ADOPTION OF NEWER SOFTWARE DEVELOPMENT METHODOLOGIES: AN INSTITUTIONAL THEORY PERSPECTIVE

George A Mangalaraj

University of Texas at Arlington

mangalaraj@uta.edu

Sridhar P Nerur

University of Texas at Arlington

snerur@uta.edu

Radha K Mahapatra

University of Texas at Arlington

mahapatra@uta.edu

ABSTRACT

The growing need to improve the success rates of software projects coupled with the pressures to be nimble in an ever changing environment have ushered in several radically different software development methods. Software practices resulting from traditional structured and object-oriented methodologies are firmly entrenched in many organizations. The question of why organizations would abandon or drastically alter institutionalized practices in favor of adopting new methods is addressed in this paper. In particular, the research draws from the literature on institutional theory to formulate a research model for the adoption of emerging software development methods.

Keywords: Agile software, institutional theory, software process innovations, adoption

INTRODUCTION

Development of an information system is done in an environment where technologies, requirements and human resources could change dramatically even before the project gets completed. One of the ways to overcome these uncertainties is to evolve rules, processes and procedures [2]. Traditional Software Development Methodologies (TSDM) try to eliminate these uncertainties by formulating rigid processes. In TSDM, user requirements are fully specified at the start of the project and software development proceeds then through predefined stages. These processes become institutionalized over time. In fact, many organizations try to get their processes certified to conform to models such as the CMM, ISO9000, and the like [3].

The high failure rates of TSDM-based projects has been a major source of concern [4, 5]. The late 1990s saw the introduction of many innovative software development processes. These processes are collectively called 'Agile Software Development Methodologies' (ASDM). They question the fundamental assumptions / processes that have hitherto guided software development. ASDM promises to increase the success rates of software development projects [6]. Practitioners have shown considerable interest in the agile approach to software development, as evidenced by the findings of a recent survey [7].

The agile methods require significant changes to existing software practices [8]. Organizations are now faced with the challenge of overcoming deeply ingrained processes in order to adopt these methods. The question of why companies abandon or significantly alter firmly entrenched practices to assimilate an approach whose legitimacy is yet to be established is of primary interest to academics and practitioners alike. To this end, this paper uses concepts from Institutional Theory to explore the probable causes for companies to adopt newer software development processes.

The organization of this paper is as follows. The next section reviews prior works in institutional theory. Some of the key differences between ASDM and TSDM that play a major role in the adoption of the former are then discussed. Subsequently, a research model for understanding the deinstitutionalization of TSDM practices is proposed. Conclusions and research opportunities are then discussed.

THEORETICAL BACKGROUND

Software Development Process Innovations

Software development is a process innovation rather than a product innovation because it pertains to the way software is produced [9]. These software development process innovations are among the least researched upon areas in IS [10]. The stages in the evolution of software development processes can be explained through Utterback and Abernathy's [11] model for process development. According to their model, which is based on production processes, there are three stages in the development of processes. These are: (a) uncoordinated – processes are new and un-standardized, (b) segmental – processes mature and become rigid with emphasis on efficiency, and (c) systemic – processes become highly developed and increasingly difficult and expensive to alter.

Evolution of software development processes followed very similar stages to the Utterback and Abernathy's model. Initially companies were following diverse software development processes that were un-standardized. The 1980s saw the introduction of many software development process models such as the Waterfall model [12] and the Spiral Model [13]. In the context of this research, TSDM refers to those methodologies that use the waterfall model, spiral model, or some lifecycle model that resembles these. These processes share a number of fundamental principles. For example, they are all plan-driven and rely on extensive documentation. These development processes, which were dominant for decades, have become institutionalized in many organizations, thus making them systemic and hard to change.

In the past, there have been attempts to explain software process innovations using diverse theoretical perspectives. Fichman and Kemerer [14] studied the adoption of object oriented-programming languages (OOPL) from the perspective of organizational learning. In their longitudinal study on software process innovation, Mustonen-Ollila and Lyytinen [10] used the diffusion of innovation perspective. This paper has adopted an institutional theory perspective to explain the adoption of a specific software process innovation, namely ASDM.

