The Internal Value of Mobile Computing in Emergency Medical Services: an Australian Case Study

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Abstract

Interest in mobile computing applications has been increasing over the past few years. The Healthcare sector has recognized the potential for providing at "point-of-care" access to applications through mobile devices. The business value of the implementation of information technology (IT) has been studied from various perspectives. This paper explores the value of the implementation of mobile computing on the efficiency and effectiveness of an Emergency Medical Services organization in Australia. The research question that is addressed in this paper is: In what way do mobile systems deliver internal value in emergency healthcare organizations? The paper evaluates the responses by various stakeholders in an Australian Emergency Service organization. The paper makes the following three contributions. First, the case study indicates that the introduction of mobile systems can support ambulance services in providing more efficient and effective information that could potentially impact on their performance evaluation. Second, a number of advantages of the mobile system for emergency services are highlighted. Third, a delicate balance between internal data capture requirements versus external requirements of readability of the final electronic Patient Care Record is highlighted.

Keywords

Mobile Computing, Healthcare Systems, Emergency Medical Services, IT investment evaluation, Case Study

1. Introduction

Interest in mobile computing applications has been increasing over the past few years. One indication of this is that by 2003, Microsoft had registered 11,000 applications, and now has more than 380,000 professional Windows Mobile developers worldwide [37]. The Healthcare sector has also begun recognizing the potential for providing at "point-of-care" access to applications through mobile devices, for the healthcare professional [9, 24, 32].

Emergency Medical Services (EMS) around the world are under increasing pressure to increase the efficiency and effectiveness of their resourcing and improve accountability [1, 14, 23, 28]. One of the major drivers for this is the ongoing annual increase in the volume of calls. There are several ways Emergency Services are attempting to face these challenges. Firstly, to look at performance frameworks for ambulance services to enable a broader set of measures rather than simply tracking response times [28], secondly, to look at supporting the drive for professionalism of paramedics [31] and thirdly to increase research and data collection as a basis for evidence based practice [10, 19, 35].

The case study investigated the implementation of a mobile clinical information system, Victorian Ambulance Clinical Information System (VACIS) at the Metropolitan Ambulance Service (MAS) branches in the metropolitan area of Melbourne, Australia. It explored both the management and the paramedic perceptions of the value of VACIS prior to using the system and after using the system for three months. Given the drive to increase effectiveness and efficiency in EMS, the paper attempts to answer the following research question: In what way do mobile systems deliver internal value in emergency healthcare organizations?

The rest of the paper is structured as follows: In the following section we review the literature on mobile technology in health care organizations and the business value derived from mobile technology. In the next section we outline our research methodology, and present the case study. This is followed by a discussion in which the implications of the use of the mobile system for emergency services are outlined. Finally, we conclude the paper, and offer suggestions for further research and practice.

2. Literature review

The literature review provides an overview of current research in business value of information technology, followed by a review of literature sources that have specifically addressed the value of wireless and mobile technologies. This is followed by a section

reviewing the use of information technology in the health care sector.

2.1 Deriving Value from Information Technology

In this section, we review literature sources that have examined aspects of business value derived from information technology at an organizational level. There has been much debate over the years about what the business value of IT is and how this can be evaluated (e.g. [20, 40]). In a recent review, Melville and Kraemar (2004) have argued that business value is dependent on the context of the organization and the type of technology that is implemented. Melville and Kraemar (2004) categorized the research in business value of IT on three levels: the focal organization (including intra-firm business processes), competitive environment (e.g. industry) and macro environment (e.g. country characteristics). As such, Melville and Kraemar (2004) define organizational performance as consisting of business process performance as well as organizational performance. Given the scope of this paper, we focus mainly on literature that has examined business value at the level of the focal organization.

