Why Do Shadow Systems Exist after an ERP Implementation?

Lessons from a Case Study

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Abstract

One of the main promises of an ERP implementation is the 'full integration of a business'. Reports of shadow systems in post ERP implementations suggest that this is not always the case. Using an exploratory single case study method with grounded theory coding techniques this study investigates why shadow systems exist after an ERP implementation. This paper provides a theoretical framework which reveals that the causal factors found in the categories of technology, organization, business procedures and people all contribute to the phenomenon of shadow systems in an ERP context.

Keywords: Shadow Systems, ERP systems, Case study method

Introduction

Enterprise Resource Planning (ERP) systems have been defined as "an integrated information system that replaces legacy systems with a series of software modules that communicate with each other seamlessly, replacing business processes with best practices" (Hernandez 1997). The market for ERP systems is significant with over $20 billion in revenues being generated annually for suppliers alone by early 2000 (Willcocks et al. 2000). ERP systems endeavor to integrate many different organizational functions and associated data which are expected to provide various flow-on benefits (Davenport 1998). Such benefits include but are not limited to cost reduction, increased growth, improved business processes, heightened productivity, and increased agility of the organization as a whole (Davenport 1998; Markus et al. 2000; Umble et al. 2002).

The primary goal of an ERP system is to meet all the functional and operational requirements of an organization through a single system (Davenport 1998). This goal seems to have been achieved through some successes such as Autodesk and Fujitsu Microelectronics (Davenport 1998). However there is also evidence within the literature that suggests that success is not always achieved. Strong, Volkoff and Elmes (2001) discuss the user responses to ERP implementations which include "workarounds" as well as the development of shadow systems.

'Shadow systems in an ERP system context' is the unit of analysis in this study. For the purpose of this research shadow systems are defined as systems which replicate in full or in part data and/or functionality of the legitimate systems of the organization. The legitimate systems of the organization are those systems which have been designed and installed to carry out the primary purpose of the organization as it was understood at the time of installation.

Shadow systems have been discussed within the IS/IT literature as a generally undesirable phenomenon (Oliver et al. 1999; Lee 2001; Scott et al. 2003) but offer little explanation of why they exist. Practitioner based IS/IT sources such as organizational IT reports and minutes of meetings (National Institute of Health 2003; University of California San Francisco 2000; Washburn University 2000) offer a brief examination of their associated costs and benefits. The costs associated with shadow systems include redundant workload, data integrity and quality problems associated with the replication effort (Washburn University 2000). Benefits include the provision of information and functionality which meet the needs of the individual department within the organization (National Institute of Health 2003).

Although it is not known how frequently shadow systems persist after an ERP system implementation there are organisations that state shadow systems still exist despite the presence of a fully operational ERP system (University of Wyoming and North Central Association of Colleges and Schools Commission of Higher Education 1998). There are also tentative explanations as to why implementing an ERP may not mean the total disappearance of shadow systems (Strong et al. 2001) such as control issues but no in-depth studies on the topic. The purpose of this research is to contribute to addressing this gap and we try to answer the question: "Why do shadow systems persist in organizations after an ERP system implementation?"

The remainder of this paper will outline the research design employed in the study, followed by the findings. The paper will conclude with a brief discussion on the study, contributions to both research and practice and finally the conclusions.

Research Method

The research methodology used in this work was that of a single exploratory case study. Such a study focuses on a single case only (Yin 1993) and involves the unusual, critical or revelatory case. An exploratory case is aimed at defining research questions and hypotheses or at determining the viability of research procedures to be used in a subsequent study (Yin 1993). As an exploratory case study it was felt that it was necessary to use an inductive approach to coding the raw data. The grounded theory method involves a primarily inductive coding technique and was adopted for this research.

The case study method was decided upon as the most appropriate choice due to three main characteristics of the research problem and its objectives.

1. The problem was tightly interwoven with its context. At the outset of this study it was considered that shadow systems were inextricably linked to the organisation and the various stakeholders within it.
2. The phenomenon under investigation is unique. As stated previously there has been no in-depth studies on shadow systems and therefore this case is revelatory in nature.
3. Trying to understand what role shadow systems play in an organisation post ERP implementation is an exploratory style of problem.

