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Managing Stored Data For Mobile Apps: Survey Of Apps And Case Study

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MANAGING STORED DATA FOR MOBILE APPS:

SURVEY OF APPS AND CASE STUDY

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Abstract

Stored data is a critical component of any application. The stored data component of mobile applications (apps) presents special considerations. This paper examines the management of stored data for mobile apps. It identifies three types of mobile apps and describes the stored data characteristics of each type. It presents decision factors for selecting a data storage approach for a mobile app and the impact of the factors on the usability of the app. The paper surveys over 70 apps in a specific domain (that of walking the Camino de Santiago in Spain) to examine their data storage characteristics. Finally the paper presents a case study of the development of one app in this domain (eCamino). The paper concludes that in the domain examined the data storage approach selected for a mobile app depends on the characteristics of the situation in which the app will be used.

Keywords: mobile, app, smartphone, stored data, data synchronization

1 Introduction

Stored data is a critical component (resource) of information systems (O'Brien and Marakas 2011). Without the ability to store data, users would need to enter all required data into a system before any processing could be done or useful output could be produced. Information systems, with their reliance on data files, databases, data warehouses, and "big data," could not function if they could not store data as part of the system. In a sense, stored data is the "glue" that holds together other components of the system.

The stored data component of mobile applications (apps) presents special problems. Devices on which these apps operate (smartphones, tablets, etc.) typically have limited storage capacity. If the app is designed to be used only offline, then it must store all required data on the device, which limits the amount of data that can be stored. In addition, the data is not updated dynamically from external sources as conditions change, and thus, except for those cases where all data is generated on the device, it is likely to be out of date. On the other hand, if the app is designed to be used online then it can access the required data in real time from a server, in which case the data storage limitations of the device do not impact the app. The app, however, is dependent on a wireless connection with sufficient bandwidth, which is not always available. A third option discussed later, that of data synchronization, presents its own challenges.

The impact on the user of different approaches to data storage in mobile apps can be severe. With some apps (e.g., personal contact list) the user updates the stored data and keeps it on the device. In many situations, however, the data needs to be updated from an external source, thus requiring access to a server, which, as explained above, has its own problems. Sometimes even locally stored data may need to be used to update data on a server (cloud storage) so that the user can share the data among several personal devices.

In mobile business, apps are used for a variety of purposes from front-end, customer-oriented applications, such as those found in mobile commerce, to back-end systems used only by employees, such as mobile inventory management systems. The trend towards BYOD (Harris et al. 2011) complicates the situation. Employees are bringing their own devices with their favorite apps to their work places (which may be remote) and expecting to use them in their jobs. All these apps, whether company-supplied or employee-provided, need stored data, but the data storage approach may vary from app to app.

The purpose of this paper is to explore data storage options for mobile apps. The main question addressed in this paper is in what situations are different approaches to data storage appropriate. The paper investigates this question by examining the data storage modality for apps used in a specific domain (described later). It surveys over 70 apps used in this domain to identify the intended use of each app and the data storage approach taken by the app. The paper also presents a case study of the development of an app in this domain and the way the data storage issues are addressed in its design. The impact of the data storage approach on the usability of the app for user is explored.

This paper is organized as follows. The next section describes types of mobile apps and the data storage characteristics of each type based partially on literature related to mobile apps data storage. Following this we present several decision factors that are relevant for selecting a data storage approach for a mobile app. Next we describe the domain of this study. Following this we present a survey of mobile apps in this domain with an analysis of the data management approach used by apps in the survey. Next we examine the case of one specific app followed by a discussion of the case. Finally, we present our conclusion.

