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An introduction to the use of time analyser software to measure computer use

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Abstract

This paper reports on the use of time-use software to measure actual computer use. The software was employed as part of a case study on individual use and acceptance of information and communications technology in the health sector. When compared with other methods of measurement such as self-report, the application proved to be a comprehensive and accurate source of objective information and a reliable method of measuring actual computer usage. Results also demonstrate the importance of qualitative methodologies in information systems research. Limitations of the application as a measurement tool are discussed as well as recommendations made for further investigation.

INTRODUCTION AND BACKGROUND

Measuring the use of technology by individuals is a critical element in technology acceptance research. This field of academic endeavour seeks to explain and predict the various factors involved in individuals' decisions to accept and use technology. In its 30^{+} year history, various theoretical models have been devised to investigate technology acceptance and the testing and validation of these models necessitates a measurement of computer use.

While technology acceptance is a mature discipline within the field of Information Systems, the methods used to measure computer use remain fairly static. The two types of methods are self-reported usage and objective or actual usage.

Past studies of technology acceptance and use have generally employed self-reported use as the lone measure of computer use. While this technique can provide useful information to researchers and organisations about user perceptions of their use, the method has various limitations. Concerns associated with the employment of subjective measures of usage have been articulated by several researchers, most notably by Straub et al (1995). Self reported measures have been found to be incongruous with actual usage measurements, suggesting that employing user perceptions of use may produce unreliable data (Devaraj & Kohli 2003; Straub, Limayem & Karahanna-Evaristo 1995; Szajna 1996). Discrepancy between actual and perceived use may arise from subjects' difficulty in accurately recalling their past usage (Devaraj & Kohli 2003). This can be overcome by requiring subjects to keep a detailed diary of their use; however, this approach is time-intensive for subjects and encroaches on their work time. It may also produce unreliable data as subjects are able to exaggerate or understate their use to fit perceived expectations of their boss or the researcher.

Given the limitations of self-report, one may assume that actual, objective measures of computer use would be gaining prominence in the literature. However, a review of the technology acceptance literature revealed a limited number of studies that employed measures of actual use. In these studies computer use was measured as duration of use via system logs (for example: Venkatesh et al. 2003). In studying the link between performance impacts of information technology and actual usage, Devaraj & Kohli (2003) utilised several methods of actual computer use: i) the number of reports accessed, ii) amount of CPU time utilised, and iii) disk input/output. These objective usage measures were captured by a log created by a utility program to track user resource consumption (Devaraj & Kohli 2003). With the exception of Devaraj & Kohli (2003), no studies were able to be located which described in detail the information gained from these logs and how they were analysed.

The use of computer log files will provide information such as the time a user logged on and logged off, which programs and files they accessed and when. System logs are not able to track idle use unless the system automatically logs off inactive users after a period of non use. Furthermore, the output of system logs requires significant time investment to analyse the data produced.

The use of time tracking or time-use software to measure actual computer use is an underdeveloped area in current literature and one worthy of exploration.

TIME USE SOFTWARE

There are various time-use applications available to track computer usage. A Google search will reveal many of these, however many offerings are either limited in what they can capture or conversely are designed as surveillance tools which compromise the security of data and information on the computer.

Following review and trial of the software by the principal investigator, Visual TimeAnalyzer (VTA) (Neuber 2004) was selected as a tool to measure actual computer use. VTA is a time tracking Shareware application that automatically tracks computer usage. The application can be installed locally or over a network and collects detailed information on individual computer use. The application records which programs were used, how long for, when and by whom. It also records working time, pauses in activity, Internet use and sites visited.

The data collected by VTA is presented in detailed graphical form which can be adjusted according to the data collection needs of the research. The comprehensive information on actual use can be reported graphically in the following formats, some of which are shown in Figure 1:

- Detailed day view, displaying chronological use of programs;
- Summary of times of the day, separated into hourly periods;
- Average daily active working time, online time and Windows runtime in hours;
- Day summary showing how long programs were used on every day;
- Summary of weekdays - active working time and Windows runtime in hours per weekday;
- Detailed program view displaying the history of the program's use;
- Pie chart of the 11 most highly used programs;
- Program runtime showing how long the programs/projects were used in the chosen time period
- Internet - shows the 11 most visited web pages and all visited web pages with title, URL and time.