Institutional Theory

Assimilation and/or adaptation of theories from reference disciplines is vital to the creation and diffusion of knowledge in IS research. Such theories not only provide the requisite variety to cope with a wide array of diverse phenomena, but also enable us to exploit the isomorphism that exists between disciplines. Institutional theory has been particularly useful in studying the deinstitutionalization of firmly established practices. While IS studies have used this theory for understanding the diffusion of innovation across organizations, to the best of our knowledge, the theory has not been utilized to explain the phenomenon of deinstitutionalization. This provides the impetus for our exploratory study on a software process innovation that questions some of the fundamental practices that have dominated software development since its inception.

Institutional theory has its roots in Sociology and has been widely used in organizational research. Institutional theories of organizations provide a rich, complex view of organizations [15]. According to this theory, organizations are influenced by internal and external pressures to adopt widely accepted elements such as standard operating procedures, professional certifications, etc. Adoption of these legitimated elements makes the organization isomorphic with the environment and this increases the chances of an organization's survival [15, 16]. Isomorphism refers to the tendency of organizations to be similar to other organizations and this comes about through (a) mimetic pressures, (b) coercive pressures, and (c) normative pressures [17].

Organizations may contain institutionalized elements that have been followed for a long period of time without proper justification or elaboration. Such elements are highly resistant to change [15,

16]. Structures, action routines, and roles are a few examples of such institutional elements. These institutional elements help organizations to achieve stability and reduce search and evaluation costs [15]. Over a period of time these processes acquire a rule-like status and may reduce the effectiveness of the organization if more efficient ways of doing things are overlooked [1]. Institutional theory has been predominantly used to explain both the persistence and homogeneity of a phenomenon [18].

Deinstitutionalization

Deinstitutionalization refers to the erosion or discontinuity of an institutionalized activity or practice. Organizations would sometimes have to alter or even abandon their institutional elements in order to accommodate changes to firmly entrenched processes or procedures. Process of institutionalization and deinstitutionalization drive change, and new practices cannot be adopted unless the old ones are abandoned [19]. Institutionalization characteristics do not offer reasons for the occurrence of deinstitutionalization. According to Greenwood and Hinings [20], institutional theory can also be used to explain changes in organizational practices. Robey and Boudreau [21] use the 'logic of opposition' to suggest how institutional theory can be used to explain the persistence and change of institutionalized practices in the adoption of information systems. Organizations sometimes adopt new processes that lack legitimacy, ones that require major changes to or abandonment of routinized activities. This paper attempts to explain why this phenomenon occurs. The ensuing section presents a case for considering the abandonment of TSDM and the adoption of ASDM as a process of deinstitutionalization.

DEINSTITUTIONALIZATION OF TSDM AND ADOPTION OF ASDM

In this paper it is argued that the adoption of ASDM entails significant changes to or even abandonment of institutionalized traditional software development practices. Institutionalization of TSDM is evident from the way companies have sought certifications such as SEI-CMM, TickIT, ISO 9000, and the like. Models such as the CMM and ISO 9000 entail strict adherence to rigid processes with a view to enhancing the process capability as well as the maturity of the organization. They typically adopt a life-cycle approach to the development of software that relies on extensive planning and documentation for optimizing software development processes. ASDM challenges many of the fundamental assumptions of TSDM. It places great emphasis on the use of small, collocated teams to develop software. Active user participation in the development team is stressed. Features included in a software release are not decided upfront, but are dynamically prioritized by customers. Daily meetings are held to take stock of the progress of the project [22]. ASDM project teams rely on high collaboration and communication among the members. ASDM encourages developers to accept different roles, thus facilitating a shared understanding of the system. Leaders of these work teams serve as facilitators and mentors, rather than as controllers and planners [8].

It is evident from the characteristics of ASDM that many of the practices differ considerably from established and institutionalized ways of developing software applications. In the context of institutional theory, these alternate software development processes are considered as illegitimate as it violates established institutional practices [23]. Abandoning or changing well-established practices is hard. The next section proposes a research model that highlights the antecedents for the deinstitutionalization of TSDM and the adoption of ASDM using the institutional theory perspective.

PROPOSED RESEARCH MODEL

The process of deinstitutionalization of a variety of practices has been investigated in the past. Oliver (1992) reviewed the literature on deinstitutionalization and concluded that functional, political, and

social forces play a major role in deinstitutionalization. Table 1 summarizes some of the prominent studies on deinstitutionalization and highlights the salient factors considered in them.

