Android Mobile Devices in Everyday Practice

Abstract

The proposed project reported in this paper will aim to investigate users Android devices and their impact on energy consumption and data connectivity draw. This is important in determining how the use of Android smart phones and tablets are contributing to rising overall demand for energy.

The first stage of the project will involve creating and installing a logger application onto 10 participant's Android devices. This logger will collect data such as the apps that are loaded and the device battery level. Information collected in the log files will then be discussed within semi-structured interviews with the participants and analysed for the final paper. Results from the project are expected to show that there is a correlation between Android device usage, and energy and data connectivity demand; and more importantly to characterise relations between specific practices incorporating Android devices, at high or low levels of demand.

1. Introduction

Mobile devices are becoming increasingly used and relied upon in everyday life, whether it is at work or at home. This is particularly the case with Android, where in 2013 their global market share increased to 79.3% in the second quarter from 69.1% the previous year [1], and where Android device sales are predicted to hit one billion in 2014 [2].

Energy use in the UK is also increasing. There has been an 18% rise in UK homes domestic energy consumption in 40 years, particularly with lighting and appliances which has more than doubled since 1970 [3]. The average household number of consumer electronics has actually raised by 11 times from the 1970's to 2009, causing electricity consumption to grow from 3.2TWh to 20.8TWh, an increase of over 600% [4]. Furthermore, recent DECC (Department of Energy and Climate Change) reports show that the rise of appliances energy consumption is similar to the increase in household energy consumption, where household appliances such as chargers use nearly 12% of total energy compared to the 5% in 1970 [5].

The proposed system will aim to investigate the impact of Android devices in terms of energy demand and data connectivity draw within everyday life, and therefore inspect whether the increase of mobile device use contributes to energy demand in the home and beyond the home. This will be carried out by implementing a logger application and installing it on a sample of participants' Android devices. The logger will be used to store quantitative data, such as the active applications, and will be explored in depth by interviews as a form of qualitative evaluation. The information gained both from the logger and the interviews will enable the data connectivity and energy demands to be analysed, both between users and device types; for whether mobile devices help or hinder our everyday life activities to be discussed; and allow for comparisons to be made with previous studies of the demand associated with iOS devices [6].

This project proposal will be split into the following sections; background, the proposed project; the programme of work; the resources required; and references. The background will contain a

description about the related projects and existing systems involved in monitoring and analysing user behaviour towards devices and the energy consumption of technology. The proposed project will contain the project's overall aim and its main objectives, along with the methodology approach taken for data retrieval and evaluation. The programme of work will describe the project plan, breaking down the schedule of tasks for the year with the use of a Gantt chart. The resources required section will detail the resources needed within the project and the references section will contain references to any resources and papers used within this proposal.

2. Background

Previous projects relating to the proposed project include a study on the energy impacts of ICT [7]. The paper reports on how the use of ICT in everyday life impacts the use of energy, based on information gained by applying a theoretical framework on everyday activities and energy demands. It was argued that a change in the activities using ICT may change energy consumption; however no direct correlation between ICT in everyday use and an increase in energy consumption was found, and that ICT may even have the ability to reduce it.

However, this paper focused on ICT as a whole, and so conclusively the results are rather general in terms of technology and energy. Finding out the data connectivity and energy use for Android devices specifically has not been yet analysed. Therefore, it would be interesting to find out whether Android devices particularly are a cause for energy consumption within the proposed project.

Furthermore, the application Carat [8] also relates to this proposed project. The project involved making Android device users more aware of their battery power using an application named Carat, and researched into how Carat changed their behaviour by analysing interaction logs. Results gained from the project involved Carat users saving more battery, charging their devices less often and learning to manage their battery life without Carat.

This project showed how a change in a user's behaviour towards the use of their device can reduce the amount of times a user has to charge it, and therefore reducing the energy needed to support the device through everyday life. The proposed project will also be involved within user behaviour, but in terms of analysing it by examining the applications they use within their day-to-day activities to investigate their energy and data connectivity demands, rather than changing their behaviour to reduce these demands. However, the Carat application may useful to use as a reference tool for the Android device logger if similar information is logged.

Another paper involved investigating the use of technology in homes due to the increasing use of mobile devices such as tablets and smart phones [9]. To gain the research data, a logger was used within each household to store home occupants' most common internet activities, where the data was then analysed more in depth by semi-structured interviews with the users in order to find out their device preferences and what they use each device specifically for.

However, this project focused on computing and mobile devices used at different times and places only within the home rather than computing through mobile devices in everyday life. Therefore, it would be interesting to find out within the proposed project how the location of the user affects their mobile device usage, and whether certain areas, or times, lead to an increase in the device energy consumption and data connectivity demand.

Similarly to the proposed project, an application developed by the University of Cambridge called Device Analyzer [10] has been created to gather statistics and information about an Android device's usage. This application logs data such as when the device is turned off and on, what apps are used, the battery level, the times the device is charging, and the WIFI and Bluetooth devices nearby. Due to this application logging similar data to what this proposed project logger should, it may be able to be used within this project as the raw data collected is allowed to be accessed by the device user before then being shared online with the user's permission.

