A Risk Driven Framework for Open Source Information Systems Development

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Abstract – **This paper attempts to justify the need for a framework to address concerns with the use of open source software for information systems development (ISD). The premise of this argument is that the open source paradigm primarily addresses technical concerns while IS failures tend to be multifaceted in nature. OSS may improve but will not ultimately solve the problems of ISD due to its inherent socio-technical complexities. Issues of concern for open source ISD are identified in this paper and a theoretical framework is outlined allowing organisations to take a more balanced approach to open source ISD. The framework is predicated upon risk management and a lifecycle that addresses social and organisational concerns throughout the ISD process. The objective of this framework is to aid in avoidance of the social and organisational pitfalls of ISD while leveraging the ability of the OSS paradigm to address software crisis issues. Finally, the implications of this framework and future directions for research are discussed.**

I. INTRODUCTION

Open source software (OSS) has been lauded as a new paradigm for software development and addressing the technical concerns of the software crisis. The success and growth in popularity of the OSS paradigm has resulted in increasing interest from commercial organisations in adopting OSS as a potential solution to their Information Systems (IS) requirements. Although OSS addresses technical concerns evidence suggests IS failures tend to be socio-technical as opposed to purely technical in nature. The OSS paradigm may represent a new era in addressing technical software issues, however the social and organisational problems of IS Development (ISD) still remain.

This paper outlines a theoretical model based on a review of the ISD and OSS literature. The purpose of this model is to assist organisations in the planning and implementation of open source IS. This model introduces a spiral organisational lifecycle at a higher-level abstraction to the software development lifecycle (SDLC), providing a formal process at the organisational level catering for the non IS stakeholders involved in the decision making process. This paper identifies issues of concern for organisations considering using OSS for ISD and a framework is then presented to address these issues. This model should prove beneficial to academics and practitioners concerned with areas such as tailored methodologies, and also the social impact of OSS deployment within organisations. This paper begins with an introduction to open source and its potential problems in an ISD context, followed by the derivation and presentation of the framework. Finally, implications of this model and areas for future research are outlined. This paper concludes suggesting the need for a more balanced approach to open source ISD to address all facets of IS success.

II. OSS IN AN ISD CONTEXT

Open source is a software development methodology that involves making software source code freely available and distributable. Like all software development methodologies its goal is to develop robust software quickly and address the core issues of the software crisis [1].

Open source utilises an ad-hoc development style and conventions have evolved socially as opposed to being clearly defined as in plan driven methodologies. From seemingly disorganised OSS projects quality software products have emerged including some category killer applications. This can be attributed to the large developer pool incorporating some top class developers, peer reviewing and massive parallel development and debugging efforts [1]. Commercial companies and public-sector organisations are choosing to adopt open source solutions for a variety of reasons including cost saving robustness, flexibility or increased security [2]. This paper posits that the technical benefits of OSS development are well known, however in the context of commercial ISD where failures tend to be multifaceted the affects of OSS on the social and organisational aspects of ISD are equivocal and an area requiring further research. The following sections outline concerns with OSS development from an IS viewpoint followed by a review of the generic issues of IS failure faced by organisations.

A. OSS Concerns for Commercial Organisations

Besides the technical aspects of the OSS methodology itself, OSS research has focused on the motivation of developers [3], OSS business models [4] and the social interactions of open source development [5]. OSS adoption in the IS domain and its social and organisational impact has not received so much attention. OSS development is located primarily in the implementation phase of the SDLC [1]. As a consequence of this the OSS methodology has produced some quality software, however due to the overtly technical nature of OSS development other types of expertise such as project management, business strategy [1] or usability [6] are rarely incorporated. The lack of involvement of such expertise is a source of risk for commercial organisations, positioning OSS at a disadvantage within the realm of traditional justification of proposed solutions. Evidence suggests it is risks that constitute a significant barrier to OSS adoption [7]. Nevertheless the ability of this new paradigm to address software crisis issues, increase security and emancipate from vendor lock-in is generating increasing interest among organisations.

The agile, evolutionary and virtual organisational structure [5] of OSS development projects contrasts with the hierarchical organisational structures and top down ISD typically found in large organisations. This is further

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exacerbated by the fact that the evolutionary OSS development lifecycle does not incorporate risk management [8]. These problems coupled with perceived lack of reliable technical support, learning costs and compatibility issues with existing systems [7] further compounds the situation, increasing the organisational risk associated with open source ISD. In addition to OSS specific concerns, ISD itself is fraught with risk for organisations. The following section reviews the ever prevalent problem of IS failure.

B. IS Failure

Since the inception of the IS field an unacceptable number of IS projects have failed and continue to do so [9]. Approaches to IS failure have evolved from allocating blame on individuals or technology. Other explanations of IS failure include social, cultural, organisational factors, considering stakeholders and perceiving failure situations as systems [10]. Although it is recognised that IS failures are not related to technical issues alone the majority of IS research still remains in the technical domain, possibly due to the unresolved issues of the software crisis. If the OSS paradigm can successfully address these issues, perhaps the preoccupation with technical concerns in ISD will abate, leading to a more balanced approach.