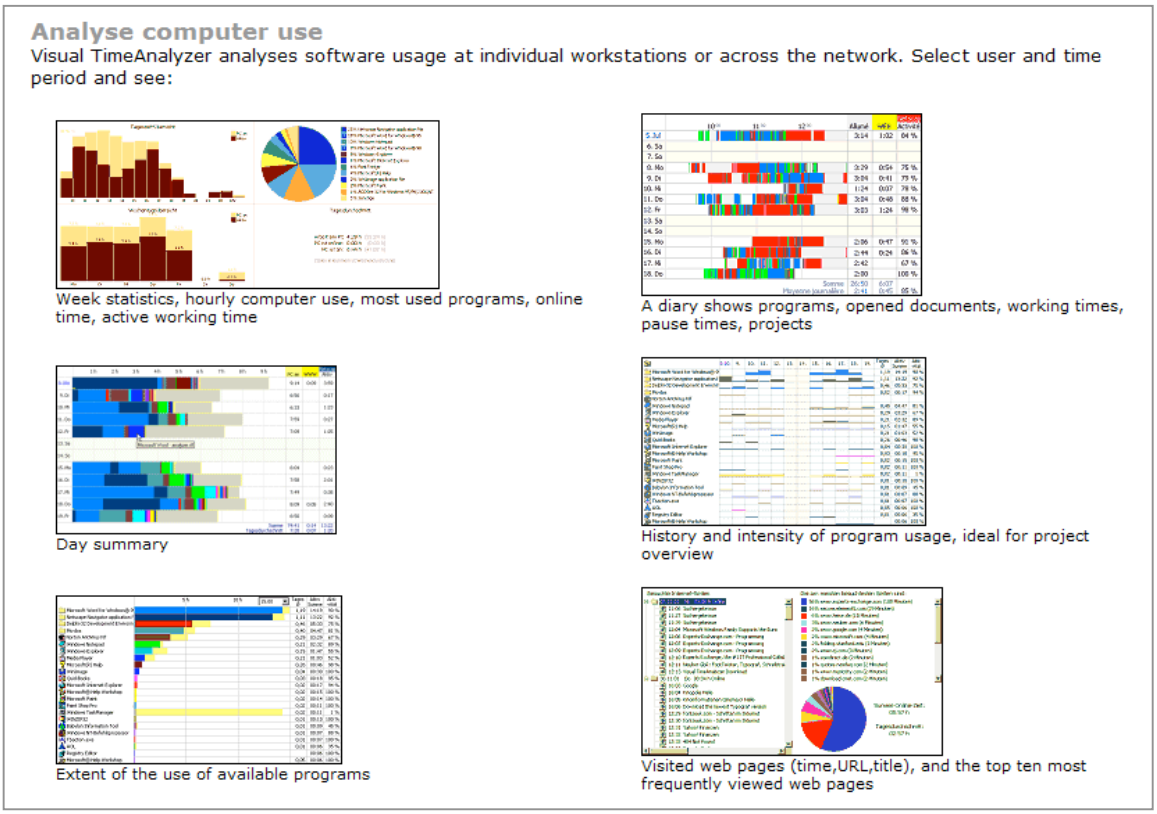

Figure 1. Example screenshots from Visual TimeAnalyzer

As seen in Figure 1, the data captured by VTA is extensive. The program automatically converts this data into usable and relevant information in an array of visual formats. The use of this application is not limited to English as it can be translated to any language. The security of data and information is maintained as specific keystrokes and text are not recorded, nor does it run background screen captures. The minimum system

requirements for running VTA are: Windows XP, 2000, 2003, NT, ME, 95, 98 and 3 MB of free disk space (Neuber 2004).

METHODOLOGY

Research Design, Background Information and Data Collection Procedures

A longitudinal multi-method field study was designed to examine information and communications technology (ICT) acceptance and use within a small non-profit, community-based health care organisation. The organisation (referred to as KaK) provides specialised therapy and education services for children and families. It is predominantly dependent on Government funding. Of the 16 paid staff members, only 5 are full-time employees.

