Work Sampling Mobile Application

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Abstract — Work Sampling is a technique used to investigate the proportions of total times devoted to the various activities that constitute a job or work situation. This statistical analysis or technique constitutes a very important aspect to increase productivity in all tasks performed by the user. The results obtained in this analysis provide the same information as a time study, but faster and at less cost. These results allow quick analysis, recognition and enhancement of tasks and performance competencies. The validity of the study depends on the quantity of observations obtained and the period over which the random observations are taken. In order to make a Work Sampling study more efficient and easy to implement, a mobile application will be develop as a tool to help conduct the Work Sampling technique. The application will be develop using Objective-C programming language and will be release for iOS mobile devices. The software that will be used to develop the application is Xcode Apple's development environment. In order to use the application as an integrated tool for a Work Sampling study, it has to be able to generate random notifications in a given time interval, generate a new event for every time a study is performed, integrate a database to store the information retrieved in the study by the user and be able to export the events.

Key Terms — iOS, mobile application, random reminders, work sampling.

INTRODUCTION

Every day millions of people strive to provide a service or a product to their end users or customers. The productivity of this work depends on the time they consume performing their everyday tasks. In most cases, the work is distributed among numerous critical tasks, which become the heart of their work. These tasks must be performed every day by the user to complete their ultimate objective. The efficiency of the work performed can be translated to the summation of the efficiency of all tasks needed to perform the job.

One powerful method is Work Sampling. This method is conducted by taking a comparatively large number of observations at random time intervals. The ratio of observations approximates the percentage of time that the process is in that state of activity.

In the present there exist software that could be used as a complementary tool when performing this study. But most of these softwares are only for personal computers (PC) or personal digital assistant (PDA). PC's are not the most efficient tool to use in this study while still gathering information and PDA's are not very common these days. In the present, almost everyone owns a smart phone and carries it almost all the time. Therefore a Work Sampling Mobile Application has been implemented to help perform the work sampling study in a more simple and fluent way. This project aims to implement a mobile application that can work as a complementary tool in a work sampling study.

The mobile application has been developed using Objective-C programming language. This is a very powerful object oriented (OOP) language. All Apple computer and devices in the present are developed using Objective-C. This language was originally developed in the early 1980's and it was intended to be very similar to C, but with the upgrade of being object oriented.

In the present, iPhones are one of the most used smart phones in the United States of America.

The Apple App Store reported that 50 billion apps have been downloaded until May 2013. This positioned Apple App Store the number one app selling marketplace worldwide. Therefore, an application that's being sold on the Apple App Store have chances of reaching more people around the world. This is why the application developed for this project will be targeted for iDevices (iPhone 4S, 5, 5S, 5C and iPod Touch). The following charts show the Apple App Store overall downloads quantity for 2011 and the holiday overall applications sales for the holidays in 2013. In figure 2, there is a comparison between the two biggest application sellers operating system, Android OS and iOS. As we can see in figure 2, Apple applications sales dominated the market with a 23%, while Android sales were 4.6%.

Figure 1
Apple App Store Applications Download for 2011

Figure 2
Mobile Applications Holiday Sales

BACKGROUND

Work Sampling is a technique used to investigate the proportions of total times devoted to the various activities that constitute a job or work situation. This technique was developed by L. Tippet in England in 1927. Labor standards are set using output and percentage of time workers spend on tasks. It involves recording the activities workers perform at random times.

The Work Sampling method has several advantages. Some of these are that it does not require continuous observation by an analyst for long periods of time, clerical time is diminished, observers need little training, less intrusive, the total work hours expended by the analyst are usually fewer, the operator is not subjected to long period stopwatch observations, crew operations can be readily studied by a single analyst, worker has little chance to affect results, among others. Also, it has some disadvantages. Some of these are that does not divide work elements as completely as time study, can yield biased results if observer does not follow random pattern and less accurate than time study, especially when job elements times are short.

The Work Sampling theory is based on the fundamental law of probability: at a given instant, an event can be either present or absent. In other way, it is how likely an event is to occur. The statistic formula is as follow:

$$(p + q)^n = 1 \qquad\qquad (1)$$

where:

p = Probability of a single occurrence
q = (1 - p) = The probability of an absence of occurrence
n = Number of observations