As a result, this proposed project would specifically investigate Android device users' behaviour in all aspects in everyday life, rather than ICT impacts on energy in general and users' behaviour only in the home as mentioned above. It will enable for information such as the applications they use, how often they charge their phone, and their data connectivity usage to be gained, allowing for an analysis of how this impacts data connectivity and energy use to be discussed.

3. The Proposed Project

3.1 Aims and Objectives

The aim of the project is to investigate the impact of Android devices in terms of mapping low and high intensity ways of using phones to energy demand and data connectivity draw within everyday life. In order to collect the data possible for the investigation, the following objectives will be involved;

- Creating an Android logger application – An Android application will need to be created to log the appropriate data for a user's device, so that the energy consumption and data connectivity usage values can be derived. The specific data to be logged is listed in section 3.2.
- Exploring the meanings, materials and competencies associated with Android devices – Once the data logger has collected the user's device usage information, a user-device study will be carried out in the form of semi-structured interviews to find out more about the way the user uses their device; to evaluate whether they find the device helps or hinders their everyday life activities; and to tease out information related to the user's device logger data.
- Analysis of the data for links between practice and demand – When both the log data and interview information is collected, the data will be analysed to find out whether there is a relation between Android device usage and energy and data connectivity draw. This will be discussed within the final paper.

3.2 Methodology

The software engineering approach used will be similar to the waterfall method with the use of a pilot study, due to the natural linear style of the project. How the project will be split up and carried out is described in the Programme of Work (section 4).

For the research, a sample of 10 participants using Android mobile devices, tablets or phones, within an age of new to 3 years old will be selected. Using 10 participants will allow for confident and reliable evaluation results to be concluded within the study, and using a relatively recent device model will ensure that most of the Android facilities will be able to be used for the logger. The user

must fill out the appropriate ethics forms, i.e. the participant information sheet and agreement forms so that they know the nature of the study and the types of data to be stored by the application. To make people aware of the study and therefore gain study participants, advertisements such as fliers will be dispersed within the Lancaster area.

Due to project aims and objectives, there will be two phases of the evaluation; the quantitative phase (the application), and the qualitative phase (the user study). The quantitative phase will involve the Android application logging the user's phone usage over a period of 2 weeks. The data to be logged will involve;

- The loaded applications, i.e. the applications the user has running in the background.
- The active application, i.e. the current application the user is using.
- The battery level.
- Whether WIFI or 3G is being used, and if WIFI then the name of the network.
- Whether the data connectivity type is upstream or downstream.
- Whether the screen is on or off.
- Whether the device is charging, and if either the mains or a USB port charger is being used.
- When the phone runs out of battery or is turned off.
- Other devices being used with the mobile, such as headphones.

To ensure that the application does not have any major bugs in the code, a pilot study will be carried out on a sample of 2 or 3 participants before the main study. This will ensure that any errors are found and fixed to reduce the chances of any serious errors occurring within the main study; to practice and hone the semi-structured interview; and to allow for initial analysis.

Furthermore, the application should not log any information that is sensitive to the user, such as internet URLs, and should not become a drain on the phone's battery or storage. Therefore, the application itself will only log the information bullet pointed above every minute, and will have a simple, titled interface, allowing the user to stop and remove the logger at any time if they wish to withdraw from the study. Mechanisms will also be put in place to ensure that the logger is resumed when the phone is turned on, and is not closed accidentally.

The qualitative phase will involve semi-structured interviews for each participant. These will take place after the log results have been obtained and studied to find any particularly interesting data which can be discussed with the user in the interview. Structured questions will be previously revised and asked for all interviewees allowing for a general discussion, however further questions may also be put within the study, drawing information from the appropriate log file and tailoring the interview towards the user. These interviews will take between 30 minutes to an hour to make sure enough time is available for the results discussion. The information gained from these interviews will then be merged with the quantitative data from the logger for each participant, allowing for a written analysis in the final project paper.

4. Programme of Work

The project will begin early October 2014, running until March 2015, and it will be broken up into the following stages;