Study	Focus of the study	Antecedents considered	Classification
Kraatz and Zajac [24]	Changes in liberal arts institution program	Local and global technical environmental factors	Functional, Social
D'Aunno, et al.[25]	Radical changes in the rural hospital practices	Social forces and market forces	Social
Ahmadjian and Robinson [19]	Deinstitutionalization of permanent employment in Japan	Performance problems, firm age, ownership patterns and the level of downsizing	Functional, Social
Greenwood et al.[26]	Role of professional associations in accounting firms	Social, technological, and regulatory pressures	Functional, Social and Political
Zilber [27]	Changed work practices in rape crisis center in Israel	New organizational members	Political

TABLE 1: Past studies on deinstitutionalization

The proposed research model (shown in Figure 1), based primarily on the works of Oliver[1], attempts to explicate the deinstitutionalization of TSDM and the adoption of ASDM.
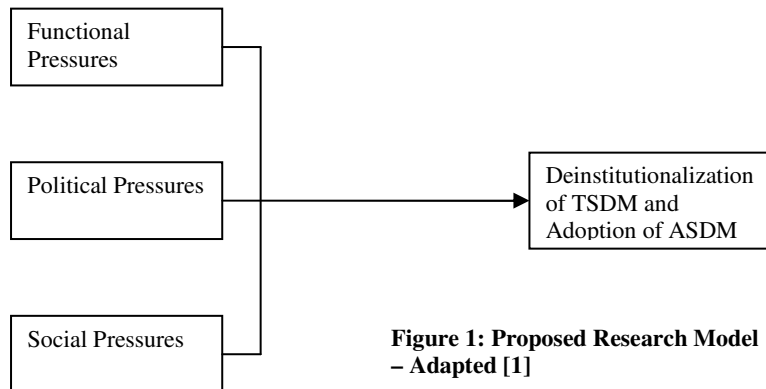

Figure 1: Proposed Research Model – Adapted [1]

Proposed model and the diffusion of innovation literature:

Concepts from diffusion of innovations literature have been extensively used in IS to study the adoption of various IS innovations. Adoption of innovations such as EDI [28], information systems development processes [10], and web technologies [29] are some examples of studies that are grounded in the diffusion of innovation literature. Wejnert [30], in the review of diffusion of innovation literature, has incorporated concepts from institutional theory to explain the adoption of an innovation. Three broad factors were considered: (a) innovation characteristics, (b) characteristics of the innovators, and (c) characteristics of environment. The factors considered in the proposed research model are quite consistent with those articulated by Wejnert (2002). The following section explains various pressures involved in deinstitutionalization and provides exemplars for each of these pressures. The exemplars are provided for illustrative purposes only and are by no means exhaustive.

Functional Pressures:

Functional and technical pressures arise due to a variety of reasons. Performance shortcomings may question the instrumental value of existing practices [1]. Need for innovation arises when organizational members recognize need for change triggered by the emergence of a problem or an

opportunity [31]. An exemplar considered in this study to be a functional pressure is the high failure rate of software projects.

High failure rates of software projects: Imitative forces do not significantly impact the desire to adopt or reject an innovation when performance gaps exist [32]. In the case of software development, performance gaps, such as project failures, exist when there is cost, schedule overruns, and requirements are not met. These performance gaps in TSDM may compel organizations to favor ASDM. ASDM became quite popular because of its ability to turnaround failing software projects. The very first known use of ASDM happened when there was a series of failures with a payroll software development project at the Chrysler Corporation. The existing TSDM-based approach at Chrysler led to both cost and schedule overruns, which prompted them to adopt 'Extreme Programming', an agile software development methodology. The success that ASDM had in reviving the project has been well documented [33]. There are other such instances that compelled organizations to adopt ASDM [34].

Political Pressures

Political pressures primarily arise when there is crisis in performance and conflicting interests of the involved parties. These pressures give rise to the abandonment of institutionalized processes and create innovation pressures [1]. Operation of group interests may compromise the formal, rational mission of an organization [35] [Selznick (1949) as cited in 20, 35]. Due to these reasons, considerable pressure may be exerted on instutionalized practices that are no longer efficient. Two exemplars of political pressures are discussed below.