There are four tests which are relevant when judging the quality of any research design whether it be a case study or otherwise (Yin 1993). These tests are construct validity, internal validity, external validity and reliability. Due to the nature of this study being a single

exploratory case study only two of these four tests were relevant:
construct validity and reliability (Yin 1993). . Construct validity, the establishment of correct operational procedures for the concepts being studied, was achieved through use of multiple sources of evidence to encourage convergent lines of enquiry as well as establishing a chain of evidence. Reliability, the objective of minimizing errors and biases in a study, was encouraged in this study through the use of a case study protocol and keeping a case study database. How these tactics were applied is explained in more detail in the discussion under data collection.

Using multiple sources of evidence is a common method used to increase the accuracy and precision of judgements and thereby the results of a study (Ghauri et al. 2002; Yin 1993; Neuman et al. 2003). This study used the two most popular forms of collecting evidence in case studies: documentation and interviews.

Specific types of documentation collected included communiqués such as email, mass media documentation such as online news clippings concerning the university, administrative documents such as formal business cases from departments within the university and formal evaluations of the university done externally to the university. A total of 27 such documents were used to augment and corroborate interview data.

The interviews conducted in this study were of a focussed nature. As such the interviews were scheduled for a short period of time – 30 to 45 minutes and rarely went over the allotted time period with the maximum being approximately one hour. The interviews were focussed in that they followed a certain set of questions derived from the case study protocol. However they employed open-ended questions and were conversational in tone. The open-ended questions used in the focussed interviews are provided in Appendix B.

A total of eleven individuals were interviewed. All had experience with at least one shadow system within the organisation, being associated either as a user, sponsor or developer. Four were users, four were sponsors and the remaining three were developers.

The coding of the raw data collected during this study used the grounded theory methodol proposed by Strauss (1987). This methodol has three phases of coding including:

1. Open coding – where categories, along with their properties and dimensions, are extracted from the raw data.
2. Axial coding - involves relating categories which were discovered in the previous phase with the goal of explaining a particular phenomenon or event.
3. Selective coding – this is the final phase of coding and involves the integration and refinement of categories in order to form the final theoretical scheme.

NVivo was the tool used throughout all phases of the coding. The following sections will first introduce the research setting and then present the findings of the open, axial, and selective phases of coding.

Research Setting

Central Queensland University (CQU) was the organisation selected to be the single case study site for this research as it satisfied three case study conditions.

1. Implementation of an ERP.
   CQU, in conjunction with Accenture, implemented the PeopleSoft ERP system for both the Student and Finance areas. The ERP was fully operational at July 2001 for the Student area and August 2001 for the Finance area.
2. Presence of shadow systems.
   CQU has various shadow systems which both mimic and extend what is provided by the ERP. Three main shadow systems were selected for the investigation of this study. Table 1 summarises their characteristics.
3. Willingness to participate in the study.
   CQU, at both the organisation and individual level, supported the study and were willing to give objective in-depth answers

Shadow System	Purpose	Users	Developer	System Owner
Pete's tracker	Tracking financial information about an academic's consulting funds	Academic/end user	Individual	Individual
Impromtu	Provide reporting services	Staff in many divisions/faculties	ITD	ITD/University
MyCQU	Web-based access to student enrolment data	General and academic staff in faculties	Infocom web team	Infocom

Table 1 Summary of shadow system characteristics

The Case Organisation

Central Queensland University (CQU) is a higher educational institution based in regional Queensland, Australia. It has a diverse geographic arrangement of its campuses with six regional, four interstate and three overseas campuses. The university offers a range of educational services from engineering to law. It is a large organisation and has a number of support divisions responsible for various operational requirements such as financial services, IT support and human resource management.

The management structure of CQU is hierarchical but the faculties and divisions are given a certain amount of control to self-manage. This control is realised through the allocation of resources to make their own faculty specific decisions. There are five faculties with two of those faculties receiving over 60% of the total student enrolment and consequently receiving a larger proportion of the funds.

In 1998 the Information Technology Division (ITD) of CQU employed an evaluation team to assess its administrative systems. The result of this evaluation was a request for proposal for a system which would address perceived deficiencies. The two main goals were to achieve an integrated administrative system and achieve best practice in higher education (Central Queensland University 2001).

Results of the Open Coding phase: Categories and Properties

The goal of the open coding phase is to identify categories as well as their properties and dimensions from the data. Categories are the theoretical building blocks which represent certain phenomena existing within the data. Properties are the general or specific characteristics or attributes of a category whereas dimensions are the location of a property along a continuum or range (Strauss et al. 1998). Table 2 and the following paragraphs outline and discuss the categories, properties and dimensions identified in this research.

