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ORGANIZATIONAL CHANGE MANAGEMENT FOR THE IMPLEMENTATION OF COLLABORATION ENVIRONMENTS

by

BİLGE ERDOĞAN

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@by Bilge Erdoğan 2008

ABSTRACT

Although emerging technologies offer the construction industry many opportunities for IT-enabled collaboration environments, the companies adopting these technologies usually fail in achieving the full benefits from their implementations. The reason for this is found as focusing too much on the technical factors and ignoring or underestimating the factors related to change, implementation, human and organizational factors, and the roles of the management and end-users. Each new information technology implementation involves some change for the organization and the employees, and is therefore a source of resistance and confusion unless special attention is paid to managing this change.

This research aims to find how to introduce collaboration environments to construction organizations and how to manage the changes required in order to obtain the full benefits from their implementation. In order to achieve this aim, the theoretical concepts and previous work on collaboration environment implementations in construction industry, and change management with a focus on organizational change management are reviewed. The perspective of the construction organizations on the implementation of collaboration environments are investigated conducting case studies. Based on the findings from the literature review and the case studies, an organizational change management framework is developed for implementing collaboration environments. A computer based prototype is also developed in order to automate the framework. The framework and the prototype are evaluated by the industry professionals.

Keywords: Construction industry, collaboration, collaboration environment, organizational change management, human factors, framework

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CHAPTER ONE: INTRODUCTION

1.1 General Introduction

This chapter introduces the context for this research. It starts with a brief overview of the background to the research and the justification for the research. This is followed by the aim and objectives of the research study and a brief summary of the research methodology. The chapter concludes with the thesis structure, which introduces the chapters of the thesis.

1.2 Background and Justification for Research

In the construction sector, traditionally, a project is divided into a series of sequential and separate operations undertaken by individual parties (Egan, 1998). The traditional separation of design from execution, the uniqueness of each project, and the temporary teams set up for each project are some of the aspects that result in a complicated and complex construction process. Emerging technologies offer the construction industry an opportunity to address this complexity. With the emergence of technological innovations, distance and spatial boundaries have been blurred to the point where any organization can theoretically participate in a design or construction project in any location (Chinowsky, 2000).

Much of the recent work in construction focused on the delivery of Web-based technological solutions, collaborative visualisation, virtual reality and CAD applications, and knowledge management systems and technologies. The rapid developments in Internet and Web-based technologies have led construction research to focus on the development of collaboration solutions for globally dispersed project team members.

Analysing the adoption of collaboration technologies in terms of the traditional product lifecycle approach, shown in Figure 1.1, Wilkinson (2005) argued that following the stimulation of awareness and interest in collaboration technologies in the construction industry (by the clients who are open to innovations), the industry had successfully passed the development and introduction phases and by the mid-2000s had gone on to the growth phase. Likewise, in a case study-based research conducted by Ruikar et. al (2005) in UK, all construction companies were found to be early adopters of extranet technology for collaboration. However, although there have been some successful examples, the benefits of collaboration tools are not yet proven industry wide (Allen et. al, 2005).

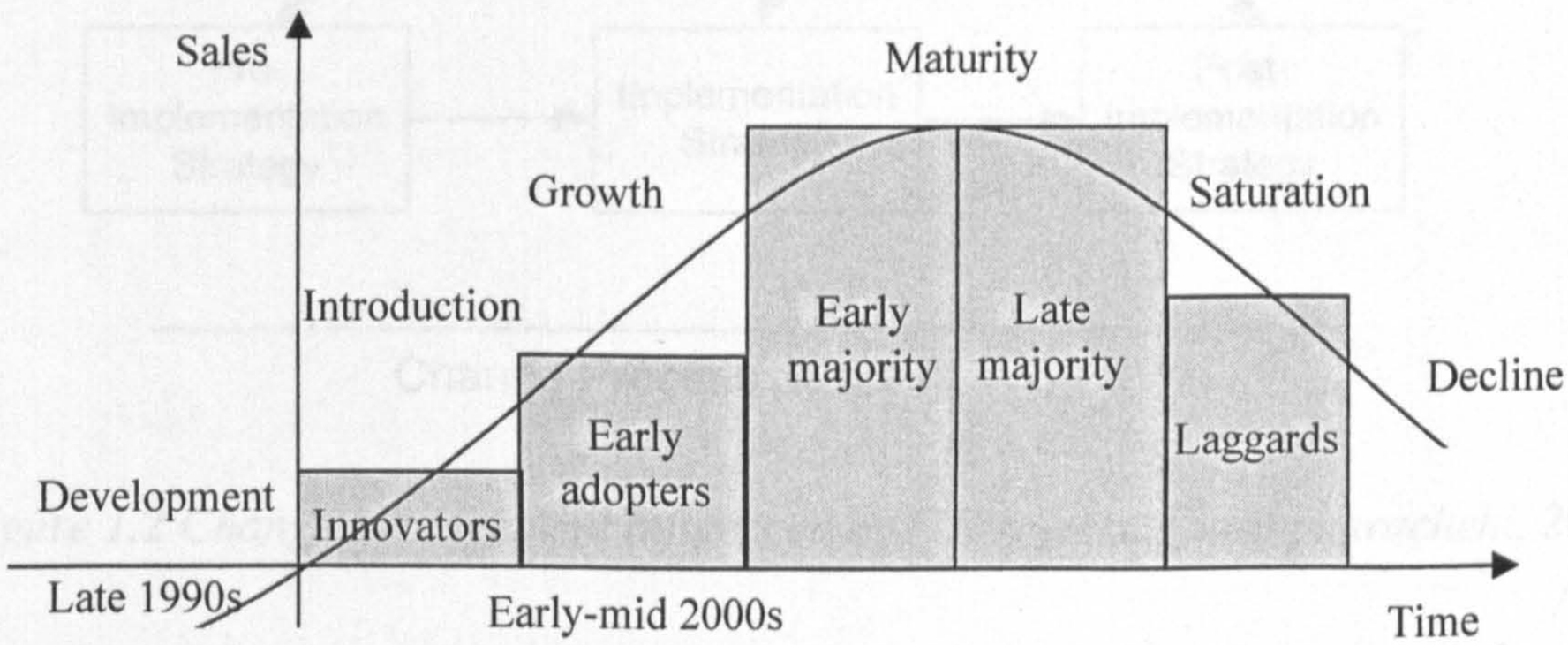


Figure 1.1: The Product Lifecycle (Wilkinson, 2005)

The main reasons for failure in achieving the full benefits of collaboration environments are mostly related to people and organizational issues. While introducing a new technology, it should be kept in mind that the construction industry is a conservative industry that does not welcome change very easily. There have been several research efforts mentioning the link between the IT adoptions and the accompanying change (Kuruppuarachchi et. al, 2002;. Maguire, 2000; Ash, 2003; Bartoli and Hermel, 2004; Cheng et. al, 2001).

Kuruppuarachchi et. al (2002) stated that the implementation of IT projects is similar to the management of changes in an organization regarding altering the work culture or gaining competitive advantages. Based on this statement, Kuruppuarachchi et. al (2002) proposed a framework of change management process reflecting the strategic considerations and the facilitating actions at various stages of IT project

implementation. This framework is shown in Figure 1.2.

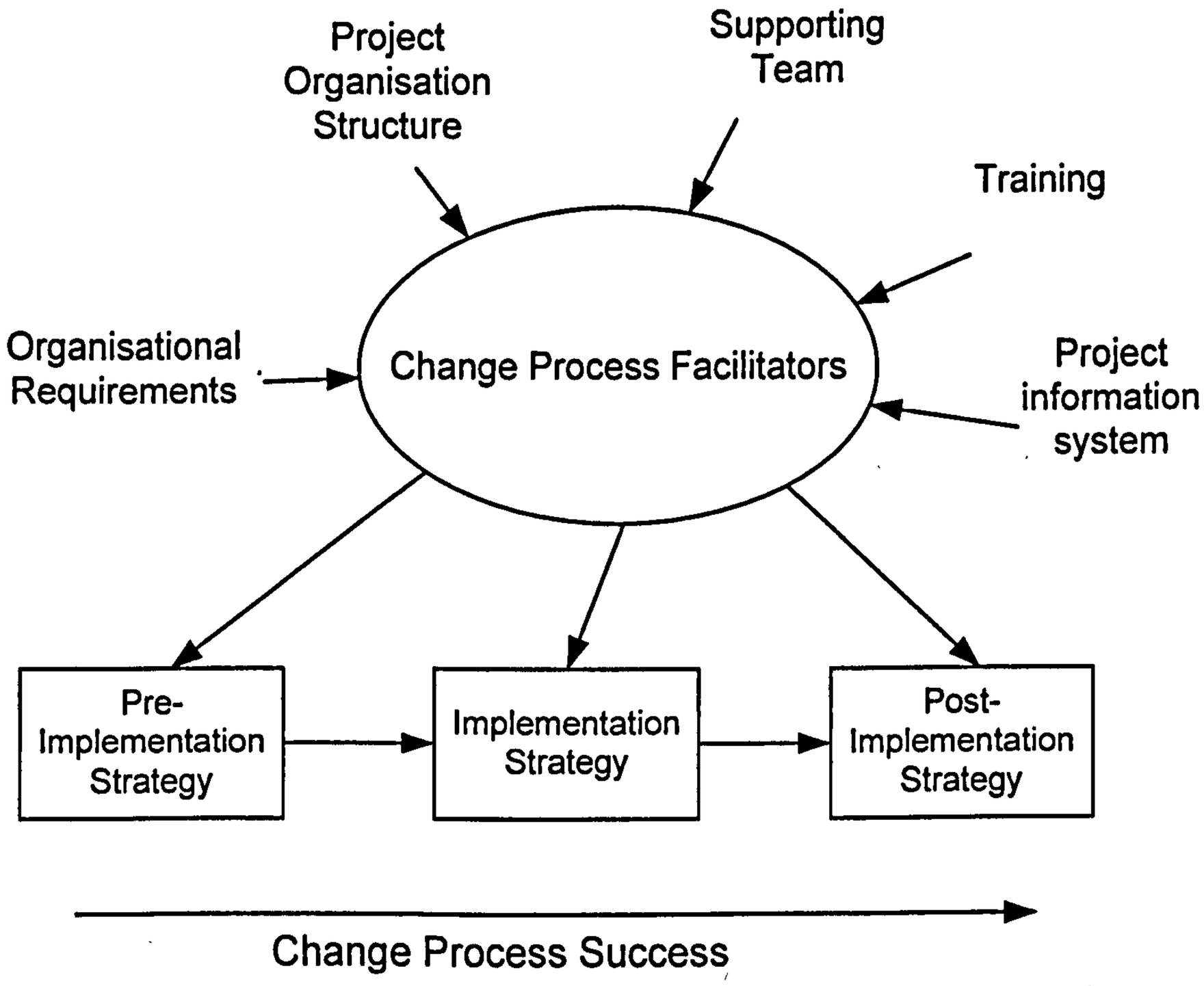


Figure 1.2 Change Management Influenced by IT Projects (Kuruppuarachchi, 2002)

A study by Maguire (2000) investigated what to do when inserting a new information system/information technology in an organization and suggested that there is a need for development methodologies to take a more business-led perspective. Gardner and Ash (2003) suggested that for an information and communication technology (ICT) enabled environment, change is generated at the interface between people, technology, and change agents and it should be managed and shaped through mutual adjustment of the change implementation approaches employed by IT practitioners, line managers, and other stakeholders. Bartoli and Hermel (2004) suggested that the development and introduction of IT must be conceived and controlled as a true process of change with its global effects, considering the strategic, structural, cultural and behavioural aspects as well. Cheng et. al (2001) also discussed the need for a change management approach for introducing an e-business model to support supply chain activities in construction. The factors supporting the introduction of this e-business model are addressed as:

- resource planning;
- teamwork;
- process improvement tools and techniques;
- information management;
- training and development; and
- performance measurement.

Although previous research mentioned the need for a change management approach for the implementation of IT enabled environments, there has been very little research effort mentioning how this change can actually be managed. The human and organizational factors resulting in the failure of the collaboration environment in achieving the full benefits can be controlled through a change management approach. This research was carried out in order to address the urgent need for a change management approach for the successful implementation of collaboration environments in the construction industry.

1.3 Research Aim and Objectives

The aim of this research is to explore the introduction of collaboration environments to construction organizations and to manage the changes required to obtain full benefits. The specific research objectives of the research project include:

1. To review the theoretical concepts and previous work on collaboration environment implementation in construction and on change management with a focus on organizational change management;
2. To investigate the current collaborative working approaches in construction organizations and how collaboration environments are implemented;
3. To develop an organizational change management framework for the implementation of collaboration environments;
4. To automate the project organization level of the framework in the form of a computer based prototype system; and

5. To evaluate the framework and the prototype.

1.4 Research Methodology

The methodology adopted to achieve the research aim and objectives consisted of a combination of five methods: literature review, case studies, framework development, rapid prototyping, and evaluation. These are discussed in detail in Chapter 4 but are briefly outlined here to provide some context.

The literature review consisted of two reviews: review of previous research on collaboration environment implementation in construction and review of change management. The reviews were mainly based on secondary documentation (e.g. journal papers, books) and primary documentation (e.g. PhD theses).

In order to investigate the current collaborative working approaches of the construction organizations, explanatory case studies were carried out in nine construction organizations, three contracting, two consultancy, two architecture companies and two technology providing companies. The data was collected through semi-structured interviews with top level managers in the companies.

Based on the results of the case studies, a framework for implementing collaboration environments and managing organizational changes was developed. The representation method for the framework was IDEF0 modelling. The conceptual framework was automated using Microsoft Visual Basic.net as the development environment, Microsoft Access as the database medium and Microsoft Word as the documentation tool.

For the evaluation of the framework and the prototype, a survey was carried out. The data collection was designed as a combination of a questionnaire and unstructured interviews. Thirteen respondents from eight companies participated in the evaluation survey.

1.5 Thesis Structure and Contents

Figure 1.3 shows the overall research process carried out to achieve the specific objectives of the research. The thesis consists of nine chapters for each of which a brief description is given below:

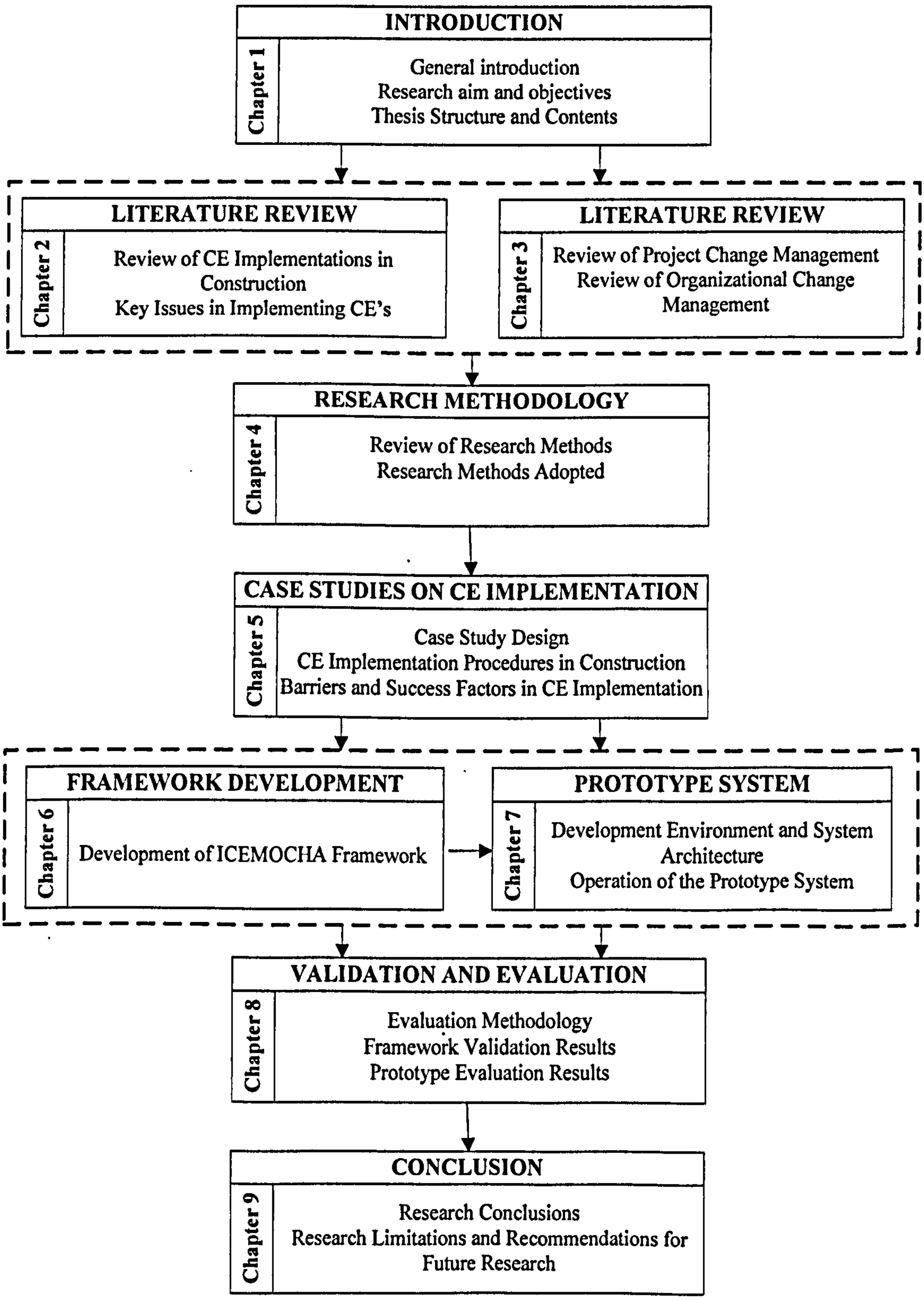


Figure 1.3 The Research Process

Chapter One: Introduction

This chapter provides an introduction to the doctoral research undertaken and describes its background followed by justification for research. The research aims and objectives and the research methodology adopted to achieve those objectives are also briefly presented in this chapter.

