

A Framework for Co-alignment of Doctor's Performance and Computer Mediated Characteristics in Hospitals: Task and Technology Fit Perspective

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ABSTRACT The evaluation of healthcare service task and how technology (computer mediated tools) support the delivery of such services in rural hospitals is of great concern to doctors at the point of healthcare servicedelivery. The study investigated the relevant set of healthcare service tasks rendered by the doctors in remote areas in South Africa and assessed how computer-mediated technology support users (doctors) to communicate with experienced or specialist doctors for professional advice using Task-Technology Fit Perspective. The case study approach was used. Participants were selected from a population group of doctors. Semi-structured, open-ended interview questions were used to gather evidences from the participants regarding the different task doctors perform, how do they communicate with their counterparts using computer mediated tools and how these tools fit and support the task and vice versa. The findings revealed that "time critical tasks, information dependent task and mobility task were not supported by the characteristics of computer mediated technology available in the hospitals. The findings led to a proposal of "Fit Task Technology Framework (FTTF). The FTTF is to align doctors' tasks with technology (computer mediated tools). The proposed framework of FTTF will lead to high work performance of doctors, which will intend produce satisfaction to the doctors. Besides, the FTTF as a framework will underpin the assessment of doctors task and supportive communication technologies in other hospitals and healthcare institutions

INTRODUCTION

The delivery of healthcare services in Africa is severely affected by massive shortages of doctors, inadequate deployment of ICT infrastructure and unattractive incentives especially to doctors from universities who are deployed to remote rural hospitals in Africa. These doctors are often deployed to remote locations where access to knowledge sharing facilities to improve their work performance is unavailable (Coleman et al. 2012). The task of such doctors' in remote environment is often categorized as routine and sometimes non-routine activities. These activities, either routine or non-routine can be aided by computer mediated tools such as (e-mail, Group support system-GSS, intranet, telemedicine system and video conferencing). All these tools are components of Information and Communication Technology (ICT) systems and can bridge the gap between doctors in remote locations and specialist doctors in urban areas (Dates 2008). These tools which can provide support to doctors in remote rural areas are not just mere mechanism for exchange of knowledge but a mechanism for creating knowledge repository and accessing the knowledge repos-

itory (Walsh and Ungson 1991). They are tools (thus, technology) which can fit and support the task of doctors if appropriately matched. However, a number of factors influence the efficiency of knowledge sharing which include the characteristics of the knowledge being shared and those of the channel and tool being used (Furst et al. 1999). Computer-mediated communication system is a channel that can support and promote such knowledge sharing among health professionals (Dates 2008). Despite the compelling advantages of computer-mediated technology in healthcare, doctors deployed to remote regions in South Africa are unable to access neither a real time (synchronous) communication nor asynchronous communication through computer-mediated tool to communicate with their counterparts who are specialist doctors at provincial or teaching hospitals in South Africa for professional advice. This is compounded by a lack of substantive evidence regarding the impact of computer mediated tool (either synchronous or asynchronous) on health care service delivery and whether the tools like Group Support System (GSS) intranet or emails are adequately design to fit with the intended tasks (either routine or non-routine) which these newly deployed doctors are exposed to.

Objectives

The purpose of this study, therefore, is to determine the relevant set of healthcare service tasks render by doctors in remote areas in South Africa and assess how computer-mediated technology support users (doctors) to communicate with experienced or specialist doctors for professional advice using Task-Technology Fit Perspective.

Literature and Theoretical Background

'Fit' is defined as the matching of the capabilities of technology to the demands of task (Vessey and Galleta 1991). Subsequently, Goodhue and Thompson (1995) defined 'fit' as 'task-system fit' which means the degree to which information systems or systems environments assist an individual in performing a portfolio of tasks. The concept of fit is now well accepted in the Information Systems (IS) domain, where Task-Technology Fit (TTF) has been examined as a theory to assess the extent of technology functions to support user needs (Teo and Men 2008). The TTF model, based on rational choice theory, assumes users will adopt technology provided that it has the characteristics necessary to support their tasks. TTF, thus, refers to the extent of the capability of technology to support at ask (Teo and Men 2008). Technology will be utilized well only if the functions of the technology can support user needs (Dishaw and Strong 1999). It supports the degree at which the functionality of a technology matches the task, and complements the abilities of the individual who is performing the task. This will determine the level of utilization (Junglas et al. 2009). 'Under-fit' denotes minimal technological capability because the technology is ineffective when it does not sufficiently meet task requirements. Conversely, 'over-fit' implies excessive technological capability, because the technology provides excessive resources, causing 'IT slack' (Gupta 2003). Thus, it can be implied that the best technology is the 'fittest', defined as adequate capability to sufficiently meet user needs, thus, aiding task completion (Teo and Men 2008).

