



UPPSALA
UNIVERSITET

UPTEC IT 13 013

Examensarbete 30 hp
Augusti 2013

Data Driven Development for Mobile Applications

Oskar Wirén



UPPSALA
UNIVERSITET

**Teknisk- naturvetenskaplig fakultet
UTH-enheten**

Besöksadress:
Ångströmlaboratoriet
Lägerhyddsvägen 1
Hus 4, Plan 0

Postadress:
Box 536
751 21 Uppsala

Telefon:
018 – 471 30 03

Telefax:
018 – 471 30 00

Hemsida:
<http://www.teknat.uu.se/student>

Abstract

Data Driven Development for Mobile Applications

Oskar Wirén

The purpose of this thesis was to examine the suitability of applying data driven concepts developed for the web on mobile application development. This was done in order to give an overview of what is needed for a company to work with a data driven approach when developing mobile applications. A literature study was performed in order to investigate the state of the industry. This study gave background information about the relevant aspects of being data driven. To give the report a closer connection to Valtech, the company for which this thesis was developed, interviews were performed with consultants experienced in mobile application development.

These interviews together with the literature study gave the materials needed to reach the conclusion that it is generally a good idea to strive towards a data driven approach when developing mobile applications. This is however, dependent on the scale and the revenue model of the application.

The interviews uncovered three applications that would be well suited to a data driven development approach. Two of them were large scale media applications that made the majority of their revenue on selling advertisement inside the application. The other application's revenue was generated by the users booking taxi rides with the application, a revenue model very similar to an in-app purchase.

Handledare: Daniel Chow
Ämnesgranskare: Anders Jansson
Examinator: Lars-Åke Nordén
ISSN: 1401-5749, UPTec IT 13 013

Contents

1	Introduction	5
1.1	Who should read this report?	5
1.2	Being data driven	5
1.3	Purpose	5
1.4	Problem description	6
1.5	Goal	6
1.6	Delimitations	7
2	Background	8
2.1	Mobile Applications	8
2.1.1	Native Application	8
2.1.2	Hybrid Application	8
2.1.3	Web Application	9
2.2	The Data driven Process	9
2.2.1	The organization	9
2.2.2	The analysts	10
2.3	Agile development	10
2.3.1	SCRUM	11
2.4	Digital Analytics	12
2.4.1	Web analytics	12
2.4.2	Mobile analytics	14
2.5	Tools	16
2.5.1	Analytic frameworks	16
2.5.2	Analytic frameworks - How do they work?	16
2.6	Summary	19
3	Method	20
3.1	Sources of information	20
3.2	Finding literature references	20
3.3	Validity and Accuracy	20
3.3.1	Reference reliability	21
3.3.2	Interviews	22
3.4	Planning	22
3.5	Interviews - Preparation and motivation	23

3.5.1	Why do interviews?	23
3.5.2	How were the interviewees chosen?	23
3.5.3	What questions to ask?	23
3.5.4	How were the interviews conducted?	24
3.6	Profiles and agendas	25
3.6.1	Interview 1	25
3.6.2	Interview 2	26
3.6.3	Interview 3	26
3.6.4	Interview 4	27
3.6.5	Interview 5	27
3.6.6	Interview 6	28
4	Result	29
4.1	The Interivews	29
5	Analysis	35
5.1	Working with analytic tools	35
5.1.1	Skill sets needed	35
5.2	Agility	36
5.3	Testing	36
5.4	To be data driven	37
5.4.1	Organization	37
5.4.2	The implementations	38
5.4.3	The application types	39
6	Discussion	41
6.1	The literature study	41
6.2	The interviews	41
6.3	The lack of actual implementation	41
7	Conclusions	43
7.1	Digital Analytics	43
7.1.1	Analytics on the web and Available tools	43
7.1.2	Analytics in mobile applications and Available tools	43
7.1.3	Problems and possibilities with the different mobile im- plementation	44
7.2	Summary	45

Glossary

Conversion rate *"Conversion rate, in percentage, equals Outcomes divided by Unique Visitors during a particular time period."*[1] An outcome is considered a successful visit, for example the purchase of a product or a subscription to a news letter.

Flurry Flurry is an Analytic tool used to track user data on mobile applications.[2]

Google Analytics Google Analytics is a tool that enables the tracking of user data on websites as well as mobile applications.[3]

Heat mapping A heat map is a graphic visualization of how users interact with a user interface. Areas are color coded in order show to what extent the website is interacted with. [4]

Hybrid Application A hybrid application is a mobile web application that is run on each specific device in a shell of native code.[5]

Integrated Development Environment (IDE) An IDE is a tool which helps software developers manage their software applications. It contains all the tools needed for development, such as a debugger and version control.[6]

Key Performance Indicator (KPI) *"A key performance indicator (KPI) is a metric that helps you understand how you are doing against your objectives."* [7, Chapter 3]

Linkpulse Linkpulse is an Analytic tool used on news sites. It gives real time information about the usage of the website.[8]

Minimum Viable Product (MVP) Croll et al. defines the minimum viable product (MVP) as follows in Lean Analytics *"The Minimum Viable Product is the smallest thing you can build that will create the value youve promised to your market."*[9, Page 6]

Mobile Application A mobile application is a piece of software developed for use on mobile devices, such as smartphones and tablets.[10]

Mobile Web Application A mobile web application is a web application optimized for use on mobile devices.[11]

Native Application A native application is a mobile application developed for one specific type of device, for example iPhone or Windows Phone.[12]

Product backlog The product backlog is a prioritized list that contains the features that are to be implemented in the product at hand.[13]

SiteCatalyst SiteCatalyst is an analytic tool that enables the tracking of user data on websites and mobile applications.[14]

Software Development Kit (SDK) *"An SDK is a collection of software used for developing applications for a specific device or operating system. Examples of SDKs include the Windows 7 SDK, the Mac OS X SDK, and the iPhone SDK."*[15]

Testing When testing is mentioned in this report it will refer to graphical user interface (GUI) testing. This is when you try out different versions of the GUI in a piece of software in order to improve the GUI.[7, Chapter 7]

Chapter 1

Introduction

1.1 Who should read this report?

This report is written for those who have a basic understanding of web and mobile application development. The reader wants to know how the web industry uses data driven concepts in order to improve their websites and how to use similar concepts while developing mobile applications.

1.2 Being data driven

Being data driven basically means that you try to base your decisions more on data and less on gut feelings. A data driven organization continuously gathers data about their product, analyzes said data, and decides how to proceed with the development according to the analysts recommendations. A more detailed description of the data driven concepts can be found in section 2.2.

1.3 Purpose

During the last couple of decades the web industry has become increasingly adept at gaining insight into how end users behave while visiting their websites. This has lead to increased revenue, increased user satisfaction and lowered development costs. This can in many cases be attributed to companies adopting a data driven approach to their development.

The business of developing mobile applications is still in its infancy. Many applications are developed, released, and then sporadically updated with content based on gut feelings. There is much to be learned from the web industry when working with an application that has already been released on the application markets. One thing that has been developing rapidly in the world of mobile applications is different analytic tools. Similar tools have been in use for

the web for a long time, and therefore there is a lot to be learned from the more experienced world of web analytics.

1.4 Problem description

In the already established web industry, being data driven is something many strive towards. There are few technical limitations due to the short deployment times, and great analytic tools. In the world of mobile applications however, there are several factors that get in the way when striving towards being data driven.

This report will give an outline of how the web industry works with data and analysis in order to become more data driven, and how similar concepts can be applied to mobile application development.

1.5 Goal

The goal of this report is to highlight the value of being data driven on the web and examine in which ways this is suited to a company developing mobile applications. The following list shows the key items that will be described and discussed in this report.

- The way analytics is used for the web.
- The available options of analytic tools on the following implementations of mobile applications:
 - Native applications.
 - Hybrid applications.
 - Web applications.
- The problems and possibilities of the above listed implementations regarding the following aspects:
 - Time from completion to distribution on each platform.
 - Skills needed in order to implement analytics.
 - Testing and optimization.
- The limitations that the different application distribution channels infer, for example Apple's App Store, Google Play and Windows Phone Store.

1.6 Delimitations

This report will not include any implementations. All technical analysis is based on input from interviews and personal experience. Due to the fact that the author of this thesis has experience in working with iOS development, the technical aspects of the iOS platform will be given more attention than the other platforms.

Whenever testing is mentioned in the report, it will refer to User Interface (UI) testing, such as A/B testing. Read more about testing in section 2.4.

Whenever the different implementations (web, native and hybrid) are discussed in the report, it will be strictly regarding their respective suitability for data driven development. Their technical performance, possibilities and limitations will not be considered.