Since the 1980s, much controversy has surrounded the debate about whether investments in IT translate into business value (from an economics perspective). Brynjolfsson (1993) coined this controversy 'the productivity paradox' – despite significant spending on IT across the board, no evidence could be found of resulting economic productivity gains [8]. Others at the time have echoed this argument (e.g. [2, 40]). The paradox is captured in the aphorism of the Nobel laureate economist Solow: "…you see the computer age everywhere but in the productivity statistics" [39] cited in [42]. Brynjolfsson (1993) has argued that the productivity paradox can be explained due to 'mismeasurement of inputs and outputs', 'lags due to learning and adjustment', 'redistribution and dissipation of profits' and finally 'mismanagement of information and technology'.

Given the debate about the productivity paradox, suggestions were made to explore productivity gains at an organizational level. Despite the organizational focus, mixed evidence of the business value of IT was reported. Issues came into play that impacted the value that organizations' derived (or didn't derive) from their IT spending, for example the competitive environment in which these organizations operate; alignment between business and IT strategy, and IT strategies [2, 3, 4, 7, 18, 25]. Melville and Kraemar (2004) in their review of IT business value literature, define IT business value as the impact IT has on the organizational processes on an intermediate and organizational wide level as well as the efficiency and competitive impacts of IT. *Efficiency* is defined as the competency with which processes are performed within the organizational context [41]. A concept that is closely related to *efficiency* is effectiveness that is defined as measuring whether the implementation has achieved the intended objectives, also described as the external view (op. cit).

The debate of the value of technology for organizations is again under the spotlight with the advent of mobile technology. Scheepers and McKay (2004) pointed out that the marketing of mobile devices has concentrated on the individual use of mobile devices and very little focus has been placed on the value of mobile computing at an organizational level. Clarke (2001) listed four value propositions which may be derived from mobile technology – ubiquity, convenience, localization and personalization [13]. However, as Scheepers and McKay (2004) argue, these all come from the interaction between the organization and the customer who is using the mobile device. This view is therefore limited in understanding other areas of potential impact from mobile technologies. Scheepers and McKay (2004) introduced another value proposition - that of internal value for the organization as well as external value. The internal value proposition involves improving the effectiveness and efficiency of the staff within the organization through mobile computing. The external value is derived from the interaction of the staff using mobile computing and their clients (see figure 1). Based on these value propositions three types of outcomes can be identified: managerial, mobile staff and customer (or in this case patient).

Another way of conceptualising the internal value is described by Soh and Markus (1995) as the IT use process in which IT is used appropriately or inappropriately. The use of the technology has an impact on the organization and will ultimately have an impact on the performance of the organization. On the level of determining the impact of the introduction of electronic data interchange, Teo et al. (1995) conducted a study in which the efficiency and effectiveness was evaluated based on specific criteria related to the focal technology. The instrument that measured the impact of the technology identified three constructs: efficiency, effectiveness and satisfaction with features and price. These constructs need to be interpreted for the internal value of mobile technology. Scheepers and McKay (2003) based on a study conducted by AvantGo identified the following constructs specifically related to the use of mobile technology: user satisfaction (specifically focusing on data exchange quality, data exchange frequency and staff satisfaction), operational cost (eg. staff management, management of corporate information, management of operations) and organizational effectiveness (eg. staff effectiveness, increased effectiveness in management processes and client value).
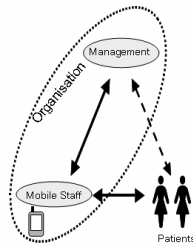
Figure 1: Mobile technologies enabling internal and external value propositions (Adapted from [33])

2.2 Use of information technology in healthcare

In this section, we review literature sources that have examined the use of information technology in health care, specifically focusing on the use of mobile technology in health care.

Healthcare is an information intensive industry. As noted by Cho and Choi (2003), the healthcare industry is facing constant challenges to provide healthcare professionals access to patient information wherever and whenever it is required. They say this access can be achieved through mobile computing [11]. Several recent studies have discussed the use of Personal Digital Assistants (PDAs) to document healthcare services at the point-of-care [6, 12, 21, 22, 29, 30, 34, 36].