Category	Property	Dimension
Organisation	Arrangement	Hierarchical to Peer
	Role Positions	Centralised to Decentralised
	Resources	Rich to Poor
	Flexibility	Rigid to Pliable
Business Processes	Transparency	Clear to Unclear
	Appropriateness	Good Fit to Mismatch
	Latency	Fast to Slow
People	Expectations	Fulfilled to Unmatched
	Relationships	Amicable to Hostile
	Control	In Command to No Control
Technology	Functionality	Well Adapted to Poor Fit
	Infrastructure	Simple to Complex
	Affordances	Limited to Multi-faceted
	Reliability	High to Low
	Development Paradigm	Lightweight to Heavyweight
Resource	Level	Rich to Poor
Support	Internal	High to Low
	External	High to Low

Table 2 Categories, properties and dimensions identified in the open coding phase

Organisation

This category concerned the structural establishment of the enterprise as a whole, based on its administrative and functional divisions. In this case study the organisation is the university, which includes the organisational units of chancellery, faculties and departments.

At CQU the **arrangement** of non-academic organisational units are strictly hierarchical with departments and faculties directly responsible to chancellery. **Role positions** of functional and administrative roles were moving toward a more centralised operation. ERP systems themselves are seen as centralised systems and its implementation within the university was accompanied by a move toward the centralisation of various roles.

Resources in terms of people, money and time available to the organisation determined priority allocations and hence resources available to each particular division. One interviewee from chancellery discussed how the funding was distributed toward the Information Technology division supporting the ERP system while other divisions missed out:

> *"At the end of 2001 we got a qualified audit from the Queensland government. The only thing we did in 2002 in terms of priority was to get the audit fixed … so the available resources again … are going into improving Peoplesoft."*

The **flexibility** of the organisation to adapt to changing requirements was another area which was significant. The university under study underwent a substantial period of change not only with the implementation of its ERP system but also with external influences of having to satisfy audit requirements at the same time. All interviewees agreed that many organisational units struggled to keep up with their normal operating requirements. As one interviewee states, their division had to cope with an extended period of "not having access to financial information" (either through the ERP system itself or any other means) required for normal functioning of the division.

Business Processes

Performance of work within divisions and faculties consists of various steps. These steps include tasks such as information processing and communication (Alter 2002).

Transparency, interviewees emphasised the ability to decipher how certain business processes are to be achieved. One interviewee discussed the experience of the Division of Teaching and Learning Services. This division is responsible for supporting distance education students through various processes such as mail-outs of course materials. This division was told that their business processes requirements were out of scope for the new ERP system. However, they would still be expected to interface to the ERP to keep it updated with the latest information. This requirement left the division unsure of exactly what their business processes should be and resulted in various " .. issues in there which caused frustrations".

Appropriateness refers to how well the business process encapsulated within the ERP system matched the work it was meant to support. After the ERP implementation interviewees discussed their annoyances with the mismatch between work they were required to perform and the business processes used to complete it after the ERP implementation. One interviewee discussed their total exasperation at the clear unsuitability between the business processes actually used and the "relatively simple task" of acquiring access to information belonging to their division.

Latency of the business process refers to the time it takes from when work enters the business process to when it exits or is seen to be complete. Implementation of the ERP system meant many business processes changed or were not even accounted for. However all were required to interface to the system to get information in or out. Many interviewees stated that during and after the ERP implementation the time taken to complete work tasks slowed drastically. The progress of particular business processes were even halted due to trying to interface correctly to the new system. One interviewee describes their experience:

> *"We've had to wait years for responses to requests - not even solutions, just responses about the request."*

An interviewee within the support division for the ERP concurs with the lack of speed in completing their own job requests.

> *"so there will probably be a lead time of six months or … and sometimes that is just too long for them."*

People

People refer to participants within the organisation responsible for performing functional and administrative tasks. The participants in this study belong to various parts of the organization including divisions, faculties and chancellery.

The **expectations** of people are what they perceive or are told will happen post ERP implementation. In the phases during and after the ERP implementation interviewees described feelings of distrust due to their expectations not being met. Expectations were raised due to statements by the ERP implementation team but were quashed post implementation with those expectations being "out of scope".