Chapter Two: Collaboration Environment Implementation in Construction

This chapter reviews the literature on collaboration environment implementations in the construction industry. After a brief introduction to collaboration context and the key issues, it focuses on the collaboration technologies used and discusses the barriers to implementation of collaboration environments in construction. The key issues to focus on during the collaboration environment implementation to overcome these barriers and to ensure successful collaboration are extracted and discussed. The need for an organizational change management approach in order to enable successful collaboration environment implementation is justified using contingency theory.

Chapter Three: Change Management

This chapter reviews previous work on change management in construction both at organizational level and project level. The focus is mainly on the organizational change management since it is shown in Chapter Two that organizational change management is necessary for the effective implementation of collaboration environments in construction.

Chapter Four: Research Methodology

This chapter presents the research methodology. It discusses the methodological considerations for this study and presents the adopted research methods. This chapter is presented after the literature review chapters since the research design was carried out after the research problem and the context were clearly known.

Chapter Five: Collaboration Environments for Construction: Implementation Case Studies

This chapter presents the results of case studies carried out to obtain the perspective

of the construction organizations on the implementation of collaboration environments. All results obtained from the cases are discussed together and interpreted following a systems thinking approach. Finally, the conclusions drawn from the case studies are summarised and the need for a detailed organizational change management approach to control all the factors affecting the success of collaboration environments are simultaneously justified.

Chapter Six: Organizational Change Management Framework for Implementation of Collaboration Environments

The chapter starts with an overview of the ICEMOCHA framework, developed to facilitate the successful implementation of collaboration environments. It discusses the background and rationale for the framework, aims and objectives, and the framework development approach. This is followed by a detailed explanation of the framework with an explanation of each process.

Chapter Seven: Prototype for Implementation of Collaboration Environments

This chapter describes the development of the prototype system which automates the conceptual framework presented in Chapter Six. It first gives an overview of the development environment used for the prototype and then goes on to describe the system architecture of the prototype. It also describes the operation of the system.

Chapter Eight: Evaluation of the ICEMOCHA Framework and the Prototype

This chapter presents the evaluation of the conceptual ICEMOCHA framework and the prototype. It starts with evaluation aim and objectives and then presents the adopted evaluation methodology. The results obtained from the qualitative and quantitative research approaches are presented and the chapter concludes with the discussion of these results.

Chapter Nine: Conclusions and Recommendations

This chapter presents a summary of the major findings obtained and the conclusions derived from the research and discusses the limitations of the research. It also provides recommendations for future research.

CHAPTER TWO: COLLABORATION ENVIRONMENT IMPLEMENTATION IN CONSTRUCTION

2.1 Introduction

This chapter reviews the collaboration environment implementations in the construction industry. After a brief introduction to the collaboration context and the key issues, it focuses on the collaboration technologies used and discusses the barriers to implementation of collaboration environments (CE's) in construction. The key issues to focus on during the collaboration environment implementation to overcome these barriers and to enhance successful collaboration are extracted and discussed. The methodologies and frameworks found in the literature proposing socio-technical design solutions are presented to discuss whether they can provide a basis to introduce collaboration environments to construction projects. Finally, the need for an organizational change management approach in order to enable successful collaboration environment implementation is justified using the contingency theory.

2.2 Collaboration in Construction: Key Issues

Collaboration is defined as an activity where a large task is achieved by a team through communication and sharing of knowledge (Lang, et.al, 2002). Wilkinson (2005) provides a more detailed definition to collaboration: "*a creative process undertaken by two or more interested individuals, sharing their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust and mutual respect, to jointly deliver the best solution that meets their common goal*". The difference between teamwork and collaboration is not very well defined in the literature, but the term collaboration is more frequently used than teamwork when large tasks are considered and is also more associated with

information technologies. Many collaboration technologies are used to provide a collaboration environment, however the stand alone IT implementation is not sufficient for this. Vandenbosch et. al (1997) identified four conditions under which collaboration technologies will enhance the collaboration in an organization:

1. There should be a need to collaborate between the organization members.
2. Users should understand the technology and how it can support the collaboration.
3. The organization should provide appropriate support for the implementation and adoption of technology.
4. There should be a collaborative working culture in the organization.

Although emerging technologies such as Web-based technologies and extranets offer the construction industry many opportunities for computer supported collaboration environments, the companies adopting these technologies fail in achieving the full benefits from their implementations since they fail to provide these four conditions. The problem in the construction sector is not a lack of technology but more a lack of awareness of how to fully exploit it and how important cultural changes are in order to allow this to happen (Betts and Smith, 1999). Lang et. al (2002) identify the following areas in which effectiveness is required for successful collaboration:

1. Cognitive synchronisation/ reconciliation;
2. Developing shared meaning;
3. Developing shared memories;
4. Negotiation;
5. Communication of data, knowledge, information;
6. Planning of activities, tasks, methodologies; and
7. Management of tasks.

Cognitive synchronisation and communication of data are related to organizational, people and technical issues. The remaining five factors are related only to the organizational and people issues.

The need to have focus on managing people, process, knowledge or developing strategies together with the technology have been mentioned by many researchers. Wilkinson (2005) refers to an industry rule of thumb which suggests that 80 percent of the successful implementation of collaboration systems depends on tackling the people and process issues whereas 20 percent is related to resolving the technology aspects. Shelbourn et. al (2007) approach the collaborative working from a strategic management perspective and state that effective collaboration results from the harmony of three key strategies: Business strategy, people strategy, and technology strategy. Shelbourn et. al (2007) also define six key areas to be addressed in each of these strategies to enable effective collaboration: 1) Vision; 2) Engagement; 3) Trust; 4) Communication; 5) Processes; and 6) Technologies. Alshawi et. al (2003) propose that equal attention should be given to the technology, process, people and knowledge management for the successful adoption of a web-enabled collaboration environment for project management in construction. Vadhavkar (2001) states that the spatial set up, information technology and organizational processes are the three main elements to enable successful collaboration between globally dispersed teams.

Therefore unless supported by the relevant people, process and change management issues, the stand-alone implementation of collaborative IT technologies will not be able to enhance collaborative working.

2.3 Collaboration Technologies in Construction

There is a high amount of collaboration requirement in construction due to its multi-organizational and geographically dispersed structure. In order to enable this collaboration requirement, there are many collaboration tools and systems currently used in construction. The following definition for collaboration technologies by Wilkinson (2005) is considered to be the most appropriate definition for the purposes of this research:

"*A combination of technologies that together create a single shared interface between two or more interested individuals (people), enabling them to participate in a creative process in which they share their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust and mutual*

respect, and thereby jointly deliver the best solution that meets their common goal."

The researchers in this area tend to categorize these technologies according to different characteristics. Chinowsky (2003) divides the existing technologies used for collaboration according to their interaction spectrums as communication, cooperation and collaboration, as shown in Table 2.1. However, the boundaries between communication, cooperation and collaboration are not usually very clear since these concepts are inter-linked to each other. Sun and Howard (2004) believe that collaborative working using computers is covered by two research areas, computer mediated communication (CMC) and Computer Supported Cooperative Work (CSCW), which often overlap in producing the actual technical solutions. Depending on the way they are used, some technologies might be put under different categories. The way Baldwin (2004) categorizes the collaboration technologies, which is given in Table 2.2, is more suitable for this research.

Table 2.1 Spectrum of Electronic Interaction Technologies (Chinowsky, 2003)

Spectrum Category	**Interaction Technology**	**Description**
Communication	Phone/ Teleconferencing	Traditional analog, oral communication
	Fax	Digital or analog text communication
	e-mail	Digital text communication
Cooperation	Project Web sites	Digital repository for project data and communications
	Discussion board	Electronic message center for archiving text communication
	Work sharing	Asynchronous data exchange and project solution process
Collaboration	Videoconferencing with data sharing	Synchronous discussion with ability to exchange project information
	Virtual teaming	Real-time data manipulation and exchange

Table 2.2 Categories of Collaboration Technologies (Baldwin, 2004)

Main Categories	**Examples of Technologies**
Communication technologies	e-mail Instant messaging Audio conferencing
Shared information space technologies	Document management systems Web-based team/project rooms Data conferencing/application sharing Electronic bulletin boards
Meeting support technologies	Electronic meeting systems
Coordination technologies	Workflow management systems Calendar and scheduling systems
Integrated products	Collaboration product suites Integrated team support technologies e-learning technologies

Depending on the time and space factors, the collaboration can be considered to have four modes: Face-to-face collaboration, asynchronous collaboration, synchronous distributed collaboration and asynchronous distributed collaboration (Anumba et. al, 2002). Baldwin (2004) categorizes the current collaboration tools according to these four modes in a time-space matrix shown in Table 2.3.

The construction industry is constantly searching for new, more efficient and effective IT-based collaboration methods. Much of the recent work on collaborative working focus on the delivery of Web-based technological solutions, collaborative visualisation, virtual reality and CAD applications, and knowledge management systems and technologies. The enhancements in Internet and Web-based technologies has led construction research to focus on the development of solutions for distributed collaboration mainly for design or project management purposes. Examples include: a collaborative design system developed to improve design coordination for building projects (Hegazy et. al, 2001; Zaneldin et. al, 2001), a multi-user workspace as a medium for communication in collaborative design (Woo et. al, 2001), an Internet-based shared virtual reality environment for design and management (Caneparo,

2001), the CODE system which is an integrated industry foundation class (IFC)-based, Internet-enabled collaborative building design environment (Roshani et. al, 2005), the COMMIT project aiming to improve information management to support decision making in collaborative projects (Rezgui et. al, 1998), TITS which is an internet-based project management system (Deng et. al, 2001), and a collaborative project management system for real time collaboration between geographically dispersed project teams (Pena-Mora et. al, 2002), a system enabling collaborative supply chain preplanning through a multi-agent systems approach (Tah, 2005).

Table 2.3 Time-Space Matrix for Classifying Collaboration Technology (adapted from Baldwin, 2004 and Anumba et.al, 2002)

SPACE	TIME: Same time	TIME: Different time
Same place	Face to face collaboration Electronic meeting systems	Asynchronous collaboration E-mail Document Management systems Workflow management systems Electronic bulletin boards
Different place	Synchronous distributed collaboration Audio conferencing Videoconferencing Data conferencing Instant messaging Desktop conferencing	Asynchronous distributed collaboration E-mail Document Management systems Web-based team/project rooms Calendar and scheduling systems Workflow management systems Electronic bulletin boards

Despite these research efforts, there are still a number of barriers to the implementation of collaboration environments in construction. These barriers are discussed in details in the next section.

2.4 Barriers to the Implementation of Collaboration Environments in Construction

This section focuses on the barriers to the successful implementation of collaboration environments. The literature review on collaboration environment implementations in construction have revealed a number of issues that need to be considered with respect to the failure of IT implementations. Therefore, the first part of this section discusses the barriers related to IT implementation whereas the second part focuses on barriers specifically for collaboration environment implementations other than general IT implementations.

2.4.1 Barriers to general IT implementation and adoption in construction

According to a research project that gathered information on the experience of 45 leading experts (researchers and consultants) in the UK, 80-90% of IT investments do not meet their performance objectives (Clegg et. al, 1997). The reason for this is found to be rarely technical but related to change, implementation, human and organizational factors, and the roles of the management and end-users. The major reason was determined as the lack of attention to the human and organizational aspects of IT adoption. Focusing too much on technical issues and ignoring or underestimating the human and organizational factors has been mentioned in other research efforts (Laudon and Laudon, 2000; Kuruppuarachchi et. al, 2002; Mitropoulos and Tatum, 2000; Clegg et. al, 2001).

The reasons for failing to achieve the full benefits from implementation of IT systems referred in previous research are summarised in Table 2.4. It is seen from the table that most of the authors refer to similar or related issues as the failure reasons, which can be grouped into six barrier categories: poor user requirements capture; user resistance to change; lack of user involvement; lack of proper planning/project management; technical characteristics; and lack of strategic approaches. Table 2.5 summarises the failure reasons according to these six categories.

Table 2.4 Failure Reasons for IT in Construction

Failure Reasons	**Source**
Failure of introducing the technical change properly Poor project management Poor articulation of user requirements Inadequate attention to business needs and goals Failure to involve users appropriately	Clegg et. al., 1997
Problems in resources development Lack of development tools Lack of proper plan/project management User resistance to change Lack of management support Rapidly changing project specifications Technical feasibility of project	Suwardy, 2003
The different approaches, experiences and backgrounds of the IT managers and senior management No alignment of the IT implementation with the organization's business strategy	Andresen et al, 2000
Focusing on operational requirements for short term solutions and failing to notice long term goals Failure to consider the maturity level of IT Lack of consideration of people, culture and customer issues	Aouad,1999
Not considering how the new technology interacts with working spaces, work organization, job design and work processes	Clegg et al., 2001
Conservative culture of the industry Poor investment in construction IT Poor marketing of the software Inadequate user-interfaces Mismatch between innovations and industry needs Poor uptake by software developers	Anumba, 1998
Lack of user involvement and influence Lack of management support Level of complexity/risk Poor or lack of management of implementation process User-designer communication gap	Laudon and Laudon, 2000

Table 2.5 Categorised Failure Reasons of IT Implementations

	Poor capturing of user requirements	User resistance to change	Lack of user involvement	Poor project management	Technical characteristics	Lack of strategic approaches. (organizational link)
Clegg et. al., 1997	√		√	√		√
Suwardy, 2003		√		√	√	
Andresen et al, 2000	√					√
Aouad,1999	√	√	√		√	√
Clegg et.al., 2001						√
Laudon& Laudon, 2000	√	√	√	√		
Wood-Harper et.al., 1985	√			√		√
Baldwin, 2004						√
Kuruppuarachchi et. al, 2002						√
Anumba, 1998	√	√				

Another failure reason is designated as risk. According to Kuruppuarachchi et. al (2002), three basic requirements should be met for successful implementation of IT projects: a clear business objective; understanding of the nature of change; and understanding of the project risk. The level of complexity and risk of the project depends on project size, project structure and the level of technical experience of the end users and the project team (Laudon & Laudon, 2000). The larger the project, the higher the risk and the higher the complexity. The more structured the project is, the lower the risk of change in the expected outputs. The less experienced the project team and the technical team are, the higher the risk is.

2.4.2 Barriers to Collaboration Environment Implementation

The previous section focused on barriers to IT implementation in construction in a general sense. Therefore, all the barriers listed in the previous section would be valid for the collaboration environments in terms of the technology implementation. Collaboration is difficult to establish even as a soft issue regardless of the accompanying IT. However, each IT implementation is a source of resistance and confusion on its own unless special attention is paid while it is introduced to the organization. Focusing too much on technical factors may result in technically excellent systems which are incompatible with the organization's structure, culture and goals since it neglects to consider how the new technology interacts with working practices, work organization structure, job design, and work processes (Laudon and Laudon, 2000; Clegg et. al, 2001). Tanyer (2004) categorizes the barriers identified for Computer Integrated Construction (CIC) under six main headings:

1. Industry level problems: related to the fragmented structure of the industry;
2. Organization level problems: Readiness of the organization for the new technology, cultural issues, people issues, incompatibility of the processes and technologies between organizations collaborating on a project;
3. Project level problems: Uncertainties and risks at project inception, multiple project information management systems implemented for different projects;
4. Technology related problems: Coordination and management of information (Data access rights, data change rights, database transactions), data exchange

standards;

5. Legal problems: Ownership of data, insurance and indemnity requirements;
6. End-user level problems: usability issues, training.