2 Stored data for mobile apps

Mobile apps come in three varieties with respect to their stored data component:

1. Offline apps: These apps store all their data on the mobile device. The data may be initially populated when the app is installed (e.g., maps) and possibly updated by the device user, or initially populated and updated during the app's use (e.g., contact list) by the device user. These apps do not need to be online to function. (We recognize that the data for some of these apps may be backed up in a cloud based system, but we do not consider this to change the nature of these apps.)
2. Online apps: These apps depend on access to a server for their stored data. Although some data may be stored on the mobile device, the app relies on the data stored on a server for its functionality. This data can be updated on the server by uploading user entered data from the mobile device to the server. It may also be updated by external entities (e.g., system administrators) directly on the server, which is then downloaded from the server to the mobile device. Apps used for e-commerce fall into this category. These apps must be online to function.
3. Synchronized apps: These apps store all their data on the mobile device and thus can be used offline, but the stored data may be updated (downloaded) with data from a server when the device is online. In addition the data on the server may be updated (uploaded) with data from an online device.

(A fourth type of app is one that combines offline and online characteristics. This type of app provides limited functionality when offline but full functionality when online. We call it a hybrid app. This type of app, however, must be online to provide access to stored data. Thus, because the concern of this paper is with stored data management in apps, we include this type of app in the online category.)

Table 1 summarizes the data storage characteristics of these types of apps.

Type of app	Primary location of stored data	Currency of stored data on mobile device	Currency of stored data on server	Updating of stored data
Offline	Mobile device	Current	NA	Device user
Online	Server	NA	Current	Device user and external entities
Synchronized	Mobile device and server	Current as of last synchronization	Current as of last synchronization	Device user and external entities

Table 1. Data storage characteristics of mobile apps

Synchronized apps create a special challenge because a number of synchronization patterns can be used. McCormick and Schmidt (2012) classify these patterns as follows:

- Data synchronization mechanism patterns: These patterns deal with *when* data is synchronized between the server and the mobile device. Two patterns are:
    - Asynchronous data synchronization: Data is synchronized while the app continues its normal functioning. The user can continue to use the app during data synchronization.
    - Synchronous data synchronization: The normal functioning of the app is blocked while data is synchronized. With this pattern the user is not able to use the app during synchronization.
- Data storage and availability patterns: These patterns related to *how much* data is stored on the mobile device. Two patterns are:
    - Partial storage: Only data from the server that is needed by the app is stored on the device.
    - Complete storage: All data from the server is stored on the device.
- Data transfer patterns: These patterns deal with *what* data is transferred between the server and the mobile device. Three patterns in this category are:
    - Full transfer: All the data on the server is transferred to the device or vice versa.

- Timestamp transfer: Only the data changed since the last synchronization is transferred from the server to the device and vice versa using a timestamp to indicate when the last synchronization took place.
- Mathematical transfer: Only the data changed since the last synchronization is transferred from the server to the device and vice versa using a mathematical algorithm to determine what data has changed (e.g., checksums).

Different combinations of these synchronization patterns impact the usability of an app in different ways. For example, synchronous, complete storage, full transfer can take considerable time for large amounts of data preventing the user from using the app for an extended period. On the other hand, asynchronous, partial storage, timestamp synchronization, although not impacting the user's use of the app, may result in the needed data not being available on the mobile device at the time the user needs it. The app developer must select the synchronization pattern for the app based on the intended use of the app.

Another treatment of data synchronization for mobile apps can be found in Stage (2005).

Database capabilities on servers can use common database management systems such as Oracle and DB2. On mobile devices used for offline and synchronized apps, however, the data storage software must meet special requirements. Because the memory capacity of mobile devices is limited, the data storage software must occupy a minimum of storage and must store data efficiently. In addition, the software must be designed so that it provides adequate performance with the limited processing power of mobile devices. Finally, for synchronized apps, the software must be able to synchronize the data with the server's database management system. Two examples of data storage software for mobile devices are SQLite (SQLite 2015) and SQL Anywhere (SAP 2015). SQLite is public domain, open source. SQL Anywhere is a product of SAP (formerly a product of Sybase until Sybase was acquired by SAP).

