

Exploring the Impact of Information System Introduction: The Case of an Australian Hospital Emergency Department

Abstract

In recent years, a large number of healthcare organisations have adopted information systems to improve their operations. An analysis of the existing literature shows that there is little concrete understanding about information systems' impact within the healthcare context. This study aims to improve the current understanding in the field by conducting an in-depth, exploratory study of the impact of IS in the healthcare industry. A longitudinal single case study was carried out in a major emergency and trauma centre in Australia, which just recently introduced a large scale IS. By focusing on a number of key work routines involved in the case organisation, this study gathered rich and deep insights into how the introduction of an advanced IS affects what healthcare professionals do as well as how they work and think. The findings of this study offer some important implications to both research and practice.

1. Introduction

To combat the rapidly rising demand for healthcare services, healthcare reforms are currently underway in numerous countries around the world, including the United States, Great Britain and Australia. These reforms are aimed at providing more efficient and effective healthcare services in a cost effective manner. One of the key ways to achieve this goal is through transforming healthcare operations by changing healthcare work routines. In this study, we define work routine as a repeated pattern of interdependent actions carried out by multiple organisational actors informed by a collection of deeply seated organisational knowledge. Work routines are fundamental to the operations of any organisation [1, 3-4, 50-51]. The daily enactment of work routines allows organisations to operate continuously, changing and adapting to the environment [2-7]. Consequently, transforming

organisational work routines is essential in reforming healthcare organisations.

Hospital Emergency Departments (ED) are on the top of most hospital reform agenda. Due to the highly dynamic work environment of the ED and its information intensive nature [8-9], Information Systems (IS) are considered to have significant potential in improving ED work routines. Further, because EDs are often the main entry point for many patients into the hospital system, getting the work routines 'right' can mean significant flow on benefits for the entire patient flow in hospitals. Getting it wrong can contribute to inefficient use of limited public health resources, such as unnecessarily tying up hospital beds. Finally, because so many patients admitted to ED's have been there before (approximately half are repeat patients to the hospital), the opportunity to use data wisely to speed along medical and administrative decision is significant.

It is expected that by introducing large scale IS to assist and change ED work routines, significant benefits can be gained in the forms of improved operational efficiency, more effective decision making and better quality of patient care. However, the introduction of information systems in the ED environment is plagued with difficulties. The failure rate (include system rejections, implementation failures and inability to achieve project goal) is reported to be as high as 91% [10]. As a result, investigating IS introduction and its impact on the ED work routines has immediate relevance in the current social context.

Despite the importance of IS in reforming healthcare, little concrete understanding about IS's impact on organisational work routines has been developed [11-15]. Only a small number of studies has invested the resources required to systematically investigate work routine changes. More studies are required to fully explore this rich field of study [46-47]. This study therefore aims to explore the impact

of IS on healthcare work routines through a longitudinal in-depth single case study. The main research question addressed is: *What are the consequences of introducing a new IS within Australian public hospitals?* For the purpose of this study, we conducted a 9-month longitudinal case study in one of the major Australian emergency and trauma centres, which recently introduced a large scale information system. As a result, this case site presents a rare opportunity to directly observe the impacts of IS on work routines. Continuous in-depth observations and interviews were conducted to collect study data and facilitate finding triangulation. By focusing on work routine, the study identifies a number of positive and negative consequences of the IS introduction in the case organisation.

This paper first presents a literature review to synthesise the existing knowledge in the field and highlight some knowledge gaps. A detailed account of research methodology is then provided and the findings are presented. Finally, the results are discussed and the paper is concluded.

2. Literature Review

Literature review shows that the most commonly investigated IS consequences in healthcare can be grouped into two main categories: performance and work routine. The main foci of investigation under the performance category include efficiency, cost savings, quality of patient care, error rate and work load. The work routine category includes documentation and communication. So far no general conclusion can be made regarding the consequence of IS introduction in healthcare for either of these categories.

2.1. IS Impact on Performance

First, operational efficiency is one of the most important issues healthcare industry is trying to address through IS introduction. A significant increase in healthcare service demand due to aging populations is pushing the healthcare service providers to their limits. As a result, the impact of IS on operational efficiency is of critical concern to most adopters. Yet, efficiency improvements are harder to achieve than expected. The ability of IS to impact on efficiency varies depending on the nature of medical work, the characteristics of the medical staff and the system itself. A number of studies have found that efficiency improvements are achievable through improved information flow, assisted administrative and clerical work practices as well as supported decision making processes [16–20]. These

studies pointed out that tangible efficiency gains can be achieved across different healthcare organisation types including hospital, clinics, EDs and healthcare networks by introducing a range of healthcare IS such as the EHR, Electronic Whiteboard and CPOE.

Meanwhile, a smaller set of studies have also highlighted some contradictory findings. First, these studies demonstrated that IS introduction does not automatically lead to efficiency gains. The new IS are found to cause different changes for different work processes and different users [21–23]. These mixed findings can be attributed to the dynamic social aspect of IS, which influences organisational consequences through ongoing social interaction.