In 2004 KaK was awarded a grant to fund the complete overhaul of their existing information system (IS). The pre-grant infrastructure at KaK was vastly inadequate and did not meet the organisation's needs. Staff were often not able to gain physical access to a computer; were not able to share resources; and most didn't have access to email or the Internet. The IS implemented at KaK refers to the entire system, as changes were made to every aspect of the existing infrastructure. This included substantial changes to hardware, software, data and networks.

Data collection was longitudinal over a 7-month timeframe, timed in conjunction with the introduction and use of the new computer system. Methods of data collection included questionnaires, interviews with members of the organisation, participant observation, a review of documentation and the installation of a time-use program. Figure 2 presents the longitudinal data collection schedule.

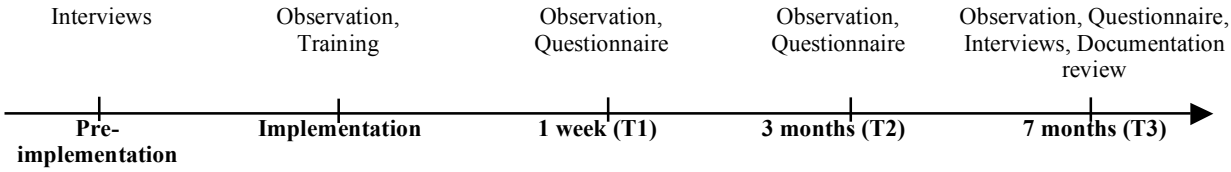

Figure 2. Longitudinal Data Collection Schedule

Analysing use longitudinally as participants' experience with the technology increases, permits a detailed understanding of technology acceptance and use over time, This is consistent with prior technology acceptance research (Davis, Bagozzi & Warshaw 1989; Venkatesh, Morris & Ackerman 2000; Venkatesh et al. 2003). The combination of quantitative and qualitative methods in information systems research, as opposed to only quantitative, is an important methodology consideration (Kaplan & Duchon 1988), and one that is noticeably infrequent in technology acceptance research (the notable exception being Venkatesh et al. 2003). Collecting qualitative data recognises the importance of context, people and organisational issues in the use and acceptance of ICT; and the dynamic interaction between the constructs which may change over time. It also increases the robustness of results by permitting triangulation of the data and providing a deeper understanding of what is actually occurring (Kaplan & Duchon 1988).

The focus of this research was literally on the use of computers (desktop and laptop) by KaK staff, rather than use of a particular software/system. This broad focus was necessary, and most appropriate, given the extensiveness of the new system implemented. Usage measures therefore needed to capture a large amount of data which would be pliable to multiple analytic techniques.

Measuring Self-Reported Use

The questionnaire developed for this research was modelled from the questionnaire developed by the authors for a national survey on ICT acceptance and use amongst Australian occupational therapists (Schaper & Pervan 2004). Self-reported ICT use was captured via participant interviews and questionnaires. The interviews were conducted during pre-implementation and at seven months post-implementation (T3). The questionnaires were administered at three points in time: 1 week post-training (T1), three months post-implementation (T2) and seven months post-implementation (T3). At T1 and T2 the questionnaire provided participants with a list of systems/software and asked to indicate their use of each. At T3 the questionnaire content was modified slightly and participants were asked to indicate whether their use of each system/software had increased, decreased, not changed or if they didn't use it at all. They were also asked to estimate the percentage of time they used computers during their work day both before the new system was installed and at the time of completing the questionnaire.

Measuring Actual Use

To maximise the accuracy and comprehensiveness of actual computer use data collected throughout this research, Visual TimeAnalyzer software was installed on each desktop and laptop computer. As detailed earlier in this paper, data captured by VTA is extensive and includes computer runtime, runtime of multiple applications and active use of these applications by each individual. VTA logs mouse and keyboard use every minute. If either of these input devices have been used during the previous 60 seconds, that minute is recorded as 'active' use. VTA deems periods of use as 'inactive' when the keyboard or mouse have not been used during that minute.

