Of the initial three points of interest in the mockup tour, only one contains an architect and building year. As the description is too long to fit on the page, a ‘more info’ button is included that leads to the description, as well as related information from the other collections.

As the first pages contain information from State Monuments only, a heterogeneous presentation is employed for the related items, indicating from which collection the information comes from to avoid confusion. The items are presented in a list (with a name and small image) and can be tapped to view more information in a similar manner as the information presentation of the monuments themselves, also focusing on the properties from table 2 (chapter 6). We set a limit of four items per collection per monument to not overwhelm the user. Although not included in the mockup, these pages could include a ‘give me more’ option, which fetches more related items on user request.

In order to find items related to a monument, several properties can be used to create links to the other collections. The architect can be linked to the persons in the person thesaurus of the Amsterdam Museum as well as the persons in the City Archive. The address (and possibly the area) can be linked to the concept thesaurus of the Amsterdam Museum and the location property in the City Archive. The building name can be linked to the concept thesaurus of the Amsterdam Museum and (with some effort)

\(^{42}\) https://maps.google.com/
to the description property of the City Archive. Properties from the State Monuments that are too generic to create useful links include the original function, the CBS classification and the year built.

**Ranking method**

The question is what objects are interesting out of all the possible links to the other collections. The possible links have to be ranked and limited in a way that the user is presented interesting information. This is done in the following, ordered manner:

1. *Semantic distance*. The number of links that have to be followed; the more steps, the less important the items. If there were plenty of close items, we did not look further.
2. *Type of predicates*. Some predicates are more ‘interesting’ than others, which were ranked manually. If the system is used much, we could include usage statistics in the ranking of predicates.
3. *Amount of information present*. We gave a higher rank to objects that have 1) a picture, and 2) more metadata.
4. *Random ranking*. If we could not distinguish any further and still too many items remained, we assumed that they are equally interesting and randomly picked a number of items up to the set limit.

An extensive explanation of how the related items for each waypoint in the tour were determined can be found in Appendix C. In the next subsections we described the generic selection procedure for the Amsterdam Museum and the City Archive. The ranking method can be applied to other data collections as well, within one domain and possibly even for cross-domain collections. However, across or within other collections semantic distance might be less important than the type of predicates. This is also dependent on the context in which the data is used. Either way, determining the semantic distance of choice and the most interesting type of predicates are most difficult and require quite some manual labor.

**Amsterdam Museum**

The concept thesaurus contains very few addresses with museum objects linked to them. By removing the number from the address, we could find museum objects linked to the street names. However, these objects are less related to the monument than objects found using the building name and the architect, which are therefore preferred.

A building name can link to both the concept thesaurus and the person thesaurus. As a building is not a real person, objects linked to that person entry can be considered less interesting than links to the concept entry, and were only used if no other links were available. An entry in the concept thesaurus is linked to objects via the predicates contentSubject, currentLocation, associationSubject, exhibitionVenue and documentationTitle. We determined that in this context, the predicate contentSubject is most interesting. From the remaining objects, we dropped the ones without a picture and thereafter dropped the ones without text from the museum. If still too many objects remained, objects were chosen randomly.

The architect can be linked to the person thesaurus, of which the triples from a person entry have predicates in lines of creator and designer, which are one step further in the graph than other predicates; associatePerson and contentPersonName. We determined that contentPersonName has the strongest relation to the person; therefore those objects are preferred over objects linked via the other predicates.

When it occurred that links to objects with a similar semantic distance related to both the architect and the building name with equally interesting predicates were available, a combination of objects via both thesauri was selected.
City Archive

As the pictures in the City Archive collection have no title, we chose to display the image and the year on the related information page, which are available for each picture. Year, location and persons are more present than descriptions, as 100% of the pictures have a corresponding year, 78% has a location, 62% has an associated person and 32% has a description. Searching in a description for a building name is error-prone, where locations and persons give an (almost) exact match. Therefore, links from the address and architect from the State Monuments to location and associated person in the City Archive were preferred.

Exact matches to the address were preferred over wider ranges of house numbers and the broader street name only. For example, the address Rokin 58 has an exact match to location Rokin 58, but only two pictures are connected. To get to the four picture limit, pictures connected to close matches Rokin 58-60 and Rokin 48-58 were chosen as well. If there would be no close matches, pictures connected to Rokin would be chosen.

Connecting the architect to the person thesaurus can bring forward different roles the person has for a picture. For example, H.P. Berlage is listed with two roles, architect and draftsman. As one role is not clearly more interesting than another, we chose to use pictures from different roles.

When it occurred that links to pictures with a similar semantic distance related to both the architect and the address with equally interesting predicates were available, a combination of pictures via both ways was selected.