Task Characteristics

Tasks are defined as actions carried out by individuals in turning inputs into outputs, and

comprise features that move a user to rely more heavily on certain aspects of the technology (Balasubramanian et al. 2002). Based on a review of past TTF research, four task characteristics are deemed most relevant to the context of doctors (Time criticality, interdependence, mobility distinguishes and Information dependency). *Time criticality* refers to the importance with which a task needs to be performed promptly or urgently, and flexibly (Gebauer et al. 2010). Flexibility captures the extent to which computer mediated tasks must be performed on time, whilst urgency reflects the degree of rigidity in time structuring and task completion, that is, to start and finish within a time window (Yuan et al. 2010). *Interdependence* referred to the extent to which an on-going task is related with other tasks and work units. This included the degree to which workers interact with and depend upon others to accomplish their work (Gebauer et al. 2005). This takes into account the extent to which coordination with other work units is required. *Mobility distinguishes* mobile from stationary work, and has been measured as the frequency of absence of an individual from his or her standard work location – described as location variability (Yuan et al. 2010). The need for manoeuvrability in spatially constrained spaces is also indicative of mobility (Junglas et al. 2009). *Information dependency* referred to the extent to which dynamic task related access to information is required to perform a task. This is also described as the extent to which a task depends on access to information at a service location such as a health service delivered at the point-of-care (Junglas et al. 2009). Information such as routes to a particular destination and environmental conditions is also critical to task performance (Yuan et al. 2010). Doctors may have the need to access field information (for example, the location of equipment or supplies needed) to complete monitoring tasks. Doctors carry out various monitoring, promotional and referral tasks that have varying degrees of rigidity in time structuring that are, to promptly responding to medical emergencies versus occasional follow-up care). In addition, they are engage in interdependent tasks requiring the coordination and sharing of patient and health related information and material resources with other healthcare practitioners and facilities in the health system like clinics and hospitals (Teo and Men 2008). Doctors by nature work in varying loca-

tions, as they travel to various households in delivering health services at points of care. Considering the nature of their work, time criticality, interdependence, mobility, and information dependency are relevant task characteristics and are, thus, examined as user needs important to TTF.

Technology Characteristics

Technologies are viewed as tools used by individuals in carrying out their tasks, and can refer to computer systems and devices, namely - hardware, software, and data (D'Ambra et al. 2013). This study is based Computer mediated Group support system (GSS) tools and email tools used by doctors. Based on a review of past TTF research, four GSS tool characteristics most relevant to the context of this study were identified. These are time criticality support, interdependence support, mobility support, and information dependency support. *Time criticality support* referred to the degree to which the technology offers timely responses to requests for information (Wixom and Todd 2005) whilst supporting urgently required interventions by providing urgent information (Junglas et al. 2009). This is essential in dealing with emergency situations as they occur (Liang and Wei 2004). This aspect of technological functionality is instrumental to the provision of emergency or time-critical services. *Interdependence support* referred to the degree to which technology supports the coordination of work in collaborative settings (Teo and Men 2008). Teo and Men (2008) further suggest that users who perform interdependent tasks should use technology that supports collaboration and coordination (including information sharing), as opposed to acting alone (Jarvenpaa and Staples 2000). The use of Group Support System (GSS) as a computer mediated tool is a viable option. A key indicator of support for task interdependence is the way in which technology allows data to be integrated from various sources (Wixom and Todd 2005) thereby, facilitating ease of coordination amongst users. *Mobility support* referred to the extent to which technology enables spatial manoeuvrability, by adjusting according to calibrated individual movement, based on location sensitivity (Yuan and Zheng 2006). Location-aware services provide timely location re-

lated information to remote doctors as they perform their tasks. *Information dependency support* referred to the extent to which technology supports the performance of tasks that rely on the access to and use of information at the point of service. This includes identification and navigation mechanisms.