With the exception of Brody et al (2001), the studies found that documenting healthcare interventions on PDAs provided an advantage over more traditional (ie paper-based) documentation methods. The advantages listed were:

- More complete and standardized documentation [12, 29, 34]
- greater efficiency [12, 34]
- more interventions recorded [12, 36]
- greater user satisfaction [12]
- increased visibility and recognition of work done by staff [22, 29].

The time taken to record an intervention was found to be about the same for both PDA and paper-based systems [12]. An additional advantage was the ability to generate reports on the data collected. Paradiso-Hardy et al (2003) stated that "unlike the paper-based system, the PDA based data collection sheet standardizes documentation and generates reports that are comprehensive and consistent" [29]. A limitation noted by Paradiso-Hardy et al (2003), however, was the limited view of data on the PDA.

However, there are challenges to achieving the above benefits in health care institutions. As Dickerson (2003) states, the implementation of IS systems "reflect a larger non-technical business-process change, but IT is

often the front-line messenger of such change" [15]. Even if the system produces productivity improvement according to objective measurements, the end-users will often complain that it slows them down. Dickerson (2003) suggests that the best way to alleviate this is to ensure that end-users get the training they need for the new system and also basic IT training.

Furthermore, it helps to have a healthcare professional system "champion" providing encouragement, training and support. Wolf (2003) outlines the reasons for a successful implementation of a CPOE (Computerized Physician Order Entry) system in a US hospital. They were detailed planning, executive commitment, a dedicated physician leading the effort, early-adopter physicians providing training to others, financial resources past implementation, and ongoing user support [43].

There is a growing interest in measuring performance across the health system [26]. As stated in the vision of the National Health Performance Committee in Australia:

"The vision of the NHPC is for a health system that searches for, compares, learns from the best and improves performance through the adoption of benchmarking practices across all levels of the system. Its goal is to extend the national performance indicator framework for services other than acute inpatient services to include not only indicators of the overall health system's performance, but also for services such as community health, general practice and public health". [p3, 26]

"Finding desperately needed answers to many important questions in EMS is hopeless without the development of new ways to collect, link, and analyze valid, meaningful information. This is the very foundation of the future of EMS!" Daniel W. Spaite, MD Cited in [27].

3. Research method

Case study research lends itself to the exploration of new areas of research [16] such as mobile computing. The research strategy allows for in-depth description of the relationships in context [5, 17]. The case research strategy was chosen here owing to the novelty of mobile technology applications within organizations and to examine individual use contexts in depth [44].

The case study used for this paper included forty-five in-depth, half-hour to one-hour interviews. These were held with a number of different stakeholders. The following are from the information systems group - the CIO of the Metropolitan Ambulance Service (MAS), the technical project manager of the VACIS system, the systems analyst of the VACIS system. There were interviews with Management – one with the Subject Matter expert for data for the VACIS system who was also Manager of the Clinical Support Officers and two with Clinical Support Officers. There were also interviews with twenty paramedics and two team

managers obtaining their views prior to using the VACIS system and then after they had been using VACIS for at least three months. The interviews were semi-structured and the participants were free to discuss the main issues/advantages of the mobile computing initiative from their perspective. Each participant signed a consent form giving permission to be interviewed and to have the interview audio-taped. The interview was then transcribed and the transcript was sent back to the participant for review.

The interview script was based on a similar study done in another healthcare organization and centred on the staff member's perceptions of VACIS – importance, ease of use, management support, advantages and disadvantages of use and the implementation process. The interviews were conducted over a 16 month period from late Nov 2005 through to mid Feb 2007. The management interviews were conducted mainly in December 2005. The paramedic interviews prior to using VACIS began late Nov 2005. Interviewing of main group paramedics for their views of VACIS after using it for a least three months are currently ongoing.