7.4 Interface Evaluation: Think Aloud

The first iteration of design was qualitatively evaluated to see whether it works the way it was intended to work, and to learn what improvements could be made. The evaluation was in the form of a think-aloud walkthrough performed with several end users. The users were provided with a scenario and instructions that set the context in which the mock up was supposed to be used. The users then used the application in an effort to achieve the imaginary goal of learning about points of interest, while describing their thoughts in the process. When the user believed all functions had been treated, we asked the users several questions that were based on the design choices addressed in the previous section. These questions were in lines of “is it clear what the suggestions are?” and “what do you think of the related items for Tuschinski?” The scenario, instructions and the questions can be found in Appendix D.

The results indicated an overall positive attitude towards the mockup, which was considered easy to use, user-friendly and organized. It was easy to alter the tour by adding or removing a location from the tour and to navigate through the mockup. Also, the map interface was recognizable, the preferences clear and the related items were considered fun and very interesting if the user would be at a point of interest. Points for improvement were particularly the overview and the suggestions tabs. In the overview it was not clear that the listed locations were all points in the tour, which was information that could also not be extracted from the map. Most participants did not understand the suggestions, and wondered what these items were, what they were based on and what they are for. Other remarks included unclear explanations on the origin of the related items, no understanding of the term ‘push info’, no help function or settings in the home screen, some unclear ‘type of location’ terms, the ‘more info’ page for points of interest displaying many (unorganized) text, and the inconvenience that the architect and building year were missing for most points of interest.

Based on these remarks, several changes were made to the mockup in order to improve the interaction in, and understanding of the application. The overview and map were improved by adding the total
number of locations in the tour in the overview, and adding a clear starting point to the map as well as a sequence number in the markers. The suggestions page was altered by changing the headers and the explanation to create a better understanding of the concept. A help page was created that explains what the user can do with the application, and an explanation for the push info option was included. Some smaller changes included changing the explanation for the related items pages, adding a settings link to the home screen, and correcting some inconsistencies in text size and text alignment as well as small link errors. The second version of the mockup can be found online\(^\text{43}\), and several screenshots of altered screens can be found in Appendix E.

### 7.5 Interface Evaluation: Online Survey

The second version of the mockup was evaluated on the five points of research question two, to see how it supports flexibility in the user interaction and which interface elements are necessary. Flexibility is defined in four ways, to see if the mockup is 1) appreciated by the users, 2) effective in performing tasks, 3) efficient in terms of interaction time, and 4) usable and quickly learnable for first time users.

#### 7.5.1 Survey Design

The evaluation was in the form of an online questionnaire, adopting a slightly modified version of the system usability scale (SUS) from J. Brooke (1996). Next to the usability questions, several questions to answer research question two were included. The questionnaire was distributed digitally to different online communities.

The SUS questionnaire consisted of ten five-level Likert items with answers ranging from Strongly Disagree to Strongly Agree. The other questions consisted of sixteen five-level Likert items with the same answer range as the SUS. These questions were grouped in subsets representing the different features: 1) creating a tour based on preferences, 2) the overview and map, 3) the suggestions, 4) the information on POIs and 5) customization. Respondents could explain their answers in a comment box after each subset. The complete questionnaire can be found in Appendix F.

#### 7.5.2 Participants

In total, 26 persons participated in the evaluation of which 23 completed the survey. Due to problems with the survey host, some results from 3 out of the 23 completed surveys could not be retrieved. The results from the remaining 20 were included in the calculations, where the incomplete and lost surveys were not taken into account. The respondents’ age ranged from 17 to 47, with most of them being in their twenties (75%). 55% of the participants were male, and 45% were female. 40% of the participants indicated they had some experience with mobile tours, with 60% indicating they owned a smartphone. Most people see themselves as an open-minded (30%), a see-it-all (30%) or an easy-going (15%) type of tourist.

#### 7.5.3 Results

Overall, the respondents indicated positive answers to the questions and in addition provided suggestions for improvements. The complete results of the survey can be found online\(^\text{44}\).

\(^{43}\) [https://dl.dropbox.com/u/4576864/AmsterTour_2.0.ppsx](https://dl.dropbox.com/u/4576864/AmsterTour_2.0.ppsx)

\(^{44}\) [https://dl.dropbox.com/u/4576864/complete_survey_results.xlsx](https://dl.dropbox.com/u/4576864/complete_survey_results.xlsx)
SUS
The SUS score is calculated by first summing the score contributions from each item. Each scale position had a score: strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, and strongly agree = 5. For items 1, 3, 5, 7, and 9 the score contribution is the scale position minus 1. For items 2, 4, 6, 8, and 10, the contribution is 5 minus the scale position. The sum of the scores is multiplied by 2.5 to obtain the overall value of system usability. All calculations can be found online45.

