

Perspectives of Success and Failure in Healthcare Information Systems: An Evaluation of Existing Theories and Models

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The phenomena of successful or unsuccessful implementations of healthcare information systems have been widely discussed. In fact, there is very often a dichotomy if the new implemented information and communication technology is a success or failure or even both at the same time. This literature review therefore compares success theories, models and frameworks in the healthcare industry and how these theories are applied in the field to evaluate a healthcare information system implementation. It starts with a discussion of the definition of success (and respectively failure), gives an overview of different schools of thought in the healthcare industry and finally critically compares success theories and models with each other. The outcome shows that the success and failure of a healthcare information system cannot be analysed by only one theory or factor but needs many interrelated and emergent factors.

Introduction

Successful implementation of information and communication technologies (ICT) in complex organisations such as hospitals has been a source of much research and claimed as one of the most challenging and promising research areas (Reinhold, 2006). It is evident that ICT in hospitals offer tremendous opportunities to reduce clinical errors, increase efficiency and improve quality of patient care (Ammenwerth *et al.*, 2003). At the same time, however, many challenges such as complete failures or resistance from practitioners like physicians, clinicians, nurses and clerical staff can have negative effects on the patient focus process, and even loss of life may occur (Fitzgerald & Russo, 2005; Han *et al.*, 2005). Han *et al.* (2005), for instance, identified that the mortality rate of children after an ICT implementation increased from 3.86% to 6.57%.

Most of the literature that analysed these failures, though, either focuses only on specific points supported by one case study or comes up with generic “cookbook” recommendations (Reinhold, 2006). Fundamental points of situation-specific working practices and interrelated societal factors in an emergent environment are seldom specified for each particular ICT case (Heeks, 2005). Therefore, this paper does not come up with guidelines of successful ICT implementations; rather, it tries to analyse how these universal approaches, theories and criteria to analyse success (respectively failure) are presented in the current literature. While focus is on healthcare information systems (HIS) in hospitals, examples from electronic health record (EHR) systems are mainly used to illustrate the nature of this complex environment.

First, different criteria and perspectives of success and failure are outlined, and then different epistemological approaches that have been used in the current literature are presented. The main part critically evaluates and compares theories, models and frameworks through which authors analysed successes and failures of HIS.

Drawing these different theories and models together enables to identify a specific structure or evolution of thought, from technical to socio-technical over emergent organisational and psychophysical and lastly hermeneutic theories could be iden-

tified. This theme shows an evolution of theories and models applied in the current HIS literature to analyse success and failure.

Discussion of success and failure perspectives

The current literature has an ongoing debate about the definition of success or failure and defines success in a multidimensional and elusive nature (Berg, 2000; Berg, 2001). Many criteria to define success such as technical-centred, socio-technical, organisational, economical, level of patient satisfaction and complexity of the medical business process have been stated (Berg, 2001; Reichertz, 2006; Fitzgerald & Russo, 2005; Klecun & Cornford, 2005; Andersson *et al.*, 2002). Berg (2001) outlines that “no simple formulae exists for success”. In turn, for other authors it is obvious that the main goal for a successful HIS implementation is to contribute to patient-centred, high-quality, efficient care (Reinhold, 2006). By contrast, other authors focus on technical criteria, examples of which are to define a technical standard to be able to facilitate integration of data (Hersh, 2002) or only looking at the functions and features of an EHR system itself. This approach, however, mistakenly assumes that medical stakeholders are changing their work habits along a sequenced and defined process defined in a HIS system (Berg, 2000).

Social aspects highlight HIS within their environment and organisations where human players form new user ecology (Ammenwerth *et al.*, 2003). In addition, identification of user psychology and behaviour plays an important part in the socio-technical development process (Reichertz, 2006; Berg, 2001). It may be further argued that multiple decision-makers such as physicians or clinicians with different subjective interests and backgrounds play an important role for the system’s success, since one group can view the system as a success, while the other simultaneously views it as a failure (Fitzgerald & Russo, 2005; Elbdabi & Paul, 2002). For instance, an EHR system implementation is successful for specialists since they can directly get the structured patient data from the database, while for physicians the system is too rigid to capture the essence of a patient’s visit and has been neglected (Berg, 2001). Organisational approaches, on the con-

trary, emphasise implementing systems in the whole organisation and design systems that support the process flow in the complex medical environment (Andersson *et al.*, 2002). Berg (2001), however, contradicts this opinion since organisational implementations demand a wider span of implementing the system, apparently making it much more complex and difficult to achieve success (Berg, 2001).