The measure of usage utilised in this study is the average daily active working time within each month, represented as a percentage of computer run time. This is recorded by VTA as 'activity', and is automatically calculated by dividing the time period of active use with computer run time. For example, a figure of 36% indicates that individual was actively using that computer (i.e. using the keyboard or mouse) for 36% of the time their computer was on. A measure of actual use was needed which would allow both between-subjects and within-subject analysis over a 7 month period. The decision to use this figure as a measure of actual use was necessitated given the context of computer use within KaK. Staff work varied hours and computer use is only a part of how they occupy their work day, consequently, computer run-time, total hours of active use or daily average of active use data would not allow for accurate comparisons. This figure also corresponded to the self-reported use question asked in the T3 questionnaire.

KaK gave permission for this software to be installed for the duration of the study and all staff were made aware of its presence on the system.

DATA ANALYSIS

Qualitative data from interview transcriptions, interview notes and responses to open ended questions on the questionnaire were entered into NVivo (QSR International Pty Ltd 2002) and analysed as per analysis methodologies described by Miles & Huberman (1994). Throughout the 7 month duration of this study it became evident that although participants had a primary computer to use, they would often login and use other computers at KaK. As VTA was installed on each individual computer, the application was unable to automatically combine multiple sets of user data. Data from VTA was manually entered into MS Excel to enable analysis of individual computer use across multiple computers.

RESULTS

Of the 16 individuals employed at KaK, 14 consented to take part in this research. During the course of the study, 3 people resigned and the organisation created new positions and employed several new staff. This paper reports an analysis of computer use of 8 staff, 7 of whom were at KaK for the entire duration of the research and 1 of whom started 5 weeks after implementation of the new system. Due to space constraints, only the results for overall computer use and use of MS Outlook are presented.

Self-Reported Technology Use

The data collected on self-reported use of technology shows that ICT use at KaK increased dramatically over the 7-month duration of this study. In interviews all participants reported an increase in frequency and extensiveness of use. In the T3 questionnaire, staff were asked to estimate the percentage of time they used computers during their work day. As shown in Table 1, with the exception of the receptionist (who began working at KaK during this study), all staff reported large increases in their computer use. While management staff reported a 60-250% increase in their use of computers, therapists reported a 100-150% increase, as shown in Table 1.

Participant ID	Position	Pre-Implementation (% of work day)	Post-implementation (% of work day)	% increase
ID1	Therapy assistant	10	37	270
ID4	Therapist	10	25	150
ID5	Mngmt/Therapist	30	60	100
ID7	Therapist	15	30	100
ID10	Management	50	80	60
ID11	Management/Admin	20	70	250
ID13	Receptionist	-	75	-

Note - 1. both measurements taken at 7 months post implementation (n=7, due to 1 no response N/R)

Table 1. Staff perceptions of time spent using computers pre- and post- implementation[1]

Participants use computers for a variety of clinical, administration and professional purposes. Since implementing the new system: 67% of participants reported an increased use of computers during client interventions (i.e. as a tool in therapy); 78% increased their use of ICT to communicate with clients and/or families; 67% increased their use of computers to document client information and to schedule client appointments; and 56% increased their use of ICT for continuing professional development and education. 100% of participants foresee an increase in the use of ICT in their work in the next 5 years and 88% believe ICT can add positive value to their work.

All staff have learnt new ways of using computers in their work. Examples observed by the researcher and reported by participants include: i) Clinical purposes, e.g. including digital photos and scanned images of a child's handwriting into a report that is saved in PDF format and emailed to the relevant external agencies; ii) Administrative purposes, e.g. utilising a laptop and data projector for staff meetings; and, iii) Therapeutic purposes, e.g. creating a PowerPoint presentation for a child as a motivating tool to improve hand-eye coordination and communication.

Actual Technology Use

As depicted in Table 2 and graphically in Figures 3a and 3b, the level of actual active computer use by staff varies both within-subjects and between-subjects. For example, ID5 who has a management and therapist role at KaK had similar levels of use in month 2, 4 and 5 but in the final month her level of use dropped significantly. When queried about her computer use in month 7, ID5 responded that she had taken annual leave during that time and on the days when she was working, she spent much time in meetings and other appointments and therefore was not using the computer as much as previous months.