Second, saving cost is a main driver for IS introduction in healthcare. It is hoped that by digitalising healthcare practices and documentations, cost savings can be achieved through cheaper and more effective test procedures, streamlined work processes and more effective delivery of patient care [20]. However, similar to efficiency, cost savings are difficult to obtain. The existing literature shows that while IS is capable of delivering savings in the production and storage of medical records, the IS investments, ongoing maintenance and higher resource requirements can offset the cost savings obtained [23–26]. Given the mixed results generated in existing research, calls have been made to treat IS projects not as a money saver but as a tool for promoting better patient care [24].

Third, improving the quality of patient care is the ultimate objective for the large majority of initiatives undertaken by healthcare organisations. Investments in IS are similarly made with patient care improvements in mind, and understanding the influence of IS on the quality of patient care is fundamental to the understanding of impact of IS on healthcare. The majority of findings from the existing empirical studies support IS's capability in improving the quality of patient care [17], [20], [24]. Such improvements can be attributed to improved timely delivery of patient care [16], [27], [28], better patient education [29], [30], more effective decision making [28], [30], [31] and improved doctor-patient relationship [32].

Despite these seemingly consistent findings, no empirical healthcare IS studies conducted so far has offered a clear definition of patient care and proposed a systematic framework to guide its measurement. Measuring medical performance and the quality of patient care has always been a challenging issues to address in the field of medicine as demonstrated by a large of body of literature devoted in the assessment of medical performances [27], [33–39]. Without a clearly defined conceptualisation of patient care

quality, the reliability and validity of these studying findings are significantly discounted. In addition, given the small number of empirical studies conducted so far, it is still too early to make any conclusions about the influence of IS on patient care quality.

Fourth, IS's impact on medical staff's work load is of significant concern for most healthcare organisations. Medical staff members are known to shoulder one of the heaviest workload in any industry and the consequent work related stress and pressure poses major concerns for the wellbeing of the medical staff members. Reducing workload is another main objective of introducing IS. The literature review shows that only two studies identified a reduction in workload after IS introduction, while another two found an increase in workload. The increased complexity in daily work practices, especially clerical and administrative work is regarded as the main culprit of workload increase [17], [40].

Finally, medical errors are one of the most important issues that healthcare organisations have to tackle. Reducing error rates can directly improve the quality of patient care and patient safety. It is expected that IS can help reduce the medical error rate through embedded error checking mechanisms, integrated data storage and presentation services. Again, the literature reviewed paints a mixed picture of IS's influence on error rate. Two studies reached positive conclusions [19], [22] while the other two discovered negative influences [20], [41]. It was argued that despite the ability for IS to improve data validation and presentation, IS can introduce medical errors during data entry, communication and coordination of the processes that are supported by the system [41]. A study conducted by Yusof et al. (2008) further highlighted the divergent influences of IS.

2.2. IS Impact on Work Routine

Work routines also play an important role in facilitating the delivery of medical care in healthcare organisations. Work routines such as documentation, communication, test ordering, patient consultation, information processing etc. are usually carried out in a standardised and structured fashion. It is through these work routines, healthcare organisations are able to function consistently and efficiently. However, only two work routines have been briefly examined by the existing literature while investigating the performance impact of IS. They are the documentation work routine and the communication work routine.

Given the nature of medical work, documentation plays a significant role in the facilitation of continuous medical care provision across different medical providers over lengthy time periods. Documentation is a fundamental part of medical work process and influences the smooth delivery of patient care in a timely manner. The digitalisation of documentation activities through IS has been shown to positively affect the legibility of medical records [18], [19]. However, the accompanying changes in documentation activity can also produce negative impacts on documentation quality. Doctors' objections to typing have been frequently quoted as one of the main obstacles to the acceptance of IS [40], [42], [43]. As a result, depending on which medical staff is involved in the study, the level of IT/typing skills of the staff, and the type of documentation, the attitude of the medical staff may differ in different studies, resulting in different impacts of IS on documentation.

Second, effective communication drives the daily operation of any healthcare organisation. Communication plays a pivotal role in information intensive organisations such as hospitals. Information systems as a suite of technology with a focus on the gathering, processing and distribution of information can have significant and direct impact on the way medical staff members communicate. As expected, the ability of IS to improve information access and distribution has received consistent acknowledgement from the existing empirical studies that examine communication factor. IS introduction has been found to improve both written and verbal communication through better document legibility, more timely information update and easier information access [16–18], [20]. It is also interesting to note that despite the additional avenues of communication offered by IS, face-to-face communication was found to persist. This highlights the personal and tightly coupled nature of medical work [17].