Time critical support is enhanced by Synchronous communication. Synchronous communication is direct communication where the communicators are present at the same time. This includes, but is not limited to, a telephone conversation, a company board meeting, a chat room event and instant messaging using a tool like Group Support System (GSS). Synchronicity exists among individuals when they exhibit a shared pattern of coordinated synchronous behaviour with a common focus (Harrison et al. 2003). Asynchronous communication on the other hand, does not require all parties involved in the communication to be present at the same time. Asynchronous computer-mediated communication is limited to communication where a network infrastructure capability of sustaining real time media connection is not cost-effective (Hersh et al. 2006). Asynchronous remote communication systems can be divided into the following: message, storage and discussion centric systems. Message-centric systems are those which function like e-mails (Vassallo et al. 2001). It enables doctors to send questions to specialist doctors and receive replies. They are easy to use but lack content management features that are useful to establish a community of communicators. Storage centric systems are like Web or message-based picture archive communication systems that are often used in tele-radiology (Jirotko et al. 2005). It adds basic search and storage capabilities. Discussion-centric systems implement the functionality of a typical Web-based bulletin-board system (incorporating messaging, discussion, and image storage facilities) which allows for two way communication.

The present paper, therefore, positions asynchronous computer-mediated communication between storage and discussion-centric system. At the same time the study positions synchronous communication through the use of Group support system (GSS) and assessed how these technologies support the doctors' task and how these task fit the technology in the hospitals.

METHODS

The study was carried out in the North West Province of South Africa. Ten community hospitals in the North West Province of South Africa were purposefully selected. These hospitals were selected based on their geographical locations which span across the entire province and form part of the government owned institutions in South Africa.

The participants for the study were drawn from the entire population of doctors in the ten hospitals. In describing population (Polit and-Beck 2008) indicated that it is the aggregate of cases having a common and designated criterion that is accessible as subjects for a study. A purposive sampling technique was used in selecting the participants. A doctor from each of these hospitals was selected. The participants were selected by their professions which was relevant to the study. Ten doctors volunteered to participate in the study.

Data was collected using semi-structured open ended interviews. The interviewees represented different roles ranging from specialist doctors to general practitioners. The interviewees were asked to tell in their own words:

1. The different task they perform,
2. The processes used in consultation with other doctors when performing emergency tasks,
3. Availability of computer-mediated communication tools.
4. The level of satisfaction using the computer-mediated communication to enhance their task.

The interview lasted for one and a half hours with each interviewee and was audio-recorded and transcribed by the researcher.

Integrity of data entry from the study was checked by another researcher. Transcripts were coded using Wolcott (1994) method of case study analysis techniques. After the initial coding, broad categories were identified by searching for patterns in the participants' responses. The categories were *Task Characteristics of doctors; Technology Characteristics; task technology fit (Gss and email and intranet) based on doctors satisfaction.*

RESULTS AND DISCUSSION

The results were categorized as indicated above and will be presented and discussed below.

Task Characteristics of Doctors

When the doctors were asked to explain the different tasks they perform, it became evident that some of the task were routine in nature while some were also non routine.

Some of the routine tasks mentioned by the doctors were *time critical* in nature and included

- ♦ Performing physical examination and talking to patients to diagnose their medical conditions
- ♦ Admitting patients requiring special care followed by investigations and treatment;
- ♦ Carrying out specific procedures, for example, performing operations and specialist investigations.
- ♦ Prescribing appropriate drugs
- ♦ Monitoring a patient's responses to drugs
- ♦ Modifying the drugs and drug dosages as necessary

In addition to these, the doctors indicated that they have to visit their patients in different wards to examine their condition and this must be done timely. *Time criticality task, according to* (Gebauer et al. 2010) refers to the importance with which a task needs to be performed promptly or urgently, and flexibly. Flexibility captures the extent to which computer mediated tasks must be performed on time, whilst urgency reflects the degree of rigidity in time structuring and task completion that is, to start and finish within a time window (Yuan et al. 2010)

One doctor stated "*I woke up between 5:00-5:30 am to get to the hospital between 6:00-6:30 am, which gave me enough time to pre-round on my patients before rounds at 8:30 am. Rounds usually lasted until 10:00-11:00 am; depending on how efficient we were and how many patients we were carrying*"

In carrying out the routine task mentioned above, doctors were asked to describe the process of consultation with other doctors when performing emergency tasks.

The doctors, further, indicated that their work is interdependence and work with other units and teams.

One doctor said:

"We work with other doctors as part of a team, either in the same department or within other specialties. We liaise with other medical and non-medical staff in the hospital to ensure quality treatment to promote health education.

And we teach junior doctors and medical students, as well as auditing and research”

Interdependence of task according to (Gebauer et al. 2005) refers to the extent to which an on-going task is related with other tasks and work units. This includes the degree to which workers interact with and depend upon others to accomplish their work and it is more pronounced when the task is unstructured in nature. This takes into account the extent to which coordination with other work units is required (Gebauer et al. 2005). This, therefore, requires a computer mediated technology to facilitate it.