Chapter 2

Background

This chapter presents the idea of being data driven. Tools and techniques that support data driven organizations are also described. Along with this, relevant information concerning mobile applications will be shown in order to display similarities and differences between the worlds of mobile applications and the web.

2.1 Mobile Applications

A mobile application is a piece of software developed for use on mobile devices such as smartphones and tablets. Compared to desktop applications they are usually small, with functionality limited to a specific scope. [10]

2.1.1 Native Application

A native application is developed in a device-specific environment with a device-specific programming language. The development environment is usually created by the device's creators. One example is Apple's iPhone applications. They are developed in an integrated development environment (IDE) called Xcode, with an integrated iPhone and iPad simulator and a user interface (UI) editor called Interface Builder.

The native development environment gives access to all of the device-specific utilities, such as the calendar, camera, email, accelerometer, etc. Since the code and tools are tailored for each specific device, the end user usually gets the type of UI experience that they expect. This kind of application is distributed through the device's respective application markets. [12]

2.1.2 Hybrid Application

A hybrid application is basically a web application that is run in a native shell. The application is usually written in framework, such as Phonegap[16], using

HTML, CSS and Javascript. The use of the native shell allows hybrid applications access to more device capabilities than the standard web application. Some of those capabilities are the accelerometer and the camera built into the devices. This kind of application is also distributed through the application markets. [5]

2.1.3 Web Application

A mobile web application is a web implementation where the app is not downloaded from an app market, but is accessed through the device's browser. [11]

2.2 The Data driven Process

For an organization or process to be data driven, it needs to actively collect data and use that data as support for future decision making.[17] A strictly data driven organization would base all its decisions purely on what the data says, which is why there are hardly any such organizations. An example given by Eric T. Peterson in the blog Web Analytics Demystified shows how being strictly data driven can result in a company taking a different direction than it would have preferred. The example illustrates how a news site would only have gossip related articles instead of actual world news if it were to strictly follow what the data showed to attract more readers.[18]

Peterson suggests that organizations should strive towards being “data informed”, rather than data driven. The main difference between the two terms is that being data informed actually implies that analysis is a part of the process.[18]

2.2.1 The organization

In Caroline Watts blog From Analytics To Action Part I[17] she states that many organizations have trouble with data, though not in the way you might expect. She states that many companies have too much data, which makes it difficult for them to identify their Key Performance Indicators (KPI). The purpose of the data is to help show what effect changes in the software have on user behaviour.[19] Questions that often drive companies to try new things on their websites, and which can be answered by continuously collecting and analyzing data, are usually questions like:

- *“will our website redesign improve our conversion rates?”*
- *“is my content marketing driving revenue?”*
- *“is our brand awareness improving?”*

[17]

2.2.2 The analysts

An important part of being data driven is realizing the difference between reporting and analyzing. In many cases no real distinction is made between the two, whereas the difference is actually very significant. The fundamental difference is one of purpose. The report presents data, it shows unexpected events, and helps monitor what is currently happening. It is used to raise questions within the organization about how to steer the end user's behavior towards a specific goal. The analysis, on the other hand, is where the actionable recommendations come from. The analyst's job is to, using the reports as a base, find out what can be done in order to improve the performance of the product.[19]

2.3 Agile development

Agile software development is a programming principle that is widely used today. This section describes the basics of the principle behind the modern agile software development methodologies. It also gives an example of one such methodology.

Kent Beck et al proclaims the Manifesto for Agile Software Development[20]:
“We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

Individuals and interactions over processes and tools.

Working software over comprehensive documentation.

Customer collaboration over contract negotiation.

Responding to change over following a plan.

That is, while there is value in the items on the right, we value the items on the left more.”

Being agile means that you are able to adapt to change and regularly deliver functioning software.[21] There are several different software development methodologies that are considered agile. All of these have a couple of things in common:

- They all work in iterations, meaning that they entail planning for short periods at a time, usually no longer than four weeks. During the iteration, the team develops a set of features from the product backlog. During the first iteration, a basic working version of the product is delivered. The following iterations add features to this basic version.[21, 22]
- Continuous communication and interaction within the organization (not only within the team of developers) is encouraged in order to reduce waiting times. This also shortens the feedback loop regarding features, which

gives the team the possibility to quickly adapt to changes in planning.[21, 22]

2.3.1 SCRUM

There are several different popular Agile Software Development Methodologies, one of them is Scrum. Scrum will be described shortly in the following section.

The people

In Scrum you can divide the people that are involved into three categories.

The first is the team of developers, the second is the product owner, and the third is the Scrum master. The development team usually consists of between three and ten developers. The team is preferably cross functional, meaning that it contains developers with all the different skill sets needed to complete the software without needing help from external personnel.[13, 23]

The Scrum master's role is to make sure that the developers have everything they need to work efficiently, organize meetings and protect the team from interruptions, for example from someone trying to sneak in a new feature in an iteration.[13, 23]

The product owner is the key stakeholder, he/she owns the product backlog from which the team will know what features to implement. The priorities of the features on the product backlog are determined by the product owner, thus giving him or her control over what order features are to be implemented. [13, 23]

The process

First the product owner, together with the other stakeholders create a product backlog, which is a prioritized list of features. It is not unusual that the Scrum master helps with this procedure.[13, 23]

After the backlog is in order, the team has a sprint planning meeting. During the meeting it is decided what features from the backlog to implement during the sprint.[13, 23]

During the iteration there are daily meetings, to which both the Scrum master and the product owner are required to attend. During these meetings everyone involved gets a snapshot of the project status, and eventual changes to specific features might be discussed.[13, 23]

After each iteration there is a demo and a review meeting. During the demo the team displays to the stakeholders what has been accomplished during the

iteration. The review meeting is a retrospective of the previous sprint where the team, Scrum master and product owner discuss the effectiveness of the current work process. At this point, adjustments to the process can be made for the upcoming sprint in order to make it more efficient. [13, 23]

2.4 Digital Analytics

When developing websites it is important to have insight into what actually generates the value that the website is supposed to deliver. The area of digital analysis is where these insights can be found. By gathering data from the usage of a website, analysts can analyze the data, and gain insights regarding what is needed to increase the website's value.[7, Chapter 1]

Before going into the specifics, there is a common misconception between the two concepts of analysis and analytics. Camuel Gilyadov[24] on the blog Big Data Craft defined the difference as: “*Analysis is the examination process itself where analytics is the supporting technology and associated tools.*”. The thing most important to be aware of is that without someone to do the analysis, the data gathered by the analytics is close to useless.

There are many aspects that can be affected by using analytics. Some of these aspects are more reasonable to focus on, as they make it easier to quantify success as well as have a strong connection to what generates value. For a web shop the value could be generated by the number of sold items, while on a informative site it might be through advertisement. In that case the goal is to get the user to see as many pages as possible on the site, thus exposing the user to as many chances as possible to find an advertisement interesting.[7, Chapter 1]

The following sections describe the relation between the analytics, the tools used to gather data, and what kind of data is valuable. It will be presented first in the context of the web, and then in the context of mobile applications.

2.4.1 Web analytics

Metrics

Avniash Kaushik states the following in Web Analytics 2.0:

“a metric is a quantitative measurement of statistics describing events or trends on a website.”[7, Chapter 3].

Looking at this definition of a metric, it is reasonable to assume that it is valid for software in general, not only websites.

The data has two main purposes. One is to help the analyst decide what

could be improved on the website, and the other is to provide a benchmark for the performance of the website. If you compare data gathered on the new improved page, the KPIs are hopefully looking better than they did before. The experimental part of improving a website based on measured metrics is a science in and of its own, which will be covered briefly in section 2.4.1.[7, Chapter 3]

All analysis is based on data, and the data needs to be relevant. There are different metrics that are extra relevant from case to case. These metrics are called KPIs, and are what a good analyst finds and pays extra attention to. Below is a list of different types of websites, and useful KPIs for each site type.

Commerce

- Overall purchase conversion.
- Step-by-step purchase conversion.
- First-time versus returning buyers - look at behaviors, conversions, revenue, etc. . .
- Average order size
- Average order value

Customer Service

- Onsite search effectiveness.
 - Searches per search visit.
 - Exits from the search return page.
- Average cost-per-service option and average cost per touch overall.
 - Call center
 - E-mail
 - Online chat
 - Online self-service
- Percent of support touches served successfully online.

[25, Page 5-6]

Testing graphical user interfaces

There are several different ways to test how users interact with the graphical user interface (GUI) of a website. Three of them are described shortly in the following paragraphs.