As a consequence, in drawing these different viewpoints together it is not only difficult to measure success but also to define success. “*It is not clear how to measure the success or benefits of a system, or even what ‘success’ really means, or for whom*” (Klecun & Cornford, 2005, p 230). Heeks mentions the various perspectives of failure, “*one person’s failure may be another’s success*” (Heeks, 2005, p 126). Saleem *et al.* (2006) in their empirical studies, though, define specific success criteria such as user satisfaction, user attitudes, and perceived system quality and system usage. Berg (2001) provides an even more complex criterion: the dynamic success, meaning that the success of an HIS changes over time, especially when stakeholders start using the system and change their view of a successful implementation (Berg, 2001; Lapointe, 2005). Furthermore, the organisation and HIS transform to each other during the implementation process (Berg, 2001).

From these positions, we can conclude that this interrelation between HIS’s technical functions, work habits of various stakeholders and emergent organisational aspects makes it difficult to define success only by a single factor. Rather, it must be defined by many interrelated and emergent factors, such as socio-technical, individual opinions of stakeholders and economical etc. (Berg, 1999; Berg, 2001).

Epistemological approaches

In health informatics, a discrepancy to apply a rational functionalist or rather interpretative approach to evaluate success is still evident (Klecun & Cornford, 2005). The central question concerns whether this is due to the methodological insufficiencies or rather to the complexity of measuring improvements of the quality of patient care with various stakeholders involved in a medical process (Ammenwerth *et al.*, 2003). An innate organisational resistance to evaluation and to publicise and measure failures have been identified by Ammenwerth *et al.* (2003). Consequently, to apply the appropriate approach can be a cumbersome task even before the analysis of a specific case has started.

A majority of authors explore the issue of HIS from an interpretative point of view and use case studies, such as electronic health records system implementations, to gain a deep understanding of the administrative rationalities. The complex and unique medical environment, however, makes it difficult to analyse and compare many cases, and it is difficult to legitimately generalise conclusions or even define generic guidelines (Heeks, 2005). Ammenwerth *et al.* (2003) also highlight that the quality of evaluation studies should further improve. Walsh (2004), for instance, uses only one case study to analyse the complexity of capturing relevant data from patients for an electronic patient care system. Since every patient is a unique case it is a very complex task to define a system capable of capturing all relevant data from only one case study (Walsh, 2004). In addition, many case studies refer only to pilot projects, short-term outcomes and efficacy rather than effectiveness have been evaluated (Heeks, 2005).

Furthermore, to get a better understanding of the multiple decision-makers in hospitals, semi-structured interviews followed by an interpretative analysis are conducted in all identified case studies (Heeks, 2005; Reinhold, 2006; Moser & Law, 2006; Walsh, 2004). Ammenwerth *et al.* (2003) underline that “*stakeholders often have different conceptions and views of successful information technology*”. Hence, while semi-structured interviews depend on adequate methods and questions, many studies try to integrate different views and questions. These different views and questions lead to a complex study with changes to questions frequently occurring during the evaluation (Ammenwerth *et al.*, 2003). To analyse intangible effects of improvements in quality of patient care is another obstacle since it is difficult to relate these with such things as having a better structure in a patient care records (Reinhold, 2006).

Positivistic approaches to measures quality of patient care improvements or impact of EHR systems implementations have not been found very often. Rather in tangible rationalities such as systems usage, measurement of the skill set of stakeholders or economical rationalities such as cost and benefit analysis (Saleem *et al.*, 2006). These tangible benefits are easier to quantify, but they do not represent a complete picture of the impact of HIS and should be complemented with other interpretative methods such as semi-structured interview techniques (Ammenwerth *et al.*, 2003). Furthermore, the call for analysing organisational impacts and process changes demands the interpretative rather than the formalist school of thought (Klecun & Cornford, 2005). Nevertheless, due to the limited time and focus of EHR systems, it could be that other important positivistic approaches were omitted.