2.3. Research Gap

The literature review demonstrated two research gaps. First the inconsistent findings highlighted the weakness of current performance-focused investigations. These inconsistent findings can be attributed to different studies adopting different study foci to measure performances as well as conducting their investigations at different points in time. Currently, there is no commonly agreed upon investigation focus for measuring organisational performances in the field. As a result, directly examining organisational performances is too early

given the current state of literature. In order to advance the current understanding in a systematic manner, it is important to first go to the root of the organisational operation, namely work routines. By focusing on work routines, we argue that a clearer and more reliable understanding about the impact of IS can be developed. This knowledge will in turn facilitate more effective performance studies in the future.

Second, current understanding of IS enabled work routine change is fragmented at best. Such fragmentation can be attributed to the research approach and focus. The majority of the existing studies adopted a static approach in investigating the work routine impact of IS [16],[21-22]. This approach is not sufficient to address the emergent nature of the IS consequences. Consequently, it can lead to inconsistent findings depending on the time the investigations are conducted. Furthermore, very few of the existing studies reviewed have a clear definition and conceptualisation of work routine in their studies, which further fragments the findings in the field. In order to provide better guidance to the current explosion in healthcare IS projects, systematic in-depth investigations on IS enabled work routine change need to be carried out.

3. Research Methodology

This study is exploratory in nature. A longitudinal single case study approach is adopted to answer the proposed research question. This study was carried out over a period of 9 months in one of the major emergency and trauma centre in Australia which is referred to as ED-A in this paper (Ethics Approval ID: QA2010094). This case study tracks the introduction of an advanced emergency department information system (EDIS) in ED-A and its impact on work routine changes. The case study was structured into four main phases namely the preliminary phase, observation phase, interview phase and validation phase as illustrated in figure 1. Observations and interviews are used as the main data collection techniques. The main study targets are the Duty Consultants (DC), Resuscitation Consultants (RC) and Floor Coordinators (FC).

The preliminary phase started in April 2010, approximately four months after the EDIS was rolled out in the department. The decision not to start the investigation immediately after implementation was made based on two main reasons. First, due to the scale of the project, the system introduction can cause extreme volatility in the organisation immediately after the rollout. The resulting change in behaviour has been proven to be a temporary phenomenon that

will dissipate quickly. Second, it was determined that conducting investigations right after EDIS introduction will have detrimental impacts on ED staff members' work. As a result, it was decided that study should start only when the ED operation resumed some sort of normality and the green light was given by the ED director.

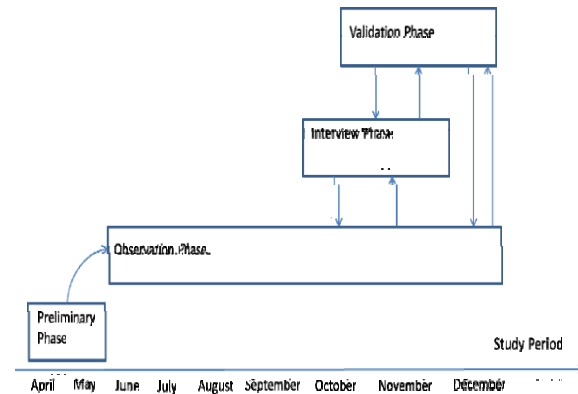


Figure 1. Four study phases and their timeline

The first phase has three main purposes. First, it allows us to gain detailed understanding of the study site. Second, it helps us to schedule the main study. Lastly, this preliminary phase is useful for the primary researcher to master the shadowing technique to ensure the accuracy of data collected during the main study period.

The second phase (observation) covers the period from June to December 2010. It is designed to directly identify the changes caused by IS introduction. In order to paint a picture of work routine transformation, observations were carried out in two-hour sessions throughout the entire study period. In total, 400 hours of direct observation were carried out, generating over 120 pages of field notes.

The third phase (interview) started from October and lasted until the end of November when new work routines have become largely established in the organisation. This phase allowed direct examination of the transformations from the users' point of view in a retrospective manner. Overall 20 interviews were conducted to cover all full-time senior consultants and the majority of Floor Coordinators (FC) observed during the investigation period. The interview questions were developed following the interview protocol aiming to explore the impact of EDIS on work routines over the investigation period. At the same time, the actual questions asked during the interviews were also tailored to each interviewee according to their specific personality, role, background and work preferences that the student researcher was able to learn during months' of shadowing. Findings generated during the

observations also informed the development of interview questions to explore issues that were not anticipated in the research model. All these interviews were recorded and transcribed by the primary researcher for further analysis. Through direct interactions with the study targets, the interviews provide better insights about the medical staff members' behaviours and opinions.

The validation phase did not have an exact starting point as it was closely integrated into the observation phase and interview phase. During this period, an additional set of 10 casual interviews were conducted when the research targets were on breaks. These casual interviews clarified puzzling observations and verified the interpretation of observed phenomenon. In addition, the results of the observations and the interviews can also validate each other through triangulation. Hence, the research validation was a continuous process throughout the investigation period. It constantly provided feedback to the ongoing research effort to enable more reliable data collection.

All interview transcripts and fields notes were compiled and analysed using open, axial and selective coding for several rounds. Meetings were carried out with all the research team members throughout the data analysis period to continuously verify the coding technique and interpretations of findings. Codes and themes were analysed and discussed at the team meetings to ensure the validity of the findings generated.