The SUS scores ranged from 37.5 to 87.5, with a mean of 70.625 and a standard deviation of 11.72. This score corresponds to the overall mean of all SUS scores of about 70. According to rating scale from Banger et al. (2009), this score can be interpreted as the top-notch of ‘OK’, close to the ‘Good’ rating that starts at 71.4. According to the school grading scale from A to F it would be a ‘C’, and according to the acceptability scores it is ‘Acceptable’. The mockup was particularly easy to use (question 3, 4, 8) and easy to learn and understand (question 2, 7).

Preferences (research question 2a)
Creating a tour based on preferences is a functionality that appeals (80%), and the options were clear (90%). Some respondents did find it too much trouble (15%): “I did find it a bit annoying that you are forced to go through all the options. I am a bit torn, (...”). Although indicating locations from a certain type, period and architect would generally help the respondents in finding locations of interest (85%), one respondent indicated that “Choosing what type, period, and architect I am interested in is difficult for me because I don’t have a lot of knowledge about these things.”

Finding locations of interest to the user in this way could use some tweaking and additions in order to help the user create a tour to their preferences. As the respondents indicated; “Maybe some example images in a stepwise setup instead of a list of checkboxes would help me create a better tour for my needs.” And, “Maybe it would be useful to put some default setting and some preset ones too.” Also, a ‘popular list’ or ‘most famous locations’ can be interesting to the users as an addition; “Simply listing locations by certain properties like the age in which they were build does not tell you much about their entertainment value. Even the type of building is not a good predictor of this. Some locations are more famous for a reason so I think the locations should be weighted to reflect this.”

Overview and map (research question 2d)
The overview was intended to provide more information than a map could provide, a summary of the tour at a glance, which is confirmed by 100% of the respondents indicating that the overview is a nice addition to the map while following a tour. Also, all respondents thought the overview provided a useful summary, and 90% found that the overview helped them to determine whether they indicated their preferences correctly.

One respondent noted that the overview could use a makeover; “I don’t know if it’s the color scheme or the layout of this screen that bothers me but the visual layout is definitely distracting me from the content.” Another suggestion for improvement was related to time spent during the tour. “It might be useful to display for each location how much time you are "expected" to spend there. This way you’ll get a better idea of how much time you spend walking and how much time you spend actually looking at locations.”

Suggestions (research question 2e)
Suggestions for waypoints were perceived as useful while following a tour by 70%. As a respondent noted, “I think the suggestions are a good addition, however it only seems useful to add extra locations to

45 https://dl.dropbox.com/u/4576864/SUS_results.xlsx
the tour if there’s still time. So once you’ve created the tour and you are already moving, I think it would be difficult to squeeze in extra locations automatically. It would become confusing for me to decide what I should remove from the tour in order to stay within my timeframe.” The problem of time was also noted by another respondent: “I really liked being able to customize the tour. I would see myself adding a lot of things and missing appointments set after the tour though ;)”. This suggests that in adjusting the tour by adding and removing waypoints, an indication of time change is important. This can be done by means of ‘adding this location will increase the tour time by xx minutes’, or more drastic by suggesting to substitute a waypoint in the current tour.

The respondents were somewhat reticent in believing the suggestions helped them in finding more locations of interest (70%), and as one person said before: “Some locations are more interesting than other regardless of how they are connected. I would be more interested in buildings close by that are on a ‘must see’ list of Amsterdam than buildings built in the same year.”

Information on POIs (research question 1, 2b and 2c)
Most people agreed that the information on the locations in the tour helped them determine whether they are of interest to them (65%), and helped them learn about them (70%). There is just a slight tendency towards it being inconvenient that some locations had less information than others (40% agree against 30% disagree), even though all participants of the think-aloud evaluation thought it was inconvenient. This could suggest that as long as the information that is available is interesting, it does not bother the user that much that some points of interest have more or less information.

The related objects from the Amsterdam Museum were considered not very relevant and interesting (30% positive, 65% neutral). As we saw in the reactions; “I had strongly agree on the related items, until I saw a soupterrine was related to the beurs van Berlage. So I changed it to agree”, and “I am not interested in who built the ‘Beurs van Berlage’ but I am interested in what I can do or see here”. The related images from the City Archive were more relevant and interesting (55% positive). As one respondent indicated; “I guess it really depends on the location you are looking at. When you’re specifically going to a museum, then it’s very useful to see what artworks are on display inside. However, when you’re visiting a historic building, the city archive is more useful. In this case I found the information from the city archive more relevant to that specific building.” As we saw in the focus group, tangibility and close relatedness is important. In that sense, museum objects are less tangible and related to monumental buildings than historic images, which could be the reason why it is considered more relevant and interesting. Most respondents did agree that the related items were of added value (65%) to learning about the locations in the tour.