It was also noted that some task mentioned by the doctors were

The next section will solicit responses from doctors the availability of computer-mediated communication tools to support their routine and non-routine task in the hospitals.

Technology Availability and Characteristics

The findings revealed that there are ICT equipment like computers, fax machines, telephones, scanners and Internet connections in the hospitals. The computers were found in the OPD (Out Patient Department) and in the accounts department. It was noted that there were computers in the doctors' consulting rooms. These computers were used by the doctors for e-mails and also for video conferencing. It was also noted that the Internet connection in some of the hospitals (Taung, Ganyesa, Revilon, Bloemhof) was very slow and often down for two to three times per week. GSS was available in many of the hospitals.

Group support systems have frequently been used for group communication and idea generation in synchronous meetings, in which group members meet in one place at the same time. Although, GSSs, in principal, can also be used to support asynchronous group work (in which group members may be temporally and spatially dispersed), research in dispersed groups has, however, been frequently conducted using either e-mail or computer conferencing. 'Real-life', organizational workgroups are considered as continuing, intact social systems engaged in projects that are likely to extend beyond temporal boundaries of a single meeting.

Technologies (like emails and GSS) are viewed as tools used by doctors in carrying out their tasks, and can be referred to computer-me-

diated tools (D'Ambra et al. 2013). Based on this TTF research, four GSS tool characteristics were most relevant to the context of this study and were identified. These are time criticality support, interdependence support, mobility support, and information dependency support. *Time criticality support* refers to the degree to which the technology offers timely responses to requests for information (Wixom and Todd 2005) whilst supporting urgently required interventions by providing urgent information (Junglas et al. 2009). This is essential in dealing with emergency situations as they occur (Yuan et al. 2010). This aspect of technological functionality is instrumental to the provision of emergency or time-critical services. However, the findings indicated that the GSS used in the hospital could not provide this support because of slow internet speed. *Interdependence support* refers to the degree to which technology supports the coordination of work in collaborative settings (Teo and Men 2008). The findings revealed those doctors:

- ♦ Worked with other doctors as part of a team, either in the same department or within other specialties.
- ♦ Liaised with other medical and non-medical staff in the hospital to ensure quality treatment;
- ♦ Promoted health education.
- ♦ Thought junior doctors and medical students, as well as auditing and research

Teo and Men (2008) suggested that doctors who perform interdependent tasks should use technology to support collaboration and coordination (including information sharing), as opposed to acting alone (Jarvenpaa and Staples 2000). The use of Group support system (GSS) as a computer mediated tool in the hospital were not effectively used because of internet connectivity speed. *Mobility support* refers to the extent to which technology enables spatial manoeuvrability, by adjusting according to calibrated individual movement, based on location sensitivity (Yuan and Zheng 2006). Doctors depended on asynchronous communication using emails, intranet and internet to;

- ♦ liaised with other medical and non-medical staff in the hospital to ensure quality treatment
- ♦ undertook managerial responsibilities such as planning the workload of staffing of the hospital.

Besides, doctors could provide information to other remote doctors as they perform their tasks. *Information dependency support that was provided to doctors refers* to the extent to which emails and GSS supported the performance of tasks that rely on the access to and use of information at the point of service. This includes identification and navigation mechanisms to support:

- ♦ promotion of health education
- ♦ Prescribing appropriate drugs
- ♦ Monitoring a patient's responses to drugs
- ♦ Modifying the drugs and drug dosages as necessary and
- ♦ Obtaining guidelines, protocols and standards documents from many different bodies.

Considering the two computer communication technologies reported in our study, GSS were often used in a decision room setting in time- and place-synchronous mode, while E-mail, on the other hand, is generally used by individuals who are temporally and spatially dispersed. The next section will report on doctors' satisfaction in using these computer mediated communication tools.

The Level of Satisfaction Using the Computer-Mediated Communication to Enhance Their Task

All the doctors (n=10) interviewed expressed their dissatisfaction about the use of the computer-mediated tool (e-mail) and cited the slow transmission speed of the Internet and down turn of Internet connectivity. Again the doctors expressed that consultation which involves the usage of GSS to share ideas with expert (specialist doctor) were difficult because of poor and slow Internet connectivity and lack of adequate software application.

The dissatisfaction expressed by the doctors was categorized around, efficiency, adequacy and lack of Information which the computer mediated communication tools (GSS, e-mails internet and intranet) could not support their task. According to Teo and Men (2008) Task-TechnologyFit (TTF) must promote technology functions to support userneeds and vice versa.