A/B testing A/B testing is used to compare two versions of a web page, often with a single element changed. During the test period, a certain percentage of the users are routed to page A while the rest get routed to page B. By doing this, the website’s stakeholders can see how the two pages are used, and if it is clear that one is better than the other it might be reasonable to implement it permanently. [7, chapter 7][26]

Multivariate testing Multivariate testing is similar to A/B testing, with the difference that there are more elements changed between the different versions of the web pages.

When a user enters the web page the content is dynamically created according to different variations of elements that are defined beforehand. The analytic tools then help to identify how well the different combinations work, and presents the data for each combination separately. This is a more complicated way of running tests than the simple A/B testing. It yields results faster, but at a higher implementation and administration cost.[7, Chapter 7]

Controlled experiments Controlled experiments are used when it is difficult to control all the relevant variables for a test. One such case could be when experts contradict each other and you need to have some sort of validation of which expert’s theory is the most relevant. An example of such a case is presented in Kaushiks Web Analysis 2.0.[7, Chapter 7] It shows how the conversion rates of a website vary when spending different amounts of money on paid search¹. The experts had different opinions on whether or not using paid search was worth it.

Putting the measured results in a graph (see figure 1) clearly show how the conversion rates are increased when the money spent on paid search is increased. Thus illustrating which of the theories were correct in this case.[7, Chapter 7]

2.4.2 Mobile analytics

The concepts of mobile analytics are very similar to those of web analytics. If a technique or concept is mentioned in the following sections it can be assumed to work in the same way for Web analytics unless the opposite is stated.

Two ways to make money on mobile applications are through sales and different kinds of advertisement.

- You can sell the application directly in the application store, meaning that the user has to pay before downloading the application.

¹Paid search in this case is search marketing for your website keywords

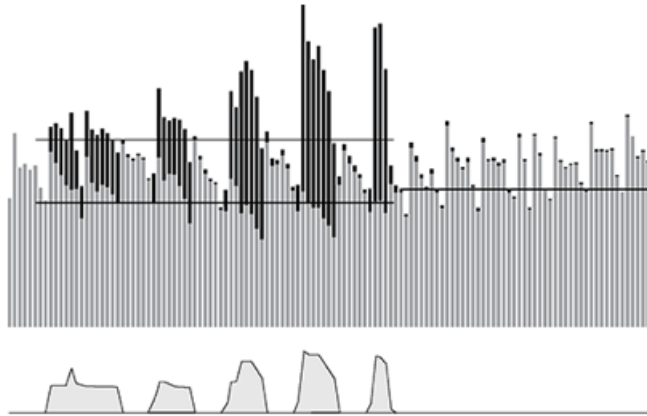


Figure 1: Upper graph: The y-axis shows conversion rates and the x-axis shows time(days). Lower graph: The y-axis shows Money on spent on paid search, and the x-axis corresponds with the upper graph.[7, Chapter 7]

- You can provide a free download of the application, and then sell an upgrade to a premium version inside the application.
- You can provide downloadable (purchaseable) content inside the applications.
- You can sell commercials inside the applications. Some applications draw a very large audience, and you can therefore charge interested companies large sums for advertising in the app.

[9, Page 103-106]

Metrics

The metrics tracked in mobile applications serve the same purpose as those on the web. One big difference between the accessibility of a mobile application and a website is the amount of commitment a user needs to download and start an application compared to simply entering a website. This leads to a couple of KPIs that are always very relevant in any kind of mobile application:

”Downloads - How many people have downloaded the application, as well as related metrics such as app store placement, and ratings.”

”Launch rate - The percentage of people who download the app, actually launch it, and create an account.”

[9, Page 105]

Testing

Testing on mobile devices is more troublesome than on the web. This is largely because of the limitations that the different application stores add to the release of applications.[9, Page 103] Apple for example has a review process, whose duration varies, for every application released on their Mac App Store or iOS App Store.[27] Another problem is the lack of established testing frameworks. Some promising frameworks that handle A/B testing and goal tracking are emerging, one such framework is Arise.io. You can read more about Arise.io on their website. [28]

2.5 Tools

2.5.1 Analytic frameworks

There are several different analytic frameworks that can be used to track and gather data about the usage of a website or an application. One of them is described shortly in this section.

Some relevant aspects are shared between all analytic frameworks. All of them consist of at least two parts: the actual tracking code and a graphical interface that displays the tracked data.

In the following sections, when native implementations are mentioned, only iOS implementations will be considered.

2.5.2 Analytic frameworks - How do they work?

In this section Google Analytics will be used as an example of how an analytic framework can work. It has been chosen because it is the most extensively used web analytic tool[29] and it also has support for mobile devices.[30]

Google analytics user interface

Google analytics provides a web user interface with which you can see the data that has been tracked for your website. It allows the user to see, in different graphs and tables, how the tracked metrics correlate to each other. This is useful in the case that a metric, that is easy to manipulate, influences a really important part of the business. Kaushik[31] gives an example of a correlation between metrics on his blog Occam's Razor where it seems like the fewer posts he makes to his blog, the more RSS subscribers he gets. It is very simple to change the amount of posts you make on a blog, therefore if a key part of your business is getting subscribers to the blog, it might be a good idea to make fewer posts.

The graphical interface of Google Analytics also gives the possibility to compare data from different time periods, to make it easier to show how the data is evolving as changes to the UI are being implemented.

One other important feature is goal tracking. Goal tracking gives you the possibility to track specific user behavior. There are four different kinds of goals defined in Google Analytics:[32]

- Destination - A specific location loads.
- Duration - Visits that lasts a specific amount of time or longer.
- Pages/Screens per visit - A visitor views a specific number of pages or screens.
- Event - An action defined as an Event is triggered.

[33]

Goal tracking example When setting up a destination goal you can define a path that the user is expected to take towards an action or destination. That path is called a funnel. The interface then lets you see where the user enters and leaves the funnel, as shown in figure 2, giving you insights to where you need to focus your efforts in order to make the users perform your defined goal action.

Google analytics on the web

Google Analytics is implemented on a website by including a piece of javascript on all of the web pages that you want to track. The javascript initiates an array that acts as an action queue for the different API calls. It also refers to a separate javascript file that is hosted on a server managed by Google. That file contains the analytics code and is named ga.js. This script file is used to gather data about page requests, transactions, or user defined events. Any customization of what to track is implemented using javascript. There is a lot of information to be gained about how the website is used with just the most basic implementation.[35]

If more advanced tracking is desired, it can be accomplished by adding more tracking commands to the queue. An additional type of tracking event is often used during A/B testing. During these tests it is necessary to see to what extent the differences in the two versions of the page affect the desired outcome of the users behavior. This can be accomplished by tracking page-specific events on the completion of the desired task with different events on page A than on page B.[35]