4. Study Findings

Overall, the introduction of EDIS changed the way ED-A staff members process information, prioritise task, write documentation and communicate. The following section discusses the detailed changes in each of these work routines. Table 1 summarises both positive and negative consequences to the work routines investigated in this study. As shown in the table, the introduction of EDIS has positively affected most of the work routines, except for the task prioritisation.

Table 1. Work Routine Changes

Work Routine	Consequences	Work Group
Information Access and Processing	(+) easy information access (+) no information loss (+) less time spent on information searching (-) increased demand for statistical interpretation (-) focus more on	DC and FC

	information than on patients (-) increased statistical analysis work load	
Task Prioritisation	(-) increased pressure to prioritise throughput (-) increased mental load with competing priorities of patient care vs. discharge time	DC, RC and FC
Communication	(+) use computer to facilitate communication (+) reduce progress update discussion and increase problem discussions (+) more effective communication (+) better problem solving through discussion	DC, RC and FC
Documentation	(+) rationalised note-taking approach (+) reduce mental processing load (+) improved patient history accuracy (+) shorter and easier to read medical notes (-) heavier documentation workload (-) longer documentation time	DC and RC
Legend:	DC: Duty Consultant RC: Resuscitation Consultant FC: Floor Coordinator	

4.1. Information Processing

Due to the dynamic and highly information intensive nature of the ED work, ED-A staff members were constantly under pressure to process large amount of information to guide their ongoing work practices. EDIS as an information-centric computer system hence had direct impact on how ED-A staff members process information during their work. In ED-A, it was found that as a result of EDIS introduction, changes occurred on how users obtain their information and how they process the information to produce meaning.

Overall, the EDIS management was successful in selling EDIS as the central point of information access. It collects immense amount of information and allows ready access of this information by anyone with system access. The centralisation of information collection, storage and distribution quickly gained widespread acceptance among the ED-A staff. Losing patient notes was no longer a problem and everything is just a click away. The

information access benefit of EDIS was widely recognised by all work groups in ED-A as revealed in the following quotes.

“Because all the information is on the screen. Notes do not go missing as often, you don’t have to look for a note, that’s improved” (Dr. G)

And

“... Accessing information is all there, at a click of a finger. There is no doubt about that.” (Nurse F)

This ease of information access hence caused a change in the information gathering behaviours of the staff members. They are no longer required to walk around the department to find and gather information. ED-A staff members became increasingly dependent on the EDIS and were spending increasing amount of time in front of computer screens. This increased focus on computers worried some medical practitioners. It was believed that this new information access approach is detrimental to medical care delivery. By eliminating or otherwise reducing the need for making personal contacts while gathering information, the quality of patient care can be compromised. This sentiment is especially prominent among the nursing group as reflected in the following quote by Nurse F:

“You check what has been done and what hasn’t been done in front. Sometimes the workflow is such that you forget about them needing help.”

Changes in the way information is presented and accessed also transformed how ED-A staff members interpret information. Previously, information is stored in a variety of formats such as paper charts, diagrams, hand drawings and short notations. The introduction of EDIS digitalised all these information and put it into numeric form. Consequently, ED-A staff also changed their approach and focus when interpreting information. Before the introduction of EDIS, ED-A staff members were used to form their interpretations based on a range of visual, audio and statistical information. After the introduction of EDIS, majority of information was translated into numbers and were presented through on-screen tables. As a result, ED-A staff were forced to change their habit of information interpretation. They relied more heavily on their statistical skills after EDIS introduction and became increasingly data driven as EDIS became more integrated in the department.

4.2. Task Prioritisation

The area of task prioritisation is also heavily impacted by EDIS introduction. The way information is presented and highlighted in the system as well as the design of the EDIS work process has significant impact on users’ perception of their work focus. After

EDIS introduction, department throughput became one of the most important foci of daily operations. This change was observed to be universal across all three work groups studied.

Towards the end of the observation period, permanent changes in the task prioritisation routine can be detected. ED-A staff members became increasingly pressured to prioritise tasks based on competing priorities of patient care quality versus discharge time. In addition, the dilemma of delivering patient care fairly or delivering patient care to optimise statistical performance became a common issue that ED-A senior staff had to deal on a daily basis. This change pushed the ethical standard of the medical professionals and had a significant detrimental impact on the quality of patient care if not managed properly. From the following quotes, the shift in the task prioritisation process is quite evident.

“I have become more conscious of my statistics and my throughput. So this is the impact on my work” (Nurse. F)

And

“It is difficult, do you deliver fair care to patients who are already behind schedule, which won’t make any more difference to the statistics once they get pass the limit, or do you just ignore the already delayed patients and treat newer patients so that they can be discharged in time? It can make the statistics look better, but it is not fair for the patients.” (Dr. M)

Although this change in work routine can be regarded as fundamentally rooted in political pressure, EDIS played a significant role in promoting this political pressure in ED-A daily work operations. Things such as the prominent display of a treatment time counter heightened the awareness of patient treatment time and in turn, fed into the sense of urgency in discharging patients within the specified timeframe.