Many research projects on collaboration environment implementations in construction mention similar barriers. Ruikar et. al (2005) identify security issues, multiple-vendor issues, cost issues, cultural issues, legal issues, connectivity issues, and technology issues as barriers to project extranet-based collaboration environments. Alshawi and Ingirige (2003) identify security issues, cultural issues, legal issues, incapability of telepresence to replace face-to-face meetings and not being integrated to a common database for Web-based project management tools as key barriers.

The debate on whether IT tools or collaboration environments can replace face-to-face meetings or whether the distance between the collaboration participants is still a barrier has been ongoing since the introduction of electronic communication. The following differences between electronic communication and face-to-face interaction have been mentioned to have an effect on the outcome of the distributed collaboration groups (Kiesler and Sproull, 1992; Gonzalez et. al, 2003; Potter et. al, 2002):

1. Electronic communication helps people cross barriers of space and time. There is no built-in temporal sequence of discussion, many speakers can talk at the same time or in different times or not at all. Therefore, there might be an illogical speaking order creating problems during the collaboration. On the other hand, electronic communication has the advantage of archiving, so anyone can go and check what had been discussed in the meeting whenever they want.

2. Electronic communication helps people cross social and psychological barriers. In face-to-face communication there might exist some social context cues, importance of which changes according to the culture of the organization and the work group. Social context cues can be a signal to speak or act, or a prompt or reminder to do something from one to another, usually from the person who is stronger according to social and hierarchical relations.

In electronic communication the effects of cues are low. Since people will not perceive the social or hierarchical order due to the absence of social context cues, thereby creating an equality between the team members.

3. The advantages of non-verbal communication such as toning and using gestures during speaking are often lost in electronic communication.

The differences in the local physical context, time zones, culture and language act as barriers to effective collaboration between teams at different places (Olson et.al, 2000). Allen et. al (1990) found that the team members who are either physically or functionally distant, communicate with each other less frequently than those who are nearby. However, according to case study-based research by Vadhavkar (2001), the teams are found to be affected by the time dispersion more significantly than the geographical dispersion.

2.5 Key Issues in Implementing Collaboration Environments

The human and organizational issues are very important especially for the success of collaboration environments. Each new IT implementation involves some change for the organization and the employees, and is therefore a source of resistance and confusion unless special attention is paid to managing this change. Since previous research has showed that the technical characteristics are rarely the reason for the failure of collaboration environments, this section focuses on the other factors and discusses seven key issues in design and implementation of collaboration environments. Three of these focus on the user and are inter-linked: user requirements capture, managing user resistance to change, and user involvement. The other four are related to planning/project management, strategic IT implementation, buy-in and trust.

2.5.1 User requirements capture

It is not possible to analyse the performance of a system by just measuring its technical performance. The system cannot be considered as successful if the people using the system do not create better work with it. Therefore, to consider a system as successful, both the technical evaluation and the employee performance evaluation

should have positive results. Since the performance of the system depends on the users as well as the technical characteristics of the system, the needs of the user should be captured carefully. When the requirements of the users are met, they will work better through the system, improving the overall performance.

The process of capturing user requirements can also be termed as requirements engineering. Requirements engineering is considered as a significant enabler for the development of computer integrated construction (CIC) systems since it facilitates the verification and validation of the system, enables team work and collaboration with the end users, increases the shared understanding and communication between the parties, and provides for human-centred, adaptive systems development (Arayici et. al, 2005). The requirements engineering framework given in Figure 2.1 is proposed as part of the strategic implementation of CIC which are computer environments through which collaborative working can be undertaken.

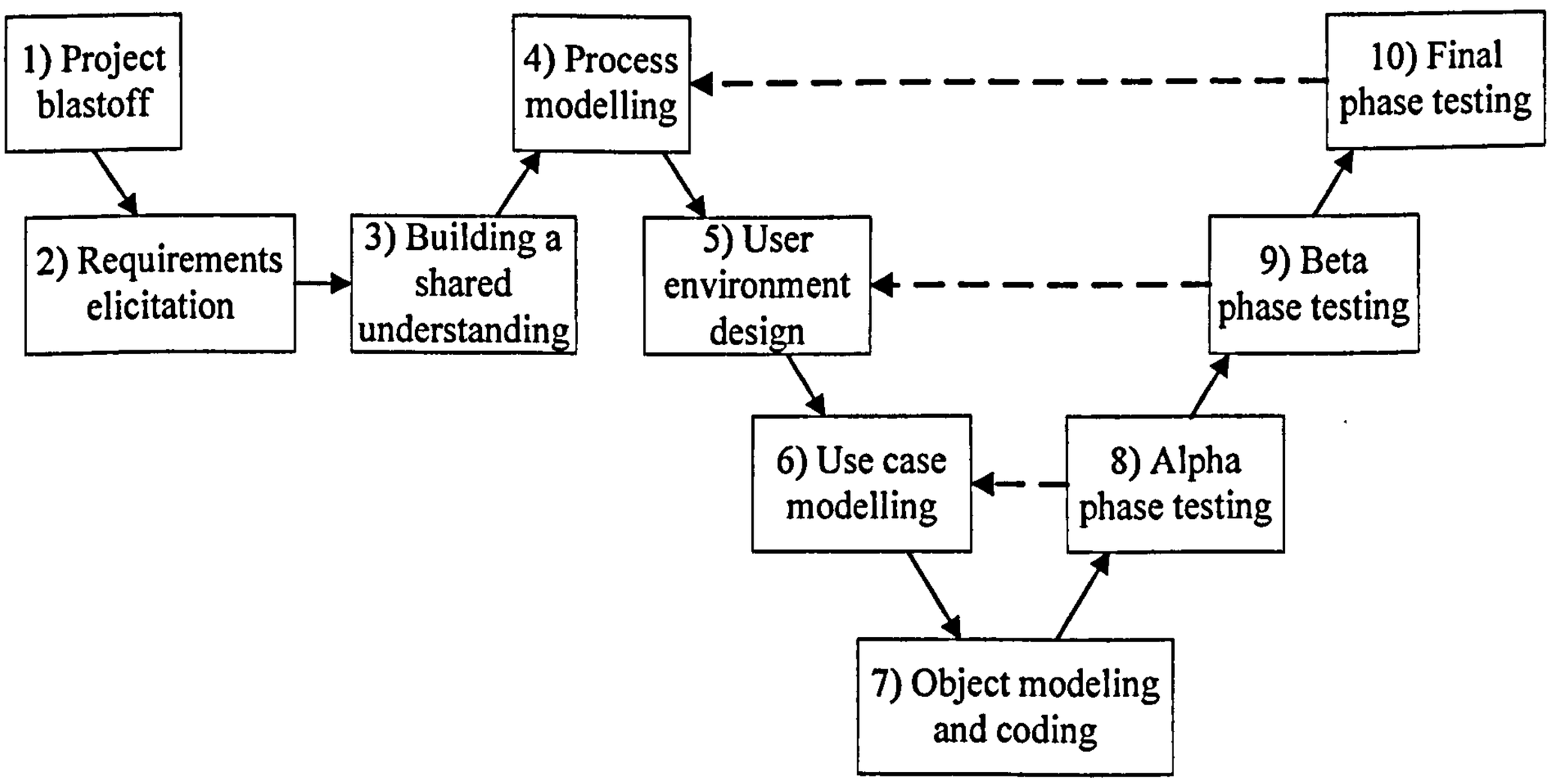


Figure 2.1 Requirements engineering framework proposed by Arayici et. al (2006)

The role of communication between the users and the technology designers is very important in the requirements capture process. The differences in the backgrounds, interests and priorities between the users and information technology specialists are referred to as "user-designer communications gap" by Laudon and Laudon (2000). Whilst developing their technology, the designers/technology providers should keep in mind that the technology solution is the facilitator of a process, not the process itself (Ruikar et. al, 2005). The communication problems between end users and

designers mean a high risk of failure and result in technically perfect systems not serving the needs of the end users. When there is a conflict between the designed system and the expected system, the IT tool is usually not adopted.

2.5.2 Overcoming the user resistance to change

Technological changes with obvious benefits and few discernible negative consequences are often readily accepted in organizations. Changes affecting social relationships take longer to implement (Kast and Rosenzweig, 1974). When a change is to be introduced to an organization, resistance from the employees is inevitable and needs to be managed. The resistance to technology is investigated as a combination of resistance to the strategic principle of collaborative working and the resistance to the adoption of the technology itself, technology in general and collaboration technology in particular (Wilkinson, 2005). The first one can be found at the individual level, departmental or intra-organizational level, inter-organizational level, and industry level whereas the second one is at a more tactical level (Wilkinson, 2005).

Sources of resistance to change have been studied by many. These are summarised as: fear of the unknown, lack of information/knowledge/skill, threats to status, fear of failure, lack of perceived benefits, uncertainty regarding the change outcomes, internal politics (such as elitism and interdepartmental rivalry) (Ford et. al, 2002; Hoag et. al, 2002; Proctor and Doukakis, 2003).

The reasons behind the resistance should be clearly known in order to take the correct action against it. Training and communication can be used to overcome the resistance if it results from the lack of information, knowledge or skills. The importance of effective communication and employee empowerment in reducing employee resistance to change has been mentioned by many authors (Proctor and Doukakis, 2003; Kitchen and Daly, 2002; Holt et. al, 2000; Rye,1996).

If the resistance is due to some adjustment problems, facilitation and support might be helpful. If there is a person or a group with considerable power resisting the change (since they will lose their current opportunities after the change), negotiation and agreement is a more appropriate way to avoid major resistance. If these fail, manipulation might be tried but this approach might lead to future people problems

since nobody likes being manipulated. If the change has to be implemented in a very quick time and the initiators of the change are very powerful, explicit or implicit coercion can be used and it will overcome any kind of resistance, but the employees might be angry with the initiators. Using coercion might seem to be successful in the beginning, but later, the anger among the employees might lead to passive and silent resistance in other areas. These methods are not aimed at solving the resistance problem, they just suppress it for a while, in other words they just delay the resistance. The aim must be to prevent or minimise the resistance before it happens.

The reasons behind the resistance should be clearly known in order to take the correct action against it. Education and communication can be used to overcome the resistance if it results from the lack of information, knowledge or skills. Effective communication helps to overcome ambiguity and uncertainty, and provides information and power to those who are the subject of change enabling them to have control over their destiny and to understand why change is necessary (Proctor and Doukakis, 2003). At a deeper level, communication will effect a common understanding of the intended change and common perspectives over the specific issues (Rye, 1996).

Change is not just about how people act, but it is also about how they think and this perspective forms a basis for the link between change management in organizations and internal communication with the people responsible for making those changes happen (Kitchen and Daly, 2002). Communication and employee empowerment, due to their contributions to overcome human resistance, are considered as key issues in the effective and successful change management by many sources in literature. Holt et. al (2000) consider empowerment as an employee's perception that they believe in and control what happens to their work processes, and that they are capable of controlling those processes efficiently and effectively. Empowerment, other than acceptance of responsibility by employees for their own actions and allowing them to make mistakes without fear of reprisal, is about trust and accountability, therefore it gives people the opportunity to do the job they are assigned without interference (Proctor and Doukakis, 2003).

2.5.3 User involvement

People who develop and implement new systems and new ways of working in the organization tend to think of end-users of the system, who can be considered internal customers of the organization, in a very different way than they think of their external customers (Clegg and Walsh, 2004). The users are accused of being resistant to change or failing to understand the potential benefits offered by the system. Most of the time, end-users are the last ones to see the new system. In this kind of top-driven approach, the system is imposed on users, and any hesitation or unwillingness from them are not appreciated. This hesitation and unwillingness are usually due to the fact that the users are kept away from all decisions at the design stage. A proper user requirements and needs capture is not possible without their involvement and a system not meeting the users' needs is likely to be rejected by the users. Since the system is designed or implemented without their involvement, the system will mainly be based on the developers' perception of what is needed (Clegg et. al, 1997).

User resistance, user involvement and user requirements capture are interrelated. Involving the users is important to capture the users' requirements and the resistance of the employees will hence decrease.

2.5.4 Proper planning/project management

Introducing an IT system into an organization requires careful project management effort to enable all the other key areas. In order to strategically manage change, the following change levers must be equally available for the use (Tichy, 1983):

1. External Interface;
2. Mission;
3. Strategy;
4. Managing organizational mission/strategy processes;
5. Task;
6. Prescribed Networks;
7. Organizational process (Communication, problem solving and decision

making);

8. People; and

9. Emergent Networks.

Maintaining a balance between these levers is the role of project managers. Project managers should use their human and financial resources to deal with the cultural aspects of the organizations (such as individual or group values, attitudes, and role perceptions); operational aspects (such as knowledge of new practices and services, new working styles, and transformations in the job functions); and policy aspects related to the redistribution of power, and redefinition of rewards (Songer et.al, 2001; Laudon and Laudon, 2000; Robertson, 2000).

2.5.5 Strategic IT implementation

According to Walton (1989), the company's formal organization and IT must be designed to reflect all components of the strategic vision and it should take account of environmental factors. Furthermore, the organizational design and IT design should be matched and integrated for the development of effective organizations as shown in Figure 2.2.

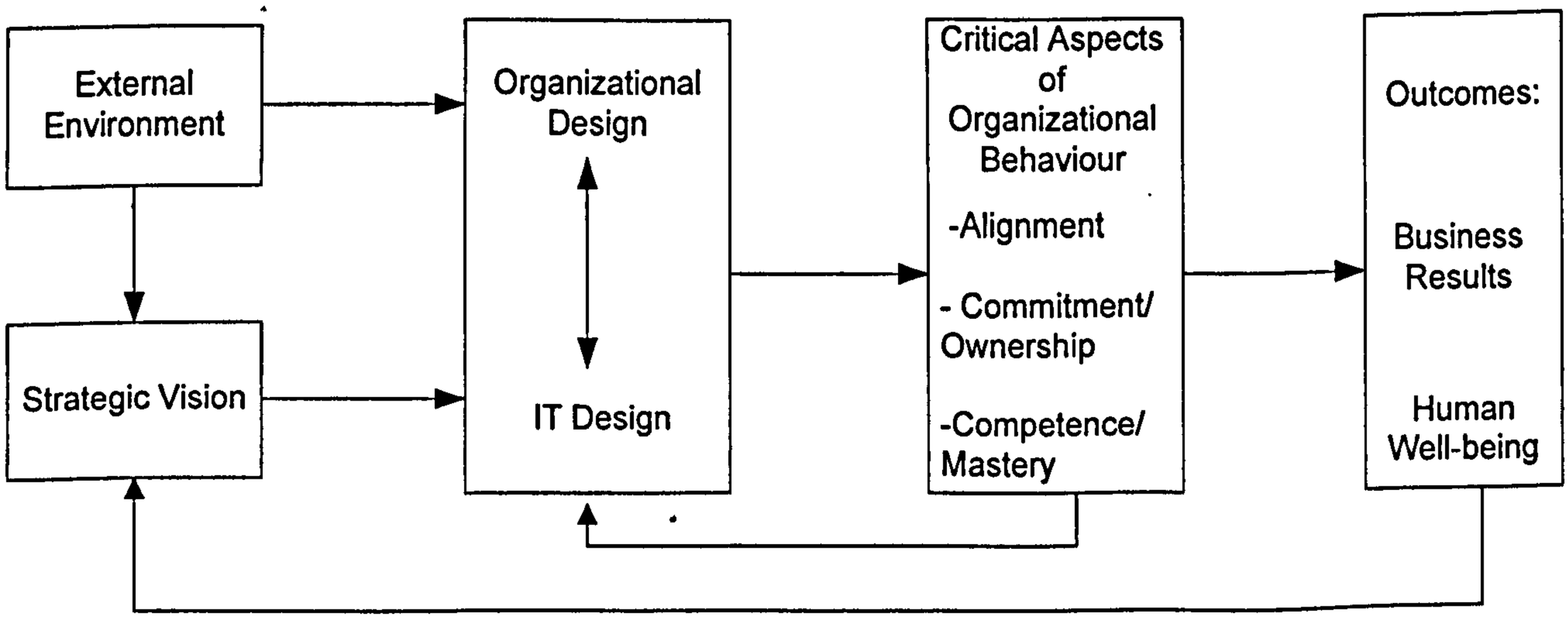


Figure 2.2 Factors in the development of effective organizations (Walton, 1989)

In this research, the focus is on how to introduce collaboration environments to construction companies. If an analogy is made between the aim of this research and Walton's work, it will be seen that due to the external reasons (See Section 3.3.1), the

construction companies want to benefit from the advantages of collaboration environments. Depending on the level of match between the characteristics of the collaboration environment and the characteristics of the organization, the companies may have to carry out some changes at the project level or they may have to define a new strategic vision and carry out changes at the organizational level aligned to this vision.