It became clear during this phase of coding that relationships between certain divisions and faculties were strained. University documentation shows divisions and faculties are treated in distinctly different ways. This is evidenced in their enterprise bargaining agreement with one for general staff (divisions) and one for academics (faculties). Interviewees in both divisions and faculties discussed these tense relationships.

Interestingly, **relationships** before the ERP implementation were strained but after they became increasingly hostile. Interviewees from the faculty stated that management were not recognising their needs and requirements. Instead the focus was on meeting the needs and requirements of the divisions capable of meeting the external requirements; namely the finance division and the ERP central support division (ITD). This bred a certain amount of hostility from the people within the faculties toward both the management in chancellery making the decisions as well as the divisions getting the priority.

Interviewees from ITD demonstrated a certain amount of hostility toward the faculties as they believed that they had been given too much priority in previous years. One interviewee illustrates this perception:

> *"faculties rightly or wrongly … are the strongest voice in the university and being a university the academics have the strongest political voice"*

Even though this hostility exists the faculties still have to rely on the divisions to get work done. Divisions, however, are directly answerable to chancellery who do not recognise the needs and requirements of the faculties. As one interviewee in ITD states:

> *"so there is a tension there because we as a division get our direction down the general staff side which sees things such as audit compliance as being extremely important but the academics are sitting out there and saying but hey nobody is servicing my needs and you get a tension there"*

Control deals with the amount of control people within the organisation feel they have over their work processes. Prior to the ERP implementation many divisions were in control of how certain operations relating directly to their division were performed. In this sense they were in control of these particular business processes. After the ERP system was implemented they

were no longer in control of many of these processes. An interviewee speaking from the ERP system support division highlights this:

> *"faculties would rather do things than have the division do it. They want to have control of things"*

Technology

Technology refers to tools and techniques, not necessarily IT based, available to people to meet their work requirements.

Functionality is how well the technology matches the functions it was designed to perform. When interviewees discussed the functionality of the ERP system they discussed how inadequate it was. For example one interviewee states

> *"The reporting side of Peoplesoft is manifestly not adequate"*

Another interviewee discussed this lack of functionality in terms of trying to get a class list from the ERP system. Using the ERP this task required 26 steps and the use of two separate applications. This was confirmed by both a demonstration and by the central ERP user support.

Infrastructure includes the human, information and technical resources used to support the ERP system and in particular the underlying architecture and design base of the technology. Interviewees, both developers and database administrators, commented how complex this property of the ERP system was. Developers commented on how this complexity impacted negatively on the maintenance of the system.

> *"ERPs are generally inflexible in the sense that there is a high overhead in maintaining them. You can do changes but every time there is an upgrade you have to reapply those changes"*

Affordances are the functions and operations which are provided by a technology. A particular technology may be very limited in scope providing only a single function. On the other hand a technology may provide many and varied functionalities being multi-faceted in nature. When interviewees discussed the affordances provided by the ERP system the general belief was that it was too limited. A couple of comments by the interviewees illustrate this belief.

> *"It's geared for online transaction processing which doesn't suit [our requirements]"*

Reliability is the ability of a given system to consistently produce the same results, preferably meeting or exceeding its specifications (Imperial College Department of Computing 2004). Interviewees both internal and external of the central support system felt that the ERP system was generally unreliable. One interviewee discussed their experience with trying to interface to the ERP system.

> *"Peoplesoft database was going up and down lots, we couldn't rely on it".*

This comment was confirmed through email messages sent by the central ERP support division notifying users that the ERP system was "down" and could not be accessed.

Development paradigm is the software process model used for development (Sommerville 2001). These models or paradigms range from lightweight approaches to more heavyweight

approaches such as the waterfall model. The model adopted by the ERP system support division in this case study was a heavyweight model. Severely delayed solutions were attributed to this type of model by many of the interviewees. An interviewee from the ERP system central support describes this problem.

> *"going through the ERP they have to probably put in a request and then someone will analyse the functionality and do something and then it will have to be programmed so there will probably be a lead time of six months or so before anything happens … . So it can take six month,s a year or never to get their request handled."*

Resources

Resources refer to the wealth available for the development and maintenance of a shadow system. This wealth is not only measured in monetary terms but includes the people, their skills base and time.