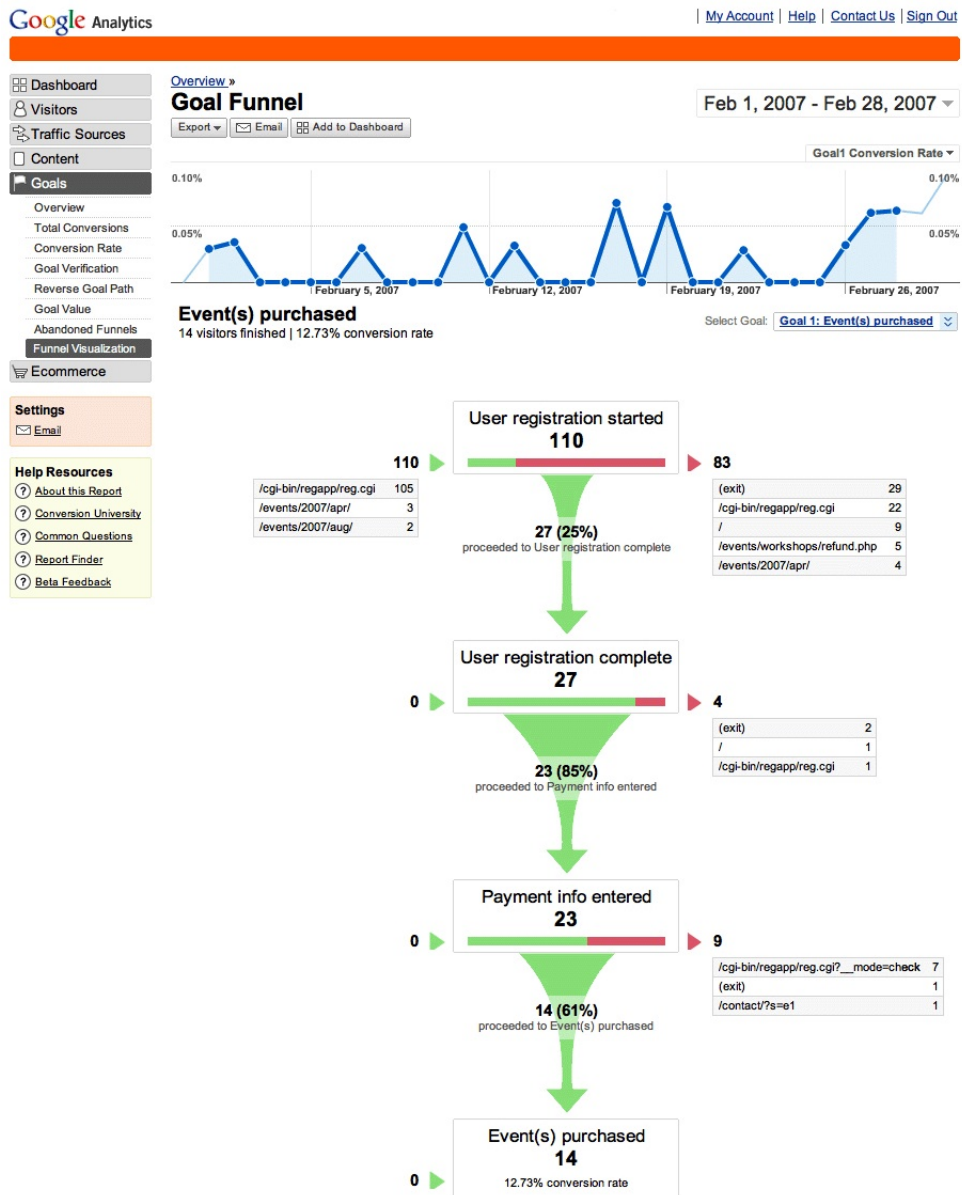


Figure 2: This figure displays how Google analytics graphical interface shows data related to users reaching specific goal actions through a funnel.[34]

Google analytics on mobile applications

Native iOS applications Implementing Google Analytics in a native application is a bit different than on a website. First of all you need to download a

software development kit (SDK) and integrate it into your project, whereas on a website you would simply copy paste the tracking code generated on the Google analytics website. After including the SDK and importing the header files that are needed, you manually initialize a global tracker, to be used throughout the application. In order to get automatic screen measurement (used for engagement flow, screens report and goal flows), you need to make all your view controllers extend a convenience class called `GATrackedViewController`. This will give the class an attribute called `trackedViewName`, which is used to identify the views in the Google Analytics reports.

Custom events are logged manually by accessing the tracker and passing a collection of arguments that is very similar to how it is done on the web.[36, 30]

Web applications Mobile web applications are tracked in the same way as an ordinary website. There is a report in the standard implementation of Google Analytics called Mobile Devices, which shows mobile device specific data, such as what device and what OS is being used. For more information about Google Analytics on the web, see section: 2.5.2.

Hybrid applications When you are developing a hybrid application and want tracking, there are two things to handle: in a hybrid application you need to track both the native views, and the web views. This is usually done by using javascript to trigger requests to custom URLs , for example: `myApplication://event1` when you need to track something in the web view. Then you catch the request made in the web view and encapsulate it in a native tracking event. By doing this you keep all the tracked data consistent, by only using one tracking framework, as compared to logging the web views and native views separately. [37, 38, 39]

2.6 Summary

Having read about agile development, analytic tools and how the web differs from the world of mobile applications, you have the background information needed to see the use of being data driven. You have probably begun to grasp the eventual problems that might occur when employing processes designed for the web while developing mobile applications. The following chapters will complement the literature study with a number of interviews with mobile application developers.

Chapter 3

Method

3.1 Sources of information

The goal of this report was to use as much material of academic nature as possible. During the research phase the scope of material to be used was extended to include blogs, in order to get the newest concepts and ideas as well.

At times in the report, sources regarding one subject have been used in order to explain another subject. At one point a source explaining Digital analytics was used to describe Web analytics. In this case the reasoning behind that decision was that Web analytics is a more specific type of Digital analytics, therefore most of the concepts behind Digital analytics are also valid for Web analytics.

At an early state of the research it was decided that the different skills at Valtech would be accessed through the use of interviews. Interviews gave the opportunity to discuss what was learned during the literature study and get practical insights into what the more experienced developers knew about working with data driven development, digital analytics and testing.

3.2 Finding literature references

Google's scholar search engine[40] was very useful when trying to find academic material. When using search engines to find material, care was taken to not always choose the first result that showed up. Instead the different search results were compared in order to find the most reliable references.

3.3 Validity and Accuracy

This section discusses the accuracy of the material used in this thesis. Explanations of how the sources for the literature study were chosen are provided

as well a brief explanation of the eventual problems with accuracy that might occur when using interviews as a resource.

3.3.1 Reference reliability

Blogs

In the cases where blogs have been used as source their content have been compared with similar blogs or other literature in order to ensure its accuracy. The credibility of the author of the blogs were also examined. One way that was used to validate the authors was looking for references to them in other blogs. Avinash Kaushik in particular was mentioned very often by different bloggers, therefore he has been given some extra attention. All in all the community surrounding digital analysis and being data driven is mature and has many skilled and experienced contributors, so validating the blogs has not been a big problem.

Definitions

For definitions of basic complexity, such as abbreviations and simple technical terms, fact sites such as techopedia[41] have been used. After comparing the definitions from those sites with each other and various literature it was decided that these sources were accurate enough, and that they would be used throughout the report.

Forums

In one case a post on Stack Overflow[42] was used as a resource. In this case the post was made by a user named simply Eduardo. It might seem like a controversial source of information, but after examining the posts he had made on the forum, he was accepted as a reliable source. One extra thing to take into account was the context that reference is used in. Stack Overflow is a well known source of solutions for technical questions, and the context in which the reference was used was in discussing a very specific piece of functionality while implementing tracking in hybrid applications, which he answered in an intelligent way.

Company websites

While describing different tools and their functionality, the websites of the tool's creators were used as resources. A company should not be assumed to have an objective view of their product's value in comparison to their competition. That however, is not what they have been used for. These kind of websites have been used only to get lists of features and implementation details.

Statistics used for finding release time on Apples App Store are also gathered from a website driven by a company. The website monitors a hashtag on twitter

in order to gather reported release times. This does of course mean that if there are few reports on twitter the average release times will be less accurate. The site was however deemed reasonable for supporting the statement that release times can vary, which is shown on the site in a graph.

3.3.2 Interviews

There are several things to take into account when using interviews as a source of information. First of all there is always the possibility of the interviewer misinterpreting what the interviewee says. There is also the problem of taking notes during the interview. It is possible for the interviewer to miss points of interest or take notes that, lacking the context of the interview, make no sense afterwards. In this case the interviews were conducted in Swedish since both the interviewer and the interviewees are all Swedish. This in turn might lead to translation problems when the results are put together.

Even though there are many problem areas regarding using interviews as a source in a thesis it was still the best way to get the information that was needed. The purpose of the interviews was to get an overview of the state of the industry rather than specific facts. That means that individual translation errors or misinterpretations are negligible, since what is used in the thesis are the general trends made apparent by the collection of the interview results rather than the individual cases.

3.4 Planning

The first month of this thesis was spent on defining the subject. During the process it changed multiple times, therefore the original planning was no longer valid or reasonable. The following section describes the process of defining the subject and what consequences it had for the planning of the thesis.

Originally the goal of the thesis was to investigate the different limitations and possibilities of three types of implementations for mobile applications: Hybrid-, Native- and Web applications. In the beginning of the research process several recent papers and reports that had similar goals and methods were found, making the subject much less interesting to pursue.

In order to make the thesis more unique, the scope was extended to cover how it is to work with a data driven approach for mobile applications. The original goal of the thesis was to compare the different implementations of mobile applications (hybrid-, native- and web applications) and that was an interesting aspect of this context as well, so it was still included as a part of the thesis.

3.5 Interviews - Preparation and motivation

3.5.1 Why do interviews?

For the discussion in this thesis to be relevant it was deemed important to make sure that it was connected to a reality closer to the reader and Valtech than literature found online could provide. By conducting interviews with consultants at Valtech it would be possible to discuss the thoughts generated by the literature study with people connected to current projects. This in turn would give insight into how the interviewees work with data today and hopefully generate new ideas about how to make that work more effective.

3.5.2 How were the interviewees chosen?

It was decided to do interviews with a number of developers with experience in different areas of mobile application development and web development. Each developer that was interviewed had experience working with either iOS, android development, or both. Most of them also had a background of working with web development. Working with a data driven approach is much more common on the web than on mobile applications, therefore this characteristic of the interviewees was very interesting.