Interview details		
Number of interviews:	Formal interviews	45
	Informal interactions	7 VACIS training sessions
		7 meetings with MAS staff
Range of interviewees	Information systems group	3
	Management	2
	Clinical support Officers	2
	Paramedics ((before) and [after] implementation interviews)	Pilot group (12) + [12] = 24
		Main group (10) +[4] = 14

Table 1: Interview details

3.1 EMS mobile computing application – VACIS

The VACIS system records the clinical treatment of the patient and it is also an information tool containing Clinical Practice Guidelines, eMIMS drug reference, Clinical procedure animation and maps. It resides on a Panasonic Toughbook tablet PC in a magnesium alloy case with spill resistant keyboard. It had to be able to withstand the rigours of day-to-day use by paramedics and was tested to US military standards. The battery has a 3 to 3.5 hour life and can be recharged in the ambulance. Also spare batteries are available at the hospitals if required. It uses a digitized screen with a digitized stylus. Major hospitals have 802.11 wireless networked printers and each ambulance is equipped

with a Canon IP90 printer which uses Bluetooth software to print the case sheet from the toughbook within a five metre range. The toughbook can be used as a standard laptop with keyboard or can have the top swiveled into a tablet. Having access to a keyboard and mouse was very important to some of the paramedics, whereas others were quite happy to use the pen and tablet. The VACIS system is very intuitive and reliable and the paramedics have been happy with the usability and reliability of the system overall.

The MAS management and the Information Management group were keenly aware of the importance of acknowledging the needs of the paramedics when designing the VACIS system. They conducted extensive consultation with the paramedics and ran several focus groups working through the requirements for the VACIS system from the paramedics' perspective. As noted by the Emergency Operations manager: "*VACIS is designed by paramedics for paramedics*". [Int020, Feb 2006].

MAS were also keenly aware of the possible anxiety that some paramedics may feel towards VACIS so they had an in-depth training session for every paramedic who was part of the pilot group for the initial rollout of the VACIS system. Once the paramedic was trained, a nominated trainer would go out with the paramedic on their first shift immediately following training and work with them as they used the VACIS system for the first time.

4. Discussion

The discussion evaluates the internal value from the perspective of management and the paramedics in different roles. The comments of the interviewees in terms of the use of the mobile technology have been categorized into user satisfaction of staff (specifically focusing on data exchange quality, data exchange frequency and staff satisfaction), reduce operational cost due to the mobile technology use (eg. staff management, management of corporate information, management of operations) and increase organizational effectiveness due to the mobile technology use (eg. staff effectiveness, increased effectiveness in management processes and client value). The evaluation of the mobile technology from this perspective highlights a number of advantages and disadvantages. Table 2 gives a summarised view of the evaluation of the comments of paramedics and management. The criteria will be discussed in the next section with supporting quotations from interviewees.

Data Exchange quality (1)

Most paramedics acknowledge that the electronic PCR is more legible due to being typed rather than handwritten. They have indicated that the ePCR looks more professional. Some have said that they are writing more comprehensive records due to being required to put more information into VACIS.

> I think... the paperwork by far looks a lot more professional and hospitals you know.... staff don't

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have any problem reading it... I think.. from what I've heard of hospital staff and from other people it just, they picked up a case sheet and read through it, it just seems a little bit disjointed sometimes and its hard to find just a brief overview of the story.
Int017, Lines 69-73

With the old PCRs I would be writing information directly onto that. Whereas with this it is onto a notepad then putting it in later. It has helped me be a lot more accurate with my information recording and things like that. Like really keeping track of times and when things were done. And that sort of thing. I think that's made a big difference. And a lot more thorough ....history and symptoms and things like that too. So from that perspective I think it has really helped with my whole assessment of the patient.
Int017, Lines 241-247

I can see the benefits of standardization...of language.... I guess a lot of stuff is... that individuals write is open to interpretation and ....there's not a particularly standard way even in which we're taught to write PCRs. Everyone has their own little different method and all that sort of stuff... And obviously some people are better at it than others.
Int012, Lines 128-132

The data provided by the ePCR is standardised, following the same format. This has both advantages but also disadvantages. The advantage of this standardisation of the record is that it allows quick access to the relevant information as it is always in the same location and uses consistent terms.