The **level** or number of resources available to potential implementers of shadow systems plays an important role in their development and maintenance. How rich the person or division is in terms of resources to them are important factors impacting on shadow systems. The interviewees discussed the resource level as a key enabling factor for the shadow systems within their divisions. As one interviewee in one of the faculties states:

> *"The Dean also gave it financial support by giving Web developers and the Dean had started sponsoring it before I got involved in sponsoring it. I could see the value of [MyInfocom]".*

Support

Support refers to the encouragement, either formal or informal, given to the development and maintenance of a shadow system.

Internal support refers to support available within the host organisational unit. The direction the support came from as well as how many people were encouraging a particular course of action impacted on shadow systems.

External support refers to support for the system from outside the host organisational unit. In general interviewees felt that shadow systems visible across organisational divisions were discouraged unless they were supported by the central IT division. Interviewees explained this contradiction by stating that the shadow system within the ERP central support division held "legitimacy" purely due to its location. As one interviewee within the central support division states:

> *"from a social perspective it's [Impromptu] legitimised already whereas because MyInfocom is sitting within a faculty it's not legitimised in the same way. It's not to say that you shouldn't be asking the same questions about both groups but … which is why did they have to do what they are doing … but those questions don't get asked of [us]."*

Axial Coding – Category Relationships

The axial phase of coding involves finding relationships between categories in order to explain a phenomenon. Grounded theory coding method (Strauss et al. 1998) states categories will refer to causal conditions, phenomena, context, intervening conditions, action/interaction strategies and consequences. Causal conditions are sets of events that influence a phenomenon. The context is the precise set of conditions that produce the phenomenon. Intervening conditions mitigate the impact of causal conditions. Action/interaction strategies are possible responses to intervening conditions. Consequences are outcomes of the actions/interactions.

Figure 1 depicts the relationships of the categories identified in the previous open coding phase to their appropriate classifications of causal conditions, phenomenon and intervening conditions. Table 3 shows the contextual conditions. Action/interaction strategies and consequences are not included as they were not the focus of the study.