3.5.3 What questions to ask?

The questions were divided into three groups separated by purpose. The interview questions were originally in Swedish, since the interviews were held in Swedish. Below comes a listing of the questions translated into English.

- The purpose of the first three questions was to identify the interviewee. These questions were important in order to show that there was a diversity in the interviewees.
 1. How long have you been working with software development?
 2. What have you mainly been involved with. The web? Mobile applications?
 3. What type of college education do you have?
- The second category was used in the cases where specific applications were discussed. The questions were used to categorize the applications by length of development, team size and purpose. The purpose of these questions was to see if certain types of applications are more suited for data driven design than others.
 1. What functionality does the application offer?
 2. How does the application generate revenue?
 3. How many developers are working with the application?

4. How long has the development been going on and how long will it continue?
 5. What platforms does the application run on?
- Finally, there were general questions regarding the interviewee's personal experiences about the different aspects of data driven development.
 1. Have you worked with any analytic tools, such as Flurry or Google Analytics on mobile applications?
 2. How useful does the data gathered while tracking mobile applications seem to be?
 3. To what extent is that data actually used?
 4. How advanced is it to implement the analytic tool/tools?
 5. To what extent have you been working with A/B testing or similar tests?
 6. Do you believe that working with a data driven approach is something to strive towards when developing mobile applications?

3.5.4 How were the interviews conducted?

The interviews took an average of 30 minutes. They were conducted in isolated places where there would be no problems with background noise. The first three interviews were recorded using an iPhone. After comparing the recordings with the notes it was realized that the notes were complete enough for the recordings to not add any additional information. Therefore the last interviews were not recorded.

In total there were 7 interviews. During the first interview it became apparent that the questions were not comprehensive enough to get the desired information. Luckily the interviewee was kind enough to do a second, more orderly, interview at a later date. The first interview was not a waste of time however. The application we discussed was complicated enough for the double interview to yield plenty of extra material. It also helped me organize the other interviews better, thus enabling me to take more coherent notes and keep the discussions more straightforward.

The interviews were semi structured with six questions regarding the interviewees experience of working with mobile applications, testing and data driven development. The purpose of these questions was to start a discussion. If the discussion sidetracked into a different area than intended that was fine, as long as it was relevant in the context of data driven development.

3.6 Profiles and agendas

In this section the background of the interviewees and the general theme of each interview will be described. In the cases where specific applications were discussed they will also be briefly described. The analysis will be performed in section: 4.1.

The interviewees will be described according to 3 parameters:

1. Number of years they have been working professionally with software development.
2. What techniques they have experience in working with.
3. What type of higher education they have.

If, during the interview, a specific application was discussed it will also be described according to the following:

1. Which implementation was used (hybrid, native or web).
2. The purpose of the application.
3. What generates revenue in the application.
4. The number of developers working on the project.
5. How long the application has been under development and if there is a known end date of the development.
6. Which platforms the application is intended to work for.

Each interview and corresponding interviewee will be labeled with numbers in no specific order to enable referring to specific interviews while keeping the interviewee anonymous.

3.6.1 Interview 1

The interviewee

- **Years of experience:** 3.5
- **Techniques:** iOS development
- **Education:** Master of computer science (unfinished thesis)

The application

- **Implementation:** Hybrid
- **Application type:** News application
- **Revenue:** Advertisement and a purchasable premium service

- **Number of developers:** In total 10-12 people, including project managers, user experience experts, etc.
- **Development time:** The development has been ongoing for 7 months, no end date is set.
- **Platforms:** The application has a native shells on iOS and Android, but can be accessed through the browser on any smartphone.

This application is more or less a website with a native shell, where almost all of the content is retrieved and displayed in web views. However, much of the navigation has a native implementation. The main income of the application was generated by selling advertisement areas inside the application. In order to have accurate pricing for the different areas they need statistics showing how much traffic each area is exposed to. This makes tracking the usage of the application close to a core value in the application.

3.6.2 Interview 2

The interviewee

- **Years of experience:** 8
- **Techniques:** Web development
- **Education:** Master of computer science

The application

This interview regarded the same application as in interview 1.

3.6.3 Interview 3

The interviewee

- **Years of experience:** 8
- **Techniques:** Web development (.Net) and about three years of iOS development experience
- **Education:** Bachelor of computer science

The application

- **Implementation:** Native
- **Application type:** Ordering taxi rides
- **Revenue:** The application owners are the taxi companies, therefore they make money each time an order is made.

- **Number of developers:** Two to three at a time.
- **Development time:** Two years and still ongoing
- **Platforms:** iOS, Android, Windows Phone, Windows 8, iPad

3.6.4 Interview 4

The interviewee

- **Years of experience:** 10
- **Techniques:** Backend web development. During the last two to three years: full time mobile application development, where 60% was iOS- and 40% Android development.
- **Education:** Master of computer science

The application

In this interview the application discussed in interview 3 was discussed briefly, though the interview as a whole was not about one specific application.

3.6.5 Interview 5

The interviewee

- **Years of experience:** 16
- **Techniques:** Mainly web development, but the last couple of years mainly mobile application development, both on iOS and Android.
- **Education:** Bachelor of literature studies

The application

- **Implementation:** Native
- **Application type:** Video streaming
- **Revenue:** Advertisement and a purchasable premium service
- **Number of developers:** Five application developers with additional support of user experience experts and such.
- **Development time:** The application has been under development for three to four years and there is no set end date.
- **Platforms:** iOS and Android

3.6.6 Interview 6

The interviewee

- **Years of experience:** 2.5
- **Techniques:** Web and Android development
- **Education:** Master of computer science

Chapter 4

Result

4.1 The Interviews

The interviewees were asked several questions in order to examine their collective width of competences, experience and education.

- Their professional work experience varied between 2.5 and 16 years, with the average experience being 9.7 years.
- Four out of six developers had a background in working with web development and had worked with mobile applications during the last couple of years. The other two had experience in working with either web or iOS development.
- All of the interviewees had some form of higher education, three were graduated masters of science in engineering, one had a bachelor in literature studies, one had a bachelor in computer science, and one did not finish the final thesis of a master of science program.

The purpose of this thesis is to illustrate how the web industry works with data and data driven concepts and how this information can be applied when working with mobile applications. According to this, the optimal interviewee would be one who has experience in working with both the web and mobile applications.

The majority of the developers have experience in working with both web technology and mobile applications. Therefore their opinions regarding being data driven in mobile applications are very relevant. The two developers who had exclusive experience in working with the web or native applications are interesting due to the fact that they worked in the same team developing a hybrid mobile application. The web developer worked in close conjunction with the iOS developer in order to enable data tracking in the application.

The questions

In this section the answers will be presented. See section: 3.5.3 for a full listing of the questions. Since the interviews were held in such a free way many of the discussions were general throughout the entire interview. That leads to many of the interesting points made being hard to separate into being answers to a specific question, therefore there is some overlapping between the questions.

In interview 1 and 2 the same application was discussed, therefore they will be used collaboratively in order to describe 'the news application' throughout this section. The application mentioned in interview 5 will be called 'the streaming application' and the one mentioned in interview 3 will be called 'the taxi application'.

Question 1 - Have you worked with any analytic tools, such as Flurry or Google Analytics on mobile applications?

All of the interviewees had experience in working with analytic tools on mobile devices. Some had experience in working with them on the web as well. In interview 1, 2 and 5 the interviewees explained the need for working with several different tracking tools in the same application.

Question 2 - How useful does the data gathered while tracking mobile applications seem to be?

A consensus throughout the interviews was that the data can be very useful. Interviewee 6 mentioned that tracked data is not always usable though. It depends a lot on the developers and their grasp of the application's business value, since the developers are ultimately the ones who decide what to track during the implementation. Interviewee 5 stated that much of the tracked data was hard to use in its base format. Therefore it usually ended up as the developers responsibility to make the data readable.

A basic problem that was mentioned in several interviews was the goal of tracking. In the absence of a clear goal to track, the tracking easily generates a large quantity of jumbled data, in which it is very hard to find valuable insights.

Question 3 - To what extent is that data actually used?

The answers to this question were very segmented, the most interesting comments regarded specific applications. Therefore the news application, the streaming application and the taxi application will be discussed separately, followed by a general discussion.

The news application Data tracking is very important in the news application. Several different tracking tools are used and all of them are special in different ways.

