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Exploring the Theoretical Foundations of the Process of Information Systems Development

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Abstract

Methodologies are a key tool for managing information systems development projects. Underlying these methodologies is a process, which is usually defined as the systems development lifecycle. The concern for this study is to investigate the relevance of the lifecycle as the underlying process. Adopting a case study approach, and drawing on research from organizational change, the paper highlights some of the limitations of the lifecycle view, and introduces three other perspectives to address these shortfalls (teleology, evolution and dialectic). In doing so, the paper broadens the theoretical understanding of the development process.

Keywords: information systems development, process theory, methodology

INTRODUCTION

Information systems development (ISD) methodologies are a key tool for the management of projects (Iivari et al., 2000/2001). They can be described as a "...collection of procedures, techniques, tools and documentation aids which will help the systems developers in their efforts to implement a new information system..." (Avison & Fitzgerald, 2003, p20). A organization will adopt a methodology because it either produces better end products, a better development process or a standardized process (Avison & Fitzgerald, 2003).

There are numerous methodologies available for use, with some suggesting that the number exceeds 1000 (Jayaratna, 1994). There are also a number of frameworks and typologies that have been developed to categorize these methodologies (Avison & Fitzgerald, 2003; Iivari et al., 2000/2001; Jayaratna, 1994). Iivari et al. (2000/2001), for example, propose a four-tier framework, which includes: paradigm, approaches, methodologies and techniques. Grounded in the paradigms of the philosophical foundations of social science, this framework provides a deep structure for better understanding the intellectual core of methodologies.

Underpinning these methodologies is a development process, which is defined as the *sequence of stages that explain how events unfold on a project* (Ahituv et al., 1984; Wynekoop & Russo, 1993). The dominant process explanation adopted for ISD has been that of the systems development lifecycle (Ahituv et al., 1984; Fitzgerald, 2000). This characterizes the ISD process as a prescribed sequence of steps from feasibility study and systems investigation through to implementation, review and maintenance (Avison & Fitzgerald, 2003).

This lifecycle view of the process first emerged in the late 1960s and early 1970s (Fitzgerald, 2000). The environment that prevails today, however, is very different to the one that existed in the 1960s and 1970s. The main difference is the pace of change, which is now more rapid (Fitzgerald, 2000). Despite these changes, little research has been conducted that explores how the development process might also have changed. Instead, alternative methodologies have been suggested. Examples include, rapid development, object-oriented development and people-oriented development (Avison & Fitzgerald, 2003). Although these new methodologies do inherently suggest a different development process, there have been few explicit attempts to elicit the theoretical underpinning of the process. Further, in the related area of organizational behavior, Gersick (1988; 1989) found that for non specific group work, the lifecycle does not reflect what is actually occurring on a project.

The objective of this paper is to address this concern about understanding the ISD process. To do this, the paper draws on recent developments in process research from organizational change. Adopting a case study approach to investigation, two particular issues are addressed. One is the limitation of lifecycle theory as the primary process explanation of ISD. The second is the potential application to ISD of three other process theories outlined in the organizational change literature (teleology, evolution and dialectic), but rarely considered in ISD. Together, the analyses of these two issues begin to fill a shortfall in the literature by providing a broader explanation of the theoretical grounding of the ISD process.

The balance of this paper is structured into six sections. First, the four process theories from the organizational change literature are described. Second, the research objectives for the study are outlined. Third, the research methodology is noted. Fourth, the development process that unfolds in the case is summarized. Fifth, the case is analyzed through the lens of the four theories, with a particular focus on the limitations of lifecycle theory for explaining the process and an emphasis on how the other three theories may be applied. Finally, the findings are discussed and the implications identified.

FOUR THEORIES OF THE DEVELOPMENT PROCESS

Background

An understanding of the development process is critical to the understanding of methodologies. However, despite years of research into methodologies, the literature suggests that there is a limited understanding of the development process that underpins ISD projects (Wynekoop & Russo, 1993). Most methodologies are embedded in the narrow field of the systems development lifecycle (Ahituv et al., 1984; Fitzgerald, 2000). For example, methodology textbooks tend to begin with a description of the systems development lifecycle and little explanation of other processes that might underpin methodologies (See for example Avison & Fitzgerald, 2003).