Based on the findings the next section explores a Fit Task Technology Framework (FTTF) to improve doctors' performance in hospitals.

The Need for Fit Task Technology Framework

Based on preceding discussions, TTF is the degree to which technology supports tasks, when computer mediated tool functions adequately to meet userneeds. This study draws on TTF by emphasising 'Fit as Co-variation', one of Venkatraman and Prescott (1990) works. 'Fit as Co-variation' has been examined in the context of hospital business unit strategy, and resource allocation.

This framework perspective is defined by a pattern of co-variation or internal consistency among a set of underlying theoretically related variables (Venkatraman and Prescott 1990). In the study's context, these variables would comprise time criticality, interdependence, mobility, and information dependency as a set of four task characteristics, which reflect doctor's needs. The support for these four variables is provided by a set of four complementary technology characteristics, which reflect computer mediated tools (e-mails, GSS, intranet and internet) tool functions. 'TTF as Co-variation' is represented as a framework pattern of consistent task and technology characteristics, all sufficient for a measure of 'fit' to be attained. The framework pattern is indicated in Figure 1.

'TTF as Co-variation' captures the pattern of co-variation amongst this study's conceptually related and contextually relevant sets of task and technology characteristics, and their constituent dimensions (Venkatraman and Prescott 1990). The task characteristics, technology characteristics, and the 'fit' between them are together illustrated in Figure 1. As per theories of fit, and theories of attitude and behaviour, use and user performance are consequences of the co-alignment between task and technology characteristics.

CONCLUSION

Having reviewed doctors task through a "fit task technology (FTT) perspective" in rural hospitals, unpacked the processes used in consultation with other doctors when performing emergency tasks it was noted that computer mediated tools (e-mails, GSS, Internet and Intranet) do not support doctors activities during time criticality, task. It was further observed that there was no "fit" between the tasks performed by the doctors and computer communication tools available.

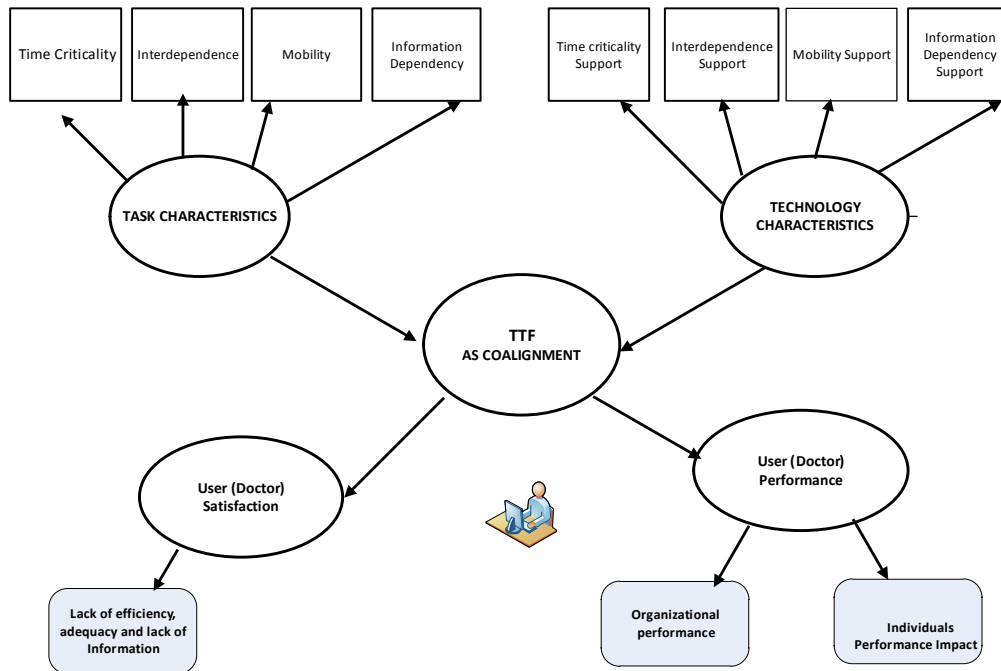


Fig. 1. Fit task technology framework

The findings lead to a proposal of Fit Task Technology Framework (FTTF). FTTF co-aligning the doctors tasks with technology. The proposal of FTTF will further lead to high performance of the doctors' work which will intend produce satisfaction to the doctors. Besides, the FTTF being adopted as a framework will underpin the assessment of doctors' task and supportive communication technologies in hospitals and other healthcare institutions

RECOMMENDATIONS

It is recommended that high speed internet connectivity be provided to hospitals in rural communities.

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