3 Decision factors

The decision about what mobile data storage approach to employ in a mobile app needs to consider factors that directly impact the usability of the app by the user and its appropriateness for mobile business. Although a number of factors could be considered, we propose that the following four factors are central to this decision as they impact the user directly:

- Speed of stored data access: Access to stored data for an offline or synchronized app can be as fast as the mobile device's storage and processing technology can provide. Stored data access for online apps depends on the speed of the communications channel and the volume of data being accessed. Users may notice data access speed differences when using offline/synchronized apps compared to online apps. This speed may impact the user's ability to access the data in a timely fashion.
- Availability of stored data: With offline and synchronized apps, stored data is always available. Stored data availability for online apps depends on the availability of an online connection. Users who have limited online connections will find stored data for online apps is less available than for offline/synchronized apps.
- Volume of stored data: The volume of the data that can be stored in offline and synchronized apps depends on the memory capacity of the mobile device. For online apps, the volume of stored data is not limited by the mobile device and can be as much as the server can store. Users of application with very large amounts of stored data may find that offline/synchronized apps do not provide all the data available for online apps.
- Currency of stored data: Stored data for offline and online apps is always current. Currency of stored data for synchronized apps depends on database activity since the last synchronization. Users of synchronized apps may find that some stored data is out of date until the next synchronization takes place, which is not the case for offline and online apps.

Table 2 summarizes these factors.

Type of app	Speed of stored data access	Availability of stored data	Volume of stored data	Currency of stored data
Offline	Fastest	Available at all times	Limited	Current
Online	May be limited	May not be available	Effectively unlimited	Current
Synchronized	Fastest	Available at all times	Limited	May not be current

Table 2. Decision factors

4 Domain of study

To explore the stored data characteristics of mobile apps, we examined apps in a particular domain, that of walking the Camino de Santiago in Spain. The Camino de Santiago (Camino for short) is an ancient pilgrimage in Northern Spain. Although there are many routes, all end at the cathedral in Santiago de Compostela (Santiago for short) in the northwest corner of Spain where the bones of St. James are said to be buried. It can be traveled by foot, bicycle, or horseback; all who make the journey, whether for religious, spiritual, recreational, touristic, or other reasons, are called pilgrims. The most popular route, called the Camino Francés, starts in Saint-Jean-Pied-de-Port in France and ends in Santiago, 774 kilometers (481 miles) away, and typically takes about 35 days by foot. Pilgrims have made the trek to Santiago for over 1000 years with the numbers varying throughout the centuries. In the recent years the journey has become very popular with over 200,000 pilgrims completing it in 2013 and 2014 (American Pilgrims 2015). The recent feature film *The Way* has sparked even more interest in the Camino.

The Camino is well marked and can be walked without guidance. Pilgrims, however, have often used one or more paper guidebooks to find their way. Two popular books in English are Brierley (2014) and Confraternity of Saint James (2013), but there are many others in English and other languages. With the ubiquity of smartphones and tablets, however, some pilgrims are using apps to guide them (personal observation during summer 2013). In an online search, we have found over 70 apps that are designed specifically for use by pilgrims on the Camino.

This domain was selected because it provides a number of challenges for app developers. Mobile phone service, although very good in Spain, is not ubiquitous on the Camino. Many pilgrims, especially those from the United States, do not want to use mobile phone service in Spain because of the high cost of roaming. A useful feature for Camino apps is maps, which require high bandwidth to download and significant storage space on mobile devices. A separate survey showed that offline apps are preferred by pilgrims (Nickerson 2015) but then data cannot be updated in real time on the mobile device. App developers need to consider the decision factors discussed previously in selecting the storage method for their apps in this domain.

5 Survey of data management approaches used by apps in domain

Through searches of the Apple App Store, Google Play Store, Microsoft Windows Phone App Store, and the Internet in general, we identified 73 apps that are designed specifically for use by pilgrims walking the Camino. Of these, 29% (21) were iOS based, 64% (47) were Android based, and 7% (5) were Windows Phone based. We note that some apps had versions for different operating systems. We counted each operating system version of these apps separately because they would be used by different pilgrims. We did not consider apps for Blackberry, Firefox OS, or other lesser-used operating systems. The Appendix lists the apps that we examined along with each app's type.