Customization
Almost all respondents thought that the settings, suggestions and overview helped them to easily customize the tour to their preferences (85%). Several users complimented the usability and flexibility of the application. “The settings would help me to select what I would find interesting in a location. Creating a customized tour that only takes me to the locations interesting for me. The suggestions helped me to find even more locations where I might be interested in. The overview shows me how much time it would take to complete the tour, the locations I have selected and the distance. It increases the usability of the application significantly.” And, “It wasn't hard to understand how the application works and you can change your preferences all the time to make the perfect tour for yourself.” And lastly, “It's a good idea to not immediately have a finalized tour and that you can add and remove locations.”
8. Discussion

During the research we made several choices and encountered several limitations, which are described in this section.

The focus group meeting on which many design decisions were based was held with Dutch people only. Even though their knowledge of Amsterdam was limited, the life experience in their native country could cause a different view on tour applications than foreign tourists would have. Despite our efforts to not limit the participants in their thoughts, a more extensive form of requirements engineering including foreigners could have given a better view on the demands of the future users of the mobile tour application.

In the mockup we have chosen to include three rather well-known locations around which a tour is formed. However, many of the monuments in the State Monuments collection are normal residences with a monumental facade, which could be less interesting to a casual tourist than the well-known monuments. Even though the user can indicate in the preferences the type of buildings to be included, the CBS classification is not sufficient in separating the well-known points of interest from the less-known points of interest. As also came forward in the survey evaluation, users would like to see a ‘popular list’ or ‘the most famous locations’. This inclines that a ranking on popularity of the monuments is necessary.

Using the Plaatsen van Betekenis Linked Open Data has its limitations. For many items very limited information is available, many items have missing or unknown values (e.g. architect), many duplicates exist (mostly City Archive), links that could exist are yet to be created (e.g. the same person in both the Amsterdam Museum and the State Monuments are unlinked), different names for the same person or building are used within and across the collections (e.g. five different notations for the person H.P. Berlage in Amsterdam Museum and another different notation in the City Archive, each with different items linked to them), the City Archive pictures do not have a name or title for identification, and many monuments and museum objects did not have an accompanying image. We were able to deal with most of the limitations by simply ignoring items with little information, missing values and duplicates; however, this might have left out possible very interesting items. Also, we manually identified whether persons or buildings are the same in order to find related items (e.g. the Berlage example), which is much more difficult and error-prone for an algorithm to do. We assumed to have determined relatedness correctly manually, but as errors may occur, it could be an option to allow the user to indicate non-relatedness for a related item, which allows the algorithm to learn in order to improve our four-point ranking method and provide better suggestions in the future.

We have used the Plaatsen van Betekenis Linked Open Data in the context of a mobile tour application, which have led to results that could have been different in other contexts such as a web application or faceted browsing. For instance, videos would be more suited and longer text would be better readable in a stationary situation. We have seen that for a city tour, users are strongly focused on the real-life tangibility of items and therefore preferred the State Monuments collection and historic pictures from the City Archive. However, if the approach would have been to bring the contents of the Amsterdam Museum outside into the city, it would have resulted in a different application where the information from the collections plays a different role.
9. Conclusions

In this research we aimed to create a personal, adaptive mobile tour guide that supports the user in achieving optimal flexibility in interaction. We aimed to demonstrate the potential of links provided by cultural LOD, and searched for solutions to determine relevance and ranking of locations and objects and to present them without overwhelming the user. We also researched if our approach can be generalized.

Despite the limitations that the Plaatsen van Betekenis LOD entails, it has the potential to become an excellent source of information for a mobile city tour guide. Short facts as architect, building year and original function plus an image provide a quick summary of a point of interest, after which more information and related items can be requested to complete the learning experience. The mobile context demands that videos are not the preferred way of information transfer, and museum objects are relatively uninteresting compared to the more tangible state monuments and archived images. We have identified interesting links between the collections, and found a way to overcome the difficulty of ranking links with a four-point ranking method, which might be improved in the future by user input. The fact that for many items in the collections values are missing is inconvenient for the user, and also limits the possibilities of determining related items. This research showed the need for more clean and complete LOD sets with relevant links, which will allow developers to more easily build applications on top of the data.

We have designed an easy-to-use user interface that supports flexibility for the user interaction with a LOD-based mobile city tour guide, of which users thought that the settings, suggestions and overview helped them to easily customize a tour to their preferences. With some tweaks and the addition of a 'must-see list' as indicated in the evaluation, AmsterTour is a promising application that can bring the power of LOD to the general public. The survey indicated that creating a tour based on preferences is something that appeals, and the information and the related items on waypoints in the tour provided a helpful learning experience. As a survey respondent mentioned, “I think that this application would be a valuable asset to tourists who wish to explore the city of Amsterdam independently.”