'[The major advantages of using VACIS are] the clinical data research... the standardization of the MAS documentation so...you've got a legible ePCR [Patient Care Record] and ...the information is recorded in the same place and it is easy for the hospital to read and they know where to look for the information....as well as that you're streamlining the clinical definitions... so it's a method of documenting how you complete your case report... and everybody would need to conform to that standard and it raises the standard I think... the organization will have a well-documented case
Int005, Lines 343-349, 355-357

The disadvantage is that all the ePCRs look the same. The following comments from paramedics highlight this:

I think the negative is still consistent with my first thoughts and that is losing the character of the case sheet. Every patient is supposed to fit into a box and patients don't fit into boxes and you feel like you lose ownership of your case sheet because you can look at yours and you look at someone elses and there's absolutely no difference and once again you often are forced to refer to case sheets when you're writing statements and things like that..... years down the track even. And having something that doesn't trigger your memory is quite a big problem for me. In that case I've just been writing up other notes and keeping them ....So it's kind of doubling up.
Int028, Lines 59-67

'This is good in a way...in that it can... it looks impressive it's black and white.... but the subtlety's missing. And ... the detail is lost. I'd be much happier talking about a case I did 5 years ago... if I've got my handwritten notes in front of me ... than trying to.....What did the computer mean by that? .... It's a bit of a barrier..... It doesn't even sound like English. It's an alien thing. Nobody talks about Abdomen Generalised Cerviacal Spine Foot. Speak English. Be a useful tool to me.'
Int010, Lines 239-247

Although most paramedics acknowledge that the Patient Care Record is more legible due to being typed rather than handwritten, they have mentioned that it is not easy to read. Conflicting comments are made by paramedics about the use of the printed ePCR by emergency doctors and nurses. Some paramedics suggest that hospital staff briefly look at the ePCR and then putting it aside. The paramedics have suggested the reason for this is that emergency staff find it difficult to find the information they need quickly. This contradiction needs further research.

Clinical support officers, who have the responsibility for auditing the Patient Care Records for compliance with Clinical Practice Guidelines, have also mentioned the lack of "readability" of the electronic Patient Care record.

'With an electronic PCR I think there is a minimum .....sheets of information. Whereas [with paper] there is one large sheet which you can open out and I can glance from side to side... for example I can glance from those patient observations at a certain time and glance over at what the comments are on the other side. With the VACIS sheets I can't do that. I have to physically go from screen to screen I change the screen I have to physically remember what was on the other screen.'
Int040, Lines 148-154

'A couple of dozen paramedics at least have mentioned to me the.... inclination of ED [Emergency] doctors not to bother reading their printed version. Whereas previously to write in hand it was easy to do a concise,.... either a dot point format of what happened or to do a brief narrative and any ED doctor could pick up that document have a quick brief read and he's informed whereas they are telling me with VACIS they are not so inclined to do that.'
Int040, Lines 171-176

Data Exchange frequency (2)

The synchronisation takes place at the end of the shift. Compared to the previous paper based system it provides faster access and processing of the information.

Emergency Care Management (3)

Interview data from all roles identified that there has been an increase in the efficiency of the capturing of data. Data (such as time in Triage, off-stretcher and cleared) that was previously not captured due to the onerous nature is now captured with more ease.

Interview data from the management and information systems group interviews identified that there is potential for efficiency gains by reducing the amount of manual handling of PCRs for statistical analysis and for reduction Code 1 dispatches, which require "Lights and Sirens" and a response time of less than 15 minutes. The hope for the reduction in Code 1 dispatches and the tailored training encourages the paramedics to persist with VACIS. The following is an example of a statement made by an interviewee:

> *'(Easy) availability of data to improve response grid therefore decrease high number of unnecessary code 1 responses & dual responses (save money)'*
> Paramedic comment, May 2006

Management of corporate information (4)

The main advantage that has been realised by the introduction of VACIS has been the decrease in paper documentation. The ePCR is used for the processing of the accounts which directly relate to an increase in the speed with which PCR's can be accessed. The following quote indicate the ease with which ePCR's can be accessed.