We prepared an extensive spreadsheet of the characteristics and features of the apps, including their stored data management characteristics. We identified 7% (5) as offline apps, 79% (58) as online apps (including hybrid apps), and 14% (10) as synchronized apps.

To illustrate the three different types of apps, we briefly describe one app of each type here:

- Albergues 2.0, offline app: This app provides information about albergues (hostel-type accommodations) on a number of Camino routes. The full database of information about the albergues is stored on the mobile device allowing the app to be used completely offline. No updating of the data is available from a server.
- Camino de Santiago – Camino Francés, online app: This app provides detailed route maps of each stage of the Camino Francés. The maps are stored on a server and downloaded as requested by the user. This app can only be used while connected to the Internet; it is fully online.
- Esoteric Camino France & Spain, synchronized app: This app provides information about unusual points of interest on the Camino Francés and some other routes. The information is written by a travel writer who has walked part or all of several routes of the Camino. The writer updates the information on a server, which is then downloaded to the user's mobile device the next time the user is online. Users can also provide comments about the writer's information, which are uploaded to a server and made available to other users. The app can be used offline for accessing information on all the points of interest downloaded at the latest synchronization.

We identified 9 features for each app: route maps, route topography, town maps, information about albergues, information about other accommodations, information about restaurants/cafes/bars, historical/cultural information, points/places of interest, and location based (GPS) capabilities. These features were selected both from personal experience walking the Camino and from a separate survey of pilgrims in which the respondents ranked desirable features of an app (Nickerson 2015). One author coded each app for these features from information provided online about the app and, when a free version of the app was available, from use of the app. The other author checked the coding. We counted the total number of features for each app. Examination of this data showed that offline apps offered the least number of features with a range of 1 to 5 features and an average of 3.4 features per app. Synchronized apps provided more features with a range of 2 to 7 features and an average of 5.5 features per app. Online apps had a range of 1 to 9 features and an average of 4.9 features per app.

None of the offline apps provided route topography or information about restaurants/cafes/bars. The most common feature provided by these apps was information about albergues. None of the synchronized apps provided route topography. All the other features were available in at least half of these apps. Maps (route and town with GPS positioning) were the most common feature of online apps. Route topography and information about restaurants/cafes/bars were the least common features of these apps.

6 A case study of data management in the development of a mobile app: The case of eCamino

In this section we examine one particular app, eCamino, focusing on the decisions made during its development. We selected this app because one author had direct contact with the app developers and was invited to meet with them at their office in Budapest. We used the case study methodology of Yin (2004 and 2014) as a guide for gathering information about the development of this app. Our approach is a single case study that is descriptive and explanatory. It is bounded by the activity of developing eCamino, and by the time from the initial conception to the first release of the product. Since we are interested in the development of eCamino, our discussion is based on the first version. Newer versions have been released that have additional features.

We conducted interviews at the office of eCamino Kft., the company that developed and owns eCamino, in Budapest, Hungary, in February 2015. Present at all interviews were two principals involved in eCamino, identified here as *A* and *B*. At one time several technical staff were brought into the meeting room to answer technical questions. Interviews were conducted in English, although some of the discussion with the technical staff had to be translated to and from Hungarian, which was done by *B*.

eCamino is a synchronized app. It includes 7 of the 9 features identified previously, excluding only route topography and town maps (added in a later version). It is based on Brierley (2014). The full database of user-relevant information with maps and content from Brierley is stored on the mobile device allowing the app to be used offline. The database is also stored on a server. Users can update data on the mobile device (e.g., update an accommodation's phone number or a restaurant's opening hours) while walking the Camino. When the mobile device is next online the data in the mobile database is synchronized with the server database. User-entered data is uploaded to the server and is subsequently downloaded to the mobile devices of other users. Users can also upload text and photos to the server, which are then available for others to view on other devices such as laptops through a web portal connected to the server.