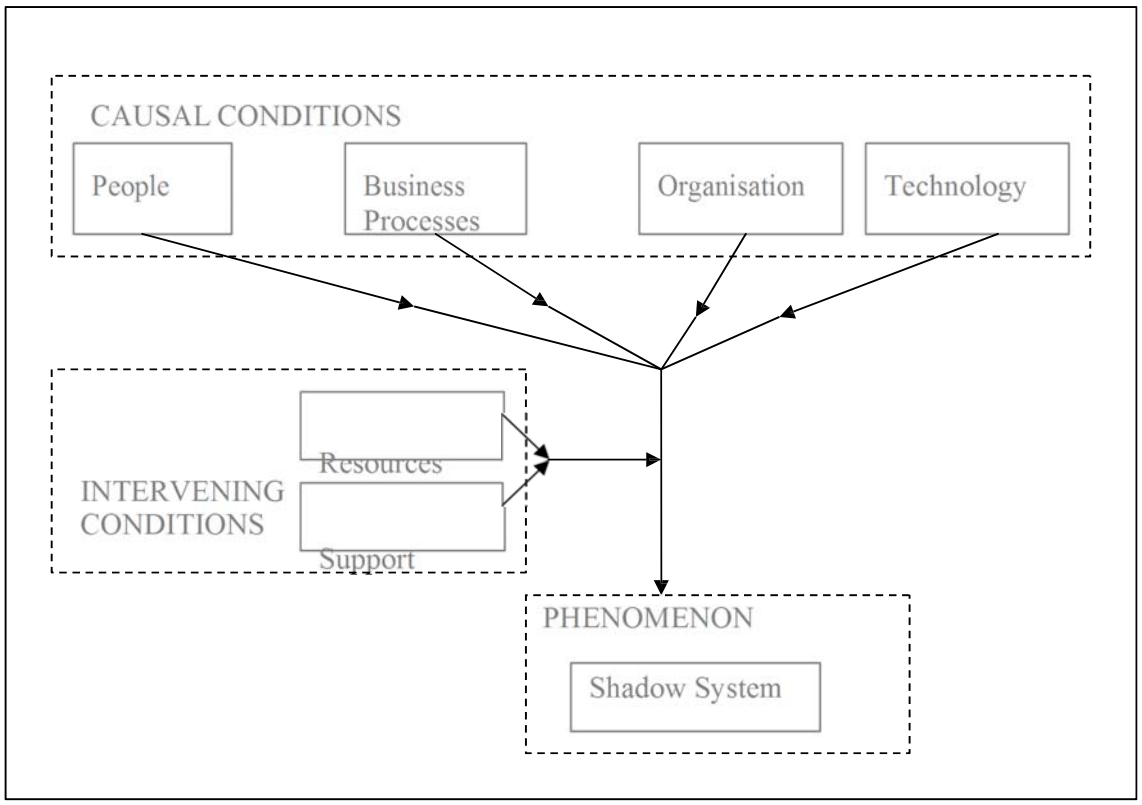

Figure 1 Axial Coding Category Relationships

Table 3 shows the contextual conditions for each of the three shadow systems focussed on in this study. The contextual conditions are the specific set of conditions which interacted dimensionally to produce each shadow system. As shown in Table 3 the main difference between the shadow system “Impromptu” and the other two shadow systems was who was in command and the level of external support. It was this difference which led interviewees to be unsure of whether this system should be classified as a shadow system at all.

			SHADOW SYSTEM		
CATEGORY	PROPERTY	DIMENSION	MyInfocom	Impromptu	Pete's Tracker
People	Expectations	Fulfilled			
		Unmatched	X	X	X
	Relationships	Amicable			
		Hostile	X	X	X
	Control	In Command		X	
		No Control	X		X
Business Processes	Transparency	Clear			
		Unclear	X	X	X
	Appropriateness	Good Fit			
		Mismatch	X	X	X
	Latency	Fast			
		Slow	X	X	X
Organisation	Arrangement	Hierarchical	X	X	X
		Peer			
	Role Positions	Centralised	Moving toward	Moving toward	Moving toward
		Decentralised			
	Resources	Rich			
		Poor	Moving toward	Moving toward	Moving toward
	Flexibility	Rigid	X	X	X
		Pliable			
Technology	Functionality	Well Adapted			
		Poor Fit	X	X	X
	Infrastructure	Simple			
		Complex	X	X	X
	Affordances	Limited	X	X	X
		Multi-faceted			
	Reliability	Steadfast			
		Unpredictable	X	X	X
	Development Paradigm	Lightweight			
		Heavyweight	X	X	X
Resources	Level	High	X	X	
		Low			X
Support	Internal	High	X	X	Not relevan
		Low			
	External	High		X	
		Low	X		X

Table 3 Contextual Conditions for each shadow system studied.

Selective Coding – Final Theoretical Scheme

Selective coding involves the integration and refinement of categories which will form the final theoretical scheme for the research. After the axial coding phase there were many categories which were identified and related to each other but there was no core category which explained "what this research was about" (Strauss et al. 1998). After further analysis a more abstract conceptual idea evolved out of the list of existing categories. This idea was termed the "gap".

Figure 2 is an amended version of the research model showing how this central category relates to the other categories. The gap is the gulf between the requirements of various stakeholders within the organisation and what the ERP system implementation provided. In all of the interviewee transcripts there exists a substantial gap between the requirements of divisions of the organisation and what the implemented ERP system delivered. The gaps' distance was affected by the contextual conditions in play at the time. These contextual conditions were a culmination of the causal conditions of people, business process, organisation and technology as well as the intervening conditions of resources and support (see table 3). If the gap distance was large enough a shadow system arose as a consequence. The nature of the shadow system depended on the resources and support available. The shadow system was seen as a way of filling this gap between the stakeholders and the delivered ERP system. In essence the shadow system provided elements which were deemed missing or lacking in the ERP system implementation.