According to Walton (1989), IT and organizations interact in at least seven different ways:

1. To be effective, an IT system may require new organizational policies or designs (e.g. broader and more flexible jobs, new training programs, different selection criteria, different type of authority distribution).
2. Unanticipated organizational dynamics might appear with the introduction of an IT system (e.g. new contests for power/status, modified patterns of communication, more pervasive behaviour).
3. Under certain organizational conditions, IT may itself be further elaborated and revised by users.
4. IT may create or promote new organizational solutions (e.g. enabling organizational members to work together across space and time, changing the centralisation-decentralisation level).
5. Organizational adaptations to changing conditions might be accelerated and refined (e.g. early detection of manufacturing problems)
6. IT systems and organizational forms can sometimes be considered as alternatives regarding their capabilities to perform similar functions.
7. Planning an IT system can create opportunities for introducing organizational changes (e.g. IT planning as an occasion to set higher standards of excellence).

These seven interactions collectively explain why IT implementation has to be undertaken together with organizational changes. Figure 2.3 shows Walton's strategic triangle indicating that the business strategy, organization strategy and IT strategy are interrelated; and a change in one will affect the other two. The first derivation from

the triangle regarding the IT is that when there is a change in IT/IS structure it must be according to the IS/IT strategy which is aligned with business strategy and organizational strategy. The second derivation from this triangle is that when there is an IT change, it must be reflected in the organizational strategy, therefore, it must be reflected in the organizational structure and characteristics as well. When the functionality of an IT system increases, the complexity increases, therefore, the required level of changes in the organization increases.

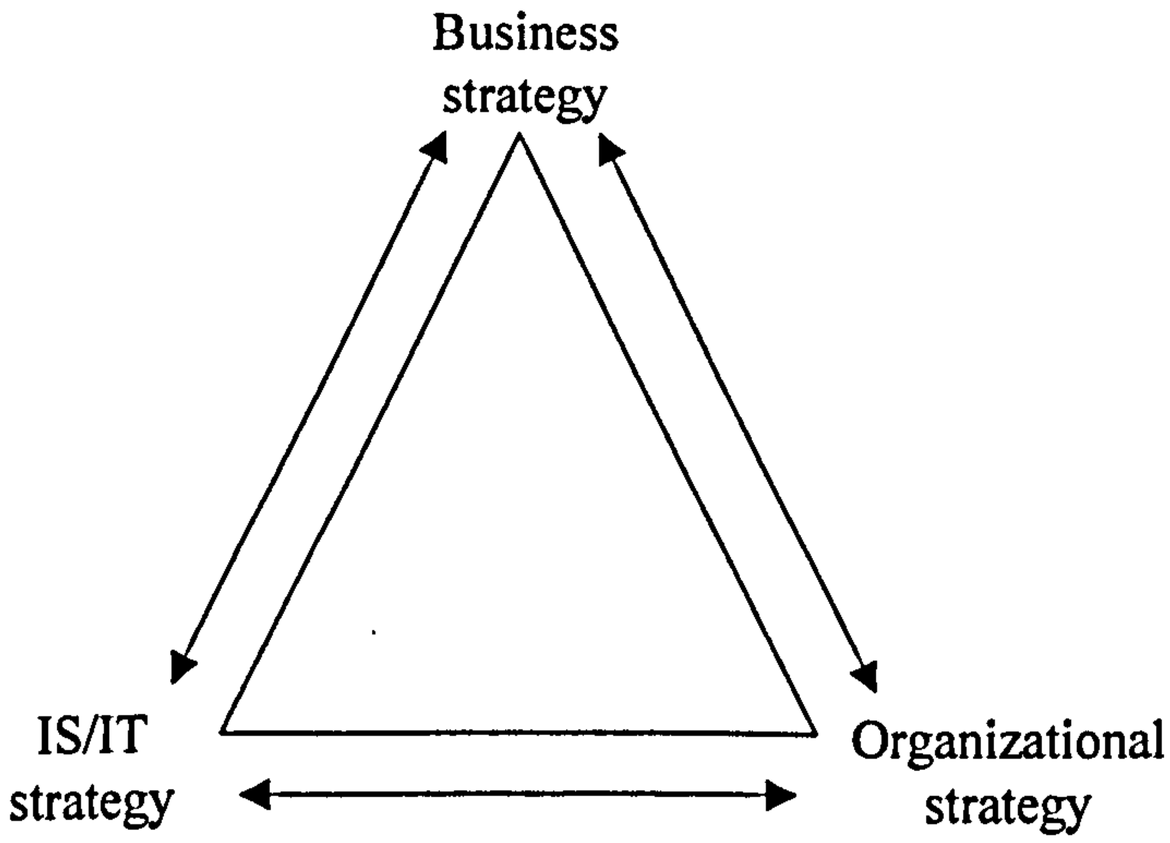


Figure 2.3 Walton's Strategic Triangle

Carrillo (2001) found out that construction companies are aware of Walton's strategic triangle, and try to make their IT implementations according to the principles introduced by the triangle but fail in the IS/IT strategy and organizational strategy link.

Companies implement IT in their internal operations for the purpose of improving efficiency within the organization, but since they do not make this implementation strategically and in accordance with the corporate strategy of the company, the investments do not provide the best possible returns. Most of the IT systems are usually introduced because of operational requirements, and therefore most of these fail due to the lack of alignment with the strategic and business requirements and long term goals (Aouad et. al, 1999; Andresen et.al, 2000). Aouad et. al (1999) also underline the importance of considering the co-maturation levels of the processes and IT.

Stewart et. al (2002) propose a framework for strategic implementation of IT/IS projects shown in Figure 2.4. This framework can help to reduce the gap between the rate of technology change and the rates at which people, tasks and organizational structures change (Stewart et. al, 2002). This framework shows that the implementation of an IT/IS project needs a thorough implementation plan starting from the strategic level and going down to the operational level.

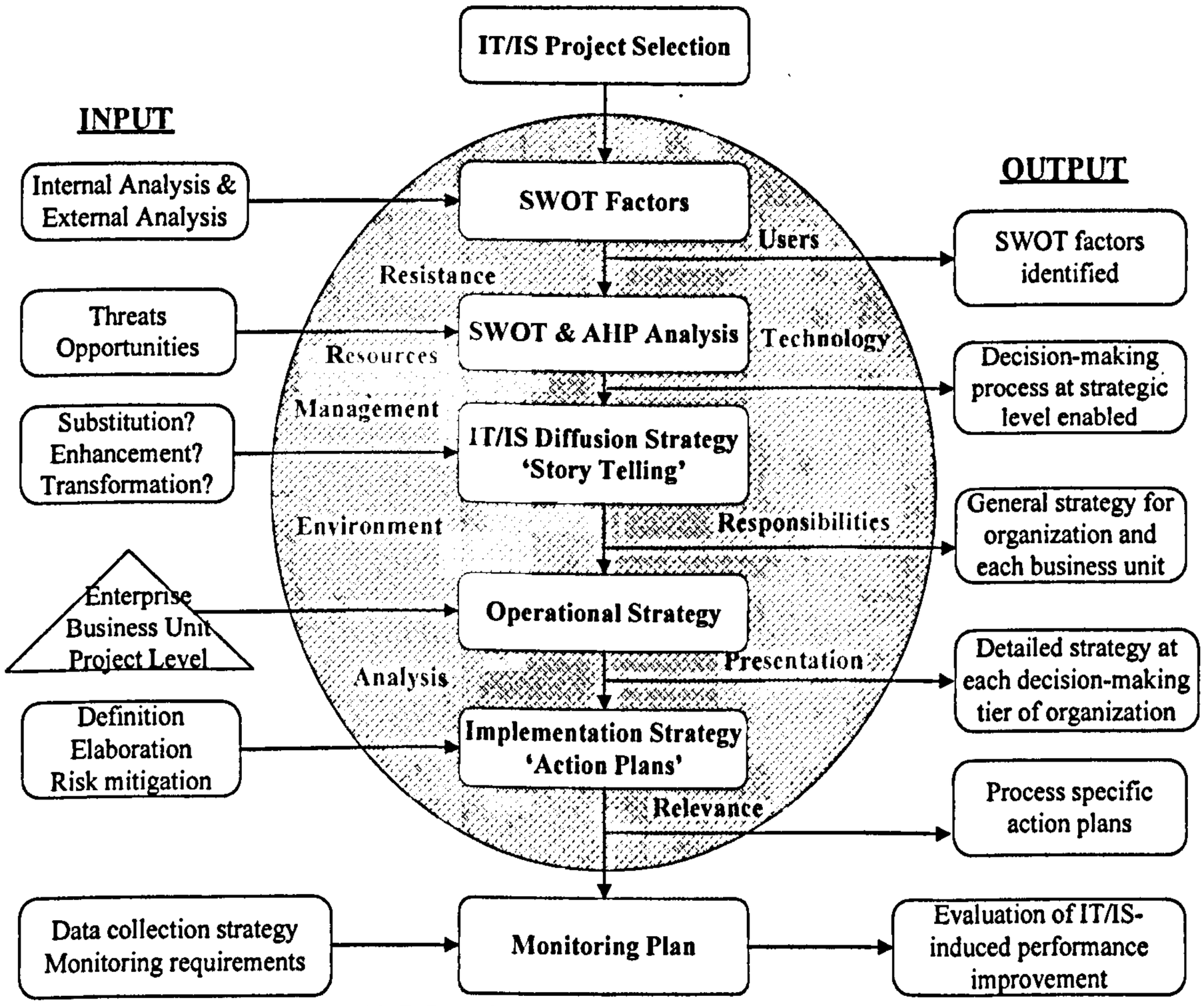


Figure 2.4 Strategic IT/IS Implementation Framework (Stewart et. al, 2002)

2.5.6 Buy-in

The success of the collaboration environment depends on the participation of all of the key members of the project team and this buy-in can be enhanced through planning and training, and through the promotion of a project technology champion (Baldwin et. al, 1999; Thorpe et. al, 2001). All project participants and stakeholders need to be fully committed to using the new CE system with buy-in and collaboration at the highest level within the participating companies (Weippert and Kajewski, 2002).

2.5.7 Trust

Collaboration is a continuous process and information exchange between the collaborating project partners throughout the lifecycle of a construction project and parts of an intra-organizational information process may need to be more visible to collaborating partners (Zhu and Augenbroe, 2006). The trust between the partners will enhance the buy-in, and hence the effectiveness of the collaboration environment.

2.6 IS Design and Implementation Methodologies

The previous section discussed the key issues in CE implementation, which are usually ignored or underestimated. The literature review on implementing a new IS carried out by Doherty and King (2002) resulted in 14 distinct organizational issues (Table 2.6) which are further grouped into four discrete classes:

1. Organizational contribution: aims at enhancing the financial, operational and strategic performance of an organization through the introduction of a new system;
2. Human issues: aims at enhancing the system's usage and its level of success by establishing a link between individual users and the proposed system;
3. Transitional issues: deals with the practical issues affecting the successful transition to the new system;
4. Organizational alignment issues: tries to establish a proper degree of alignment between the proposed system and its organizational context.

There have been many methodologies proposed in the literature for IS/IT design and implementation, most of which provide step by step guidance. The socio-technical methodologies explained below consider the soft issues during the design process of an IS/IT tool. The first section explains the SSADM methodology, which has been used as a systems analysis and design methodology for governmental software developments within the UK since the 1980s, to show the basic missing parts in the methodology.

Table 2.6 Organizational Issues in IS Implementation (Doherty and King, 2002)

Category	Specific Issues and Areas of Impact
Organizational Contribution	Ability to satisfy the current needs of an organization Capacity to support future needs of an organization Prioritisation of tasks, in line with organizational needs Degree of alignment with information systems strategy Assessment of impact on key business processes
Human Issues	Assessment of health & safety, ergonomic implications evaluation of the user motivation/needs Assessment of implications of user working styles/IT skills Consideration of job redesign implications
Transitional Issues	Consideration of timing of implementation Assessment of organizational disruption
Organizational Alignment	Impact on an organization's structure Implications for organizational culture Effect on disruption of power

2.6.1 Structured Systems Analysis and Design Methodology (SSADM)

SSADM is a methodology providing guidelines for systems analysis and design developed by the Central Computer and Telecommunications Agency in the 1980s. It was initially built for use by government bodies within the UK. It brings many models together such as the logical data models, data flow models and entity/event models. There are five main modules:

1. Feasibility study;
2. Requirements analysis;
3. Requirements Specification;
4. Logical System Specification; and
5. Physical Design.

SSADM is a very disciplined engineering approach. It specifies the modules, stages and tasks to be carried out in advance, analyses the current system to determine the

operations, problems and cost, and then specifies the requirements for the new system. There are sharp and strict boundaries between the stages, that one cannot start before the previous step is completely finished. It is one of the waterfall type of implementation models introduced from top level to bottom, without any user involvement. Therefore SSADM and similar methodologies are criticised by many researchers. Sauer and Lau (1997) mention the differences between the traditional and new mind-sets, stating that the highly structured characteristics emphasized by the SSADM are no longer the best solutions where description of reality is defined by ill-defined, tacit, diffuse and embedded knowledge in the new mind-set. The methodology rarely mentions the soft issues and its high level of prescription increases the size and complexity of the project (Middleton and McCollum, 2001; Sauer and Lau, 1997; Rogerson et. al, 2000)

2.6.2 Soft Systems Methodology (SSM)

SSM is an approach introduced by Checkland (1981) and it targets the soft factors. The methodology starts with rich picture building to find out about a problem situation. A rich picture in SSM is a pictorial representation of the organization. The people and things that interrelate within and outside that organization, other important aspects of the human activity system are shown in this picture. Arrows, crossed swords and think bubbles are some symbols used in rich pictures to denote relationships, conflict and the worries of the major characters respectively. Illustration of the unstructured problem situation on paper helps clarification of the analyst's own thinking and decision making and in explaining the fundamentals of his/her thoughts and decisions to the IT specialists. The rich picture should include both hard facts and soft or subjective facts of the organization.

The next step is the analysis of the rich picture. It starts by exploring elements of structure in the problem area (i.e. departmental boundaries, physical or geographical layout, product types) and for elements of process. The relationship between the structure and the process is referred as the climate of the situation. Analysis of these results in extraction of the themes, issues and primary tasks.

From the rich picture, the relevant systems are extracted after a negotiation process between the problem owner and the problem solver. Root definitions can be used

to define problems and systems that are otherwise vague and difficult. The following questions should be answered for root definition:

"WHO is doing WHAT for WHOM, and to whom are they ANSWERABLE, what ASSUMPTIONS are being made, and in what ENVIRONMENT is this happening?"

These questions are replaced with six technical terms, initials of which form the abbreviation: CATWOE.

- **C** Client → Whom
- **A** Actor → Who
- **T** Transformation → What
- **With** Weltanschauung → Assumptions
- **O** Owner → Answerable
- **E** Environment → Environment

Weltanschauung is a German word meaning "world view" or "all the things you take for granted".

Basically a root definition is finding the appropriate headings from the problem situation for each part of the CATWOE in order to clarify the situation.

For root definition, PQR method can also be used together with the CATWOE. PQR represents three questions:

1. What to do? (P)
2. How to do it? (Q)
3. Why do it? (R)

After defining the problem situation clearly after the rich picture building and root definition, conceptual models of the systems named in the root definition are built, and these models are compared with the real world and revised accordingly.

2.6.3 Mumford's work

Mumford (1981) introduced a socio-technical design methodology combining Mary Parker Follet's work in the 1920s with the principles of socio-technical design. The principles derived from Follet are participation, representation, joint problem solving, freedom of speech, gaining power, integrating all factors and staying together. These principles are combined with the quality of working life, multi-skilling, boundary management, information flow, continuing design. This methodology was improved later by Mumford and assigned the new name of ETHICS in the second half of the nineties.

2.6.4 Ethics

The ETHICS method involves "a set of logical, sequential and analytical steps that are taken when a new computer-based work system is being designed", integrating participation, effective communication and socio-technical design (Mumford, 1996). The ETHICS consists of the following systematic steps:

1. Identifying the user needs and problems, focusing on short and long term efficiency and job satisfaction;
2. Setting objectives for efficiency and job satisfaction;
3. Developing design strategies and matching each alternative against these objectives;
4. Choosing the strategy best meeting the sets of objectives;
5. Determining the hardware and software and designing the system in detail;
6. Implementing the new system; and
7. Evaluating the new system.