In 2012, *A* published an edition of Brierley (2014) in Hungarian. *A* has technical knowledge of maps and GIS from his experience working for the GPS company TomTom. He conceived the idea of a mobile app with maps of the Camino route as shown in Brierley and other content from Brierley. He presented the idea of an app based on Brierley to the author, John Brierley, who agreed to it in 2013. *A* formed eCamino Kft. in Hungary in 2013. Initial financing for the company was provided by the principals, friends of the principals, and Pear Williams Kft., which is another Hungarian company in the technology sector founded in 2011. The offices of eCamino Kft. are located in the offices of Pear Williams Kft. in Budapest. In 2014 a VC belonging to a Catholic order provided additional funding.

Development of the initial version of eCamino took about six months. The first version for Windows Phone was released in February 2014. The iOS version was released in March 2014 and the Android version was released shortly thereafter. The first version was developed for Windows Phone because Microsoft had indicated that it would provide financial support for the project, but that support never materialized. In addition, Windows Phone based smartphones are common in Hungary.

Development of the app first involved preparing specifications. Camino pilgrims were interviewed in the process and application functions were identified. The core database was created using Oracle on a Microsoft Azure server in Ireland. It was necessary for the server to be in Europe because of end-user license requirements. Azure was selected over AWS and other options because Microsoft provided technical support.

Most decisions were made jointly by *A* and *B*. A fundamental decision was that the app would use synchronized data storage. All user-relevant data would be stored on the mobile device so that the app could be used offline. At the same time, the data stored on the device needed to be current. (A separate survey of pilgrims supports the desirability of these characteristics (Nickerson 2015).) To provide offline use and maintain currency of the data, a synchronized approach was needed. (This decision is discussed further in the next section.)

Another early decision was that the apps should be native, with one version for each platform, rather than a single web app usable on all platforms. Developing native apps for three different platforms created a number of problems. Programming was done in different programming languages by programmers working for Pear Williams Kft. and eCamino Kft. Some initial programming was also outsourced to a local firm. Currently all programming is done in house. The core of the system on the Azure server was written in Java. The web portal was written in PHP. The Windows Phone version of the app was written in C#, the iOS version was written in Objective C, and the Android version was written in Java. No cross development solutions were available at the time, and so each version had to be written from scratch. Currently, such solutions exist. *A* and *B* estimate that using them would have saved about 30% of the development time. Programmers found development for iOS easiest, Android more difficult, and Windows Phone the most difficult. A further complication was that there were differences among smartphones in Europe and the United States because of different network providers. One activity that took considerable time was the geocoding of the points of interest. This was done manually and took one person about four months to complete.

As noted previously, the core of the system on the Azure server uses Oracle for its database. SQLite was selected as the data storage software on the mobile devices because it is popular and usable on all platforms. The complete SQLite database is approximately 160 megabytes. The web portal uses MySQL.

The architecture of the system is shown in Figure 1.

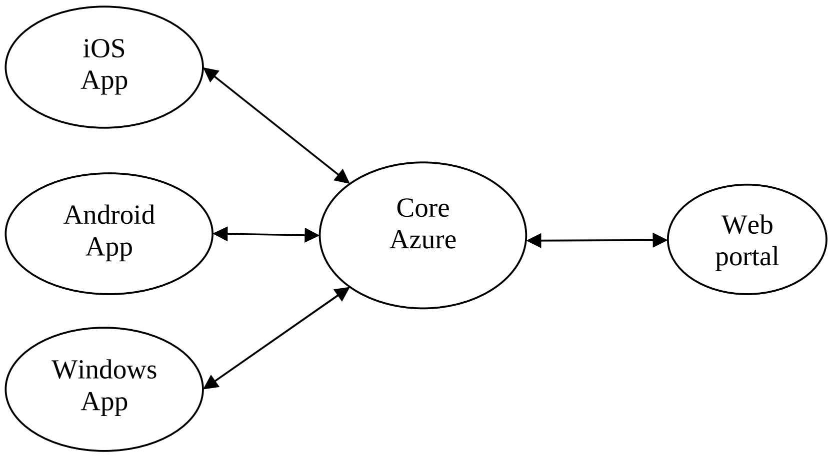

Figure 1. eCamino system architecture

Data synchronization between mobile devices and the server uses the following patterns:

- Data synchronization mechanism pattern: Synchronous. Synchronization, if needed, occurs at startup of the app. The user interface and all app functions are blocked during synchronization. Informal use of the app on an iOS device indicates that this synchronization is typically under one minute. *A* and *B* indicated that synchronization is slower on Android devices because of https transfer. (Initial population of the mobile database occurs when the app is installed.)
- Data storage and availability pattern: Partial. Only data that is relevant to the user is stored on the mobile device. Other data remains on the server.
- Data transfer pattern: Timestamp transfer. Only data changed since the last synchronization, as indicated by time stamps, is transferred between the server and the mobile client.

7 Discussion

As noted in the previous section, a fundamental decision was to use a synchronized data storage approach. This decision illustrates the application of the four decision factors presented in Section 3 of this paper:

- Speed of stored data access: The developers wanted rapid access to the data. All user-relevant data needed to be stored on the mobile device, thus providing access to the data without a network delay.
- Availability of stored data: The developers wanted the data to be available at all times. All user-relevant data needed to be stored on the mobile device so it would be available to the user, whether or not a network connection was present.

- Volume of stored data: The developers determined that the amount of data used by the app was small enough to fit on a mobile device. Although data capacity is limited on a mobile device, this limitation does not impact eCamino because the database is only about 160 megabytes.
- Currency of stored data: The developers determined that changes in the data would be limited and infrequent, and thus real-time currency was not needed, although periodic updating would be desirable. Some data on the mobile device could be out of date without significantly affecting the usability of the app. Data could be updated regularly because of the widespread availability of WiFi in albergues, restaurants, bars, and similar locations on the Camino. It was expected that users would be able to get online at least once a day via WiFi.

The totality of these decision factors indicated that the synchronized approach was best for eCamino. With this approach, data can be accessed rapidly because it is stored on the mobile device. Data is available without a network connection, again because it is stored on the mobile device. The volume of data is small enough to be easily stored on the mobile device. The occasional lack of currency of some of the data is not a problem because the data can be synchronized regularly.

8 Conclusion

This paper examines data storage options for mobile apps. It identifies the mobile data characteristics of the main types of apps with special attention to synchronized apps. It also presents factors to consider in decisions about the data storage approach used in mobile apps. With this background the paper surveys the data storage characteristics of over 70 apps for one domain (that of walking the Camino de Santiago) and examines the case of the development of one specific app in this domain (eCamino).

The main conclusion from the analysis in this paper is that in the context of the specific domain studied in this research, different approaches to data storage for mobile apps are appropriate depending on the characteristics of the situation in which the app will be used. Offline apps, with all data stored on the mobile device, are best when the data is not updated or only updated by the user. Online apps, where the app has real time access to the data on a server, are best where the data is updated by external entities and the currency of the data is critical. Finally, synchronized apps are useful where the mobile device must be used offline but may be periodically online for data synchronization.

We hypothesize that the conclusion of this research, although supported here in the context of apps used by pilgrims on the Camino de Santiago, is applicable in other contexts. Exploration of this hypothesis is an area for future research. Another area for future research would be to look at other case studies beyond the single case (eCamino) investigated for this paper. Such research may identify other decision factors besides those identified here. Finally, exploring the impact on the user of the different data storage approaches identified here could be a fruitful area for future research. Although this paper has characterized this impact in several ways, research on actual use by end-users could confirm these characterizations or reach different conclusions.

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References

American Pilgrims 2015. “Compostelas issued by the Oficina de Acogida de Peregrinos by year,” http://www.americanpilgrims.com/camino/statistics_docs_images/Compostelas_total_by_year_86-14.pdf accessed February 23, 2015.