4.3. Communication

Communication is a critical part of ED operation as it is crucial to the continuous delivery of the majority of patient care. Communication practices also went through significant transformations after EDIS introduction. In this section, “communication” only refers to verbal communication as written communication is addressed in the next section (Documentation). It was found that communication practices changed in communication type and dynamics.

Firstly, after the introduction of EDIS, there was a change in what ED-A staff members talk about. As EDIS collates and distributes large amount of information, ED-A staff members are able to obtain real time updates on the progress of different events. This functionality of EDIS reduced the need for ED-A staff to conduct verbal communications in order to know what is going on. Instead, they are able to communicate more effectively to follow up on the situation if necessary without wasting time trying to understand what is happening. As a result, EDIS introduction caused a reduction in “problem identification” and “progress update” type of communication while “problem discussion” type of communication events increased as problems were readily identified and responded to. This change in communication type is evident in the following quote:

“What you really want to know is that why there is a delay. So prior to that it is more they didn’t sort of know of that information I suppose.” (Nurse B)

Secondly, EDIS as the central hub for information access transformed the communication dynamics in ED-A. Through daily interactions with the system, ED-A staff members, especially the duty consultants (DCs) and resuscitation consultants (RCs) quickly discovered the advantages EDIS offered in facilitating communications. Over time, EDIS was regarded as the key point of reference during conversations and discussions, which in turn changed the ED-A communication dynamics. Toward the end of the investigation period, increasing proportions of the communication events became centred on EDIS, with EDIS driving the progress of case discussions and presentations. EDIS is unanimously regarded as a reliable source of information and helps improve the communication effectiveness. This change is highlighted in the following quotes:

“...because you know what you are looking for and what to look for, and from that point of view, communication is much easier because you have all the stuff.” (Dr.D)

“With the interns, they tend to have this long drawn out story, it is often quicker just to flick through and have a scan of the ENote rather than have to listen to their story. I guess it does help” (Dr.C)

4.4. Documentation

The introduction of EDIS moved the entire documentation process onto the computers. Instead of writing clinical notes on different paper forms, all notes are keyed straight into the EDIS through the documentation module. The general lack of typing

capabilities as well as the heavy documentation work load made this transformation especially taxing for the doctors. As a result, a set of new documentation processes and languages were developed to cope with the documentation challenges.

Before the introduction of EDIS, patient histories were written by hand after consultation. Patient details were committed to each doctor’s memory during consultation and written out on paper afterwards. It was also a common practice to batch process patient histories when the department was busy. DCs and RCs tended to conduct consultations with several patients in a row and document their patient histories together in a batch. This practice helped them to streamline their work practices and improve work efficiency. In the post-EDIS department, doctors and nurses were forced to use EDIS for documentation. The need to flip through different screens to find the right patient and the demand to re-login when switching between tasks negated the efficiency of the batch processing technique. To address these changes, new documentation processes were developed over time. Patient histories and medication details were no longer written after the consultation. Instead a “contemporaneous note-taking” approach was adopted by ED-A staff where patient histories and notes were typed in during consultation. This adaptation eliminated the need to memorise patient conditions and medication histories, and in turn helped reduce the mental processing load of the doctors. Such practice also improved the accuracy of history documentation by allowing the medical staff members to double check entries during consultation to ensure the completeness of histories recorded.

In addition to the development of a contemporaneous note taking approach, the formats and vocabularies used to document information were also changed. Medical staff especially the DCs and RCs was observed to shorten their notes to compensate for their slower typing speed. Over a period of experimentation and adaptation, they were able to successfully rationalise their note taking where the same amount of information is conveyed through shorter notes. This new form of note taking has been a successful new work norm where notes are shorter and easier to read but contain the necessary information, as indicated below:

“They might be writing less, but the information I need is still there. Maybe they have become more efficient at writing chest clear and abdomen soft...And I think they may be become more succinct in what they do. Yeah I actually find the information easier to read” (Nurse D)

In addition, EDIS also triggered the development of a new set of vocabulary in the department. ED-A staff developed a set of words and acronyms that they were comfortable to use over time in reflection of the post EDIS work environment. This phenomenon was particularly prominent in written communications. Acronyms were developed to facilitate speedier typing and more efficient communication. The development of different acronyms was individually based, driven by different individual needs. As one nurse put it:

“I cheat, I use shorten form. Hopefully the organisation will accept the abbreviations...you condense the information rather than type a lot of irrelevant information” (Nurse A)

5. Discussion and Conclusion

By conducting a longitudinal case study tracking the development work routine changes over time, this study is able to obtain an in-depth understanding about the consequences of IS introduction on work routine that is currently lacking in the healthcare literature. This study shows that EDIS can have a range of impacts on various work routines. EDIS was found to have both positive and negative impacts on various work routines investigated. It improves information access while at the same time shaping the way doctors and nurses prioritise their work tasks. As the main source of information, EDIS influences how ED staff members interpret their working environment and consequently evaluate the importance of various tasks. By varying the way information is presented and highlighted in EDIS, the work focus of ED staff members can be changed. In the case of ED-A, highlighting the throughput statistics in EDIS encouraged the ED-A staff members to focus more on meeting key performance index. This finding reveals a novel insight into one of the dynamic ways in which the design of IS can impact medical work. It highlights the importance of managing the information presentation through IS to foster the development of desirable work focus.