> *'When VACIS was first introduced I actually thought it was a very smart idea..... But more it piqued my interest from a research perspective.... In that we would actually be able to trap the data. We can't trap the data now. Manual case sheet searching is... labour intensive and basically...isn't done very well.'*
> Int009, Paramedic, Lines 34-38

Management of operations (5)

The main impact of the introduction of VACIS on the management of operations has been the increase in infrastructure cost and cost associated with training all paramedics in MAS.

Staff effectiveness (6)

One of the main advantages of VACIS is that it can capture data (such as time in Triage, off-stretcher and cleared) that was previously not captured. Interview data from all roles identified the future potential of the data collected from the VACIS system to improve Clinical Practice Guidelines on evidence based practice data. This may then lead on to better patient outcomes. The following is an example of a statement made by an interviewee:

> *'It's not going to help me...when I go out to treat a patient today..... having that computer will make absolutely no difference but..... I know that the data collected from the computer will probably help that patient in five years time....because they'll be able to go - Oh look at all this interesting information and it might change what we do... but in the long term because of the research they'll be able to do as a result of the data then it will make a difference.'*
> Int015, Paramedic, Lines 97-103

Increased effectiveness in management processes (7)

VACIS requires that paramedics input all mandatory fields on the screen before they can progress to another screen. This has a very positive effect of the compliance to Clinical Practice Guidelines (MAS are now getting 100% compliance for mandatory content of PCRs). However some paramedics have mentioned that this interrupts the work flow for some paramedics.

> *'Some of the screens don't allow you to bounce between screens until you've finished that screen and that's so frustrating. On the [paper] PCR I used to jump here and everywhere which really suited me.'*
> Int030, Lines 82-87

> *'As far as treating the patient is concerned it's not changing that at all. If anything,it may hamper to a certain extent because we used to be able to treat patients and do your casesheet in the back of the truck fairly easily because..... mid-sentence you can stop and talk to the patient and then take a set of OBS [Observations], and then write down that set of OBS then keep writing what you were writing before but now what happens is that there a certain sections of the VACIS where you can't input other things until you have finished inputting what you were inputting. So if you are currently writing one thing and you stop to take a set of OBS you can't go to the OBS page to write them down, you have to write them on a piece of paper to remember or on your glove or what have you. So there's a lot of using paper to help remember things for when you get to hospital to write it into the VACIS. So you are doubling up on your writing. But you know........ it's here to stay for what I've been told so perhaps we will just have to get used to that.'*
> Int038, Lines 134-147

5. Analysis

Given the pressures that Emergency services globally are facing with increases in demand for their services it is becoming even more important to look for ways of improving the efficiency of the use of staff resources within EMS. The capture of various times throughout the life cycle of the "job" allows for deeper analysis of where the paramedic time is spent. All treatment procedures of the patient is recorded and the times the procedure was performed. This time-stamping of events provides valuable data for MAS.

During the interviews paramedics expressed the expectation that the collection of data made possible by VACIS will lead to more funding, updated equipment, improved clinical guidelines in line with evidence-based practice and tailored paramedic training.

Through evaluating the responses from paramedics and management we were able to identify the role that mobile computing plays in performing these processes. In general the mobile system provides the organizations means to capture data more effectively and an expectation was expressed that this will provide a basis for further and more effective use of the information for the activities of the organization.