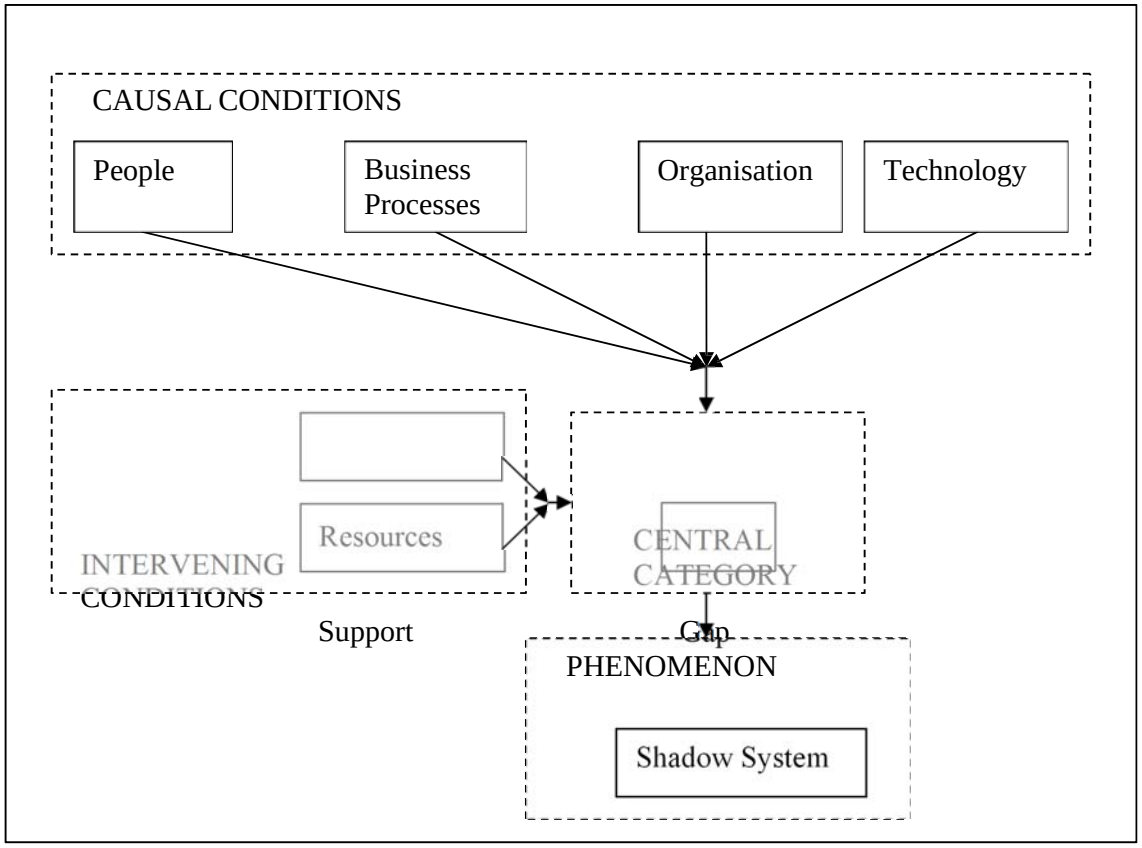

Figure 2 Selective Coding showing central category

Contributions and Implications of the Study

Using an exploratory single case study combined with grounded theory coding this study investigated why shadow systems exist after an ERP implementation. It arrived at a theoretical framework that explains this phenomenon. This framework states that shadow systems in an ERP context exist due to a gap; the distance between the requirements of stakeholders of the organisation and what the ERP system implementation provides. It is influenced by specific sets of contextual conditions; both causal and intervening conditions. Causal conditions are a culmination of organisation, business process, technology and people factors. Intervening conditions are the resources and support available. The resulting theoretical framework has relevance for both research and practice.

For research the study investigates a phenomenon which has possibly never been studied before and in this form represents a revelatory case (Yin 1993). The study is also revelatory in that it offers a new way of thinking about ERPs. It suggests that for technological, social, procedural and organisational reasons it may be difficult for an ERP to fulfil all organisational requirements. The study also offers a potential framework to explain the existence of shadow systems which can be used as a basis on which to explore the phenomenon further.

For practice organisations should be aware that the presence of shadow systems within their organisations may offer both positive and negative outcomes. Although shadow systems are generally seen in a negative light, wasting resources and duplicating effort they also offer advantages allowing individuals to achieve more positive work outcomes. These outcomes may be a more effective and efficient solution to what may be available in the main system. ERP providers should also realise that any one product will find it difficult to meet all the complex requirements of an organisation. A more practical solution may be to offer solutions which will provide core functionality required by most businesses and offer an easy way for other secondary systems such as shadow systems of interfacing to their systems. Such a solution would offer integration in a different way and may be more able to withstand the changing requirements of organisations over time.

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Appendix A – Interview Questions

1. Can you describe your involvement with (“Impromptu”/ “MyCQU” /”Petes Tracker”) shadow systems?

2. For those systems you have described and characterized earlier (mention these again) as well as those you are personally involved with can you explain why you think they are there?

3. What benefits do you think these shadow systems (list them) have over the main system (the ERP)?

4. Can you identify any problems in using these shadow systems as opposed to what has already been provided by the ERP?