In addition, no negative impact was identified for communication work routine after the introduction of EDIS. This finding confirms the findings of other studies [16–18], [20]. It further highlights the key advantage of IS in facilitating better and more effective communication. Lastly, we found that EDIS has different impacts on documentation work routine. While it is able to trigger the development of a more effective documentation practice, it also increased the documentation workload. This finding also confirms the mixed findings from the existing studies [23], [40].

Overall, this study generates makes following contributions. Firstly, this study demonstrates that the introduction of IS can have a wide range of impacts on a variety of daily work routines. These changes in work routines are directly linked with the performance of the organisation. Some work routine changes can improve performance (e.g. improved communication and improves patient care quality) while others can undermine performance (e.g. increased focus on throughput undermines patient care quality). Hence this study highlights that IS do not have deterministic impact on work routines. In order to effectively study the consequence of IS introduction, we first need to address the dynamic and emergent nature of the impact of IS [1], [11], [44], [45]. Investigations focused on the development process of routine change can be very beneficial. It further explains why inconsistent and mixed findings exist in the existing literature. Depending on the angle and target of investigation researchers adopted to conduct their studies, different studies can produce different results.

Thus, this study has demonstrated the advantage of studying work routines while investigating the consequence of IS. By focusing on the most fundamental unit of organisational operation, a clearer and more complete picture of the impact of IS can be generated. The detailed insights revealed by work routine studies can help researchers and practitioners pin-point the actual impact of IS on the daily operations of the organisation. Such detail and precision afforded by work routine studies can help organisations identify the source of the problem and better achieve performance improvements. Direct performance investigations on the other hand cannot detect the counter-acting influence of IS on different work routines, and consequently is less useful to the researchers and practitioners.

Furthermore, the work routine changes described in this study contribute to the understanding of the consequences of IS introduction in healthcare organisations. While majority of the existing literature only investigates IS’s impact on how people work, this shows that the introduction of IS can also change what people do and how people think across the organisation. Consequently, IS introduction can have far reaching consequences. This study has highlighted a wide range of operational consequences of IS introduction through a systematic investigation. The findings can therefore help consolidate and improve the existing knowledge in the field.

This study has two main limitations. First, it only offers a single case in investigation the impact of IS introduction on clinical work routine. Thus, the generalizability of the findings is limited to a certain

extent. However, since it is not easy to access a research site that has just introduced a new large scale IS, through this in-depth, longitudinal study, useful observations have been obtained regarding the consequences of IS on clinical work routine. Second, due to resource constraints, data was only collected for a 9 months period. Given the long-term orientation of the work routine change process, the length of this study may have only covered a section of the development process. Although by the end of the investigation period, ED-A appear to have settled into a new set of work routines, it is still desirable to conduct the investigation over a longer period to confirm the study findings and gain more insights. For example, it would be interesting to see how the impact of EDIS on task prioritisation changes over time to address the current issue with patient care quality. Therefore, for future studies, more longitudinal work routine investigations are needed to expand the current understanding about organisational impacts of IS. Such studies can be done within the same case organisation or in other contexts.