There is little other ISD research that can provide a guide to exploring the ISD process. As an alternative, to provide a starting point, insights can be gained from other fields that have matured in their understanding of the development process. There are several advantages to examining the developments of other fields. The most significant of these is that the other fields have already undergone observable developments. Such insights can provide highly practical and relevant advice. For example, it might include insights on which approaches to adapt or avoid. A second advantage is that it may remove the ideology or research perspective that might be fashionable in ISD. For example, it is unclear in ISD whether the lifecycle view reflects the latest thinking, the actual behaviors, or both. An alternative viewpoint, could overcome this concern.

The starting point that was seen as promising for this study was developments that had occurred in organizational change. In particular, Van de Ven and Poole (1995) provide some interesting thoughts. According to them, a process is defined as a sequence of change events that unfold over the duration of an entities existence. This is consistent with the understanding and definition of the process of ISD. They go on to suggest a typology of four ideal-types of developmental theories: lifecycle, evolution, dialectics and teleology. These four theories were derived out a literature review of a diverse range of disciplines such as biology, meteorology, geography, medicine, psychology, education, sociology, business and economics. ISD forms a subset of these disciplines. In addition, ISD can be viewed as a form of organizational change. One where the technology is part of the change. Given this, the typology is appropriate for application in this study. In the rest of this section, the four theories as outlined by Van de Ven and Poole are described, and their current ISD application is reviewed.

Lifecycle

According to Van de Ven and Poole, lifecycle theory states that a project has within it an underlying logic that governs the process of change. Change is regarded as inevitable, as a project moves from initiation through to handover. Following handover, the system developed is in production mode until its upgrade or termination. Throughout this time, as a project progresses, it becomes better defined and more mature. Upon termination, another cycle begins with a new project, and this cycle is in continuous progress. External events might influence progress, but there is always an imminent logic that governs development.

This definition is consistent with the one used in the ISD literature to describe the lifecycle process. For example, Avison and Fitzgerald (2003) define the systems development lifecycle as the general approach that includes feasibility study, systems investigation, systems analysis, systems design, implementation, review and maintenance. Most methodologies adopt a version of a lifecycle as a key component of their framework. For example, one methodology available today that has a lifecycle inherent in it is PRINCE2 (Office of Government Commerce, 2002), which has eight stages. Thus, for this study, the systems development lifecycle can be viewed as an example of lifecycle theory.

Teleological

Teleological theory assumes that a project proceeds towards a goal. It is the goal that guides the movement of the project. At the beginning of a project it is presumed that the stakeholders are not satisfied with their goals (dissatisfaction). As time passes a project adapts in a purposeful way to its environment, exploring a number of different possibilities (searching for goals), and establishing new goals that satisfy the requirements of the stakeholders (setting goals). The new goals are then developed (implementing goals). This cycle is then repeated

as dissatisfaction with the new goal develops and a new goal is required. There is no prescribed sequence that must be followed, although it is expected that a number of alternative paths could be possible.

The use of the teleological approach is not explicit in ISD. It has however been considered implicitly in a number of areas related to ISD decision-making. For example, Reinig (2003), considering goal setting, propose that meeting satisfaction is positively related to goal level. This is based on the premise that there is an objective to achieve, a goal is set to reach the objective and then it is implemented. Another example is from Abdel-Hamid et al. (1999), who use system dynamics to analyze goals. They suggest that given a goal, managers do make planning and resource allocation choices in such a way that will meet their goals.

Evolutionary

Evolutionary theory states change proceeds through a cycle of variation, selection and retention. Variations are known to occur through random change, selection occurs through competition for scarce resources and retention serves to counteract the self-reinforcing loop between variation and selection. This cycle is in continuous renewal. In making progress, a project can have a number of forms depending on the conditions faced at a particular point in time. It depends on the characteristics of the individual, project, organization and industry.