Brierley, J. 2014. *A Pilgrims Guide to the Camino de Santiago*, Forres, Scotland: Camino Guides.

Confraternity of Saint James 2013. *Pilgrim Guides to Spain, 1 Camino Francés*, Gosport, U.K.: Confraternity of Saint James.

Harris, B. J. G., Ives, B., and Junglas, I. 2011. “The Genie Is Out of the Bottle: Managing the Infiltration of Consumer IT Into the Workforce,” Accenture Institute for High Performance.

McCormick, Z. and Schmidt, D. C. 2012. “Data Synchronization Patterns in Mobile Application Design,” *Proceedings of the Pattern Languages Program (PLoP) 2012 Conference*.

Nickerson, R. C. 2015. ”Mobile Technology and Smartphone Apps on the Camino de Santiago”, presented at the 2015 Annual Symposium for Pilgrimage Studies, Williamsburg, Virginia.

O’Brien, J. A. and Marakas, J. M. 2011. Management Information Systems, 10th ed., New York, NY: McGraw Hill Irwin.

SAP 2015, “SAP SQL Anywhere,” http://www.sap.com/pc/tech/database/software/sybase-sql-anywhere/index.html accessed February 23, 2015.

SQLite 2015. “About SQLite,” http://sqlite.com/about.html accessed February 23, 2015.

Stage, A 2005. “Synchronization and replication in the context of mobile applications,” http://www14.in.tum.de/konferenzen/Jass05/courses/6/Papers/11.pdf accessed February 23, 2015.

Yin, R. K. 2004. “Case Study Methods,” http://www.cosmoscorp.com/Docs/AERAdraft.pdf accessed February 23, 2015.

Yin, R. 2014. *Case Study Research*, Thousand Oaks, CA: Sage.

Appendix: Mobile Apps Surveyed

iOS Apps

Name	Developer	Type	Source
Buen camino: Saint James Way - Camino de Santiago	Buen Camino	Online	Apple App Store
Camino (Eroski Consumer)	BIKO	Online	Apple App Store
Camino Aragonés - A Wise Pilgrim Guide	Wise Pilgrim	Online	Apple App Store
Camino de Invierno - A Wise Pilgrim Guide	Wise Pilgrim	Online	Apple App Store
Camino de Santiago - Bono Lacobus	Xunta de Galicia	Online	Apple App Store
Camino de Santiago - Camino Francés 2.0	CNIG	Online	Apple App Store
Camino de Santiago del Sur a la Vía de la Plata. Sevilla - Mérida	Imagen MAS	Online	Apple App Store
Camino del Salvador - A Wise Pilgrim Guide	Wise Pilgrim	Online	Apple App Store
Camino Finisterre - A Wise Pilgrim Guide	Wise Pilgrim	Online	Apple App Store
Camino Francés - A Wise Pilgrim Guide	Wise Pilgrim	Online	Apple App Store
Camino Guide	Jack Fellows	Synch	Apple App Store
Camino Primitivo - A Wise Pilgrim Guide	Wise Pilgrim	Online	Apple App Store
CaminoDeSantiago	COTESA	Online	Apple App Store
eCamino	eCamino Kft	Synch	Apple App Store
Esoteric Camino France & Spain	Sutro Media	Synch	Apple App Store
Le Puy / GR65	AgenceTNT	Online	Apple App Store
TrekRight	Eugene Mallay	Online	Apple App Store
Tu Camino	Pordefecto s.l.	Online	Apple App Store
Via Plata IT	IndependenTrip	Online	Apple App Store
Visitabo Santiago de Compostela	ALHENA APP TRAVEL	Synch	Apple App Store
Way of St. James, St Jacobs Route Map.	Dubbele.com	Synch	Apple App Store