Critical evaluation of theories and models used to analyse success and failure

This chapter evaluates current theories and frameworks that are used by authors to analyse perspectives of success and failure. Many authors, however, did not use any theory to analyse their case studies and only identified interpretative recommendations. The credibility of these articles should be questioned and therefore are not included in this analysis.

The focus in the 70s and early-80s to analyse HIS on only technical aspects has been overcome after many HIS implementations failed. For instance, it was not only important to define how a technical artefact captures data in an EHR system but also to assign a meaning in the emergent interaction between practitioners and patients (Berg, 2000; Berg 2001). Recent theories go far beyond technical rationales and analyse success in multilevel aspects such as organisational, socio-technical and process-based. Theories that focus on these success criteria are classified in the table (see Table 1) and critically compared with each other.

Socio-technical theory (see Table 1) has been one of the first to analyse the social aspect; however, it usually only focuses on social and technical aspects to enhance job satisfaction (Berg, 1999; Andersson *et al.*, 2002; Reinhold, 2006). Berg (2001) enhances this theory with specific success criteria defined as three interrelated myths - technical, socio-technical and organisational/architectural myths - which are important for a successful HIS. Especially, the organisational criteria show the complexity of healthcare business processes and that change management theories must be applied for a suc-

Theory / Model / Framework	Success Criteria
Socio-Technical	<ol style="list-style-type: none"> 1. Technical 2. Socio-technical 3. Organisational
Theory of Reality Gap (ITPOSMO Model)	ITPOSMO criteria: <ol style="list-style-type: none"> 1. Information, 2. Technology, 3. Processes, 4. Objective and values, 5. Staffing and skills, 6. Management systems and structures, 7. Other resources
<ol style="list-style-type: none"> 1. Actor Network Theory 2. Exchange Framework 3. Mutli-Perspective Psychophysiology Methodology 	<ol style="list-style-type: none"> 1. Sociotechnical (without a hyphen) 2. Social and political within an interwoven emergent environment
Evaluation Programme	<ol style="list-style-type: none"> 1. Social 2. Political 3. Historical 4. Hermeneutic
Discret Event Simulation	<ol style="list-style-type: none"> 1. Socio-technical 2. Stakeholder satisfaction 3. Quality of model/simulation

Table 1: Theories, Models and Frameworks classification

successful implementation. However Berg (2001) does not explain these theories further and also does not present any theoretical framework to support and interlink his myths. Heeks (2005) and Andersson *et al.* (2002), on the other hand, analyse the topic with a well grounded model: the reality gap model (see Table 1). This model not only looks at the three success criteria defined by Berg (2001) but also includes further aspects that are important for the topic at hand. In particular, the objective/values and staffing/skills criteria are distinct since it is crucial to have a detailed understanding of the skill set of various stakeholders, culture and political environment. The strength of this model is to analyse the gap of the initial situation with the outcome defined by many success criteria with an emergent and improvising approach (Heeks, 2005; Berg, 1999).

Fitzgerald & Russo (2005), Moser (2006), Berg (2000) and Berg (1999) evaluate further IS theories that go far beyond technical aspects and specifically analyse sociotechnical (without a hyphen) and political aspects within an interwoven emergent environment. Actor Network Theory (ANT), Exchange Framework and Mutli-perspective Psychophysiology Methodology analyse and reflect actors within their environment or network (see Table 1). Fitzgerald & Russo (2005), however, only use Sauer’s exchange framework in the end to analyse the London Ambulance case. The power of Sauer’s exchange framework is to analyse the information system, project organisation, supporters and its environmental influences dependently from each other. Fitzgerald & Russo

(2005) conclude in their article that after successful implementation of the HIS, the organisation itself was not ready and hence such a disaster occurred. Moser (2006) also criticises the use of ANT, arguing that they have analysed complex medical networks too simplistically in one defined process. Hanseth *et al.* (2004) mention the fundamental problem of reducing human beings to the same level as IT artefacts. In HIS the networks should rather be analysed in a local, contingent and seamless web rather than taken apart in social and technical settings or as technology in an organisation (Moser, 2006; Klecun & Cornford, 2005). Further studies of historical behaviour of actors in society are superficially defined in ANT but should rather explicitly stated. These issues have been the analysed of Klecun’s & Cornford’s (2005) evaluation programme model.