This formula shows the probability of *x* occurrences on an event of *n* observations. The distribution of these probabilities is known as the binomial distribution. As *n* becomes large, the binomial distribution approaches the normal distribution. This is the main reason why Work
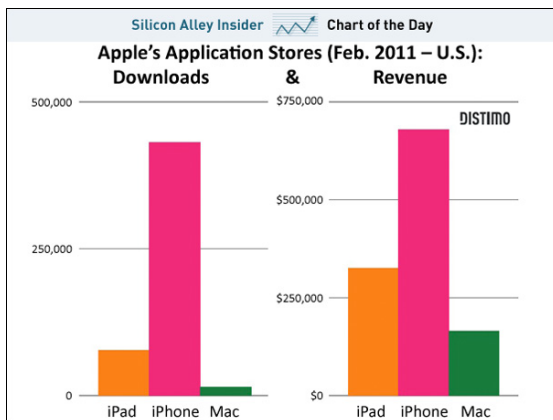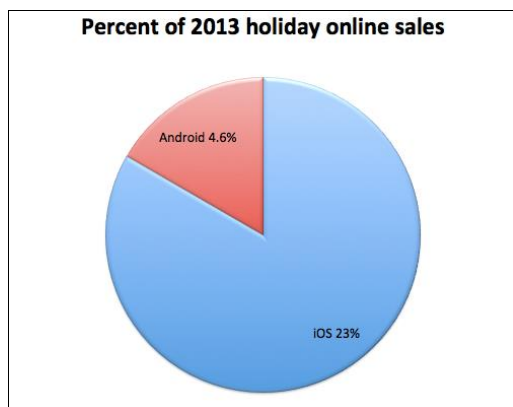
Sampling uses large sample sizes. Because the sample sizes are large, the normal distribution is a satisfactory approximation of the binomial distribution. Instead of using binomial distribution, is more convenient to use the distribution of proportion.

In Work Sampling studies, we take a sample of size *n* in an attempt to estimate *p*. This theory can be used to estimate the total sample size needed to achieve a certain degree of accuracy. The formula for the standard deviation (σ_p) of a sample proportion is as follows:

$$\sigma_P = (pq/n)^{1/2} = (p(1-p)/n)^{1/2} \tag{2}$$

where:

σ_p = *Standard deviation of a percentage*
p = True percentage occurrence of the element being sought, expressed as a decimal
n = Total number of random observations upon which p is based

The mobile application that will be used in this project has been developed using Objective-C programming language. It was originally developed in the early 1980's. This is the main language used by OS X and iOS. One difference of Objective-C in comparison to other object oriented programming languages (OOP) is that is based on message passing to object instances. While in other programming languages like C++ and C#, a method is called, in Objective-C a message is sent to be executed. This is a very powerful programming language and has a lot of advantages that helped in the development process.

PROBLEM

Administrators periodically take work samples of their own work to evaluate the effectiveness of their time usage. This is known as self-observation. Usually this self-observation is recorded in a worksheet design by user (refer to figure 3).

A very important aspect in Work Sampling is the random notifications generator. Usually a beeper like apparatus is used. This apparatus is configured to send notifications at random times. But there are no options to specify for the time interval or how many notifications will generate. Also, the notifications sometimes overlap or the time from one notification to another is relatively small. This interfere with the observations because if two notifications are received at the same time or very closed to one another, the task being performed at that moment will be "taking annotations" and not the tasks intended to measure.

In self-observation the user is evaluating itself, therefore he needs to have with him the random reminder generator (beeper), the worksheet where the tasks will be recorded (refer to figure 3) and also, need to perform his work as he usually does. It is very likely that his performance will be affected, since he have to accomplish all those additional tasks while doing his normal tasks. Filling the worksheet (in case of self-study, is the same worker) is time consuming, not very fluid and in most cases to analyze the information it must be entered into a computer software after the study is completed. The work environment must be little to nor affected by the study performed. In this case, the environment could be significantly affected by the study. The data collected will contain too many errors because it won't be representing the real performance. Therefore the data gathered in this study shouldn't be acceptable. To prevent this from happening, a tool that can help the user to perform as he usually does without interfering with his tasks significantly, must be incorporated into the study. In this situation, an excellent tool would be the application developed in this project.

Using a computer can save up to 35 percent of the total Work Sampling study cost, because the use of computer software reduces the high percentage of clerical effort relative to actual observation time. There are several Work Sampling software packages. Some of the most known are: WorkSamp and CAWS/E by C-Four Consulting. C-Four released a Palm PDA's version of CAWS/E. These tools could make a big difference in the study cost. But computers are not as easy to carry from one place to another as the PDA's, and PDA's are not a

very common technology in the present. Therefore, a combination of the PC's usability and PDA's portability would be the most efficient tool to incorporate to the study. That is the main reason this project aims to develop a mobile application for one of the most used smart phone in the United States of America, the iPhone.

The application developed in this project is specially designed for Work Sampling study. The Work Sampling Mobile Application has been developed to enhance the data recording and exporting process. This application is an excellent tool to use as a complement in a Work Sampling study to increase its efficiency. The application allows the user to configure the time interval for which he needs the application to generate the random notifications and select how many notifications he wants to receive within the time interval. All the information entered by the user is saved in the application database. Also, the application contains an advanced random notifications generator algorithm to ensure that every notification will be received at random times. Therefore, two or more notifications won't be received at the same time nor relatively closed to each other.

Figure 3
Work Sampling Worksheet Specially Designed for Self-Observation

IMPLEMENTATION

The Work Sampling Mobile Application was developed in Xcode Apple's development environment software using Objective-C programming language. The main idea behind the application is to receive the time interval t) from the user and the notifications quantity(x). Then the application generates x quantity of notifications for the entered t time. Because the random notifications play an important role in Work Sampling study, the algorithm incorporated to this application was developed to ensure that the user will have enough time to record the task before receiving the next notification.