This high level of variability between and within subjects is to be expected for two reasons: i) The computer is a tool used by participants for a range of clinical, administrative and professional purposes, however, the primary work task of participants is to deliver services to clients - services that are provided face-to-face, without the use of a computer (e.g. conducting a physical training session with a child); ii) Staff work flexible hours around appointment times with clients, which vary with external influences. For example, active computer use decreased in month 6 for the majority of staff, most likely due to fewer appointments with clients and less hours worked during the Christmas break and school holidays.

Participant ID	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
ID1	36	56	50	54	35	55
ID4	28	20	34	30	35	56
ID5	44	34	44	43	35	18
ID7	25	23	26	29	25	45
ID10	43	31	34	39	30	34
ID11	36	28	39	39	26	38
ID12	14	18	16	25	40	36
ID13	52	41	39	43	42	41

Note - Figures are a percentage of computer run time

Table 2. Actual computer use. Average daily active use of computers

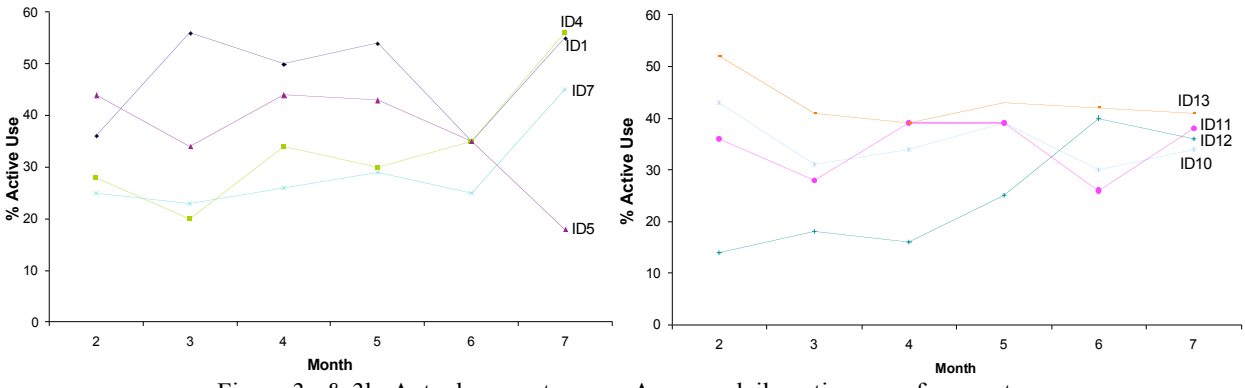

Figure 3a & 3b. Actual computer use. Average daily active use of computers.

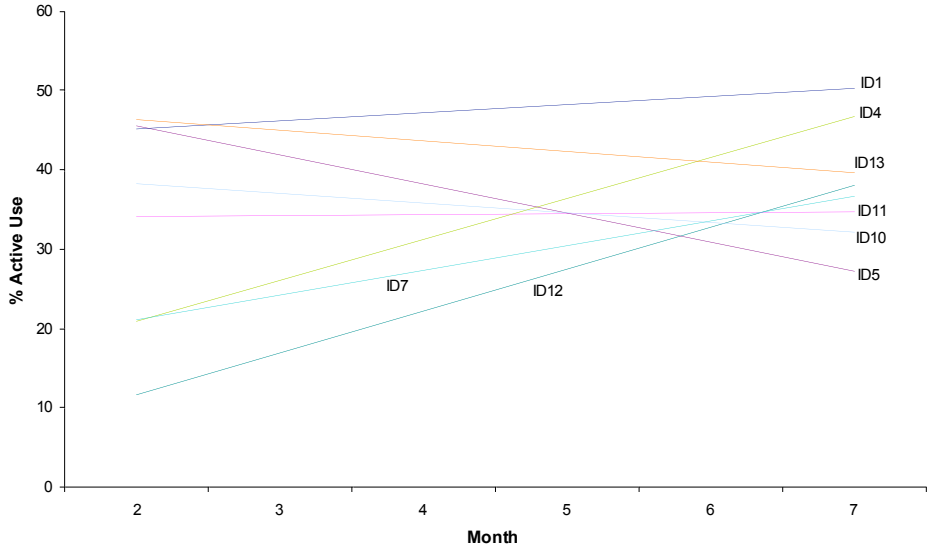

Figure 4. Trend line of actual computer use.