They use a tool called Linkpulse to do live tracking in the application. This allows the editorial staff to see which articles get the most attention in real time, thus giving them the possibility to, also in real time, update the content of the application to suit the user's interests. SiteCatalyst is used in order to acquire data on which to base advertisement pricing. Most of the pricing is based on page views. Flurry is also implemented in the application. Flurry is mainly used by the developers. Since it is easy to implement, it enables the developers to add tracking they find interesting or necessary for continued development without adding any significant development time.

Interviewee 2 mentioned a couple of specific ways in which analytic tools were used to design and improve the application. Heat mapping was used on the original website that the application is based on. The Heat Mapping was done in order to decide what functionality was to be transferred from the website to the application. Device and OS information was also tracked in order to decide which devices to support and which devices to ignore due to lack of users.

Interviewee 1 said that there is a large amount of tracking data, but they need to start using it during the continuous development. Today it is mostly used during the design phases of new features, but there is hardly any followup to verify the decisions with statistics, which according to the interviewee would be a very valuable way to use the data.

The streaming application In the streaming application interviewee 5 mentioned several different ways in which the data was used. Just as in the news application, an important use was to set advertisement pricing. But in the streaming application there are several new aspects of usage that are interesting:

- They track how many people finish watching certain streams and try to see if there is a strong connection with the amount of commercials shown.
- They track data in order to see that the video quality is sufficient.
- They track what type of internet connections the users have. One example of the use of that data is that if everyone would use a 3g connection, very data intensive functionality (such as full HD streams) would be unnecessary due to the user's lack of bandwidth.
- They track waiting times caused by slow buffering in order to optimize the user experience.

The taxi application In this application the revenue is generated when the user books a taxi ride. The tracking data has been used to find where the users end up exiting the booking process. After analyzing the data they found that their pricing model for the taxi rides could be a big part of why the users do not

always complete the booking. The pricing model was therefore updated from being only fixed price to also include taximeter as an option.

Summary The two applications that can be considered media applications (the news and streaming applications) place large value in tracking data that can be used to argue the pricing of advertisements. They also do extensive general tracking, which in the streaming application is used to a large extent in order to improve the application's streaming performance. In the news application there is also some data based decisions being made, not as much as in the streaming application though. In the taxi application there is also some tracking enabled. That tracking data has been used to analyze and improve the conversion rate in the application.

Question 4 - How advanced is it to implement the analytic tool/tools?

All of the interviewees, except for the ones involved in the news application, said that the implementation of the tracking was very simple. Where it gets complicated is in hybrid applications. In the news application, the tracking implementation was non-trivial. Interviewee 1, the one who implemented the native part of the application, described the native implementation. The application does all of it's logging on the web part of the application. So in order to enable the native part to log events via the web logging, which was Google Analytics and SiteCatalyst, a bridging event handler had to be built. In short the implementation was more complex than a regular native tracking implementation, but still not very complicated. Interviewee 2, who focused on the web part of the application, also mentioned that there was some trouble with how to count page views on hybrid applications. It is not quite the same as on the web. The typical way on the web is to log a page view each time a page is loaded. But since some navigation in the application is native there is not always a new page load where a web application would have had one, which leads to some page views not being tracked with the standard implementation. That causes a relevant problem since the application bases its advertisement pricing on page views.

Question 5 - To what extent have you been working with A/B testing or similar tests?

None of the interviewees had experience of working with A/B testing on live mobile applications. Interviewee 1 mentioned that testing was used during the start up of projects, but not with any special testing tools but rather with several different wire frame prototypes of the application.

One interesting thought that was brought up in interview 3 was that since mobile applications are downloaded it might be confusing if it started changing behavior due to tests. It takes more commitment for a user to download an application than entering a website. That leads to websites having a bigger

amount of casual visitors. Therefore it might not be as acceptable if the content were to change in a mobile application as on a website. In most applications there is a clear goal for conversion and if that flow is changed it would be very obvious for returning users. In the same interview it was said that testing could be useful for small changes, like promotion texts and upsals in the application. This mainly depends on it not changing the core functionality of the application. Interviewee 5 mentioned that iOS 7 will include automatic application updates, which might lead to an increased tolerance of content changing within iOS applications at least. Interviewee 5 also mentioned that one reason that testing has not been implemented traditionally in iOS applications is the fear of getting rejected by the App Store.

Question 6 - Do you believe that working with a data driven approach is something to strive towards when developing mobile applications?

The consensus was that it is generally a good idea to try to be more data driven. It all depends on the scope of the application in question, as well as the maturity of both the developers and product owners.

Interviewee 4 believes that revenue generated by advertisement in mobile applications will out-grow the web sometime in the near future. That in turn will lead to application developers spending more time on tracking data, since the data is needed to base advertisement prices on. When there is more thought put into what data to track, the possibilities for working in a data driven manner will also increase.

One reason that the data driven concepts are not used as much in mobile application development as in web development was mentioned by several interviewees. They said that it was the state of the industry. The mobile application industry is still very immature. According to interviewee 1 and 6 there is much left to learn from the web industry. Interviewee 1 said that the UI is more important in mobile applications, since it is more permanent than on the web. A problem related to this was mentioned in interview 5, where the interviewee said that the release time inferred by Apples App Store greatly limits the possibilities of working in a data driven manner since it makes testing and updating the applications much more time consuming than doing the same on the web. Another thing mentioned in both interview 1 and 6 was the way a mobile application is often considered to be finished once it has been released. This is a clear indication of how immature the mobile application business is.

Another potential problem with applying data driven development on mobile application development is that many applications are small, with only one or two developers, spanning only a few months. That means that the analysis of tracked data would become a significant part of the project funding, which might not be worth it in a simple application. In larger, more complicated applications, it might still be a good idea to try the data driven approach. It

is however very important to take into consideration what kind of application is being developed. In some applications the time spent on tracking and analyzing data might easily cost more than it could possibly generate in the end. Another problem mentioned in several interviews was the lack of experienced native application developers. This means that the trade off between adding new functionality and implementing tracking on mobile applications might be considered less favorable than on websites.

Chapter 5

Analysis

In this chapter the outcome of the interviews combined with the information presented in the background chapter will be discussed in order to explain the situation concerning the goals stated in the introduction.

5.1 Working with analytic tools

In this section the different aspects regarding working with analytic tools on mobile applications will be discussed.

5.1.1 Skill sets needed

There are several different kinds of skill sets involved in using analytic tools efficiently. They are largely dependent on what kind of application is being implemented. One fact that often seems to be a problem is the lack of experienced application developers. This in turn means that the implementation of analytic tools might be considered more expensive on mobile applications than on the web, since there are more developers available on the web platform.

Native and Web applications

To actually implement the tracking code, rudimentary programming skills are needed. In the case of implementing the most basic tracking setup on a web application with Google Analytics, the developer needs to have access to the source code and have a basic understanding of the structure of the website and javascript. If more advanced tracking is desired, more advanced skills in javascript are required since tracking additional events requires custom javascript implementations. The same goes for implementing tracking on mobile devices. The developer needs access to the source code, to have a basic understanding of the relevant platform and also know the application's structure.

Hybrid applications

On hybrid applications the implementation gets trickier. In the news application discussed during two of the interviews the solution mentioned was, compared to the native implementation, non-trivial. They implemented all of the official tracking in the web part of the hybrid application. The main reason for this was that they had a web implementation of the news site already. In the literature found during the research for this thesis, implementing all of the tracking in the native part of the application seemed to be more popular. It is very hard to say which one is better, since every application has its own context. In the news application it was probably a good idea to keep the tracking in the web part. One reason is that they already had the web competence in-house, since they already had a website. That meant that they could keep their tracking within the mobile application consistent with the original website, thus giving a better overview of the data.

Analysis

Once the tracking code has been implemented, the tracking data can be viewed on a website hosted by the analytic tools manufacturer. There it is up to the analyst to make sense of the data and decide what to do with it. There is no explicit need for the analyst to know specific programming languages, or to be able to write code. What is needed is instead an understanding of how users act in certain situations and how specific user patterns or modifications could help improve the application. It is also important to note that in order for there to be data, the application or website needs to be live, leading to the analysis not being able to start until a while after the release of the product.

5.2 Agility

There are a couple of things that make an agile organization well suited to work with a data driven approach. Agility in itself implies flexibility, which is a must in a data driven organization. In order to use the data as a foundation upon which decisions are made it is important to be able to make continuous changes to the plan according to what the analysts can glean from the data.

In section: 2.3.1 SCRUM is described as it is used in theory. It is important to note that in practice the teams often change the process to suit their specific situation. To work by a strict methodology is by definition not an agile way to work.

5.3 Testing

The only real way to see that a change in an application leads to something valuable, for example increased sales or increased user engagement, is to measure

the usage before and after the change. When working with analytics, the goal is often to find the point where a certain user task is canceled. By identifying a location where the user's exit rate is high, it is also possible to measure the success of trying to improve this location.