Klecun & Cornford (2005) focuses not only on technical, socio-technical, individual and organisational characteristics, but also on historical societal perspectives. They argue that it is not enough to evaluate only on success criteria but that one must also evaluate profound interrelated societal factors. Therefore, they defined an ICT Evaluation Programme (see Table 1) based on critical theory principals that focuses on social, political and historical conditions under which a system is implemented and used (Klecun & Cornford, 2005). Furthermore, it also based on a hermeneutic tradition, which explores the historical and cultural dimension of meaning (Klecun & Cornford, 2005). Applied to EHR systems, a patient record can be interpreted differently by different practi-

tioners depending on the context in which the patient record is read. These criteria have not been seen in any other related healthcare literature and could promise a new and richer theory to analyse success of HIS. Further case studies and specifically ones regarding EHR systems should be done to prove and test the practicality of the evaluation programme.

Eldabi *et al.* (2002) introduces another interesting theory, using a modelling framework based on an engineering approach, to improve the acceptance rate of users to the new system. Discrete Event Simulation (DS) (see Table 1) helps during the design and evaluation stage to give users a better understanding of the requirements of HIS and improve the communication between the various stakeholders since the model will be used as a basis for discussion (Eldabi *et al.*, 2002). This approach, however, is only successful when the model is able to represent the real life system and also focuses only on stakeholder analysis. In addition, organisational aspects as used by Fitzgerald & Russo (2005) and Berg (2000) should complement the DS theory.

Taking all analysed theories, models and frameworks presented into consideration, a common theme from technical to socio-technical over organisational and psychophysical towards hermeneutic concepts leads to a better understanding of the behaviour of every stakeholder in an emergent interwoven environment.

Limitations of literature review

The literature of failures in HIS is comprehensive and vast. Many articles analysed success and failure with different viewpoints and theories with various recommendations. Therefore, it is possible that certain issues, theories and models could have been omitted.

Another issue is the focus on interpretative epistemology, such as case studies that tend to be more subjective and could therefore bring a more subjective analysis to the literature review. More positivistic epistemological data could have complemented the analysis to get a more objective point of view.

Finally, the literature review focuses predominantly on HIS articles from healthcare journals specifically in the hospital environment. Other insights could have been gained if articles from non-medical journals or case studies from general practitioners would have been evaluated.

Conclusion

This literature review sought to analyse the different research approaches and theories that are used in the medical field to evaluate success and failure for healthcare information systems, with mainly examples from electronic healthcare records systems. First of all, success and failure criteria had to be discussed due to the ongoing debate. Since multiple stakeholders have different subjective opinions of success and failure, it is a difficult task to define success or failure in HIS (Berg, 2001).

The critical evaluation of different theories and models found in the literature shows a specific theme. Theories that highlighted the interplay of stakeholders and the environment, such as Actor Network Theory or Sauer's Exchange Framework, have been further enhanced with historical, societal and hermeneutic perspectives to gain a better understanding of the

stakeholders' habits and historical and cultural dimension of meaning in the medical context (Klecun & Cornford, 2005). These concepts focus much more on the analysis of stakeholders in an emergent interwoven environment.

The theories and success criteria evaluated in this paper should be applied interdependently with each other and would be much more powerful if they could be used in the right context with an appropriate and flexible framework as used by Heeks (2005) in his reality-gap model. For instance, the resource-based view applied in organisational contexts could define an asset as a single theory; capabilities would be the combination of different theories and core capabilities to use them in the right context for each specific case. Further quantitative measurements criteria to which degree HIS improve the patient care itself are very difficult to measure but would be another area for further research (Reinhold, 2006). Another research of interest would be the level of IT knowledge stakeholders, especially clinicians, physicians and nurses learn during their education. If the use of IT would be taken for granted even before stakeholders start working, it could reduce the barrier of acceptance of HIS.

In conclusion, while the different perspectives used to analyse success and failure broadens one's horizon, it is very likely that the success rate will still not increase due to the highly complex medical environment. Probably a fundamental change of the stakeholders' thinking towards IT artefacts has to evolve. Therefore this evaluation presented could help to gain a better understanding of recent theories and models which analyse the stakeholders' thinking and behaviour within an emergent medical environment.

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