Missing values and missing links is typical for LOD, which means that any application build on LOD has to deal with these and other imperfections. The ranking method used in this case study or a similar approach can be applied to other LOD collections, both within one domain and possibly even for cross-domain collections. More case studies will have to be conducted to evaluate whether our method is suitable for cross-domain collections. The ranking method is dependent on the context in which the data is used, and will require manual labor to determine which links are more relevant than others.
References


Appendix A

The contents of the focus group meeting are listed below. We marked with a double asterisk (**) all collaborative questions and with a single asterisk (*) all the individual questions. Questions that are not marked were discussed in the whole group.

Part I: Introduction (35 minutes):

- Introductory questions (10 minutes):
  - * Gender, age, profession, familiarity with Amsterdam, smartphone yes/no.
  - * What are previous experiences with following (mobile) tours?
- Write down five to ten words that describe or relate to: (5 minutes)
  - * Exploring a new city.
  - * Exploring a familiar city.
- Create two scenarios: (20 minutes)
  - ** One for exploring a new city.
  - ** One for exploring a familiar city.

Part II: Interaction, presentation and adaptation (60 minutes):

- Interaction questions (25 minutes):
  - ** If the participants would have a mobile tour application that supports their scenarios, what would be their goals in using the application?
  - Discuss together to create an ordered list of functionalities based on the goals, based on usefulness and how often it would be used.
  - What is the trade-off in terms of the application doing things automatically and guiding it with own choices? How much control would the participants like to have and how much input are they willing to give to the application in order to not be bothered too much?
- Presentation questions (20 minutes):
  - What kind of directions would the participants like to get in order to get to locations of interest?
  - What are criteria to determine what is of interest? (e.g. travel companions, the weather, etc.)
  - What is considered important to know about a location? Is this always the same, or does it change? Is it dependent on the context?
  - Would the participants prefer information presented as text, images, videos or any combination? Is this dependent on the context?
  - When are items related? What is considered important in the presentation of related items?
  - What would an overview of the tour be used for? What is considered important in the presentation of a tour overview?
- Adaptation questions (15 minutes):
  - Would the participants like to be able to adjust a created tour, and if so in what way?
  - Collaborate on an ordered list of adjustments, based on usefulness and how often it would be used.

Part III: Collections (30 minutes):

- Introduction of collections.
- Collection-related questions:
  - ** Pick one, which collection is most interesting to center a tour on and why?
○ ** Pick any combination, what combinations are interesting and why?
● Explanation of the information in the collections, what information is available.
● Information-related questions:
  ○ ** Pick out the information that is most useful per collection.
  ○ ** Would the participants change their answers to the collection-related questions, based on?
  ○ What are the participants' thoughts on suggestions and relations based on this information? Would they like to see where suggestions come from, and why or why not?

**Part IV: Closing (10 minutes):**
● Would the participants change their scenarios from the introduction based on everything discussed, and if so in what way?
● Indicate any final thoughts.
Appendix B
Overview | Map | Suggestions

The suggestions below are based on the properties of the closest stop in the tour: Beurs van Berlage.

- Geboortehuis van de Algemene Nederlandse Diamantbewerkersbond
- Kantoorgebouw met opleg-winkel op de begane grond
- Handel en kantoor, 1901
  - Rolin 69

Beurs van Berlage

Architect: H.P. Berlage

Built in: 1898-1902

Original function: Handel en kantoor

More info

More on Beurs van Berlage | Related

The items listed below about Beurs van Berlage are from other collections, tap them for more information.

- Amsterdam Museum
  - H.P. Berlage, bouwmeester (1856-1934)
  - Plachtooging van de nieuwe Beurs de hare majesteit de Keningin, 21 mei 1901.
  - Saaptermijn van 18-daagse servies
  - Driehoekskraan

City Archive

- 1920
- 1918
- 1920
- 1917
Appendix C

Amsterdam Museum

Architect -> Person thesaurus
Address -> Concept thesaurus
Building name -> Concepts / Persons

Nieuwe Kerk
Has no architect and no year. “Kerk en kerkonderdeel” as original function is too general to have senseful related items, so is the CBS classification “Kerkelijke gebouwen”.