6. References

- [1] H. Karsten and M. Jones, "Giddens's Structuration Theory and Information Systems Research," *Management Information Systems Quarterly*, vol. 32, no. 1, Oct. 2008.
- [2] M. S. Feldman, "A performative perspective on stability and change in organizational routines," *Ind Corp Change*, vol. 12, no. 4, pp. 727–752, Aug. 2003.
- [3] S. Ranson, B. Hinings, and Royston Greenwood, "The Structuring of Organizational Structures," *Administrative Science Quarterly*, vol. 25, no. 1, pp. 1–17, Mar. 1980.
- [4] M. D. Cohen, R. Burkhart, G. Dosi, M. Egidi, L. Marengo, M. Warglien, and S. Winter, "Routines and Other Recurring Action Patterns of Organizations: Contemporary Research Issues," *Ind Corp Change*, vol. 5, no. 3, pp. 653–698, Jan. 1996.
- [5] M. S. Feldman and A. Rafaeli, "Organizational Routines as Sources of Connections and Understandings," *J Management Studies*, vol. 39, no. 3, pp. 309–331, May 2002.
- [6] P. K. Manning, "Organizational Work: Structuration of Environments," *The British Journal of Sociology*, vol. 33, no. 1, pp. 118–134, Mar. 1982.
- [7] E. Hutchins, "Organizing Work by Adaptation," *Organization Science*, vol. 2, no. 1, pp. 14–39, 1991.
- [8] L. Lapointe and S. Rivard, "A Multilevel Model of Resistance to Information Technology Implementation," *Management Information Systems Quarterly*, vol. 29, no. 3, p. 6, 2005.
- [9] W. L. Currie and M. W. Guah, "Conflicting institutional logics: a national programme for IT in the organisational field of healthcare," *J Inf Technol*, vol. 22, no. 3, pp. 235–247, Jul. 2007.
- [10] D. Maxfield, "A Healthcare Manager's Guide to Predicting and Preventing Project Failure," 2007. [Online]. Available: <http://www.healthleadersmedia.com/content/LED-92858/A-Healthcare-Managers-Guide-to-Predicting-and-Preventing-Project-Failure.html>. [Accessed: 25-Mar-2011].
- [11] M. L. Markus and D. Robey, "Information Technology and Organizational Change: Causal Structure in Theory and Research," *Management Science*, vol. 34, no. 5, pp. 583–598, May 1988.
- [12] S. Sahay and D. Robey, "Organizational context, social interpretation, and the implementation and consequences of geographic information systems," *Accounting Management and Information Technology*, vol. 6, no. 4, pp. 255–282, 1996.
- [13] W. J. Orlikowski, "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development," *MIS Quarterly*, vol. 17, no. 3, pp. 309–340, Sep. 1993.
- [14] W. J. Orlikowski, "Improvising organisational transformation over time: A situated change perspective," *Information Systems Research*, vol. 7, no. 1, pp. 63–92, 1996.
- [15] I. Ignatiadis and J. Nandhakumar, "The impact of enterprise systems on organisational resilience," *Journal of Information Technology*, vol. 22, pp. 36–43, 2007.
- [16] M. J. Ball and J. Lillis, "E-health: transforming the physician/patient relationship," *International Journal of Medical Informatics*, vol. 61, pp. 1–10, 2001.
- [17] D. J. France, S. Levin, R. Hemphill, K. Chen, D. Rickard, R. Makowski, I. Jones, and D. Aronsky, "Emergency physicians' behaviours and workload in the presence of an electronic whiteboard," *International Journal of Medical Informatics*, vol. 74, pp. 827–837, 2005.
- [18] C. P. Schade, F. M. Sullivan, S. de Lusignan, and J. Madeley, "e-Prescribing, efficiency, quality: Lessons from the computerisation of UK family practice," *Journal of American Medical Informatics Association*, vol. 13, pp. 470–475, 2006.
- [19] T. R. Cunningham, E. S. Geller, and S. W. Clarke, "Impact of electronic prescribing in a hospital setting: A process-focused evaluation," *International Journal of Medical Informatics*, vol. 77, pp. 546–554, 2008.
- [20] B. Chaudhry, J. Wang, S. Wu, M. Maglione, W. Mojica, E. Roth, S. C. Morton, and P. G. Shekelle, "Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care," *Annals of Internal Medicine*, vol. 144, pp. E12–E22, 2006.
- [21] B. Hakes and J. Whittington, "Assessing the impact of an electronic medical record on nurse documentation time," *Computers, Informatics, Nursing*, vol. 26, no. 4, pp. 234–241, 2008.
- [22] A. Virapongse, D. W. Bates, P. Shi, C. A. Jenter, L. A. Volk, K. Kleinman, L. Sato, and S. R. Simon, "Electronic health records and malpractice claims in