The evolutionary approach has been introduced as the basis of some ISD methodologies (Avison & Fitzgerald, 2003). It is also used more generally in information systems (IS) research. One example of its use is in defining colonial systems (Porra, 1999). A colonial system was developed as an alternative to the organic and mechanistic systems. Porra outlines ten different axioms to define how local colonies survive and prosper by creating and adopting isolated prototypes. Another example of the adoption of an evolutionary approach is the punctuated equilibrium model of change (Van de Ven & Poole, 1995). Although this model was originally developed for organizational change, it has been applied to IS change so that organizations can take advantage of the evolving capabilities associated with the use of new technology (Orlikowski & Hofman, 1997).

Dialectic

Dialectic theory begins with the premise that a project exists in an environment of colliding issues that compete with one another for control and domination. There must be two or more issues that have conflicting viewpoints and they must engage one another in conflict. Stability occurs when one issue (the thesis) dominates the others. Change occurs when an opposing issue (the antithesis) confronts the thesis and this antithesis has some influence on what the new combined project looks like (the synthesis). Stability is constantly challenged project.

The use of the dialectic approach in ISD has been in isolated areas. For example, it forms the basis of the 'logic of opposition' proposed by Robey and Boudreau (1999), to explain the diversity of organizational consequences of IS. This provides an alternative view to the logic of determination that is usually adopted to explain change. Another example is Robey et al. (2002), who take a dialectic view to examining change in enterprise system implementation. They find that organizations have to overcome knowledge barriers of two types: those associated with the configuration of the package and those of the assimilation of new work processes. Finally, Sabherwal and Newman (2003) use the dialectic approach to study persistence and change in systems development. By providing insight into the strategies for improving the dialectic process, they find that the final determination of a product depends on the human actions during the process, which may not necessarily be predictable, rather it is one of many possibilities.

RESEARCH OBJECTIVES

As noted above, lifecycle theory as defined by Van de Ven and Poole, is consistent with the concept of a systems development lifecycle. The other three theories are rarely explicitly considered as process theories in the ISD literature. Given this, the objective of this study is twofold. First, the paper considers the value of the lifecycle approach as an explanation for the process of development. For this part the focus is on what lifecycle theory does and does not explain. The second objective is to determine the relevance of the other three theories to ISD. At present, the application of the other three theories is quite rare and so a better understanding of their potential contribution is a valuable insight to their use.

METHODOLOGY

Design of the Research Study

The focus of this study is the process by which a project matures. Specifically, the question asked here is 'how' the process develops, and so a case study design is appropriate (Benbasat et al., 1987; Yin, 1984). The value of case study research is that it allows researchers to study IS in a natural setting for a previously little-studied area

(Benbasat et al., 1987). To explore the research question, a single case study is considered. Considering one case in depth allows the researchers to focus on the events that unfold in greater detail. The unit of analysis is the project task.

Organizational Background

The organization selected is a corporatized utility, WaterCo¹, responsible for the delivery of local water and wastewater services to 1.4 million people. Maintenance and operations are outsourced. Although a monopoly, the business has considerable pressure from its customers, via the government, to control cost and improve value for money.

The IS Division reports to one of the six business units. The organization maintains only sufficient technical expertise to manage risk, and draws on external resources, usually one of the organizations strategic partners, to provide technical skills/advice. Project management has been standardized to the PRINCE2 methodology. In addition, the organization mandates three project functions to be filled: project management (PM), business intelligence (BI) and systems development (SD). They report to a project board (PB).

The organization also has two committees for the management of IS generally. The IS Executive Committee (ISEC), which is the highest committee in the organisation for managing IS issues related to the business, and is responsible for project funding. The other is the Project Governance Office (PGO), which is responsible for the week-to-week technical management of the portfolio of projects for the organization.

Project Background

The project selected for this study is SampProj. The objective of the project was to develop an information systems capability to ensure that WaterCo has complete and accurate access to information on water quality. This would provide a sound tool for the management of public health risk. There were also additional tangible benefits of enhanced operational efficiency, the management of operational incidents and the creation of a database for trend analysis. The project was designed to showcase the organization's ability to deliver business transformation through the delivery of technology-based initiatives, and was the largest IS project in the organization being managed by the IS Division at the time it was selected. It is envisaged that as a result of this project, business confidence in the IS Division would improve.