Users are involved in each step of the methodology. At the beginning of the design, the method describes the mission and key tasks followed by the diagnosis of the user needs related to day-to-day tasks, efficiency, effectiveness and job satisfaction. The job satisfaction is defined as a good fit between the employee's job expectations and job requirements as defined by the organization. The methodology continues with

setting specific efficiency, effectiveness and job satisfaction objectives. In the socio-technical systems design step, the findings and the knowledge gained in the previous steps are combined in order to "make work more satisfying for the individual and group doing it, while at the same time enabling them to contribute to high level of technical efficiency". Therefore, in this step, the system is designed according to the technical characteristics restraining or enabling the objectives bearing in mind the social objectives. Since the methodology involves a high level of user participation in each step and open communication, the resistance to change is expected to be lower.

2.6.5 Multiview

Multiview is an approach introduced in 1985. It advocates that information systems development should include the human and organizational aspects (Wood Harper et. al, 1985). The Multiview approach aims to provide answers to the following questions in IS development:

1. *How is the computer system supposed to further the aims of the organization installing it?*
2. *How can it be fitted into the working lives of people in the organization that are going to use it?*
3. *How can the individuals concerned best relate to the machine in terms of operating it and using the output from it?*
4. *What IS processing function is the system to perform?*
5. *What is the technical specification of a system that will come close enough to doing the things that have been written down in the answers to the other four questions?*

The answer to each question is investigated at a different stage. These five stages are shown in Figure 2.5 and explained below in detail. The links between these stages, inputs and outputs are shown in Figure 2.6. It can be seen from the figure that the Multiview approach focuses only on the design of the system and does not consider its adoption in the organization when it is complete.

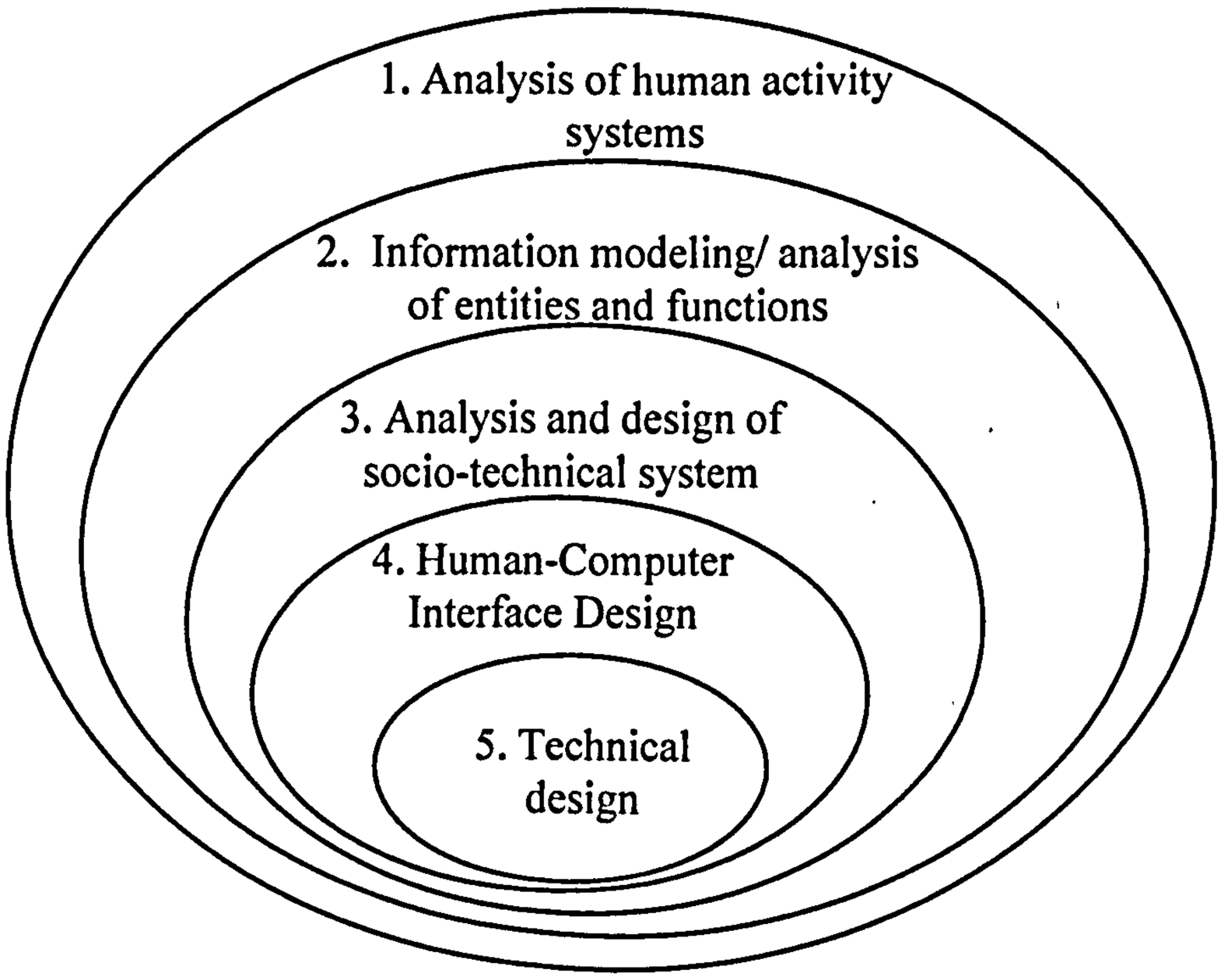


Figure 2.5 The Original Multiview Framework (Wood-Harper et. al, 1985)

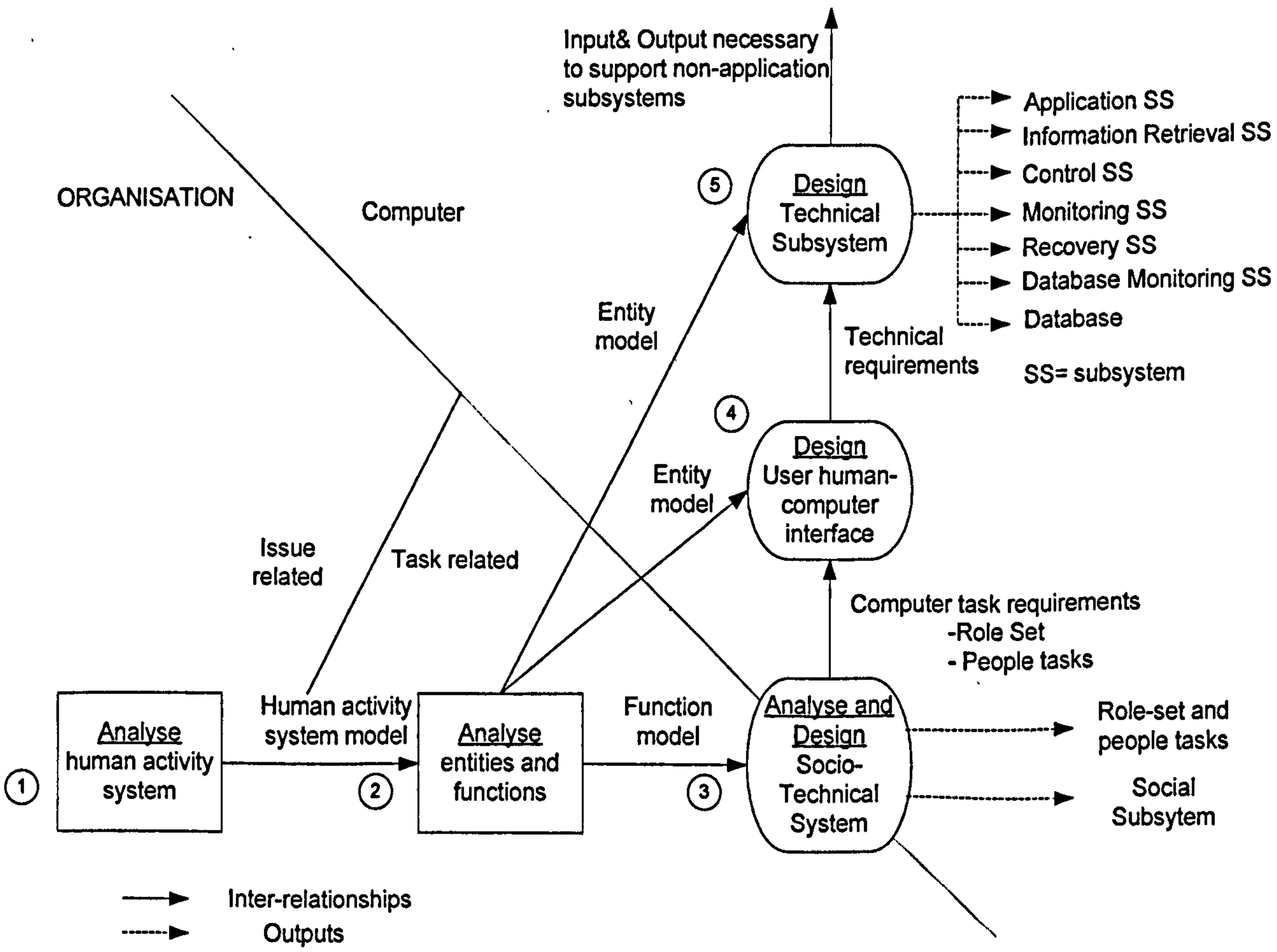


Figure 2.6 The Multiview Methodology (Wood-Harper et. al, 1985)

2.6.5.1 Analysis of Human Activity Systems

This stage is based on Checkland's (1981) work on SSM. The main aim of this stage of analysis is to understand the problem situation and the purposes of the organization. It starts with the questions: "What is it for?". "Who is/are going to use it?" Human activity system is used to denote "*the organization in which the system is to be installed which might be a one-man firm, a department, a few individuals or a company.*"

Once the human activity system is determined, the *rich picture* technique and root definition are used to analyse the system. Afterwards, a conceptual model is built to develop an alternative view of the problem definition. The conceptual model is obtained by reducing the complexity of the rich picture by filtering it and focusing on the most important information flows. After filtering the picture, the problem situation becomes less complicated so it is easier to deal with. On the other hand, if the information flows are over-filtered then it will be too broad to be useful. All activities associated with the root definition should be listed and logically grouped. Later, they are drawn together as systems to perform these activities. This conceptual model should be compared with reality and checked for any possible improvements in the way the activities are organized and the required corrections should be done.

2.6.5.2 Analysis of Entities and Functions (Information Modelling)

This stage consists of two phases. The first one focuses on the development of the functional model, whereas the second one focuses on the development of the entity model. An information model, the combination of these two models, is basically a model showing what type of information is necessary at what stage/time to carry out the tasks achieving the objectives of the organization.

The first step in building the functional model is creating a function chart which shows the functions to be performed within the new information system with their hierarchical orders. From this hierarchical model, a data flow diagram showing the events triggering the actions and what information is involved is derived. This model is an input for the socio-technical system analysis and design stage.

An entity is something, the record of which should be kept, and entity modelling is the process of identifying the entities, extracting the relationships and defining the attributes belonging to the entities. The model, refined by filtering the unnecessary or redundant relationships, is an input for the last two stages: design of user-computer interface and design of technical subsystems.

2.6.5.3 Analysis and Design of Socio-Technical System

The main principles of this stage are based on Mumford (1981). The task for the problem solver is to produce a good fit design taking into account people and their needs and the working environment on one hand and the organizational structure, computers and the necessary work task on the other. The outline of the socio-technical analysis and design is given in Figure 2.7. Social alternatives are determined according to the social objectives. Likewise technical alternatives are built up according to the technical objectives. These two are matched to form the socio-technical alternatives. The emphasis at this stage is on the statement of alternative systems and choice between the alternatives. Making a choice among the alternatives is difficult. Wood-Harper and Avison (1985) state that the costs of alternatives, in money, time and in terms of social disruption, and the benefits of the alternatives, in the short, medium and long term, should be considered and the alternative providing the best benefit/cost ratio should be chosen.

2.6.5.4 Human-Computer Interface Design

The concern at this stage is how the communication between the users and the computer is established. The entity model derived in stage 2 and the computer tasks, role set and people tasks derived in stage 3 are inputs for this system. The required dialogues should be determined and the most preferred types among the users should be identified. Error prevention in the dialogues must be one of the aims. The system can be designed in a way that it minimizes the errors in the data entries or in any type of computer interaction. (e.g. date format (DD/MM/YY). Likewise, the response time of the computers should be considered in the design. To sum up, this stage is for extracting the required technical requirements according to the entity model and the socio-technical requirements.

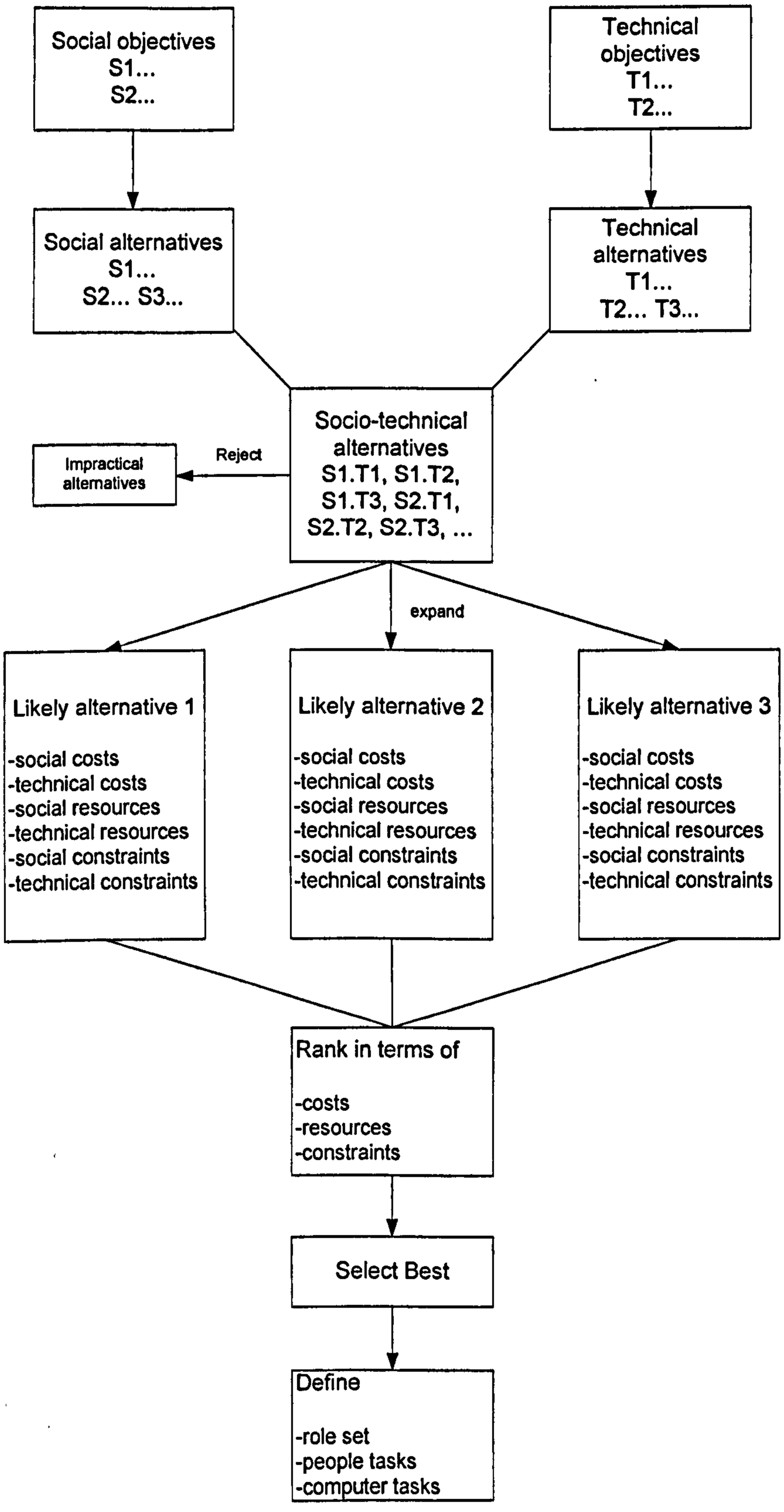


Figure 2.7 Principles of Socio-technical Design (Wood-Harper et. al, 1985)

2.6.5.5 Design of Technical Subsystem

The technical requirements obtained in the previous stage according to both social and technical objectives are used for the design of the technical subsystem. This stage

is purely focused on the technical design of the subsystem consisting of the following seven parts:

1. Applications;
2. Information retrieval;
3. The database;
4. Database maintenance;
5. Control (Data entry, program errors, operator error, machine malfunctions. database errors);
6. Recovery; and
7. Monitoring.