ISD methodologies have not succeeded in their objective of ensuring IS success [11]. Agile methodologies have arisen as a backlash against the heavy process and documentation burdens placed by structured ISD methodologies [11]. The mid lifecycle stages of programming, implementation and testing receive scant coverage in most methodologies. Agile methods such as XP and OSS have particular strength in these areas which may account for their success and increasing popularity. Agile development is more difficult for large teams [12], this is an area of concern for large scale IS projects. Agile methods have a contribution to make to ISD, however mitigation of software crisis issues alone does not ensure IS success.

IS success from an organisational perspective concerns itself with the contribution of an IS to organisational performance. As this contribution is an indirect measure, surrogate measures such as system usage and user satisfaction have gained acceptance as proxies for the contribution of an IS to organisational performance [13]. Taken in this context, IS success can be defined as a composite of individual success factors that contribute to organisational performance. Identification of these IS success factors and their consideration throughout the ISD process should theoretically promote user satisfaction and consequently system usage, thereby addressing the social and organisational factors that contribute to IS failure. IS success is a complex multifaceted issue a composite of social, technical and organisational factors many of which are identifiable from the literature [14] [15]. OSS has the potential to improve certain types of IS success factors most notably system and information quality [15]. However as IS successes are also attributable to social and organisational factors focussing on the technical dimension alone will not cater for the full range of IS success factors.

III. DERIVATION OF A FRAMEWORK

The literature suggests that OSS has particular strengths in the area of software development. Consequently the proposed framework aims to address social and organisational factors to provide a more balanced approach to open source ISD. TABLE I illustrates issues of concern for open source ISD identified from the literature and strategies to mitigate that the framework will utilise.

TABLE I

ISSUES OF CONCERN FOR OPEN SOURCE ISD

Issues of concern	Strategies to mitigate
ISD methodologies have failed to have a significant impact on IS Success.	A tailored approach to ISD will be advocated. In recognition of both the agile nature of OSS development and the need for planning in large scale ISD projects.
OSS follows an evolutionary lifecycle.	In recognition of this fact the framework will incorporate a spiral lifecycle to accommodate evolutionary design.
The lack of consideration of risk in OSS.	A risk driven approach will be adopted, to supplement the lack of consideration of risk in OSS development.
Social and organisational factors contribute to IS success, not just technical factors, while the open source paradigm addresses technical issues only.	The framework will advocate a more balanced approach to ISD, by considering the social and organisational factors identifiable from the literature as IS success factors.

A. The Framework's Lifecycle

A framework lifecycle was deemed necessary to formalise the project at a hierarchical level above the IS department thereby including other stakeholders in the process. Fig. 1 illustrates two existing software process models the SDLC and Avison and Fitzgerald's ISD lifecycle [16] and depicts how the proposed lifecycle encapsulates the individual stages of these existing lifecycles. This framework's lifecycle consists of three iterative stages with each stage consisting of four generic sub-stages. The lifecycle's three stages (Justification, Implementation and Commissioning) were derived by creating a higher level of abstraction to the SDLC in an attempt to increase the relevance to non IS staff. There is a certain degree of overlap between the peripheries of the proposed lifecycle's stages and the SDLC and ISD lifecycle stages, due to the decreased granularity of the proposed lifecycle. Unlike the two existing lifecycles which are sequential in nature, the proposed lifecycle's stages are iterative if required to promote evolutionary design.

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Avison & Fitzgerald's lifecycle	SDLC	Proposed Lifecycle
Strategy		
Feasibility		
Analysis	Analysis	Justification
Logical Design		
Physical Design	Design	
Programming	Implementation	Implementation
Testing	Testing	
Implementation		
Evaluation	Maintenance	Commissioning
Maintenance		

Fig. 1. ISD lifecycles

B. Stages of the Lifecycle

The stages depicted in Fig. 1 are elaborated upon in this section.

1) Justification: This stage is concerned with feasibility and justification of the proposed system. Traditionally IS justification has been concerned with quantitative accounting type metrics for cost benefit analysis. A major criticism of IS evaluation in the literature has been the lack of attention to intangible benefits [17]. As a consequence of this, the framework will take IS Success factors into account in an attempt to include intangible benefits in IS justification.

2) Implementation: Open source development traditionally falls into this area. This stage is concerned with the technical implementation of the IS. A methodology has not been outlined here, but a tailored approach will be advocated. Allowing for a balance between agile and plan driven methodologies, while mitigating many of their respective drawbacks. As this framework is risk driven, risk analysis can be used to balance the two approaches [18].

3) Commissioning: This stage is concerned with the deployment, maintenance and evaluation of the implemented system. IS success can be evaluated at this stage through a combination of quantitative and also more qualitative/subjective measures such as user satisfaction and system usage.

The aforementioned lifecycle stages each consist of four generic sub-stages, the following section introduces these generic sub-stages. Influenced by the risk driven spiral model the first sub-stage consists of a risk analysis. The other three sub-stages address the technical, social and organisational dimensions of ISD, thereby forcing risks, social, organisational and of course the technical factors to be addressed throughout the lifecycle. These sub-stages are discussed in more detail below.