- office practice,” *Archives of Internal Medicine*, vol. 168, no. 21, pp. 2362–2367, 2008.
- [23] M. M. Yusof, A. Papazafeiropoulou, R. J. Paul, and L. K. Stergioulas, “Investigating evaluation frameworks for health information systems,” *International Journal of Medical Informatics*, vol. 77, pp. 377–385, 2008.
- [24] C. Goodman, “Savings in electronic medical record systems? Do it for the quality,” *Health Affairs*, vol. 24, no. 5, pp. 1124–1128, 2005.
- [25] S. Devaraj and R. Kohli, “Information Technology Payoff in the Health-care Industry: A Longitudinal Study,” *Journal of Management Information Systems*, vol. 16, no. 4, pp. 41–67, 2000.
- [26] R. Hillestad, J. Bigelow, A. Bower, F. Girosi, R. Meili, R. Scoville, and R. Taylor, “Can electronic medical record systems transform health care? Potential health benefits, savings, and costs,” *Health Affairs*, vol. 24, no. 5, pp. 1103–1119, 2005.
- [27] K. W. Kizer, “Establishing health care performance standards in an era of consumerism,” *Journal of the American Medical Association*, vol. 286, pp. 12163–1217, 2001.
- [28] D. E. Burke, B. B. L. Wang, T. T. H. Wan, and M. L. Diana, “Exploring Hospitals’ Adoption of Informaion Technology,” *Journal of Medical Systems*, vol. 26, no. 4, pp. 349–355, 2002.
- [29] N. Menachemi, R. M. Perkins, D. J. van Durme, and R. G. Brooks, “Examining the adoption of electronic health records and personal digital assistants by family physicians in Florida,” *Informatics in Primary Care*, vol. 14, pp. 1–9, 2004.
- [30] D. H. Gustafson, R. Hawkins, E. Boberg, S. Pingree, R. E. Serlin, F. Graziano, and C. L. Chan, “Impact of a patient-centered, computer-based health information/support system,” *American Journal of Preventative Medicine*, vol. 16, no. 1, pp. 1–9, 1999.
- [31] Y. Denekamp, “Clinical decision support systems for addressing information needs of physicians,” *Israel Medical Association Journal*, vol. 9, pp. 771–776, 2007.
- [32] T. Dewett and G. R. Jones, “The role of information technology in the organization: a review, model, and assessment,” *Journal of Management*, vol. 27, no. 3, pp. 313–346, Jun. 2001.
- [33] D. H. Thom, R. L. Kravitz, S. Kelly-Reif, R. V. Sprinkle, J. R. Hopkins, and L. V. Rubenstein, “A new instrument to measure appropriateness of services in primary care,” *International Journal for Quality in Health Care*, vol. 16, no. 2, pp. 133–140, 2004.
- [34] O. Solon, K. Woo, S. A. Quimbo, R. Shimkhada, J. Florentino, and J. W. Peabody, “A novel method for measuring health care system performance: experience from QIDS in the Philippines,” *Health Policy and Planning*, pp. 1–8, 2009.
- [35] P. L. Dassow, “Measuring performance in primary care: What patient outcome indicators do physicians value?,” *Journal of the American Board of Family Medicine*, vol. 20, pp. 1–8, 2007.
- [36] P. H. Parkerton, D. G. Smith, T. R. Belin, and G. A. Feldbau, “Physician performance assessment - Nonequivalence of primary care measures,” *Medical Care*, vol. 41, no. 9, pp. 1034–1047, 2003.
- [37] E. F. Wenghofer, A. P. Williams, D. J. Klass, and D. Faulkner, “Physician-patient encounters: the structure of performance in family and general office practice,” *The Journal of Continuing Education in the Health Professions*, vol. 26, pp. 285–293, 2006.
- [38] P. Qvist, L. Rasmussen, B. Bonnevie, and T. Gjørup, “Repeated measurements of generic indicators: a Danish national program to benchmark and improve quality of care,” *International Journal for Quality in Health Care*, vol. 16, no. 2, pp. 141–148, 2004.
- [39] R. B. Hays, H. A. Davis, J. D. Beard, L. F. M. Caldon, E. A. Farmer, P. M. Finucane, P. McCrorie, D. I. Newble, L. W. T. Schuwirth, and G. R. Sibbald, “Selecting performance assessment methods for experienced physicians,” *Medical Education*, vol. 36, pp. 910–917, 2002.
- [40] F. Pourasghar, “Factors influencing the quality of medical documentation when a paper-based medical records system is replaced with an electronic medical records system: An Iranian case study,” *International Journal of Technology Assessment in Health Care*, vol. 24, no. 4, pp. 445–451, 2008.
- [41] J. S. Ash, M. Berg, and E. Coiera, “Some unintended consequences of information technology in health care: The nature of patient care information system-related errors,” *Journal of the American Medical Informatics Association*, vol. 11, pp. 104–112, 2004.
- [42] N. Hoffman and R. Klepper, “Assimilating new technologies: The role of organisational culture,” *Information Systems Management*, vol. 17, no. 3, pp. 1–7, 2000.
- [43] E. Reuss, M. Menozzi, M. Buchi, J. Koller, and H. Krueger, “Information access at the point of care: what can we learn from designing a mobile CPR system?,” *International Journal of Medical Informatics*, vol. 73, pp. 363–369, 2004.
- [44] G. DeSanctis and M. S. Poole, “Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory,” *Organization Science*, vol. 5, no. 2, pp. 121–147, May 1994.
- [45] D. Robey and M.-C. Boudreau, “Accounting for the contradictory organizational consequences of information technology: Theoretical directions and methodological implications,” *Information Systems Research*, vol. 10, no. 2, p. 167, 1999.
- [46] T. Greenhalgh Role of routines in collaborative work in healthcare organisations. *British Medical Journal*. 337(1), 2008
- [47] J.M. Goh,G. Gao and R. Agarwal. Evolving work routines: Adaptive routinization of information technology in healthcare. *Information Systems Research*, 22(3), 565 -585, 2011
- [50] B. T. Pentland and H. H. Rueter, “Organizational Routines as Grammars of Action,” *Administrative Science Quarterly*, vol. 39, no. 3, pp. 484–510, Sep. 1994.
- [51] B. T. Pentland, “Sequential Variety in Work Processes,” *Organization Science*, vol. 14, no. 5, pp. 528–540, Oct. 2003