The project involves two principal business units: Water Operations and Laboratory. Water Operations is responsible for the day-to-day management of the pipe system, and Laboratory is responsible for testing samples of water that come from the field. The project was envisaged as having three stages. It was initiated in early 2001, design and development began in mid 2001 and was due for completion in late 2002. The project budget was \$US1.0 million.

The principal development activity involved producing a set of procedures for gathering and recording field samples, customizing several off-the-shelf packages and integrating these into the existing organizational systems. The methodology and structure for the project complied with the organization's standard (PRINCE2). Two key third parties were employed: a consultant, who was responsible for PM and BI, and a strategic partner, who was responsible for SD.

Data Collection

The data collected included documentation, interviews and observations.

Documentation. There were multiple sources of documentation, including manuals, procedures, plans, guidelines, project status reports, schedules, meeting agendas, meeting minutes, memos and 'lessons learned' lists. This information covered the duration of the project, and was well documented in accordance with the PRINCE2 methodology. Most of the information was available on the corporate Intranet. Some of the interviewees also provided information directly.

Interviews. The interviewees were chosen to represent the principal stakeholders on the project, including senior management, users, IS staff, vendors, consultants and project managers. A total of 16 interviews were conducted. The typical length of an interview was one to two hours and they were all conducted face-to-face by either two or three interviewers. The interviews were designed to be semi-structured, and facilitate note taking. Prior to the interview, the interviewees were told that the purpose of the study was to learn about the process of managing ISD projects. The interview protocol began with a series of questions about the interviewees' career and the organization. It would then proceed to a discussion of the project motivation, scope, their role, schedule, budget,

¹ The organization, projects and individuals have been disguised for confidentiality.

major challenges/issues and lessons learnt. If a particular issue seemed highly relevant, it would be explored further. All interviewees were encouraged to provide detailed examples.

Observation. Meetings attended included those for ISEC, PGO and project teams. The objective of attendance was to understand how the individuals interacted and to confirm that the documentation produced at these meetings was a true account of the events, as observed.

Construct Validity and Reliability. The data collection approach was expressly designed to increase construct validity and reliability. Construct validity is concerned with ensuring that the correct measures are established. This can be done by using multiple sources of data (Yin, 1984). In this case, it included the use of a wide variety of documents, interviews and observations. In the few cases where there were conflicts in the information, additional data was gathered.

Reliability is concerned with ensuring that, if the study were repeated, the same results would follow (Yin, 1984). A principal mechanism to achieve this is to make as explicit as possible the way observations were made and recorded. This was achieved in several ways. First, all sources of data were recorded and catalogued in separate data files. Second, immediately following interviews or observed meetings, the interviewers wrote a detailed account from the notes taken. This included quotes or near quotes. Each interviewer would write an account, and these were then compared between interviewers. Third, reflections on the interviews were written in the form of field notes. Finally, a case report was prepared for the project.

Analysis

The purpose of the analysis is to develop an understanding of the process that prevails on an ISD project. To do this, the approach used for analyzing the case involves four steps. First, a timeline is constructed for the project, which identifies the scope, schedule and budget. This information is taken from the published project reports and is supplemented by the interviews. Second, a case history is developed that outlined how the tasks unfolded. Again, the reports and interviews provided guidance. Third, the case is analyzed against each of the four process theories, with a particular focus on what they do and do not explain. Finally, the four process interpretations are compared to identify any relevant insights. In the next section, a description of the unfolding events is provided.

CASE DESCRIPTION: THE DEVELOPMENT OF SAMPPROJ

In September 2000 the Board of WaterCo endorsed an information technology implementation strategy that included the introduction of middleware and data warehousing technologies, which would facilitate broad access to WaterCo business information. Rather than attempt a big-bang implementation of these middleware and advanced technologies, a concept of a showcase project was proposed in May 2001. The successful implementation of a showcase would provide a demonstration model to business managers, and thereby encourage them to undertake similar initiatives. As one employee noted: *“The concept of SampProj was to give them (WaterCo), practical thing, not necessarily whiz bang things. If they (IS Division) give them (WaterCo) things that actually make a difference to their working life, they (WaterCo) will respond positively”* (I6, p4).