These seven parts are the seven facets of the technical subsystem and the system designed this way will automatically satisfy the organizational and social objectives and requirements since they are already considered in the previous stages.

2.6.6 Multiview II

The original Multiview, presenting a three-way relationship between the analyst, the methodology and the situation, was modified later to eliminate its deficiency in exemplifying how this triad might come about in actual practice (Figure 2.8). The new model includes technical design and construction (T), socio-technical analysis and design (P), and organizational analysis (O) stages which are based on the work of Mittroff and Linstone (1983). These stages are followed by information modelling which acts as a bridge between these three stages.

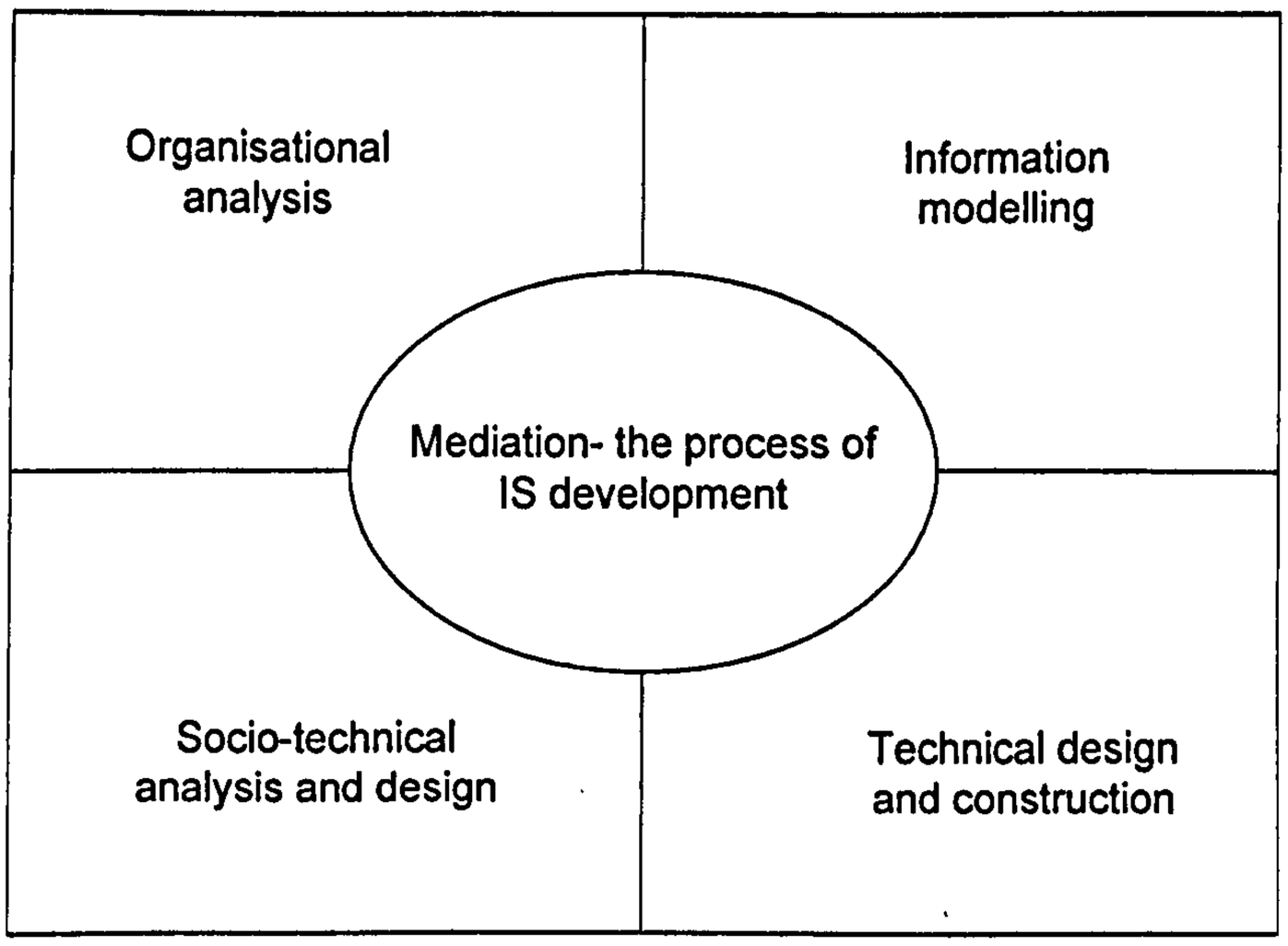


Figure 2.8 The Multiview2 Framework (Avison and Wood Harper, 2002)

2.7 Need for Organizational Change Management

It has been realised that the methodologies and frameworks mentioned in the previous section mostly focus on the design stage of an information system. However, the success of a collaboration environment does not only depend on "what is introduced to the organization" but is also related to "how it is introduced". The key issues mentioned in the literature review for the successful implementation of collaboration environments can be achieved by managing the changes at the organizational level. In Section 2.4.5, focusing on strategic IT implementation, the need for the organizational change management while introducing a collaboration environment has been discussed in the light of Walton's findings and strategic triangle. Peansupap and Walker (2005) illustrate how the organizational implementation of an ICT innovation is affected by change management and innovation diffusion in Figure 2.9. Static factors are associated with the initial IT diffusion whereas dynamic factors help to sustain IT diffusion changes.

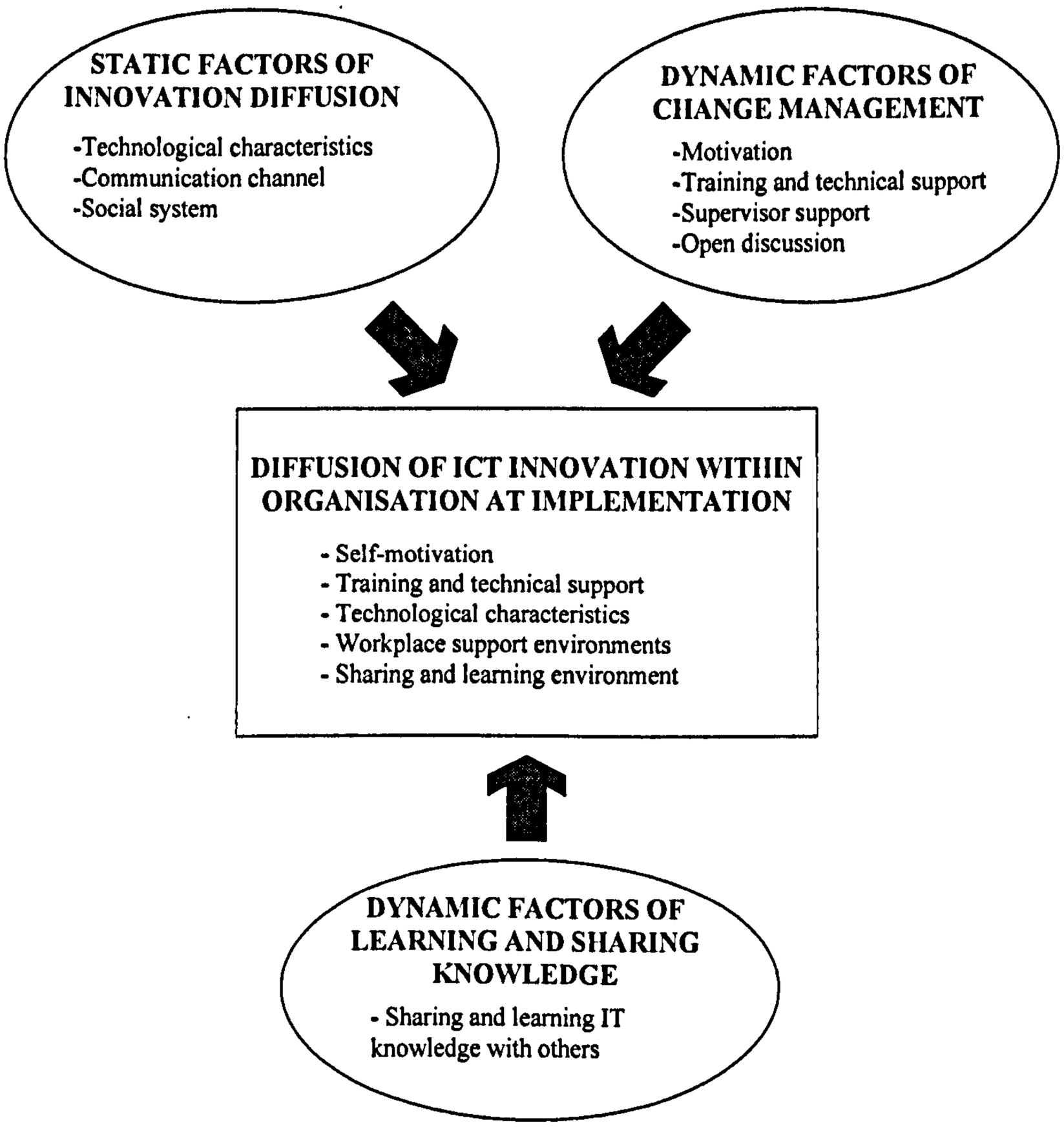


Figure 2.9 Integration of Innovation Diffusion and Change Management (Peansupap and Walker, 2005)

The need for an organizational change management approach can be best explained by Contingency Theory (See Section 3.3.3.3). According to Contingency Theory, each organization has different contingencies, such as environment, technology, organizational strategy. High performances will occur in the organization only if the organizational characteristics fit these contingencies (Robey and Sales, 1994). When a new collaboration environment is introduced to an organization, it results in changes to two contingencies: a new working approach and a new technology. The organization has to adapt its characteristics to these new contingencies. Therefore, introduction of new collaboration environments should be managed through an organizational change management approach in order to fit the organization to the changing contingencies.

2.8 Summary

This chapter has presented the results of a literature review on collaboration environment implementation concepts. It has been indicated by many researchers that the failure reason of IT systems is not only technical but related to organizational and human issues. The barriers to IT implementations and specifically to collaboration environments were reviewed and the key issues in implementing the collaboration environments suggested by previous research in order to overcome these barriers were investigated. These key issues extracted are user requirements capture, overcoming user resistance to change, user involvement, proper planning/project management, strategic IT implementation, buy in from all parties and trust. These key areas are found to be interrelated. The organizational changes and the new organizational structure should be decided whilst managing the changes, and every task should be carried out in accordance with the organizational and business strategy. All changes should be managed strategically, meaning that the changes in the IT structure should be reflected on the organizational structure as well. The findings revealed that the success of collaboration environment does not only depend on "what is introduced to the organization" but is also related to "how it is introduced". Some of the strategic IT implementation frameworks and the socio-technical design concept proposed in the literature have been discussed in order to seek their potential to be used in construction for introducing collaboration environments. However, it has been realised that none of these tools or methodologies have an established use in the construction industry and more importantly that they mainly focus on the design of the IS/IT systems but fail in providing guidance on how this design could be introduced to organizations. The need for an organizational change management approach whilst implementing collaboration environments has been discussed. It has also been found that the methodologies and approaches in the current state-of the art fail in providing a solution to this need.

CHAPTER THREE: CHANGE MANAGEMENT

3.1 Introduction

Change is defined as "the act or an instance of making or becoming different, an alteration or modification"(Concise Oxford Dictionary). There are many different reasons and sources for change which will never fade or vanish. Since changes will never disappear, the best option is to manage and control them to prevent negative consequences.

The impacts and consequences of changes on the project, organization and people vary according to the type and nature of changes, but most importantly according to how they are managed. The changes are to be managed to maximise the benefits, to minimise the penalties and ensure that both benefits and penalties are distributed equitably (Lazarus and Clifton, 2001).

Change management becomes more important, and at the same time more difficult for the construction companies which have a geographically dispersed organizational structure, are multi-disciplinary in nature, and manage one-off projects with interactions changing for each project. On the other hand, changes are not always unwelcome. In an environment characterised by ever-increasing global competition and customer expectations, change management has become a key factor in the quest by organizations to stay ahead of the competition (Cao et. al, 2004).

Change management occurs in construction at two levels: organizational level and project level. Throughout a project, construction organizations are faced with many changes, most of which are design changes. Project changes are inevitable even if there had been detailed studies during the design development, and prior to the construction stage. The impacts and consequences of changes on the organization and

people vary according to the type and nature of changes, but most importantly according to how they are managed. Besides handling changes at project level, construction companies are sometimes required to implement changes at organizational level related to management, technology, people and cultural issues. The main aim at the organizational level is managing how to introduce a change to the organization effectively and efficiently whereas, at the project level, the focus is on trying to cope with the changes that occur in the project due to internal or external reasons.

This chapter reviews previous work on change management in construction both at organizational level and project level. More attention is given to organizational change management since it has been determined in the previous chapter that organizational change management is necessary for the effective implementation of collaboration environments in construction.

3.2 Project Change Management

Project changes are considered to be any additions, deletions, or other revision to project goals and scope, whether they increase or decrease the project cost or schedule (Ibbs et al., 2001). Lazarus and Clifton (2001) widen this definition and define the change in a construction project as anything that affects:

1. The scope, requirements or brief for the project;
2. The capital cost or whole-life cost or value of the project;
3. The time required to design or construct the project;
4. The project team relationships and appointments;
5. Project-associated risk allocation or scope; and
6. The form of procurement.

3.2.1 Classification of Changes in Project Management

Different classifications of project changes exist in literature based on their impact, necessities, and timing. Construction Industry Institute-CII (1994) classifies the changes from the perspective that not all changes are bad. Changes that can help to

reduce cost, schedule or degree of difficulty are *beneficial changes* and are to be encouraged. *Detrimental changes*, on the other hand, are those that reduce owner value or have a negative impact value on the project.

Another classification proposed by CII (1994) is according to the need for the changes, whether their implementation is compulsory or not. *Required changes* are the changes that are necessary to be implemented to meet the basic, defined venture objectives or regulatory/legal requirements or defined safety and engineering standards. *Elective changes* are those that are proposed to enhance the project, but are not required to meet the original objectives. Therefore these changes might or might not be implemented.

The literature provides different classifications according to the timing of changes. Lazarus and Clifton (2001) classify the project changes as change in design development and change after design development, namely *pre-fixity change* and *post-fixity change* respectively. The post-fixity changes are also classified into two; urgent and non-urgent post-fixity changes. The urgent post-fixity changes are defined as the design work that has already been agreed with the client but now require manufacturing or construction implementation within six weeks or less. The non-urgent post fixity changes are the changes implementations of which are not required within six weeks.

Another classification based on timing is *anticipated change* against *emergent change*, or *proactive change* against *reactive change*. This classification refers to the same classification explained in the organizational change section. Anticipated change is mainly a planned change before the change occurs. Emergent change appears without any expectation or intention. Therefore, managing that change is a reactive action. The classifications are summarised in Table 3.1.

Table 3.1 Classification of Project Changes

Criteria	**PROJECT CHANGES**	
Type of impact (CII 1994)	Beneficial Changes	Detrimental Changes
	reduce cost, schedule or degree of difficulty	reduce owner value, have negative impact on the project.
Need for change (CII 1994)	Required Changes	Elective Changes
	Implemented to meet the objectives or regulatory/ legal/ safety/ engineering requirements/standards	Enhance the project, but are not required to meet the original objectives
Initiation Nature/ Responsiveness of change (Burnes 1996)	Emergent/ Reactive Changes	Anticipated/ Proactive Changes
	Unplanned, unexpected. The response is after the occurrence.	Expected before it occurs, therefore necessary actions are taken.

3.2.2 Sources and Nature of Changes in Project Management

There are many sources in the literature investigating the sources of project changes (Voropajev, 1998; Love et. al, 2002; Kast and Rosenweig, 1974; Kitchen and Daly, 2002; Lazarus and Clifton, 2001). Voropajev (1998) provides a detailed list of changes which may cause project context changing as well as the process of its implementation, and groups the changes that may affect the project management into four main kinds: Changes in distant project environment, changes in close environment, project changes, and key integrative process changing.

The first two kinds are the consequences of reforms. Distant project environment changes include the changes resulting from the factors regarding the political, legal, normative, social, economic, financial, ecological, technological, organization aspects and other external factors influencing the implementation and success of the project.