Actual computer usage, as measured by the average daily active use of computers, shows that in the post-implementation period 4 staff experienced an increase in the average amount of time they used computers during their work day. One person experienced a decrease and three staff members' level of use remained relatively unchanged (see Figure 4).

When combined with the qualitative information gained throughout this study, actual computer use for each individual can be explained. Participant ID4 and ID12 experienced the greatest increase in actual use. Both these individuals had the lowest levels of use, confidence and experience with using computers at the beginning of this study, and thus had the most to gain. Participant ID5 was observed to have a high level of experience with computers and was adept at learning new skills. It is possible that her level of active use decreased due to gains in efficiency and skill at using the computer. Participant ID1 works as a therapy assistant and one of her primary tasks is to create resources for use in therapy sessions. In her interview ID1 stated that her computer use has increased as she has experimented with new ways to make resources and as therapists make use of her skills. ID10, ID11 and ID13 experienced little overall difference in their levels of computer use over the course of 6 months. This is to be expected as these staff members have administration and management roles and thus their use of computers is less subject to external variables and is likely to be more stable than therapists who spend the majority of their work time with clients.

Use of MS Outlook

As part of the new system the organisation provided individual email accounts for all staff and directed that staff use the calendar feature in MS Outlook. Management encouraged staff to use email to communicate with each other and to book appointments with clients so that the program maintained a record of services provided to clients. Although the use of MS Outlook for email, appointment bookings and to track staff movements may seem like a minor benefit to an external reviewer, the staff at KaK are unanimous in their praise for this feature which they state has decreased their time spent in administration duties. When asked in the T3 interviews to state the main benefit of the new system all staff responded *"Outlook"*. On the T3 questionnaire, ID13 was the only staff member to state 'no change' in her use of Outlook; all others reported an increased use of Outlook throughout the duration of this study.

The actual active use of MS Outlook throughout the 2-7 months post-implementation is depicted in Figure 5, and Figure 6 depicts the trends of use over time. ID7 and ID12 experienced increases in their use of MS Outlook while other participants show little change. As this application was not available at KaK prior to the implementation, one would expect that level of use would be highest in the first month of use as users populate their calendar and contact lists and learn how to use the application. Unfortunately actual use data is not available for the first month of use; however, the negligible change in use shown by most users is expected.

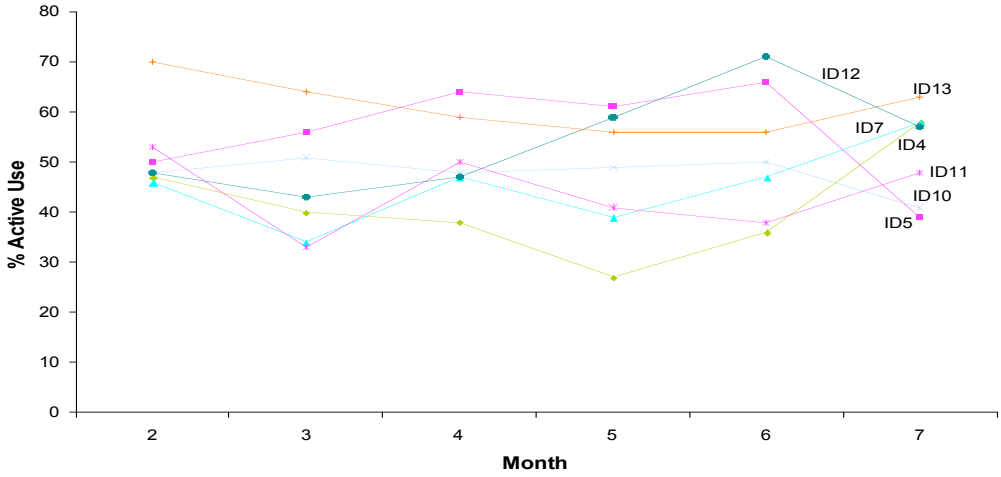

Figure 5. Average daily active use of MS Outlook.