Android Apps

Name	Developer	Type	Source
Albergues_2.0	HLE Aplicaciones	Offline	Google Play
Augmented Reality St James Way	Ricardo Meana	Online	Google Play
Buen Camino	Chaligne Aurore	Offline	Google Play
Camino de Santiago	CNIG	Online	Google Play
Camino de Santiago	COTESA	Online	Google Play
Camino de Santiago	CNIG	Online	Google Play
Camino de Santiago Guide	CaminoGuide.net	Offline	Google Play
Camino de Santiago Guide v2.0	Tournride.com	Online	Google Play
Camino de Santiago HD	CNIG	Online	Google Play
Camino de Santiago my mobile	Miguel Ángel Zamorano Porras	Online	Google Play
Camino de Santiago, Aragones	DeNAide	Online	Google Play
Camino de Santiago, Baztanes	DeNAide	Online	Google Play
Camino Francés - Wise Pilgrim	Wise Pilgrim	Online	Google Play
Camino Frances IT	IndependenTrip	Online	Google Play
Camino Pilgrim	Aurea Moemke	Online	Google Play
Camino Portugués IT	IndependenTrip	Online	Google Play

Camino Sanabrés IT	IndependenTrip	Synch	Google Play
Caminos de Santiago	IndependenTrip	Online	Google Play
eCamino	eCamino Kft	Synch	Google Play
ElCaminoenGPS_Burgos-Leon	Bluguía, S.L.	Online	Google Play
ElCAMINOenGPS_Galicia	Bluguía, S.L.	Online	Google Play
ElCaminoenGPS_Leon-Pedrafita	Bluguía, S.L.	Online	Google Play
ElCaminoenGPS_Logroño-Burgos	Bluguía, S.L.	Online	Google Play
ElCaminoenGPS_Pirineos-Logroño	Bluguía, S.L.	Online	Google Play
Esoteric Camino France & Spain	Sutro Media	Online	Google Play
Hotels Camino-Way of St James	Xose Zapata	Online	Google Play
Le Puy / GR65	AgenceTNT	Online	Google Play
Los Caminos de Santiago	DeNAide	Online	Google Play
my Camino de Sanitiago (mi Camino)	micaminodesantiago.com	Online	Google Play
OCamiñoenGPS_Burgos-León	Bluguía, S.L.	Online	Google Play
OCAMIÑOenGPS_Galicia	Bluguía, S.L.	Online	Google Play
OCamiñoenGPS_León-Pedrafita	Bluguía, S.L.	Online	Google Play
OCamiñoenGPS_Logroño-Burgos	Bluguía, S.L.	Online	Google Play
OCamiñoenGPS_Pirineos-Logroño	Bluguía, S.L.	Online	Google Play
Road to Santiago	Valerio Grosso	Offline	Google Play
Santiago de Compostela	Información e Comunicación Local, SA	Online	Google Play
St James Bono Iacobus	TNRCode.com	Online	Google Play
The Way of Saint James	SEGITTUR	Online	Google Play
TheWayofSJames_PirineosLogroño	Bluguía, S.L.	Online	Google Play
TheWayofStJames_Burgos-Leon	Bluguía, S.L.	Online	Google Play
TheWayofStJames_León-Pedrafita	Bluguía, S.L.	Online	Google Play
TheWayofStJames_Logroño-Burgos	Bluguía, S.L.	Online	Google Play
TheWayofStJamesinGPS_Galicia	Bluguía, S.L.	Online	Google Play
Tu Camino	Pordefecto s.l.	Online	Google Play
Ultreia! Camino Francés	Professor Lidenbrock	Online	Google Play
Via de la Plata IT	IndependenTrip	Online	Google Play
Visitabo Santiago Compostela	ALHENA APP TRAVEL	Synch	Google Play

Windows Phone Apps

Name	Developer	Type	Source
Camino	Anita Sparzynska DCU	Online	Windows Phone App Store
Camino de Santiago Guide	CaminoGuide.net	Offline	Windows Phone App Store
eCamino	eCamino Kft	Synch	Windows Phone App Store
Hotels Santiago	Mobimento Mobile, S.L.	Online	Windows Phone App Store
Visitabo Santiago gratuita	ALHENA APP TRAVEL	Synch	Windows Phone App Store