Close environment changes, on the other hand, refer to the changes in the property relations within parent organization; target market of products, services and solvent demand; the concept of strategic organization development and its policies; organization forms and structures; production systems and technologies; organization internal infrastructure; company's behaviour, culture and system; communication

ways between local companies and international business community; and other changes within organization affecting the projects. These two kinds are referred to as external and internal sources of change in the literature by many studies. A similar study on sources of change is provided by Love et. al (2002). In this study, a systems dynamics approach is used and the changes in the project are considered as the representation of unattended project dynamics. According to this approach, the changes occur due to internal and external uncertainties. Internal uncertainties refer to uncertainties related to project, organization, finance, and human aspects whereas external uncertainties refer to uncertainties related to or resulting from governmental, economical, social, legal, technological aspects, and institutional influences, physical conditions, and acts of god/ force majeure.

Project changes, the third kind listed by Voropajev (1998), refer to the changes that can occur in the project as consequences of the external and internal changes faced. The changes listed can also be the reason for the project change without being affected by external or internal factors. These changes include changes in scope, quality, time, cost, risk, contract/procurement, human resources, and communications. This perspective includes quality and communications which are not indicated in the study by Lazarus and Clifton (2001).

The fourth kind introduced by Voropajev (1998) is the key integrative process change, which is concerned with changes to be carried out in the processes and procedure to provide appropriate action against the first three kinds of changes. These include changing the system of project planning, changing the project plan execution, changing the overall change control system, and changing the system of documentation.

The reasons for change at project level are summarised in Table 3.2.

Table 3.2 Reasons for Changes at Project Level (Kast and Rosenweig, 1974; Kitchen and Daly, 2002; Lazarus and Clifton, 2001)

External Reasons	**Internal Reasons**
Changes regarding economic and financial issues Changes in environmental issues Changes in ecological issues Technology changes Changes in the standards and regulations Political changes Force majeure	Changes in the organizational culture Changes in the system of project planning Changes in the project plan execution Changes in the overall change control system Changes in the documentation system Ineffective decision making Design improvements Unexpected weather conditions Design error Designer change of mind Changed design parameters Contract disputes Changes in the project

Changes in projects are primarily due to variations (change orders), rework, or unexpected events such as industrial action and inclement weather (Love et. al, 2002). The problems in rework are investigated in literature mainly under the heading of quality in construction, or cost of construction. A study by Love and Li (2000), involving two case study projects, revealed that the direct cost resulting from rework was 3.15% and 2.40% of their project contract value. The same study showed that the design changes, construction changes and design errors are the main causes of the rework.

Design changes, also referred to as engineering changes, are defined as changes and/or modifications in forms, fits, functions, materials, dimensions of products and constituent components (Huang et. al, 2001). Engineering changes are one of the biggest problems in both construction and manufacturing industries. Rouibah and Caskey (2003) specify three kinds of engineering changes depending on when they occur in the design process in the manufacturing industry:

1. Engineering changes during initial design;
2. Engineering changes after the initial design period; and
3. Engineering changes during the major reconstruction of a product.

The first type refers to the changes occurring early in the design process and the impact is not very large. The second type of changes, engineering changes after the initial design period, cause greater disruption since the production has already started. The third type is referred to as development of versions and variants. This classification is actually similar to the classification proposed by Lazarus and Clifton (2001) since the first two changes are nothing but the pre-fixity and post-fixity changes. The third type, on the other hand, is not observed in the construction industry because of its one-of-a kind product characteristic.

In research considering the manufacturing industries in Hong Kong, it was found out that Engineering changes have a noticeably adverse effect on delivery time, and some adverse effects on the product quality, day-to-day jobs, and workmanship (Huang et. al, 2001). The construction industry had similar impacts with the manufacturing industry. In research carried out by Cox et. al (1999), examining the historical data from change order request procedures in the construction sector, it was found out that in monetary terms alone, the direct cost of post contract design changes amounts to 5.1-7.6% of the total project cost. Therefore, the management of change orders is very important for construction project management. The most common reasons and sources for change orders in construction can be summarised as (Hsieh et. al, 2004; Cox et. al, 1999; Love et. al, 2002):

1. Changed requirements of the client;
2. Design errors; and
3. Unforeseen conditions regarding the site conditions or administrative aspects such as change of work rules/regulations, change of decision making authority, special needs for project commissioning and ownership transfer.

Based on the analysis of data collected from a total of 90 metropolitan works projects completed in Taipei, Taiwan between 1991-2000, Hsieh et. al (2004) state that the main reason for most change orders was due to design errors such as mistaken

quantity estimates, planning mistakes, inadequate arrangement of contract interfaces, inconsistencies between drawings and site conditions, and citations of inadequate specifications. Therefore, the design process requires more attention. Concurrent engineering or Design and Build approaches to construction are believed to be more successful in minimising the number of engineering changes or coping with engineering changes during the construction stage, provided that they have a well built communication system and focus on the customer needs (Moore and Dainty, 1999; Faniran et. al, 2001; Lau et. al, 2003). The requirements for collaborative, multi company engineering change management from a company operation point of view are determined as supporting communication, involving all relevant parties, working toward a consensus, controlling the process, and identifying the scope of impact (Rouibah and Caskey, 2003).

3.3.3 How to Handle Changes in Construction Projects

Lazarus and Clifton (2001) divide the effects of the changes within the project team into two, direct effects and indirect effects. Direct effects are easily visible compared to indirect effects. Direct effects of change within the project team may be the need to review their work; change their project information and outputs; update their communications to the others; expend additional time and cost implementing the change; reorganize and schedule their work methods, production schedules and deliveries; and introduce acceleration measures to maintain the project programme. Potential indirect effects include: increased coordination failures and errors; increased waste in the process from abortive work and out-of-sequence working; reduction in productivity, quality of the product and profit; uncertainty; and lower morale. The changes in the project always result in several consequences such as: breaking of project momentum, increased overhead and equipment costs, scheduling conflicts, rework, and decreased labour efficiency (Sun et. al, 2006).

Many previous studies provide guidelines for how to manage changes. CII (1994) defined the project elements that are subject to change and that will affect the change management process as: Project Scope, Project Organization, Work Execution Methods, Contracts and Risk Allocation. The principles of effective change management according to the CII Research Team are as follows:

1. Promote a balanced change culture;
2. Recognize change;
3. Evaluate change;
4. Implement change; and
5. Continuously improve from lessons learned.

This approach and the algorithms based on these principles are also published by Ibbs et. al (2001). Reviewing these principles and algorithms, Lazarus and Clifton (2001) proposed separate change management procedures for changes during design development, post-fixity changes that are urgent, and post-fixity changes that are not urgent and might be implemented during the remainder of the project.

The EPSRC-funded research project Managing Change and Dependency in Construction undertaken collaboratively between The University of Salford, The University of West England and Loughborough University developed a framework enabling users to produce a rich description of the change event (Sun et. al, 2006). The toolkit produced by the project consists of four main parts:

1. Change Dependency Framework, which provides a hierarchical structure with four levels of which the first level corresponds to the key activities of a generic change management model whereas the other three are the decompositions at increased levels of detail.
2. Change Prediction Tool, which aims to predict the changes in the construction project and links the change, the project characteristics, causes of the change and the impact of the change to each other through a Fuzzy Logic approach.
3. Workflow Tool, a software system created to identify the workflow changes by matching two versions of a workflow specification.
4. Knowledge Management Guide, which explores the role of knowledge in managing project change in collaborative team settings.

Love et. al (2002) investigated change management through a system dynamics perspective and suggested that the dynamics of a project system should be evaluated

and monitored by project managers in accordance with the following functions:

1. Planning for being proactive to change.
2. Organizing: allocating tasks to people, requesting resources and coordinating all tasks into a working system.
3. Commanding: Leading, delegating, communicating, motivating, coordinating, cooperating with and disciplining people.
4. Controlling: Establishing standards and methods for measuring performance and determining the deviations from the planned requirements in terms of cost, time, quality and safety.

Another approach that has been suggested involves leading the companies to implement concurrent engineering so as to improve communication and handle changes quickly. Rezgui et. al (1996) presents an information management model for concurrent construction engineering that deals with four areas:

1. Versioning support;
2. Rights and responsibilities;
3. Recording intent; and
4. Notification.

Rouibah and Caskey (2003) present a parameter-based approach to engineering change management that aims to support multi-company concurrent engineering efforts through facilitation of information exchange, retrieval, sharing and use. Huang (2001) introduced a Web-based system for engineering change management and discussed its design, development and implementation in the manufacturing industry. Although it targets the manufacturing industry, the basic principles are also applicable to the construction industry.

3.3 Organizational Change Management

Organizational changes are changes to organizational processes, changes in organizational functions, changes in values, beliefs and human behaviour, and changes in power distribution and the way organizational issues are influenced (Cao et. al, 2000). All of these are interconnected and affect one another.

3.3.1 Sources of Organizational Changes

Kast and Rosenweig (1974) categorize the sources of the change under six headings:

1. Changes in environment (technological, economic, legal, political, demographic, ecological and cultural factors);
2. Changes in goals and values;
3. Changes in the technical system;
4. Changes in structural subsystem;
5. Changes in the psychological system; and
6. Managerial system.

Kitchen and Daly (2002) identify similar organizational change factors as Kast and Rosenweig (1974) but classify the factors that initiate changes in the organizations under two main headings: External and internal factors. External factors can be summarised as new technology, changes in the market place, changing customer expectations, competitor activities, quality and standards, government legislation and prevailing political values and economic cycles. Internal factors, on the other hand, relate to management philosophy, organizational structure, culture and systems of internal power and control. The sources of organizational changes are summarised in Table 3.3.

Table 3.3 Reasons for Changes at Organizational Level (Voropajev 1998; Love et. al 2002; Smither et.al 1996)

External Reasons	**Internal Reasons**
Changes in environment	Changes in goals and values
New technologies	Changes in the technical system
Changes in the market place	Changes in organizational structure
Changing customer expectations	Changes in the management philosophy
Changes in competitor activities	Changes in the psychological system
Changes in quality and standards	Changes in managerial system
Changes in legislation	Changes in organizational culture
Changes in prevailing political values	Changes in the systems of internal power
Changes in the economy	and control
Demographic changes	
Ecological changes	
Changes in cultural factors	

3.3.2 Classification of Organizational Changes

There are several classifications of changes. One classification is strategic or non-strategic change. *Strategic change* refers to non-routine, non-incremental and discontinuous change which alters the overall orientation of the organization and/or components of the organization (Tichy, 1983). The changes which do not affect the overall orientation of the company, which do not result in a drastic difference are termed *non-strategic change.*

Another classification is based on the speed of the transformation in the organization in order to achieve the change. *Incremental change* has been defined as the sort of ongoing change that is routinely necessary for any organization to adapt to its environment, whilst *radical change* can be seen as the sort of change that necessitates a thorough re-examination of all facets of an organization (Cao et. al, 2000). Incremental change is sometimes referred to as *gradual change* and radical change is sometimes referred to as *quantum change*. Cummings and Worley (2005) consider incremental change as fine-tuning the organization whereas quantum changes entail fundamentally altering how an organization operates.

Burnes (1996) classifies changes according to how they are initiated as *emergent change* or *planned / anticipated change.* Emergent change is driven from bottom up and is an open-ended continuous process of adaptation to changing conditions and modifications whereas the planned change is the result of an action research, a rational and systematic analysis of the social and organizational problems in question (Burnes,1996). Anticipated change is not planned by the organization but its occurence is expected. The different classifications for organizational changes in the literature are summarised in Table 3.4.

Table 3.4 Classification of Organizational Changes

Criteria	**Organizational Changes**	
The difference in the organization due to change (Tichy 1983)	Strategic Changes	Non-strategic Changes
	Nonroutine, nonincremental and discontinuous, alter the overall orientation of the organization	Do not affect the overall orientation of the company, do not result in a drastic difference
Speed of the transformation in the organization (Cao et al 2000; Cummings and Worley 2005)	Incremental/ Gradual	Radical/ Quantum Changes
	Routinely necessary for any organization to adapt to its environment	Necessitates a thoroughgoing re-examination of all facets of an organization
Initiation Nature (Burnes 1996)	Emergent Changes	Planned Changes
	Driven from bottom up and is an open-ended and continuous process of adaptation to changing conditions	Result of an action research and an analysis of the social and organizational problems in question
Initiation Nature (Burnes 1996)	Emergent Changes	Anticipated Changes
	Same as above	Not planned by the organization but its happening is expected

According to the characteristics of change, an organization goes through different forms of change. As seen from Figure 3.1, if the change is an incremental change made due to the anticipation of future events, it is called tuning. If it is a strategic

change due to the anticipation of external events which will require this change, then it is referred to as re-orientation. The incremental changes carried out as a reaction to external events are called adaptation whereas the reactive strategic changes are referred to as re-creation.

	Incremental	**Strategic**
Anticipatory	Tuning	Reorientation
Reactive	Adaptation	Re-creation

Figure 3.1 Types of Organizational Change (Jick and Peiperl, 2003)

Changes can also be categorised according to the way the change is implemented in the organization. According to Jick and Peiperl (2003), there are three perspectives on change as shown in Figure 3.2. Developmental change is a continuous process of change whereas transitional change involves a period for transition between the old and new states of the organization. It can also involve developmental change. Lewin's (1952) three-stage organizational change model (See Section 3.3.4.2) is a good example of transitional change. Transformational change may involve both developmental and transitional changes.

When organizational change is investigated considering the period between the present and future states of an organization –in other words, states before and after the change with respect to the rate of integrated change, three different approaches to change were identified by Felkins et. al (1993). These approaches are shown in Figure 3.3.

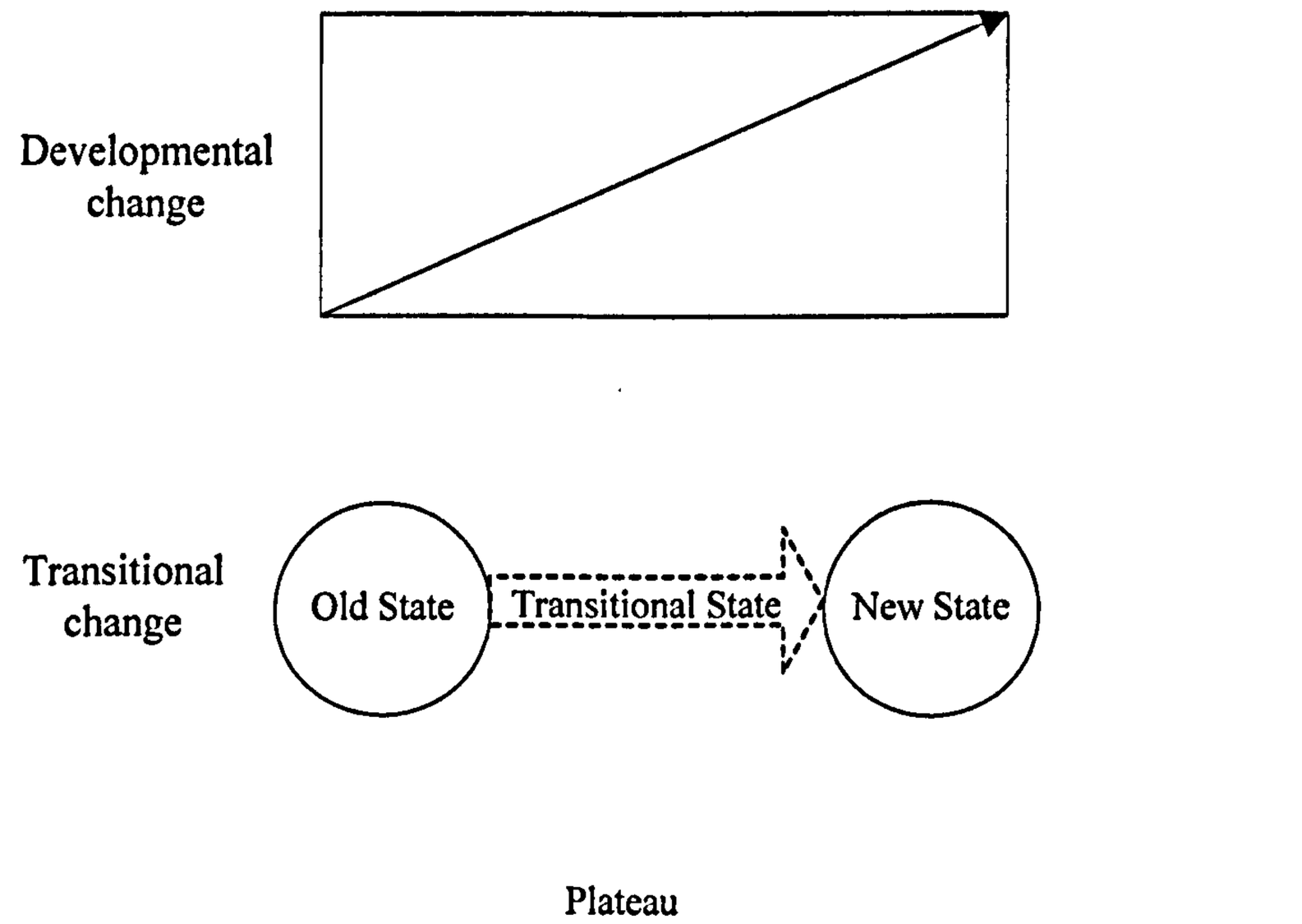


Figure 3.2 Three Perspectives on Change (Jick and Peiperl, 2003)