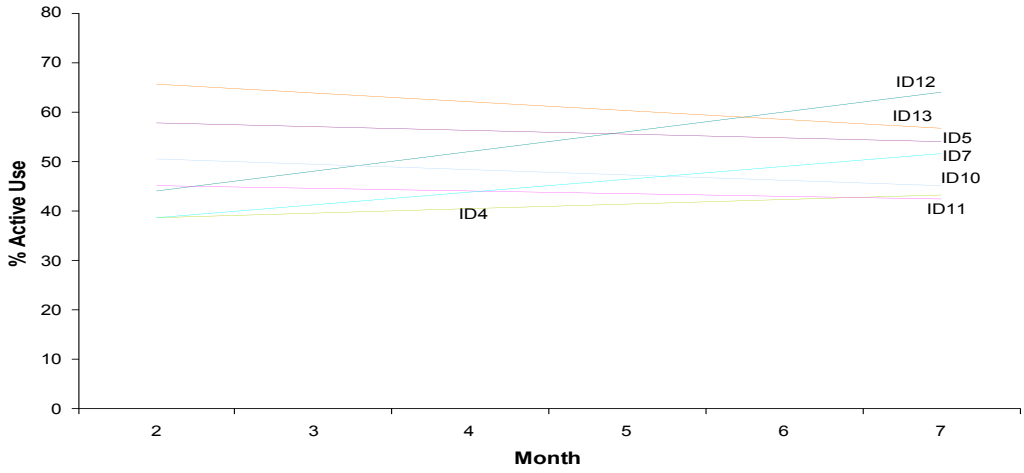

Figure 6. Trend line of actual use of MS Outlook.

DISCUSSION

Actual Vs Self-Reported Use

Usage data collected during this study show significant discrepancies between individuals' self-reported use of technology and their actual use. Results suggest that retrospective, subjective self-reported computer use is less reliable and less accurate than measures of actual use, as measured by VTA. For example, ID1 estimated 37% use, when her actual use was 55%; ID5 estimated 60% use when her actual use in the final month of the study was 18%; and ID10 estimated 80% use, when objectively her level of computer use was 34%. This supports the finding of previous research which has found discrepancies between the measures (Devaraj & Kohli 2003; Straub, Limayem & Karahanna-Evaristo 1995; Szajna 1996) and also demonstrates the need for measuring actual computer use to gain accurate measurements of time spent using computers.

Although this study has shown self-report measures of use to be inaccurate, these subjective measures are valuable in their own right, particularly given the importance of perception in influencing human behaviour. For example, although actual use of MS Outlook remained relatively stable for most staff, the majority believed their use had increased. This perception is likely due to: i) most staff had never used MS Outlook prior to the implementation and would still be discovering new uses for the application; ii) with increased experience comes increased confidence and skill, which decreases the amount of time needed to perform actions; and iii) their praise of the program and overstating their use is evidence of their positive perception of the benefits of using the program.

Time use software

The use of VTA as a measure of actual computer use was piloted in this study of computer use and acceptance within a small organisation in the health sector. Various benefits and limitations for employing this application, based on this experience, are noted below.

Benefits:

- Measurement of actual use is more accurate than self-report.
- Runs constantly when the computer is on, recording data in 60 second intervals.
- Easy to use. The Windows based environment and menu functions made this an easy program to learn and use.
- Allows the capture of detailed and longitudinal information on all programs used or on a specific application.
- Data captured is linked to individual logon id and is thus able to detect multiple users logging into the one machine.
- Offers numerous ways to use and analyse the data depending on the research questions.
- Easily and quickly analyse data collected. Because the application does all the analysis and presents the details in table and graphical format, much time is saved in calculating actual use.
- Data is captured automatically, thus eliminating the need for periodical collecting of data by users or by researchers.
- Only recorded what is needed. For example, the researchers selected not to include Internet sites visited in the data capture.
- Highly applicable to research on acceptance and use.