Address gives no hits. Nieuwezijds Voorburgwal without number does.
http://purl.org/collections/nl/am/t-2116
Building name can link to the concept thesaurus as well as the person thesaurus.
The building is not a real person, which makes objects linked to that ‘person’ entry less interesting than links to the concept entry.

person 1. One step
building name -> am person thesaurus
One “person”: Stichting Projecten De Nieuwe Kerk Amsterdam., 8 triples.
http://purl.org/collections/nl/am/p-54583

person 2. Two types of predicates
exhibitionOrganiser (5)
associationPerson (3)

Objects linked to the Nieuwe Kerk “person” via the exhibitionOrganiser predicate are one step further away in the graph than associationPerson. These objects are therefore not as directly related as associationPerson and are not considered when there are enough other predicates (ranking rule 1).

person 3. Present information
Three objects remain, which is acceptable to present.
http://purl.org/collections/nl/am/proxy-63160

concept 1. One step
building name -> am concept thesaurus
Nieuwe Kerk (Amsterdam) is Nieuwe Kerk in the thesaurus. 69 triples.
http://purl.org/collections/nl/am/t-3010

concept 2. Five types of predicates
contentSubject (26)
currentLocation (26)
associationSubject (15)
exhibitionVenue (1)
documentationTitle (1)
Objects linked to the Nieuwe Kerk via the currentLocation predicate are one step further away in the graph than the other predicates. These objects are therefore not as directly related as the subject predicates and are not considered when there are enough other predicates (ranking rule 1). The Nieuwe Kerk as associated subject is less strong than the Nieuwe Kerk as content subject, therefore contentSubject is more interesting.

**concept 3. Present information**

Two of the 26 objects do not have pictures and are dropped. Similarity between the objects is hard to measure, and even though 11 objects have ‘Dam Square’ or ‘De Dam’ in the title, they are all different and we cannot make a ‘variety selection’. The predicate objectCategory can differentiate the objects, in the following way. But it can be questioned whether it is interesting to pick objects from several different categories.

- schilderijencollectie (19)
- kunstnijverheidcollectie (2)
- fotocollectie (1)
- penning (1)
- documentencollectie (1)

There can also be too much information to view on a mobile phone. For example, the texts for “Dam Square in 1604 during the Procession of Lepers on ‘Koppertjesmaandag’” is very long, unreadable on a mobile phone. The text can be cut off in this case.

http://purl.org/collections/nl/am/proxy-38025

Several others did not have a description (ahmteksten), which were dropped.

**concept 4. Random**

From the objects remaining, we picked 4 at random:

- Dam Square http://purl.org/collections/nl/am/proxy-38477
- Dam Square looking North http://purl.org/collections/nl/am/proxy-37925
- Oaken model of the tower of the Nieuwe Kerk http://purl.org/collections/nl/am/proxy-19025
- The interior of the Nieuwe Kerk looking east http://purl.org/collections/nl/am/proxy-38956

**Beurs van Berlage**

“Handel en kantoor” as original function is too general to have senseful related items, so is the CBS classification “Gebouwen, woonhuizen”.

Year -> 1898-1902 none. Each of the five years separate not interesting, see Nieuwe Kerk.

Address ‘Beursplein’ without the number is listed in the concept thesaurus, yet does not appear in a triple.

Architect -> H.P. Berlage is not found, but Berlage, H.P. is. ‘use’ predicates in the person thesaurus should always be followed to find the person entry where it is the ‘name’ predicate, as that is where the objects are linked to. 698 triples for ‘Berlage, Hendrik Petrus’, with alternate names ‘Berlage, H. P.’, ‘Berlage, H. P. (1856-1934)’, ‘Berlage, H.P.’, and ‘Berlage, Hendrik P.’.

http://purl.org/collections/nl/am/p-22840

The triples are rdf:value for the predicate ‘Maker’ with predicate ‘creatorRole’, which are linked to objects H.P. Berlage is the maker of. Except for three, 2 associatePerson and 1 contentPersonName, of which the last one is most interesting:

http://purl.org/collections/nl/am/proxy-4912

There are several other Berlage persons that are not linked to each other, which do not have objects linked them, apart from one that appears in 29 triples:

http://purl.org/collections/nl/am/p-26387
Which links are sensible? contentPersonName yes, associatePerson no, rest is maker. Demand picture, then random. Pick one.
http://purl.org/collections/nl/am/proxy-21429

Building name -> Beurs van Berlage am concept thesaurus. 130 triples.
http://purl.org/collections/nl/am/t-2734
The concept thesaurus has 30 concepts with "Beurs van Berlage in it", relating to the different areas of the building (cafe, foyer, etc.).
Exact match 130 triples with predicates: currentLocation 120, exhibitionVenue 7, skos:narrower 2, contentSubject 1. Narrower is not needed as there are plenty. The contentSubject does not have an image, but would be considered most interesting as stated earlier:
http://purl.org/collections/nl/am/proxy-54566
exhibitionVenue
Direct, exact matching link. But currentLocation was rejected at Nieuwe Kerk and is one step further away. As the other choice, maker is the same amount of steps away, we also pick one random from here, with picture.
http://purl.org/collections/nl/am/proxy-26922

Building name -> am person thesaurus.
(use: beurs van berlage; name: nieuwe beurs NO OBJECTS)
(use: beurs van berlage; name: stichting beurs van berlage NO OBJECTS)
(use: beurs van berlage; name: beurs van berlage (museum) NO OBJECTS)
(name: beurs van berlage; usedFor three above 25 TRIPLES)
http://purl.org/collections/nl/am/p-20078
I said in Nieuwe Kerk it was not very sensible to use this link, but it could be when no other objects are available.