On native mobile applications there has been trouble with how to implement testing. The problem is that it is difficult to update the content of the applications without uploading a new version to the respective application markets. That means that there was no simple way to implement the testing in live applications. During the interviews the fear of getting rejected when trying to release an application that had changeable content on Apple's App Store was mentioned. There are however several A/B testing frameworks emerging right now. With the new support of testing it is possible that the use of testing increases. This has several explanations. When there are actual frameworks whose entire purpose is to enable testing, the fear of rejection should decrease, as long as the testing frameworks are accepted by the different application markets.

5.4 To be data driven

5.4.1 Organization

Working with a data driven approach does not suit every organization. There are several factors that are important to observe before making the decision to start working with data in such an extensive way.

- You need to have the skills necessary to implement the tracking code on your applications, as well as someone to analyze the generated data in order to recommend improvements.
- You need to have both the time and the money to afford spending time analyzing your tracked data.
- You need to have applications that are suited for working with data. It is seldom worth it to implement tracking code and analyzing the data if there is no plan for further development of the application.

In order to make the data really useful it is key to have a plan for what to track. If there is a clear goal in terms of what it is that generates value in the application, it is easy to translate that goal into a tracking goal as well. If you manage to track data that shows how your goal is or is not accomplished in the application, you have a solid foundation on which to base your future development decisions.

In many organizations it is not an option to develop for only one platform. In the cases where native implementations are necessary on several different platforms, the tracking implementations become more expensive since there are separate tracking SDKs for the different platforms. By creating a hybrid- or web application instead, the tracking could be implemented on the web part of

the application, making one tracking implementation work for all the different platforms.

The possibilities available concerning testing is dependent on which implementation the application uses. With native applications they are more limited than on web applications, while hybrid applications can use testing techniques from both web and native applications at the cost of a more complicated implementation.

5.4.2 The implementations

Native applications

Working with Analytics Implementing one of the standard analytics, for example Google Analytics or Flurry, in a native application is not very complicated. What could lead to problems is the inexperience of the developers in knowing which goals to track and optimize towards. Another problem could be that there are rather few native developers, at least compared to web developers. This in turn might lead to the trade off between implementing new functionality versus working with data which might be considered too expensive.

Working with Testing Working with testing and optimization on native applications can be troublesome. The fact that none of the people interviewed had experience in working with the simplest way of testing (A/B testing) says something about the state of the industry. The fact that there are promising testing frameworks appearing seems to indicate the rising interest of testing though. One big problem, at least on Apple's App Store, is the fact that the review process can take a long time, thus limiting the possibility of releasing new versions of the applications as rapidly as might be needed when working with certain kinds of tests.

Web applications

Working with Analytics In web applications, working with analytics is rather straightforward. A competent web developer is needed in order to implement the analytics.

Working with Testing To work with testing on a web application is very similar to working with it on a regular website. Due to the fact that the application is implemented on the web, there are no imposed limitations concerning releasing new versions as compared to native applications.

Hybrid applications

Working with Analytics Implementing analytics in hybrid applications is more complicated than in both web and native applications. Implementing

native tracking for the native part and web tracking for the web part of the application generates incoherent data. Depending on the application and available skills among the developers, it is necessary to choose one implementation, either native or web. In order for this to work, the tracking implementation needs to be able to track data from both the web and native part of the application. This requires some customization, which is where it gets a little more complicated. If the tracking is implemented in the native part of the application, it can be done by capturing javascript events created in the web views and repackaging it in a native context. If the tracking is implemented in the web part there needs to be some kind of event handler that translates the native tracking events to the web tracking context.

Working with Testing Working with testing on hybrid applications can be very complicated depending on the type of tests being carried out. Simple A/B testing should be rather simple to implement, since it is either in the web or the native part of the application, not both. If Multivariate testing that contains elements of both the native and web part of the application is to be implemented, it would take a considerable amount of customization in order to make it work. None of the interviewees even mentioned this problem, but that is probably because of their lack of experience in working with testing on mobile devices. If complicated applications, such as the news application mentioned in interview 1 and 2, were to be tested using Multivariate testing it would undoubtedly require a lot of development on both the native and web part of the application.

5.4.3 The application types

There are two ways of making money on mobile applications that have appeared during the interviews. The suitability of these two for data driven design will be discussed in the following paragraphs.

Advertisement

In the media applications mentioned in the interviews (the news and streaming applications), the revenue generated by the application was based on the user data. The fact that the price of advertising is based on page views and similar metrics means that data is very important. This makes working with data a must for this type of application. When there is such a big focus on the data, the step to working with a data driven development approach is close. You already know what to optimize towards and you have a lot of data showing the current situation and surrounding circumstances. This gives an excellent base on which to start testing the interface in order to see how it could be improved and made to generate more revenue.

In short you could say that large and complicated application with dynamic content that make money on selling advertisements are very well suited for data driven development.

In app purchases

Applications that contain in app purchases have a very clear goal to measure towards. This is one of the first things needed in order to start using the data driven concepts. As long as the development is ongoing, it is reasonably straight forward to start the tracking in order to find out what areas could be improved upon in order to increase sales.

Data driven design for the different revenue models

In order for data driven development to be useful it needs to be an ongoing process. In order to make use of the data it is necessary to analyze it continuously and keep experimenting in order to improve the relevant metrics. Therefore, it is reasonable to say that data driven development is better suited for large applications that are developed during a longer period of time, independent of the type of revenue model used.

Chapter 6

Discussion

In this chapter the strong and weak points of the planning and execution of the thesis will be presented and discussed.

6.1 The literature study

The literature study gave the background information necessary to be able to perform the interviews. Without the information gathered during the literature study, the discussions that ensued during the interviews would not have been anywhere near as constructive. Since the interviews were held in a semi structured way it was important to have a broad understanding of the concepts surrounding being data driven, working with analytics and with testing. That way, relevant follow-up questions could be asked and the discussions could be steered towards the interesting subjects.

6.2 The interviews

The choice to perform interviews was really rewarding. They were performed after the background part of the thesis was almost completed, which was really good timing. It meant having the time to learn which questions to ask, while still being early enough in the process to look for more material concerning interesting points made during the interviews. A bit more effort could have been put into preparing questions for the first interview though, as it ended up having to be redone.

6.3 The lack of actual implementation

Implementing tracking or analyzing the data generated was not a part of this thesis. This is something that could be useful in a scope larger than the 20 weeks this thesis took to complete. But that time interval is too small for there

to be enough time to implement the tracking, get the data and analyze it in order to continue the development. Performing a part of this might be interesting in itself. But the choice was made to keep the scope wide enough to cover all of the different aspects of being data driven, without focusing on one in particular. This has led to this thesis giving a general overview of what is needed and what can be gained from data driven development.

If any parts were to receive extra attention by implementation, the two most interesting ones would be testing or tracking in a hybrid application. The testing would be an interesting prospect since none of the interviewees had experience in the matter. Implementing the tracking in a hybrid application would be interesting since it still is not very standardized. In order to be able to implement any of this, there would have to be an application ready for use though. It would not be reasonable to develop the application and implement the testing or tracking in this kind of thesis due to the time constraints.

Chapter 7

Conclusions

In the introduction, a number of goals were listed. These goals have been examined throughout the report and in this chapter a short summary of the results are presented.

7.1 Digital Analytics

7.1.1 Analytics on the web and Available tools

Analytic tools are used extensively on the web in order to improve the websites in several aspects. The data generated from the tracking gives insights into how the end users actually use the website in question, which gives the opportunity to improve the user experience as well as conversion rates.

The most widely used analytic tool on the web is Google Analytics. There are however several other tracking tools used in different scenarios. Linkpulse is used on news sites in order to update the content in real time and SiteCatalyst is used to gather official data on which to base the pricing of advertisement.

7.1.2 Analytics in mobile applications and Available tools

Analytics is used to achieve the same goals on mobile applications as on the web, but to a smaller extent. Due to the fact that mobile application projects often are shorter and involve less functionality than websites, as well as due to the relative youth of the application development industry, the true value of using analytics to further the development has yet to be realized.

The most commonly used tool in native applications is Flurry. It is simple to implement and gives the functionality needed to track data in standard native applications. In web applications it is possible to use the standard web analytics implementation. In hybrid applications it is possible to use native as well as the web implementation. The best way to implement tracking in

hybrids is to choose either a native or a hybrid implementation and create a custom tracking handler that enables all of the tracking to be performed either on the native or the web part of the application, this in order to keep the data coherent.