Availability of intra-organizational entrepreneurs: Intra-organizational entrepreneurs, who champion the cause of innovations such as ASDM, may succeed in mobilizing political support for the imposition of alternate organizational values [1]. Such small groups often serve as catalysts for the creation of new institutional elements [15]. Groups that either support or oppose prevailing institutional practices have the ability to influence radical change irrespective of institutional pressures. Such groups play an important role in intra-organizational dynamics of change [20]. In the diffusion of innovations perspective, role of opinion leaders is quite important in the adoption of any innovation [36]. Radical innovations are facilitated by the presence of groups of people who act as knowledge sources [37]. Role of project champions has been studied in the IS area [38, 39]. Specifically, the influence of project champions in the adoption of software process innovation has been studied by Kautz and Nielsen [40] through multiple case studies. Thus, the availability of people who champion the cause of ASDM would perhaps increase the chances of adoption of ASDM.

Influence of Top Management Support: Seo and Creed [41] use a dialectical perspective to argue that institutional change arises from the misalignment between existing social arrangements and the interests and needs of the actors. These institutional actors, whose interests and ideas are not adequately served by the existing order, challenge existing institutional practices. Adoption of any innovation requires the support of top management. The influence of top management support in the adoption of Information Systems innovations has been endorsed by many studies [42]. The adoption of software process innovation has been studied in detail by Kautz and Nielsen [40]. Thus, it may be argued that the support of top management would facilitate the adoption of ASDM.

Social Pressures

The loss of cultural consensus among the members of the organization in terms of meaning and interpretation of institutionalized tasks and activities is a determinant of social pressure [1]. Higher turnover, leadership change and increasing diversity in the organizational work force also lead to deinstitutionalization. Two exemplars of social pressures are discussed below.

Influence of newcomers: It has been argued that deinstitutionalization occurs when there is staff turnover followed by the increase of newcomers [1]. These newcomers bring their own perceptions on work practices that may challenge institutionalized elements. Ziler [27], in her study on rape crisis centers in Israel, considered the impact of new members on changes in the existing institutionalized work practices. The notion that migration of executives influences institutional change has been supported by Kraatz and Moore [43]. Zucker and Darby [44] argued that companies in times of crisis bring in new people to transform existing practices. They studied the impact of new human capital in bringing about innovations in biotechnology companies. Sharma and Rai [45] explored the adoption of Computer Aided Software Engineering (CASE) tools and found that the IS department leader's tenure in a job is negatively associated with the adoption rate. Therefore, it appears that the influx of newcomers with an appreciation of ASDM concepts would facilitate the adoption of agile practices.

Influence of consultants: Consultants play an important role in the adoption and assimilation of any IS innovation. 'Business Process Reengineering' and 'Enterprise Resource Planning' are examples of organizational innovations that have been actively promoted by consultants. Likewise, we hypothesize that the involvement of software consultants who specialize in ASDM would help an organization to adopt ASDM practices. Diffusion of innovation literature dwells at length on the role of change agents in the adoption of newer practices [36]. Change agents are referred to as professionals who are engaged by the companies to head a change program. There are consulting organizations that specialize in troubleshooting problems that occur in software development projects. There is anecdotal evidence on the positive influence that such consultants have on their clients with regard to the adoption of ASDM. For example, Chrysler Corporation adopted 'Extreme Programming', an agile software development methodology when they employed external consultants to resuscitate a failing project [33].

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

Many revolutionary concepts have emerged in the field of software development in the last decade. The one that has received a lot of attention in the recent past is agile software development. Agile software development methodologies require significant changes in work-habits and institutionalized practices that were established and reinforced over a long period of time. Although their efficacy has not been unanimously established, there are indications that many organizations have adopted some form of ASDM. Institutional theory may provide some insights into why organizations might adopt ASDM although its dominance is yet to be established. This paper proposes an integrated model for the deinstitutionalization of TSDM and the adoption of ASDM based on the perspective of institutional theory. The model provides a conceptual framework for articulating testable propositions. An empirical study based on these propositions would further the understanding of the pressures that cause deinstitutionalization.

REFERENCES

References available upon request from: George Mangalaraj and e-mail: mangalaraj@uta.edu