In the worksheet used by the user on a self-observation Work Sampling study, the tasks to be observed are predetermined before the study begins (refer to figure 3). The mobile application developed for this project allows the user to add to the database his most common tasks before the study starts. These tasks can be accessed and edited at any time under "My Tasks" button. This feature gives the user the opportunity to access all the added tasks and use them to make annotations every time a notification is received.

The database was divided into four data tables; Event, Event Reminders, Event Variables and Tasks. The relationship between these tables can be seen in the database diagram (refer to figure 6 below). For every new event created, the event name default value is the date of the event. This can also be customizable to any other name.

The Work Sampling Mobile Application works in the following way: First, the user identifies the major task to be performed and records them in the application database. This process is made under "My Tasks" button. Second, the user creates a new event, select the time interval and the notifications quantity. Then, the application will generate the random notifications based on the quantity and time interval entered by the user. After this step, the user start working by doing its usual tasks and the iDevice (in this case, the iPhone) will notify the user every time a notification arrives. For each

notification received, the user must enter or select the task he is performing at that moment. If the task entered is not in the database, the user has the option to write the new task and save it into "My Tasks" database and recorded as task in the notification at the same time. After the event is completed, the user has the option to export the complete event to a spreadsheet document and manage it directly from a computer. This saves time by not having to pass the information from the worksheet to the PC software.
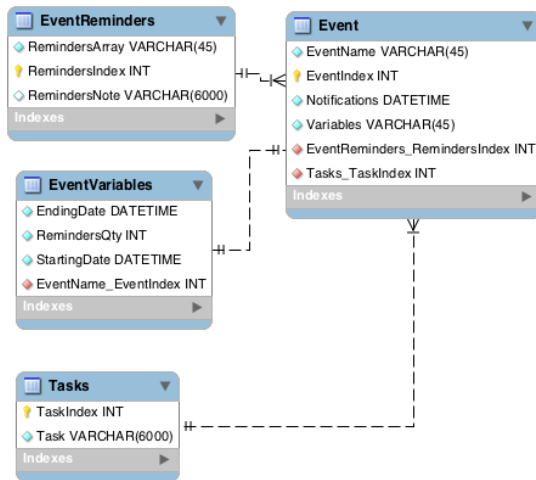
Figure 4
Work Sampling Mobile Application Database Diagram

CONCLUSION

Since the early 1930's, the Work Sampling study has been used. Over the years it has proven to be a very effective technique to measure the proportions of total time devoted to the various activities that constitute a job or work situation. As mentioned early, Work Sampling is an expensive study, but using the proper software, the total cost could be significantly reduced. We talked about computer software and PDA's software. One of the major drawbacks is that most of computer software didn't have the option to export the results to a spreadsheet document file. In order of making Work Sampling study more easy to implement and efficient, the Work Sampling Mobile Application was introduced as part of this project. The application was used in various Work Sampling

study. An eight hours study result is presented in figure 5. This study was completely made and exported into a spreadsheet file using only the mobile application.

The application proved to be an excellent tool to complement the study and that it was easy to carry around. Also, the application was very simple to create and edit events. Exporting events were intuitive and very effective. Once the file was delivered by email as a spreadsheet file, adding other calculations and additional information was a very simple and not very time consuming task. The application proves to be an excellent tool that could be helping every user in self-observation Work Sampling study.

Event Name:	First Week	Day 1
Date Created:	01/30/14-12:28 PM	
Notification:	Task:	
12:46 PM	Teaching	
12:50 PM	Teaching	
1:14 PM	Teaching	
1:39 PM	Student advising	
1:57 PM	Student advising	
2:15 PM	Professional development	
2:30 PM	Professional development	
2:46 PM	Preparation	
3:17 PM	Continuing education	
3:30 PM	Continuing education	
3:55 PM	Continuing education	
4:15 PM	Teaching	
4:23 PM	Teaching	
4:56 PM	Teaching	
5:00 PM	Personal	
5:20 PM	Personal	
5:45 PM	Student advising	
5:59 PM	Student advising	
6:20 PM	Research	
6:37 PM	Research	
6:57 PM	Research	
7:14 PM	Preparation	
7:47 PM	Preparation	
7:58 PM	Preparation	
8:19 PM	Preparation	

Figure 5
Day one of a Work Sampling Study Performed and Exported into a Spreadsheet File using the Mobile Application

Overall, the Work Sampling Mobile Application is a very productive tool to incorporate into a Work Sampling study. One of the best features is that for every day the user will conduct a

study is not necessary to prepare a new worksheet. Also, carrying the beeper to receive notifications is not necessary. Just by using the smart phone in an all in one tool would be everything you need. With this tool, the person performing the study will concentrate on its work, rather than on recording it. Therefore, this study will seldom interfere with the tasks the user wants to evaluate causing the collected data to represent a real situation.

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