7.1.3 Problems and possibilities with the different mobile implementation

Native applications

The skills needed to implement analytics on native applications are rather specific compared to those needed on the web. That in turn leads to the fact that there are fewer experienced native application developers than web developers.

Working with testing on native applications is not something that is done frequently today. One major reason is the state of the industry. There are no truly established (but several emerging) testing frameworks which allow testing to be performed in a satisfactory way. There are also limitations inferred by the application markets, especially Apple's App Store where from submitting the application it can take several days until the application is released on the application market. This adds a constraint on working with the quick releases associated with data driven development and testing.

Web applications

Developing web applications requires web programming skills. There are more skilled web developers than native developers. This leads to web applications being a good way to handle multiple platforms, since it is not necessary to find a native developer for each platform that is to be supported. Since web applications are not distributed via the application markets but through the web, there are no review times and delays on releases. This gives the possibility to deploy new versions of the application with no externally enforced delays.

Working with testing on mobile web applications is similar to how it is done on the web. The same concepts can be applied and there are established processes for how to work.

Hybrid applications

In hybrid applications there is a choice of implementing the analytics on either the native part, the web part, or both parts of the application. Implementing it only on the web or on the native part is recommended since implementing it on both would lead to segmented and incoherent data. It is possible to build custom tracking handlers that can forward tracking data from one part of the application to the other, thus allowing complete tracking of the application. The choice of implementation gives the developers the possibility to choose what is best suited for them, depending on the type of application and available skills.

Hybrid applications are released on the application markets in the same way as native applications, therefore the same limitations related to the application markets are present as mentioned in section (7.1.3 - Native applications).

Working with testing on hybrid applications is, just as in native applications, not done to as big an extent as on the web. In hybrid applications it is possible to use both web and native technologies to test. This gives the developers the flexibility to choose which of the technologies suits them better. At the same time, it adds the problem of how to test both simultaneously without getting incoherent test data.

7.2 Summary

All in all there are many problems working with a data driven approach on mobile applications. Despite this, all of the people that were interviewed in this thesis said that being data driven was very valuable and would have to be a part of the future of mobile application development. The value generated by being data driven when working with websites has been shown in many cases. That, combined with the emerging native testing frameworks and the aging of the mobile application industry, points towards a near future in which working with a data driven approach on mobile applications is as clear a choice as doing so on the web.

References

- [1] Avinash Kaushik. *Excellent Analytics Tip 5: Conversion Rate Basics and Best Practices*. URL: <http://www.kaushik.net/avinash/excellent-analytics-tip5-conversion-rate-basics-best-practices/>.
- [2] Flurry. URL: <http://www.flurry.com/flurry-analytics.html>.
- [3] Google. *Google Analytics - Features*. 2013. URL: https://www.google.com/intl/en_uk/analytics/features/index.html.
- [4] Bertrand Bathelot. *What is Heatmap definition?* URL: <http://digitalmarketing-glossary.com/What-is-Heatmap-definition>.
- [5] Doug Seven. *What is a Hybrid Mobile App?* 2012. URL: <http://www.icenium.com/community/blog/icenium-team-blog/2012/06/14/what-is-a-hybrid-mobile-app->.
- [6] Cory Janssen. *Integrated Development Environment (IDE)*. URL: <http://www.techopedia.com/definition/26860/integrated-development-environment-ide>.
- [7] Avinash Kaushik. *Web Analytics 2.0*. 2010.
- [8] *Linkpulse*. URL: <http://www.linkpulse.com/product/>.
- [9] Alistair Croll and Benjamin Yoskovitz. *Lean Ananlytics*. 2013.
- [10] Cory Janssen. *Mobile Application (Mobile App)*. URL: <http://www.techopedia.com/definition/2953/mobile-application-mobile-app>.
- [11] Sue Smith. *Native App or Mobile Web App?* 2012. URL: <http://www.techopedia.com/2/28134/development/web-development/native-app-or-mobile-web-app>.
- [12] Cory Janssen. *Native Mobile App*. 2012. URL: <http://www.techopedia.com/definition/27568/native-mobile-app>.
- [13] Mountain Goat. *An Overview of Scrum for Agile Software Development*. 2005. URL: <http://www.mountaingoatsoftware.com/scrum/overview>.
- [14] *SiteCatalyst*. URL: <http://www.adobe.com/solutions/digital-analytics/marketing-reports-analytics.html?promoid=KFGCH>.
- [15] TechTerms. *SDK*. 2010. URL: <http://www.techterms.com/definition/sdk>.

- [16] *PhoneGap*. URL: <http://phonegap.com/about/>.
- [17] Caroline Watts. *From Analytics to Action Part I: Building a Data-Driven Organization*. 2012. URL: <http://retargeter.com/strategy-2/data-driven-organizations>.
- [18] Eric T. Peterson. *The Myth of the "Data-Driven" business*. 2011. URL: <http://blog.webanalyticsdemystified.com/weblog/2011/09/the-myth-of-the-data-driven-business.html>.
- [19] Brent Dykes. *Reporting vs Analysis: Whats the Difference?* 2010. URL: <http://blogs.adobe.com/digitalmarketing/analytics/reporting-vs-analysis-whats-the-difference/>.
- [20] Kent Beck et al. *Manifesto for Agile Software Development*. 2001. URL: <http://agilemanifesto.org/>.
- [21] Mikael Lindvall David Cohen and Patricia Costa. *Agile Software Development*. Report. Fraunhofer Center Maryland, 2003.
- [22] Roger Pressman. *Agile development*. 2009. URL: http://academic.brooklyn.cuny.edu/cis/sfleisher/Chapter_03_sim.pdf/.
- [23] Norman S. Janoff Linda Rising. *The Scrum Software Development Process for Small Teams*. 2000.
- [24] Camuel Gilyadov. *Mobile Application (Mobile App)*. URL: <http://bigdatacraft.com/archives/62>.
- [25] Jason Burby Guy Creese. *Web Analytics Key Metrics and KPIs*. 2005.
- [26] Dan Sommerfield Ron Kohavi Randal M. Henne. "Practical Guide to Controlled Experiments on the Web: Listen to Your Customers not to the HiPPO". In: *KDD '07 Proceedings of the 13th ACM SIGKDD international conference on Knowledge discovery and data mining* (2007).
- [27] Shiny Development. *Average App Store Review Times*. 2013. URL: <http://reviewtimes.shinydevelopment.com/>.
- [28] Arise. *Arise.io website*. 2013. URL: <http://arise.io/>.
- [29] W3techs. *Usage of traffic analysis tools for websites*. 2013. URL: http://w3techs.com/technologies/overview/traffic_analysis/all.
- [30] Google. *Screen Tracking - iOS SDK*. 2013. URL: <https://developers.google.com/analytics/devguides/collection/ios/v2/screens>.
- [31] Avinash Kaushik. *Seven Steps to Creating a Data Driven Decision Making Culture*. URL: <http://www.kaushik.net/avinash/excellent-analytics-tip-12-unsuspected-correlations-are-sweet/>.
- [32] Google. *Google Analytics*. 2013. URL: <https://support.google.com/analytics/#topic=1726910>.
- [33] Google. *Goal types*. 2013. URL: https://support.google.com/analytics/answer/3046660?hl=en-GB&ref_topic=1007030.

- [34] Websitebiz. *Google Analytics - Funnel*. 2013. URL: <http://www.websitebiz.com/wp-content/uploads/google-analytics-new21.gif>.
- [35] Google. *Tracking Code Overview*. 2012. URL: <https://developers.google.com/analytics/resources/concepts/gaConceptsTrackingOverview?hl=sv>.
- [36] Google. *Google Analytics SDK for iOS v2 (Beta) - Overview*. 2013. URL: <https://developers.google.com/analytics/devguides/collection/ios/v2/>.
- [37] Randy Dailey. *Implementing Localytics in Your Hybrid App*. 2013. URL: <http://www.localytics.com/blog/2013/implementing-localytics-in-your-hybrid-app/>.
- [38] Benjamin Diggles. *Hybrid Mobile App Measurement*. 2012. URL: <http://blogs.webtrends.com/2012/10/hybrid-mobile-app-measurement/>.
- [39] Eduardo. *Using google analytics with hybrid mobile app*. 2013. URL: <http://stackoverflow.com/questions/15324538/using-google-analytics-with-hybrid-mobile-app/>.
- [40] Google. *Google Scholar*. 2013. URL: <http://scholar.google.se/>.
- [41] Techopedia. *Techopedia*. 2013. URL: www.techopedia.com.
- [42] StackOverflow. *StackOverflow*. 2013. URL: www.stackoverflow.com.