During 2001, once WaterCo’s Board had agreed on the progress of the showcase concept, a series of workshops were conducted to identify appropriate projects. The principal challenge at this stage was to get the business units engaged in the initiative. Most business units were not proactive in requesting ISD projects, and as one employee highlighted, *“...we (IS Division) actually have to go and approach the business. They (Business Units) don’t really come and say I really want this. This is a great project...”* (I5, p1). To overcome this problem the Board of WaterCo championed the project. As a result, over 55 individuals were involved in the discussions, and three projects were short-listed throughout the organization. Following subsequent detailed evaluations, based on predefined criteria covering the significance and feasibility of the options to WaterCo, SampProj was selected for implementation. Its initial budget was \$US0.6m.

Conceptual design began in July 2001. The current organizational outsourcing partner for ISD projects was used for SD and the organization went to tender for a consultant to lead BI and PM. Up to the time of the appointment of BI and PM, the SD partner took responsibility for these components. In addition, the organization commissioned an external consultant to undertake a benefits realization assessment (BRA). At this stage, only seed funding of \$US0.05m had been approved for the project. This was for the preliminary design and BRA.

Following further elaboration of the design, the proposal was sent back to ISEC in September 2001 with a revised budget of \$US0.7m. This budget was again not approved and the project team was asked by ISEC to produce more detail. To facilitate the production of a more detailed design, a consultant was selected late October for the joint role of BI and PM. This consultant was the same as the one selected to undertake the BRA. The BI partner’s initial charter was to confirm the design and budget, as initially developed by the SD partner. After considerable rework, a budget of \$US1.0m was approved in January 2002.

The key feature of the design was the number of different components that would need to be integrated. As one interviewee noted, “...it is really a series of projects, and its marrying a whole lot of issues together” (I2, p2). The components included; datamart, reporting and analysis tool, personal digital assistant (PDA), PDA server, sample manager, alert management infrastructure and electronic incident reporting. It also required interfacing of these with legacy systems, such as the laboratory information management system (LIMS) and the geographic information system (GIS).

Following approval in early-January, the first steps were well defined, in that they involved completing the plans and procedures and undertaking some detailed stakeholder analysis. The primary constraint at this stage was the availability of business resources, particularly as they were committed to other activities at the time. One employee notes that early on they, “lacked a lot of business involvement from laboratory” (I5, p24). Draft plans were generally produced as scheduled, however final approvals “took forever to sign-off” (I8, p3). This was not such a concern for the project management procedures, but it was a constraint for the technical specifications. The project was to be released in three stages.

The principal development activity involved producing a set of tools and techniques for gathering and recording field samples using a PDA, developing a core software system using Microsoft .NET, geographic information system (GIS) and reporting software, and integrating them into existing organizational systems.

Three challenges arose as the project progressed. The first major challenge was with data management. To develop a central repository of information for the management of water quality, as required on the project, information from the legacy systems required careful extraction and conversion. This, however, was a real problem because of low data integrity. To address that concern, the task was separated out from the core project and expenses charged to a different budget. As a result, it had little impact on the critical path.

The second challenge was the performance of the laboratory information management system (LIMS). The initial design called for information to be stored in the central repository of SampProj, and then be replicated in other systems. However, the LIMS upgrade project, that would allow this replication to the laboratory system, was delayed. The LIMS project was scheduled for completion in 2001, prior to the development work on SampProj beginning. It was not however completed until March and had ongoing issues for three months after that. It was also discovered that the configuration of LIMS would restrict this replication. As one interviewee recalled, “the moment of truth arrived in November 2002” (I9, p2). At this time, it was discovered that the original LIMS project would not be able to deliver on its planned schedule. To accommodate, SampProj was revised to do the replication in reverse. That is, replicating the LIMS data to the core system. This configuration issue did not emerge until March, the resolution strategy was approved in April, and activity on it began in June. It caused delays through to project completion. Although it was not initially on the critical path, during the closing stages of the project, it was the major constraint.