1) Risk Analysis: Risk avoidance and control and can be utilised at any phase of the development process [19]. Risk analysis is therefore appropriate throughout the lifecycle. Consequently each stage begins with a risk analysis, with the aim of exposing and mitigating risks before the stage can be progressed. The introduction of risk management also supplements the lack of risk management in OSS development. It is envisaged that this framework will aid in the identification of soft risks.

2) Methodology: This sub-stage is concerned with the technical and methodological aspects appropriate to the current stage (Justification, Implementation or Commissioning).

3) Human Factors: Each stage in the framework will explicitly takes human factors into account by considering IS Success factors identified from the literature. This is in recognition of the human and social factors that contribute to IS success.

4) Organisational Strategy: As IS failures are often attributable to organisational factors, the fourth and final sub-stage deals with aligning ISD to organisational strategy. One of the primary goals of an IS is to contribute to organisational strategy. In recognition of this each framework stage ends with a review of the current state of the IS and strategic alignment.

IV. A FRAMEWORK FOR OPEN SOURCE ISD

Fig. 2 outlines the completed framework as derived in section III. The three stages in the lifecycle (Justification, Implementation, Commissioning), are denoted by the concentric squares. The quadrants demarcate each sub-stage (Risk, Methodology, Human, Organisational). Flow is indicated by the white arrows and expands in a clockwise direction from the inner square. The framework's risk driven nature and flow of control are influence by Boehm's Spiral model [20]. As the idea for an IS is conceived to address an organisational need the lifecycle commences in the organisational strategy quadrant of the inner square (justification stage). Each stage can be iterative, progressed to the next stage as indicated by the right turn arrows or terminate the project as either infeasible or a failure. As the model is evolutionary the final stage of commissioning is ongoing until a decision is made to decommission the project.
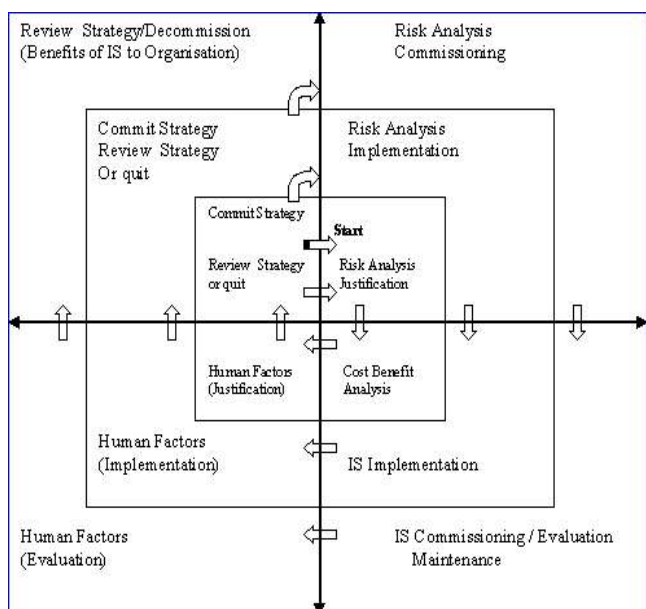

Fig. 2. A risk driven framework for open source information systems development

V. CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

Although this model was developed using existing IS and OSS literature at present it is untested and its relevance to ISD practice is unproven. A research instrument is under development intended for use in a field study to validate and refine the framework. Even before data collection, it is felt that issues of concern for commercial organisations considering open source ISD have been raised and worthy avenues for further research identified.

The scope of this framework is considerable addressing the full ISD lifecycle. As a consequence of this each individual stage of the framework merits more specialised investigation. As the framework is predicated on risk management this area deserves particular attention, specifically soft risks addressing the social and organisational concerns which have not received the same consideration in the literature as technical risks. Aside from risk other methodological areas that would benefit from research in an open source context are cost benefit analysis, tailored ISD methods and also the deployment, maintenance and evaluation of open source IS.

This paper justifies the need for a framework for open source ISD and presented a theoretical framework to address concerns identified from the literature. In summary the main issue of concern was that OSS development addresses only the technical dimension of ISD. IS success is a multifaceted issue with social and organisational dimensions which are not addressed by the OSS methodology. The evolutionary nature of OSS development and its lack of consideration of risk are also areas of concern for commercial organisations considering OSS for ISD. A resonance was struck between these conclusions and Boehm's spiral model which is risk driven and evolutionary in nature and strongly influenced the proposed model. As the framework encompasses the full ISD lifecycle there is more than adequate provision for further research. It is intention that this framework will motivate future research into open source ISD.

In conclusion, the OSS paradigm appears to have had some success tackling software crisis issues where other approaches such as planned methodologies have failed. However, until the social and organisational issues that also impact upon IS success are addressed, open source may improve but will not solve the problems of ISD. A more balanced approach is required addressing all facets of IS success.

VI. REFERENCES

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