Limitations and Learnings:

- The primary limitation of the use of this software is also one of its main advantages. Because of the high level and sheer volume of information collected by the software, one must have a clear plan of what data will be used in the analysis, and how it is going to be analysed and represented, according to the research design and questions.
- VTA captures data every 60 seconds and records 'active' use when the mouse or keyboard is used in the preceding minute. Initially the researchers were sceptical of VTA's calculations, as the level of active use was lower than expected. However, when tested on their own computer use, the calculations were shown to be correct and (to our surprise) revealed how much time one spends sitting in front of the computer and perhaps reading the screen or processing information but actually not using the mouse or keyboard.
- Detailed qualitative data on use is necessary for accurate interpretation of VTA data. For example, days at work spent primarily in meetings, the number of and length of appointments, and days away from the office altogether (eg illness, annual leave etc).
- To address ethical and confidentiality issues it is necessary to get approval from the organisation and the individuals to use the application.
- Although not particularly expensive, the cost of purchasing the software needs to be added to the research budget and total costs associated with conducting the research.

RESEARCH LIMITATIONS

The VTA software was unable to be installed on the computers at KaK until the start of the 4th week, post implementation. Actual usage measures are therefore restricted to actual use during the 2nd-7th month post implementation and no data on actual use is available for the pre-implementation period. Comparisons between actual use in the pre- versus post-implementation are therefore limited.

During the course of this study one of the computers at KaK had its hard-drive reformatted and despite efforts, VTA data was unable to be recovered. As a result, one potential participant had to be excluded from the study due to the lack of data regarding her actual use of the computer. As staff often login and use multiple machines, the actual use figures may be understated for some staff due to this lost data. Additionally, use data may have also been compromised as staff know each other's logon and passwords.

The VTA program should have been installed over the network with the data files being saved to the server. This would eliminate the problems experienced with lost data. Installing the program locally meant that VTA was unable to produce a complete analysis for each user and this added to the time and complexity involved in manually analysing the data produced by VTA.

CONCLUSION

This paper provides an introduction to the use of time use software for measuring actual computer use. The software (VTA) was employed in this case study on ICT acceptance and use within a small, non-profit community based health care organisation. The case study described involved a longitudinal multi-method investigation, collecting quantitative and qualitative data over a 7-month period, timed in conjunction with the implementation of a new information system. Results pertaining to the self reported and actual use of technology during this period are presented in order to demonstrate and evaluate the methods of measurement used to capture use.

The results of this study demonstrate the value of capturing objective and subjective measures of computer use and of the need for qualitative data for accurate interpretation of the quantitative measures. Sole reliance on quantitative data and objective measures of computer use provide partial measures of computer use, however, combined with the richness of qualitative data, the usage is able to be placed in context which increases the reliability of the analysis.

VTA collects comprehensive data which is able to be represented graphically and the application permits self-selection of time period, type of program used, computer usage by individual user and by individual machine. It has large scope for being employed as a measure of technology use within organisations and studies with very small or very large sample sizes. It is recommended that future studies seeking an objective measure of actual computer use consider employing time-use software for the benefits outlined above.

The significance of this work is that it demonstrates the efficacy of using time analyser software as a measure of actual computer use. It introduces a new tool and methodology to measuring computer use and serves as a starting point for future testing and use of this technique. This work has highlighted the complexity of the phenomenon that is computer use and of the need for more thorough and accurate methods of measurement than is currently used within the field of Information Systems. It is recommended that future studies incorporate multi-method approaches to measuring computer use to ensure interpretation of use data is correct.

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DISCLAIMER / COMPETING INTERESTS

The decision to use VTA in this research as a method of measuring computer use was independently decided by the researchers involved in this study. Neuber GbR were approached by the principal investigator and asked to provide a copy of the program at no charge for the purposes of conducting this research. While the support of Neuber GbR is acknowledged in this research, results on the use of VTA reported in this paper are results obtained through rigorous application of the research methodology. The authors received no form of payment or nepotism from Neuber GbR.

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