Finally, the integration of a number of packages that make up the core system, reporting, web interface and GIS, was also a problem. The architecture was due for signoff in March, but it was not resolved until April. The problem was the lack of resources and general uncertainty over the interface. Following development, the above integration issues subsequently threatened system stability. It took some time for the system to become stable after initial development. As a result, stage one of user acceptance testing (UAT), which was initially due for completion in May, was not completed until July. SampProj was also de-scoped and the deadline for stage two of UAT was pushed out from June to July. Stage two had similar stability problems and was divided into a number of sub releases. This had a further impact on completion, delaying it from July to September. So, stage two UAT, scheduled to begin in June and finish in July, started in August and finished in September, a one hundred percent schedule overrun.

Outside the three issues in the development of the core system, the development of the data gathering equipment also experienced delays. Two principal components, the PDA and the sample labeling, caused schedule overruns. The PDA is the hardware and software required to gather sample information from the sites. It was to be used by the field engineers to log which sites had been visited and when. The concern for the PDA was that the hardware was not available as scheduled. After selecting the device, miscommunication between the various stakeholders caused a delay in the delivery of the hardware of one month, moving the start of development from February to March, with flow on effects to programming.

The development of the sample labels also incurred a number of unplanned delays. The sample labels are the tags that are placed at every sample site. When a field engineer went to site to collect a sample they would swipe the label with their PDA. This would bring up all the records for that site. The concern with the sample labels initially was how they were attached to the pipes. When they were placed “...around the curve, instead of straight along a pole, the barcode reader could not read them” (I2, p3). This task was delayed for a month while a new set of labels was produced, and attach, in the correct way.

In addition, an external GIS project impacted the schedule of SampProj. The GIS project was scheduled for completion in 2001, prior to the development work on SampProj beginning. However, because of difficulties faced during development for GIS, it was not installed on the production server until April and had ongoing issues for four months after that. With SampProj dependent on GIS data to monitor samples locations, this required a revision within SampProj.

Overall, the planned completion of the development stage was September 2002, but was delivered in December 2002, four months late. In addition, handover for the final project was March 2003, a six month overrun. From a business perspective it was a success however.

EXPLAINING THE DEVELOPMENT PROCESS: THE FOUR LENSES

The objective of this paper is to understand the process of development, with a particular focus on understanding the limitations of lifecycle theory, and exploring the potential contribution of the three other theories. With this in mind, the explanation below starts by considering lifecycle theory, it then goes on to explain the application of the other three theories.

Application of Lifecycle Theory

The lifecycle perspective suggests that a project has within it an underlying logic that governs the process of change. External events might influence progress, but there is always an imminent logic governing development.

In analyzing the SampProj case, it is clear that the project did follow a lifecycle. It began with an initiation period. At this time, an open invitation to develop a showcase project was proposed to the business units. Following a rigorous evaluation process, SampProj was selected as the project to proceed with. The conceptual design was the next stage. For this stage, various partner organizations were engaged to assist in outlining a proposal that stated the requirements, how they were to be fulfilled and the cost and time to deliver. Some delays were experienced due to concerns over the proposal, but these were quickly overcome and the project proceeded. The next two stages, detailed design and development, were conducted concurrently. For each of the projects components, a detailed design was formulated, approved and implemented. The last three stages were testing, implementation and handover. As expected, these proceeded sequentially until the project was complete. Although the project did face a number of challenges from issues such as external dependencies and systems integration, the general path continued to be one where as the project progressed it became better defined.

This perspective supports the notion that a lifecycle governs project development. It does not however, resolve many of the process issues that arise in the case, at each of the stages. These limitations include:

- What is the process of setting the objectives for each stage? For example, the design stage of SampProj produced documents that outlined how the system will work, but the lifecycle perspective does not specify the process for how this is done.
- What is the process of creating options to address the objectives of each stage? For example, in selecting SampProj as the project to develop from the options provided, there is a process of creating options that needs to be undertaken. The lifecycle perspective does not specify the process for how this is done.
- What is the process of making choices from the options presented in each stage? For example, during development of SampProj the integration of a number of packages was a problem. Choices need to be made on how to proceed, and the lifecycle perspective does not specify the process for how this is done.