Theater Tuschinski
"Welzijn, kunst en cultuur" as original function is too general to have senseful related items, so is the CBS classification "Openbare gebouwen".

Has no architect and no year.
Address gives no hits in the AM collection. Reguliersbreestraat without the number gives 1 object, which does not have a picture or a description: http://purl.org/collections/nl/am/proxy-74991
Building name -> Tuschinski-theater person thesaurus but no objects connected.
   Tuschinski, Abraham' person thesaurus, 0 objects connected.
   Tuschinski Theater' person thesaurus, 1 object connected.
http://purl.org/collections/nl/am/proxy-28338
Building name -> not listed in the concept thesaurus
The only connection are 8 'Tuschinski-stalen', which the computer could only find if it searches for 'Tuschinski' in the titles of the objects.
http://purl.org/collections/nl/am/proxy-44821&raw=true

The linking algorithm would have to change the word order or search for 'Tuschinski' only in order to find the links to the person and the Tuschinski-stalen. That is a problem with different collections using different names for the same thing. They have to be linked manually.

In absence of anything better, the object linked to the person and the reguliersbreestraat object are selected. Two of the Tuschinski-stalen are selected too.
Kantoorgebouw met opslagruimte op de begane grond
“Handel en kantoor” as original function is too general to have senseful related items, so is the CBS classification “Gebouwen, woonhuizen”.

No architect.
Address gives no exact match.
Building name -> no exact hits (as expected). ‘Kantoorgebouwen’ is listed in the am thesaurus, yet no objects are linked to it.

Year 1898 -> productionDateStart (144 objects) & productionDateEnd (193 triples)
These objects however, have no connection whatsoever apart from the year. When one expects related information, a two-piece dress or a tip-up seat is not desired. There happens to be only one ‘dam square’ object out of all objects, which shows that linking the year is not relevant in this case.

Address Rokin without number general does give hits, 35 objects.
http://purl.org/collections/nl/am/t-2337
associationSubject (14)
contentSubject (14)
skos:broader (6)
skos:narrower (1)

Broader is not interesting as Rokin 58 is not listed in there. Narrower is one step higher which is not necessary as there are 28 objects on this level. As identified earlier, contentSubject is more interesting than associationSubject, leaving 14 objects. 5 of them do not have a (working) picture, leaving 9. 4 of these 9 have AHM texts, making these the objects of choice.

Rokin by Langebrugsteeg http://purl.org/collections/nl/am/proxy-39709
The courtyard of the old Stock Exchange http://purl.org/collections/nl/am/proxy-38673
The old Beurspleintje http://purl.org/collections/nl/am/proxy-39517
The Rokin with the Stock Exchange of Hendrick de Keijser http://purl.org/collections/nl/am/proxy-37813

CITY ARCHIVE
Architect -> Persons
Address -> Location
Building name -> Description

Nieuwe Kerk
No Architect.
Address = Nieuwezijds Voorburgwal 143.
Building Name = Nieuwe Kerk.

In State Monuments the address is Nieuwezijds Voorburgwal 143, returning in the city archive as well, both separate and coupled with 147, 149, 149 Paleisstraat, 173 and 176-182.
Beurs van Berlage
Architect = H.P. Berlage
Address = Beursplein 1
Building name = Beurs van Berlage

H.P. Berlage appears in the person thesaurus as H. P. Berlage. 103 triples. Again not exactly the same name, and it is even a different notation than all the notations from the AM thesaurus.

http://purl.org/collections/nl/stadsarchief/proxy-114210
Role-architect 91 triples.
Role-tekenaar 12 triples.
The drawings are in this case all self-portraits, with the same picture and description. As one is not clearly more interesting, we choose one picture from each role (the same variousness as described earlier), even though there is no description for any of the 91 role-architect triples.

Beursplein 1 no hits, closest hit is Beursplein 1-3, with 158 triples.

Many duplicates here as well.
There are also some pictures with a location Beursplein 1-3 plus some additional location information, such as 'Beursplein 1-3, Damrak 213-387, Damrak 79'.

What is more interesting, pictures connected to the architect of the point of interest or pictures connected to the address? Equally important. Pick from the person connection 2 pictures with a description, and from the location connection 2 pictures with a description and a person. They might even be the same.