The *Efficiency* dimension determines whether the care given was done in a cost-effective manner with optimal use of resources. Resource allocation is a constant challenge for EMS organizations. At MAS there are limited numbers of MICA ambulances and MICA trained personnel and therefore these resources need to be used judiciously. Part of the aim for VACIS is to capture clinical outcomes data and match this against the original dispatch code for the job. This will then feed back to the dispatch process so that the number of Code 1 responses are at an optimum level. As noted in quote below:

> *'It [VACIS] underpins a lot of things that we need to deliver in our strategic vision that we have for the organization....Trying to match resources to demand…It's a fairly finely balanced game that you play... so we have contact with the patients on the telephone... and we run through structured call taking on the telephone and so we know something of the patient based on .. the telephone conversation and then we dispatch resources to that patient based on what we know. Now in the past there have been studies to close that loop back. But you can only do that on the sample of the information you've got. Once you've got all the data there about all the cases you can close the loop back.'*
> Int004, Lines 135, 141-148

6. Conclusions

The Healthcare sector is an information intensive industry. The use of mobile technology supports this need through the provision of information and the capture of at 'point of care' information. In the case study, we found that the use of a mobile system enhances efficiency and effectiveness on various fronts and therefore delivers internal value for the organization.

Our study makes the following contributions. The case study indicates that the introduction of mobile systems can support ambulance services in providing more efficient and effective information that could potentially impact on their performance evaluation.

Second, the evaluation provides valuable insight into the advantages that can be gained by introducing a mobile system. In the case study it became apparent the mobile system can provide advantage to paramedics as well as the organization. The system enables the faster and easier capture of data that can be utilised for more effective management. Potential advantages for paramedics are: training, trialling of new techniques and the evaluation of these techniques. The mobile information system also provides a wealth of information that will enable the organization to more effectively manage their activities.

Third, the research highlights the advantages and disadvantages of the use of mobile technology in emergency services. There seems to be a delicate balance between internal data capture requirements versus external requirements of readability of the final electronic Patient Care Record which is used by hospitals

and occasionally as a reference document for cases which are presented in Court as explained in the effectiveness section. Some of the disadvantages can be addressed simply by changes to the software application, some of which have been implemented since the interviews took place. Furthermore, we suspect that some of the disadvantages might disappear altogether over time as users become more familiar with the use of the system.

The study has the following limitations. First, we interviewed the personnel of MAS and the views of other institutions or patients were not studied in this research. Second, the study was conducted in the Australian context. Research is needed to examine how the findings reported here manifest in different emergency services settings. Further longitudinal studies are needed to determine the long term effect the mobile system will have.

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Table 2: Evaluation of the investment (Legend: D = direct, I = indirect)

	User satisfaction	MAS	Mobile Impact
1	Data Exchange Quality	+ Patient Care Record Legibility + Standardised Patient Care Record - Loss of "the Story"	D D D
2	Data Exchange Frequency	+ Synchronisation at end of shift Data uploaded to head office and can be processed immediately rather than waiting for mail in	D
	Outcomes	*Nearly 100% adoption*	
	Reduce Operating Costs	MAS	Mobile Impact
3	Emergency Care Management	Data collection for Evidence Based practice and for tuning Dispatch code process.	D
4	Management of corporate information	+ Decrease paper documentation. + Less manual processing of PCR particularly for statistical analysis + Increase speed of PCR retrieval	D D D
5	Management of Operations	- Infrastructure costs increased - Large support cost for training and early use support for paramedics	D D
	Outcomes	*Too early to determine net position*	
	Increase organizational effectiveness	MAS	Mobile Impact
6	Staff Effectiveness	No change in capabilities of paramedics. There is however the possibility of the capturing of data to improve the skills that paramedics have.	-
7	Increased effectiveness in management processes	+ Potentially improved audit processes as Clinical Support Officers and Team leaders will have access to the online ePCRs. However this benefit is not being realized, currently due to the inability for auditors and team leaders to annotate the online record. + Improved Clinical practice guidelines as a result of statistical analysis of online PCRs.	D D
	Outcomes	*Too early to determine net position*	