These three limitations can be addressed by reviewing the other three theories.

Application of Teleological Theory

The teleological perspective states that a project advances towards a goal. At the beginning of a stage, the stakeholders are not satisfied with their goals, so they set new goals and then go about implementing them.

On SampProj, the beginning of each stage presented a new challenge. The lifecycle perspective suggests that each new stage will arrive, but it does not say anything about the process by which the goals of the stage are developed or fulfilled. The teleological perspective addresses this shortfall. For example, at the initiation stage, there were a number of alternative projects that the organization could have proceeded with. To make a choice, the organization knew they were unhappy with the current environment (dissatisfaction), they went and looked for alternatives to address this (searching for goals), they had some criteria to fulfill (setting goals), and then they went about fulfilling these criteria (implementing goals). Another example can be taken from the design stage. At the beginning of the stage the project team knew they could proceed to development, but they did not have the necessary detail to do so (dissatisfaction). To resolve this they went about exploring the organizational needs

(searching for goals), and then outlining them into a set of requirements (setting goals). This was then adopted as the design (implementing goals). Thus, the teleological perspective explains how goals are set and delivered.

Application of Evolutionary Theory

The evolutionary perspective states that change proceeds through a cycle of variation, selection and retention. In making progress, a number of options can be presented, depending on the conditions faced at a particular point in time. These options can then be compared and selected.

On SampProj, early on in the project, numerous decisions had to be made on the components of the project. For example, which packages were going to be modified and developed for the needs of WaterCo. There was even the initial decision about whether SampProj or two other options were going to be developed. The lifecycle perspective suggests that some decision will be made, but it does not say anything about how the options are established. Evolutionary theory addresses this shortfall. For example, referring back to the initial choice of project, there were a number of options presented (variation), one was chosen as the preferred path (selection) and it was kept as the solution for the project (retention). This process of evolutionary development was particularly relevant in the early stages of the project, because there was higher uncertainty over the design. Once more structure was established later in the project, it was less relevant. That is, there were fewer options to evaluate given the chosen path. Thus, the evolutionary perspective suggests how options are created to achieve project objectives.

Application of Dialectic Theory

The dialectic perspective suggests that there are two or more issues that have conflicting viewpoints and they must engage one another in conflict. Stability is continuously challenged as long as the project exists.

On SampProj, throughout the project, there were conflicting viewpoints where choices had to be made. The lifecycle perspective suggests that a decision will be made on these so that the project can proceed, but it does not say anything about how decisions are made. The dialectic perspective addresses this shortfall. For example, development required the integration of a number of packages (thesis). As the project progressed though, it became apparent that the packages could not be as easily integrated as first thought (antithesis). The vendors were then brought in to help resolve the problems (synthesis). Another example would be dependent projects, such as the LIMS project, that enforced a change to SampProj. The initial design required that data be stored in the central repository (thesis), but because of concerns over the completion of the LIMS project (antithesis), this could not be done, and an alternative solution of doing a reverse replication was selected (synthesis). Thus, the thrust of the dialectic perspective is to explain how choices are made from the options presented.

DISCUSSION

Four Process Motors in Action

The objective of this paper was to explore how the four process theories are applied in a case setting. The findings suggest that all four theories are relevant. The results began by outlining some of the limitation of lifecycle theory in explaining the process. It then went on to briefly describe how the other three theories could be applied to address these shortfalls. The findings are summarized in Table 1 and illustrated in Figure 1. In the table and figure, lifecycle theory explained the overall path of the project, following the stages as the project matures. This is the philosophy embedded in most ISD methodologies today. Teleological theory established the goals for the project, as well as the goals of each stage. This can be used to provide better structure to the business requirements that a project needs to fulfil. Evolutionary theory presents the different options that can be taken to meet the project objectives at each stage. This is more prominent earlier in the project, rather than later, because earlier on there is less understanding of the scope of a project and so more options available. Finally, dialectic theory provided an understanding of the decision-making at each stage. That is, it explains the challenges that arise on a chosen path and how they are resolved.