Role-architect: http://purl.org/collections/nl/stadsarchief/proxy-106391
Role-tekenaar: http://purl.org/collections/nl/stadsarchief/proxy-157359
Beursplein 1-3
http://purl.org/collections/nl/stadsarchief/proxy-158054
http://purl.org/collections/nl/stadsarchief/proxy-199018

Theater Tuschinski
No architect.
Address = Reguliersbreestraat 26.
Building name = Theater Tuschinski

Reguliersbreestraat 26 gives no exact match, but 26-28 is in there, as well as one picture with 'Reguliersbreestraat 26-28, Reguliersdwarsstraat’ as location. This one matches less (thus less related) and 26-28 gives 64 triples therefore it is not needed.
http://semanticweb.cs.vu.nl/pvb/browse/list_triples_with_object?l=literal('Reguliersbreestraat%2026-28')
We pick out 4 pictures with a description and a person.

Kantoorgebouw met opslagruimte op de begane grond
No architect.
Address = Rokin 58.

Rokin 58 has two exact matches, which are chosen.
http://semanticweb.cs.vu.nl/pvb/browse/list_triples_with_object?l=literal('Rokin%2058')
Non-exact matches: 1 for 58-60 and 2 for 48-58.
Appendix D

Scenario and instructions
Imagine being in Amsterdam as a tourist, without having had the desire or time to plan a whole tour through town beforehand. You are unfamiliar in the city, yet you do want to explore the city. That is where the mobile application AmsterTour comes in. Your goal in using this application is to explore the city and learn about points of interest in the city of Amsterdam. The application allows you to create a tour based on your preferences. When the tour is created, several functions are available that are associated with following a tour.

I am expecting you to play around with the application and try all available options. At the same time I want you to say out loud what you are thinking. I will just sit there without helping you or participating, what is indeed an awkward situation. But remember that the application is the subject of the test and not you. Afterwards, I will ask you several questions in which I will ask for constructive criticism. Please note that this is just a mockup, which means that some options are not available or modifiable.

Questions
1. Is it clear what the preferences and settings indicate when you are creating the tour?
2. Is it clear how the tour is created?
3. Is it clear how the overview works, i.e. the order and how it would change?
4. Is it clear how the functions on the map work, i.e. zooming and clicking a marker?
5. Did you understand the meaning of the markers on the map?
6. Did you understand what the suggestions page means, and where the suggestions for the Beurs van Berlage are based on?
7. What did you think about adding the Kantoorgebouw to the tour?
8. What did you think about removing the Kantoorgebouw from the tour?
9. To what extent were you pleased with the presented information for the Nieuwe Kerk? And what about the other points of interest?
10. Did you notice less information for certain points of interest and if so, is it troublesome?
11. What did you think of the related items from Amsterdam Museum for Tuschinski?
12. What did you think of the related items from City Archive for the Nieuwe Kerk?
13. What did you think of the quality of the related items and the information presented in general?
14. What did you think of the navigation ribbon to find your way around the functions?
15. What is your general impression of the application?
16. Did you miss anything in the application or in the interface?
Appendix E
Appendix F

SUS
1. I think that I would like to use this application frequently.
2. I found the application unnecessarily complex.
3. I thought the application was easy to use.
4. I think that I would need the support of a technical person to be able to use this application.
5. I found the various functions in this application were well integrated.
6. I thought there was too much inconsistency in this application.
7. I would imagine that most people would learn to use this application very quickly.
8. I found the application very awkward to use.
9. I felt very confident using the application.
10. I needed to learn a lot of things before I could get going with this application.

Creating a tour based on preferences
1. Creating a tour based on my preferences does not appeal to me.
2. It was clear to me what the options meant when I created a tour.
3. Being able to indicate in the options that I want locations from a certain type, period and architect in my tour would help me in finding locations that are of interest to me.
4. Having to go through all the options in order to create a tour was too much trouble for me.

Overview and map
1. The information in the overview provided a useful summary of the tour.
2. The overview tab helped me determine whether I indicated my preferences correctly.
3. I find the overview is a nice addition to the map while following a tour.

Suggestions
1. I did not see how the suggestions were of any use while following a tour.
2. The suggested locations provided me with the information I needed to help me find more locations that are of interest to me, other than those already included in the tour.

Information on POIs
1. The information on the locations in the tour helped me determine whether they are of interest to me.
2. The information on the locations in the tour provided me with the information I needed to help me learn about points of interest in the city of Amsterdam.
3. I found it inconvenient that some locations had less information than others.
4. I thought the related objects from the Amsterdam Museum contained information that was relevant and interesting to me.
5. I thought the related images from the City Archive contained information that was relevant and interesting to me.
6. I felt that the related items were of no added value to learning about the locations in the tour.

Customization
1. The settings, suggestions and overview helped me to easily customize the tour to my preferences.