- Analysis and Design – This will involve designing an application which meets the project aims. Advertisements will also be created and displayed in Lancaster to make potential participants aware of the project and gain users for the study. This will take around 1 week.
- Application Development and Testing – This will involve developing the application based on the design decided, and testing it to ensure that it meets it's required aims before installation for the pilot study. This stage will take 2-3 weeks.
- Pilot Study – A pilot study will be carried out to test the application and the study on 2 or 3 participants, allowing for any errors missed to be corrected and for early analysis to take place. This will take 2 weeks for the application to be installed, logging the device information, and a further 2 weeks for the interviews.
- Recruitment of Participants – Towards the end of the first term, the recruitment of participants for the study will take place, ensuring that they fill out the appropriate forms so that the study can begin at the start of the second term. This will take about 2 weeks.
- Application Changes and Mid-Year Write Up – During the Christmas break of 4 weeks, changes needed to be made to the application to fix any errors will be implemented and a write up of the pilot study will occur to analyse the data gathered early on.
- Main Study – This will be similar to the pilot study but carried out on all 10 participants. The application will be installed on the user's Android device for 2 weeks and then interviews will be carried out in the following 2 weeks.
- Data Analysis and Evaluation – Once the user studies have taken place, this stage of the project will be carried out to analyse the data gathered from the users in terms of energy demand and data connectivity draw. Further analysis with the iOS study data [6] and the write up of the whole data analysis will also take place. The analysed data will be evaluated to decide whether there is a correlation between Android devices and energy and data connectivity demands, and whether there is a difference between Android and iOS for these demands. This will take around 5-6 weeks.

The overall schedule for the project in 2014-2015 is displayed by a Gantt chart in Figure 1 on the following page.

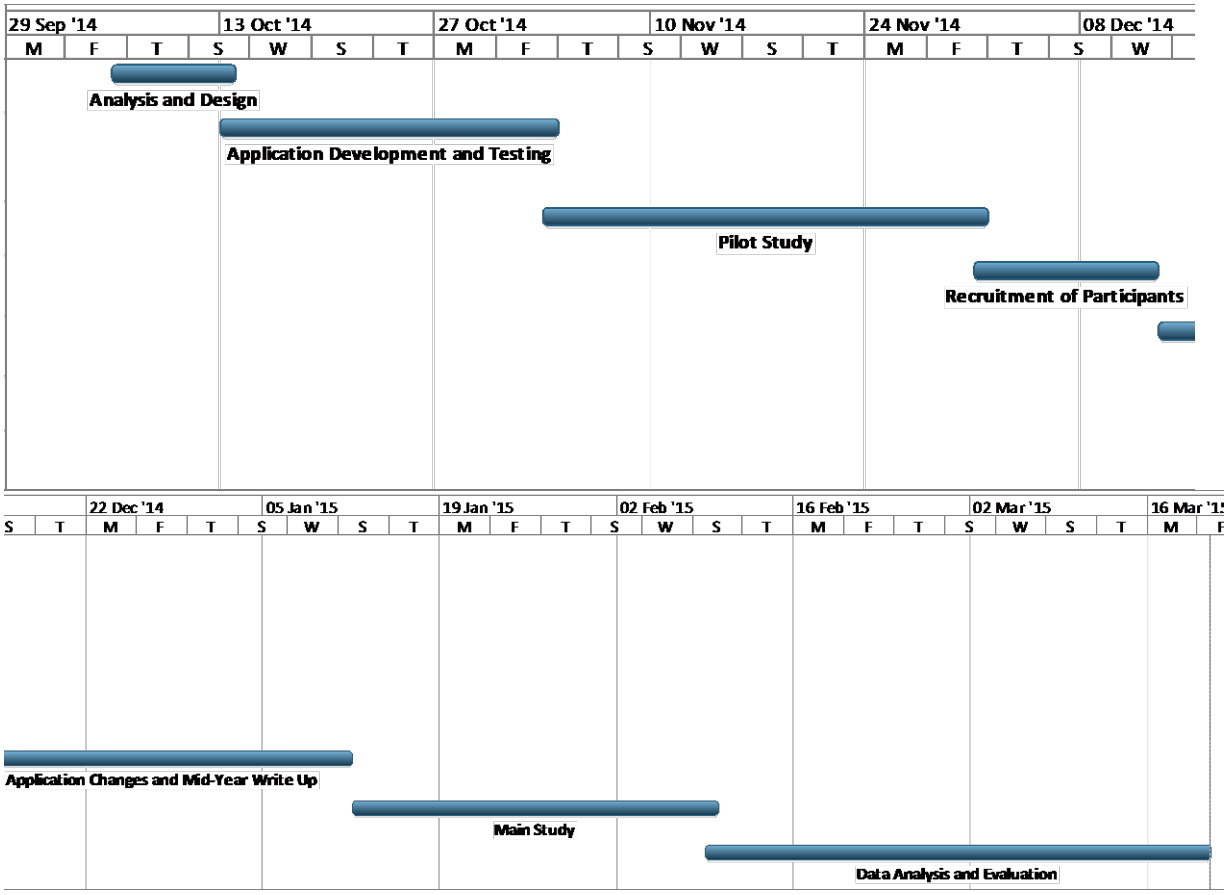

Figure 1: Project Schedule 2014-2015

5. Resources Required

Access to at least two different models of Android mobile devices will be required for the project so that the logger application can be tested on them during development. This unit testing will allow for any obvious errors to be found and corrected whilst the application is being coded. Furthermore, by having these devices it will allow for acceptance testing to be carried out to ensure the final version of the application is bug free before it is implemented in the pilot study. The use of at least two different models is required to ensure that the logger works on different types of Android devices and versions. These devices will be provided by Lancaster University.

6. References

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