What does this mean for ISD? It begins to explain how the process proceeds. Other than the general lifecycle, there is little understanding of the process of development. By demonstrating that the process has four components allows the development of a portfolio of tools that can be used on a need to basis. If a project is being developed, an organization should enable mechanisms that manage each of these four processes. Without them, they are not addressing all the potential concerns they could face on a project.

Table 1: Application of the four process theories to ISD

	Lifecycle	Teleological	Evolutionary	Dialectic
Logic	One prescribed path	One emergent path	Numerous prescribed paths	Numerous emergent paths
Path	1. Start-Up 2. Growth 3. Harvest 4. Terminate	1. Dissatisfaction 2. Search for goals 3. Setting goals 4. Implement goal	1. Variation 2. Selection 3. Retention	1. Thesis 2. Antithesis 3. Conflict 4. Synthesis
ISD Application	Guiding a project	Setting the project objectives	Creating options	Making choices from options presented

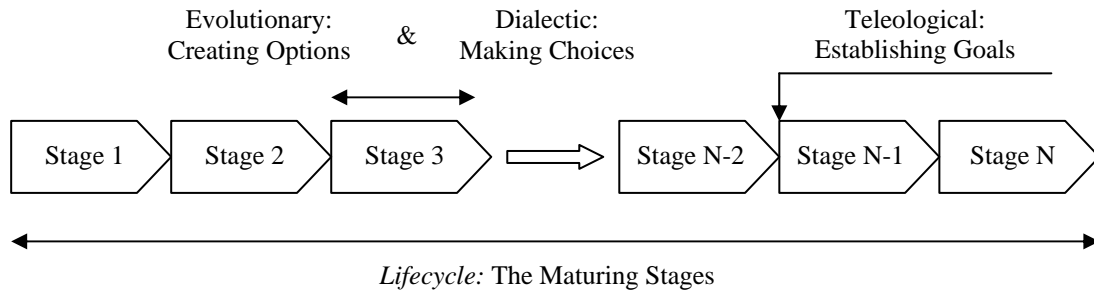


Figure 1: The application of the four process theories to ISD

Implications

There are two key implications of this paper. First, the paper starts to develop a theory to explain the process of ISD that prevails in today’s business environment. Prior to this paper, the assumption within most of the ISD literature was that the lifecycle approach represented the underlying basis from which to develop a project. This paper demonstrates there are also three other theories that can be equally applied. Second, the paper provides a promising starting point for the categorization of ISD methodologies. If methodologies can be separated into their parts based on the four theories, there is potentially a new way to select and adopt methodologies.

Limitations

There are several limitations to this study. Four of the more significant are noted here. First, one project was selected, which limits generalizability. Note though that the structure of the organization is not unusual, in that there are several business units serviced by an IS Division. However, the findings should be generalized only to similarly structured organizations. Future research should consider multiple case studies and other industries. Second, the project selected had adopted a methodology itself (PRINCE2). This might bias the findings. That is, the methodology might structure the processes in a particular way. Although the case write-up was designed to be methodology independent, some concern about this persists. Further research needs to be conducted on projects using alternative methodologies to verify the results.

Third, much of the study data was based on retrospective accounts. This could result in some distortion of the facts. However, this study triangulated data across several sources including interview, observations and documents, increasing confidence in the findings. Future research might consider a longitudinal study. Finally, the data gathered was qualitative, and this type of data can be interpreted in many ways. Using a rigorous data gathering and analysis technique, as described earlier, limits this concern. Future research might consider gathering quantitative data.

SUMMARY

In this paper, the process of ISD was examined through the lens of four process theories. The objective was to shed some light on how ISD projects are actually developed. The findings suggest that the four theories interact. Lifecycle theory provides an overview of project development. Teleological theory explains the process of goal setting. Evolutionary theory describes how choices are established. Finally, dialectic theory shows how choices are many between options. These four theories provide a backbone that can be used to describe methodologies. This could substantially change the way methodologies are viewed and used in the future. For example, it might provide a way to dissect a project so that different parts adopt different approaches depending on the theory that underpins them. This can then be used to create a portfolio of methodological tools.

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