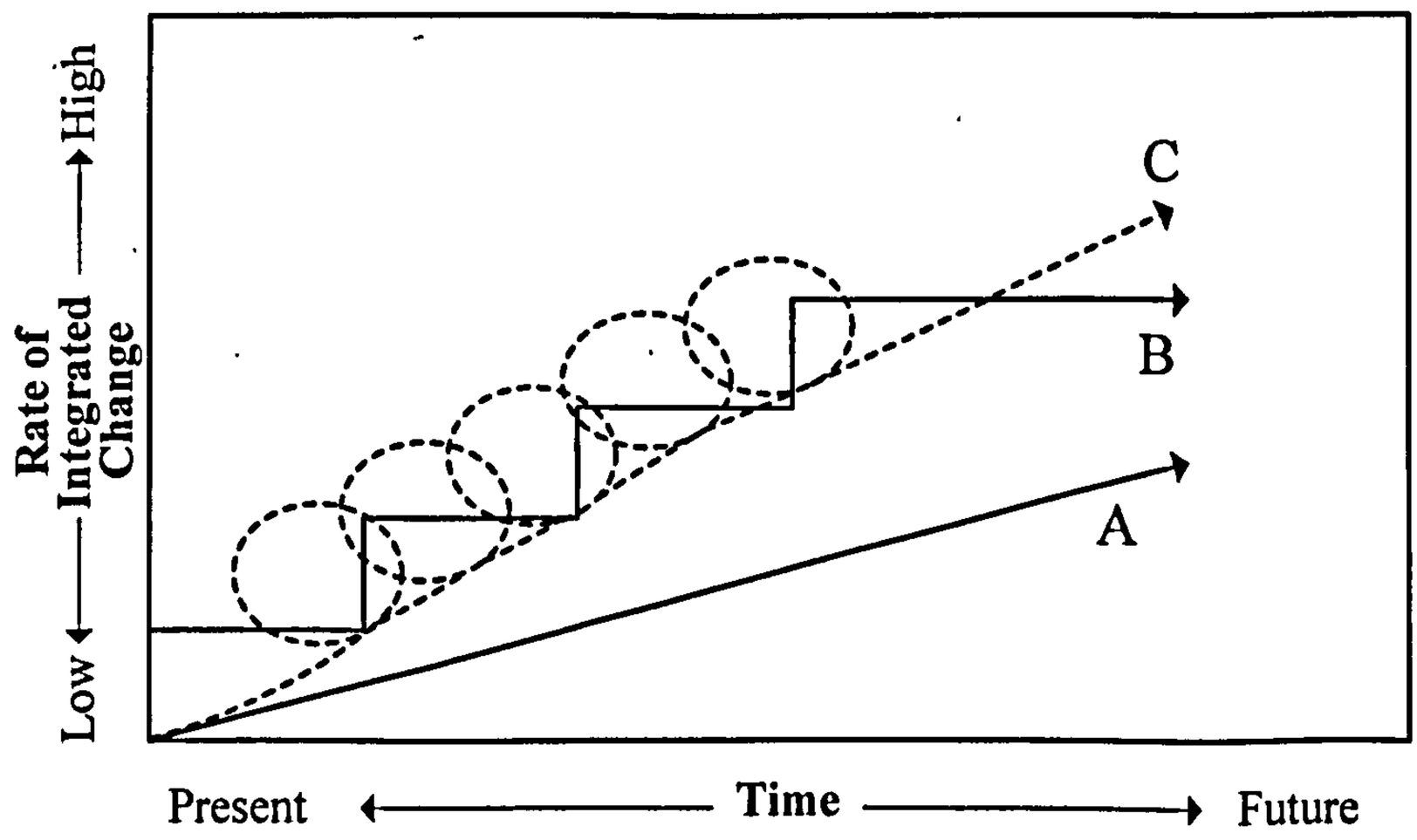


Figure 3.3: Approaches to Change (Felkins et. al, 1993)

Approach A shows a directed change carried out at a deliberate speed and intention. Although this approach can have some competitive advantages, if conditions change during the change, the time to gather information and feedback for integration of directed and non-directed processes might not be enough. Approach B shows a deliberate change as well, but it includes some intentional stops during the change in order to analyse the change movement and process to integrate the non-directed elements during the transition. Approach C deals with both directed and non-directed change processes through looping cycles of continuous feedback, monitoring and assessment, and is believed to bring more positive long term results than the other two approaches.

3.3.3 Theoretical Approaches

This section provides an overview of four theoretical approaches to change which have contributed to the evolution of organizational change management through highlighting of different perspectives.

3.3.3.1 Scientific management approach (Taylorism)

The basis of the scientific management approach is that work could be divided into sub-units or specializations. It is believed that there is a "one best way" to perform a task and each sub-unit of a task should be carried out by people capable of carrying out this task in this standardised "one best way".

3.3.3.2 The human relations movement

The theory dates back to the studies of Elton Mayo and Fritz Roethlisberger at Hawthorne plant in Chicago during the 1920's and 1930's (Roethlisberger and Dickson, 1939). The Hawthorne studies followed a humanistic approach, drawing attention to group behaviour, relations among group members and relations between group members and management. Understanding the linkages between the individual, their role among the other members of the group at the workplace, and the degree of independence given to the group is considered an initial step to effective performance.

3.3.3.3 The Contingency Theory

Contingency Theory is distinguished from most organizational theories proposing a "one best way" to structure an organization (Donaldson, 2001). According to Contingency Theory, each organization has a different way of structuring itself and this structure depends on the circumstances, referred to as contingencies, such as environment, organizational size, technology and organizational strategy (Burns and Stalker, 1961; Chandler, 1962; Child 1973). The theory provides a logic that each organization has different contingencies and high performances will occur when the organizational characteristics fit these contingencies (Robey and Sales, 1994). Organizations try to avoid misfits which mean loss of performance; therefore, they adapt themselves according to the changing contingencies so that effectiveness is maintained. In other words, the will to fit the organizational characteristics to the contingencies results in organizational change.

Burns and Stalker (1961), and Lawrence and Lorsch (1967) are known with their major contributions to the theory. Burns and Stalker (1961) identify two types of organizations which are effective under different circumstances: mechanistic organizations and organic organizations. The characteristics of the mechanistic and organic organizations are shown in Table 3.5.

On the other hand, Lawrence and Lorsch (1967) argue that the design, structure and management of an organization depend on both the internal and external environments the organization is based in. The more complex the environment, the more centralized and flexible management needs to be.

Table 3.5 Characteristics of Mechanistic and Organic Organizations (Burns and Stalker, 1961)

Mechanistic organization	**Organic organization**
• Task differentiation and specialization	• Continuous assessment of task allocation through interaction to utilize knowledge which solves real problems
• Hierarchy for coordination of tasks, control and communications	• The use of expertise, power relationships and commitment to total task
• Control of incoming/ outgoing communications from the top and a tendency for information to be provided on a need to know basis	• Sharing of responsibility
• Interaction and emphasis placed on vertical reporting lines	• Open and widely used communication patterns which incorporate horizontal and diagonal as well as vertical channels
• Loyalty to the organization and its officers	• Commitment to task accomplishment, development and growth of the organization rather than loyalty to officials
• Value placed on internal knowledge and experience in contrast to more general knowledge	• Value placed on general skills which are relevant to the organization

3.3.3.4 The systems theory

According to systems theory, in order to understand the organizational survival, adaptation and performance, the dynamics of environment-organization relations should be considered as a system (Wilson and Rosenfeld, 1990). From the change management perspective a system can be defined as "an assembly of components, which are related in such a way that the behaviour of any individual component will influence the overall status of the system" (Paton, 2000). Therefore the systems approaches to change investigate many different dimensions of an organization.

There have been many models developed for organizational change management following the systems approach. Some of these models differ from each other

according to the organizational dimensions they prioritise. For example, the organizational development approaches focus more on the soft issues and behavioural concepts whereas the intervention models focus on proposing systematic guidelines in clearly defined steps. These models are discussed in detail in the next section.

3.3.4 Organizational Change Management Models-Systems approach

3.3.4.1 Intervention models

Intervention models are developed based on the systems approach and focus on proposing systematic guidelines in clearly identified steps for implementing organizational change. Although each intervention model involves different steps, three main phases are common to all:

1. Definition/Description phase
2. Evaluation/Design/Options phase
3. Implementation

Paton and McCalman (2000) came up with a methodology for the analysis and implementation of an organizational change, which is called an Intervention Strategy Model (ISM). The basic stages of Intervention Strategy Model are shown in Figure 3.4. Likewise, Senior and Fleming (2006) proposed another approach very similar to ISM, which is called Hard Systems Model of Change (HSMC). The stages of both models are shown in Table 3.6 with respect to the three main phases common to all intervention/hard systems models.

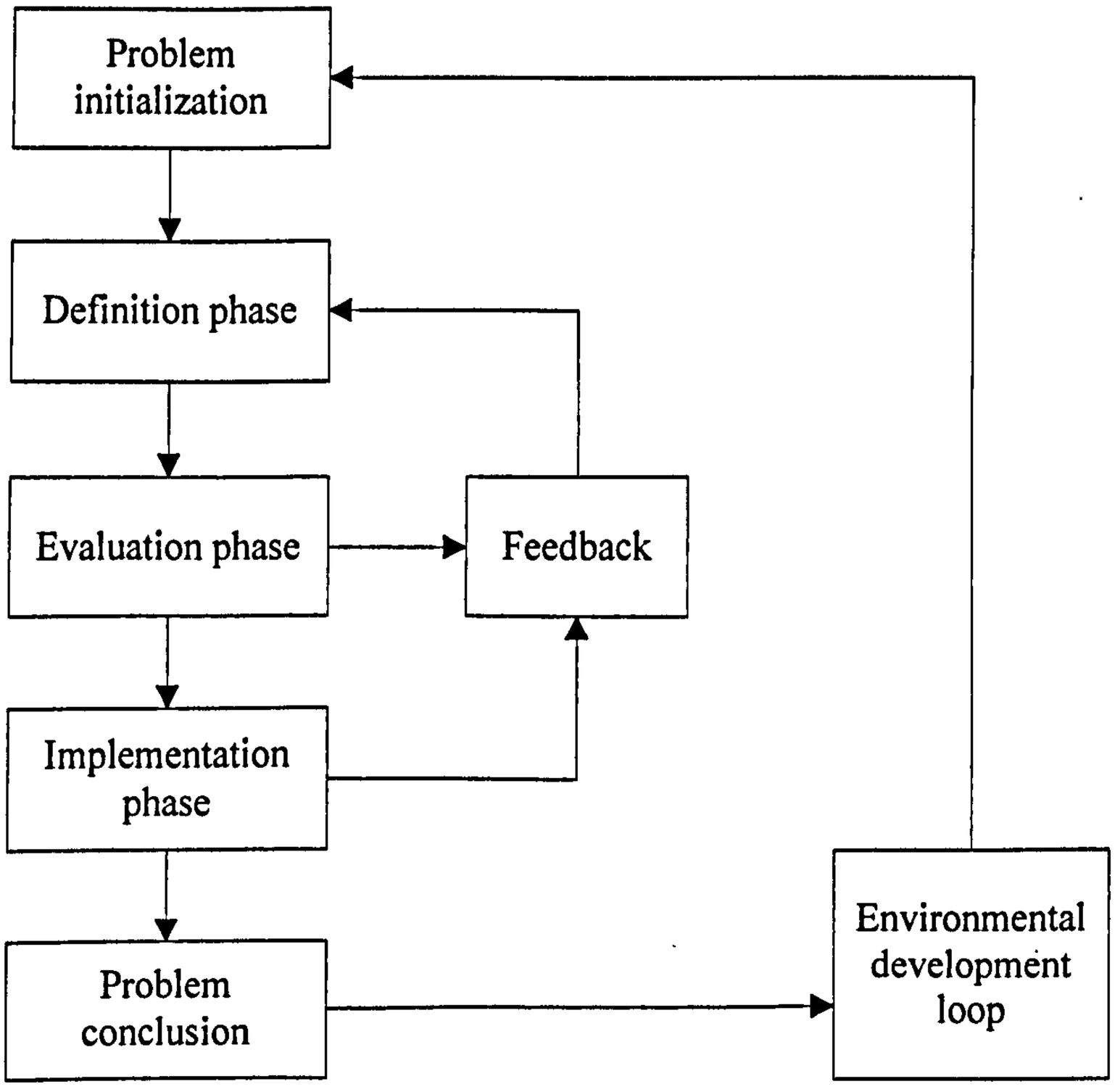


Figure 3.4 The Basic Phases of the ISM (Paton and McCalman, 2000)

Table 3.6 HSMC and ISM Stages (Paton and McCalman, 2000; Senior and Fleming, 2006)

Phase	HSMC Stages	ISM Stages
Definition	1. Situation summary 2. Identify objectives and constraints 3. Identify performance measures	1. Problem/ systems specification and description 2. Formulation of success criteria 3. Identification of performance measures
Evaluation	4. Generate options 5. Edit options and detail selected options 6. Evaluate options against measures	4. Generation of options or solutions 5. Selection of appropriate evaluation techniques and option editing 6. Option evaluation
Implementation	7. Develop implementation strategies 8. Carry out the planned changes	7.Development of implementation strategies 8. Consolidation

3.3.4.2 Organizational Development Model

Organizational Development (OD) is another approach to change which follows the systems approach. However, unlike the intervention models, OD is more related to the soft issues and uses behavioural science technologies, research and theory. OD can be defined as a planned process of change to achieve and improve organizational effectiveness through systematic application and transfer of behavioural and social science methodologies and techniques with the help of a consultant referred to as a change agent (Cummings and Worley, 2005; Warner Burke, 1994; Paton and McCalman, 2000). The change agent is the person who is responsible for the effective implementation of change. Problem owner, facilitator, project manager, master of change and change champion are also used to refer to the change agent (Paton and McCalman, 2000).

The OD approach to change cares about people and believes that people at all levels throughout an organization are drivers and engines of change (Senior and Fleming, 2006). It considers the organization as a whole as well as its parts and uses action research as an intervention model. Action research is a collaborative effort between leaders and facilitators of any change and those who have to perform the change (Senior and Fleming, 2006).

Paton and MacCalman (2000) define four situations where OD is needed.

1. The current nature of the organization is leading to a failure to achieve objectives.
2. Change is required to react faster to external alterations.
3. The introduction of factors such as new technology requires change in the organization itself.
4. The introduction of change allows a new approach to be adopted.

There have been many studies on OD models. Lewin's model (1958), shown in Figure 3.5, is one of the first OD models. According to Lewin, an organization goes through 3 phases for OD:

1. Unfreezing – raising an awareness of the need for change in the organization;
2. Moving - the stage where the actual changes are made to move the organization to a new state;
3. Refreezing - stabilizing and institutionalizing the change.

Unfreezing	**Moving**	**Refreezing**
↓	↓	↓
Unlearning stage	Recognition of need for change	New norms established
↓	↓	↓
Crisis stage	Acceptance of change by majority	New ways of doing things

Figure 3.5 Lewin's Classic Change Model (Graetz et. al, 2006)

This classic three-stage change model has been displaced by more detailed adoption models which include additional feedback and evaluation stages. According to Warner Burke (1994) an organization will experience seven phases during a typical OD change process:

1. Entry phase;
2. Formalizing the contact;
3. Information gathering and analysis;
4. Feedback;
5. Planning the change process;
6. Implementing the changes; and
7. Assessment.

The OD model developed by Senior and Fleming (2006), shown in Figure 3.6, is another example of models including feedbacks and correction loops in between stages. The feedback and correction loops led to the development of the learning organization concept, which is now considered one of the core concepts of OD. In order to survive in the increasingly complex and dynamic environment, organizations should become learning organizations (Senior and Fleming, 2006). There are two types of organizational learning: single loop learning and double loop learning. These

are illustrated in Figure 3.7. Single loop or instrumental learning is an adaptive learning through which an entity learns to do better what it is currently doing (Senge, 1992; Paton and McCalman, 2000). Incremental change and adaptation via Total Quality Management are examples of single loop organizational learning approaches.

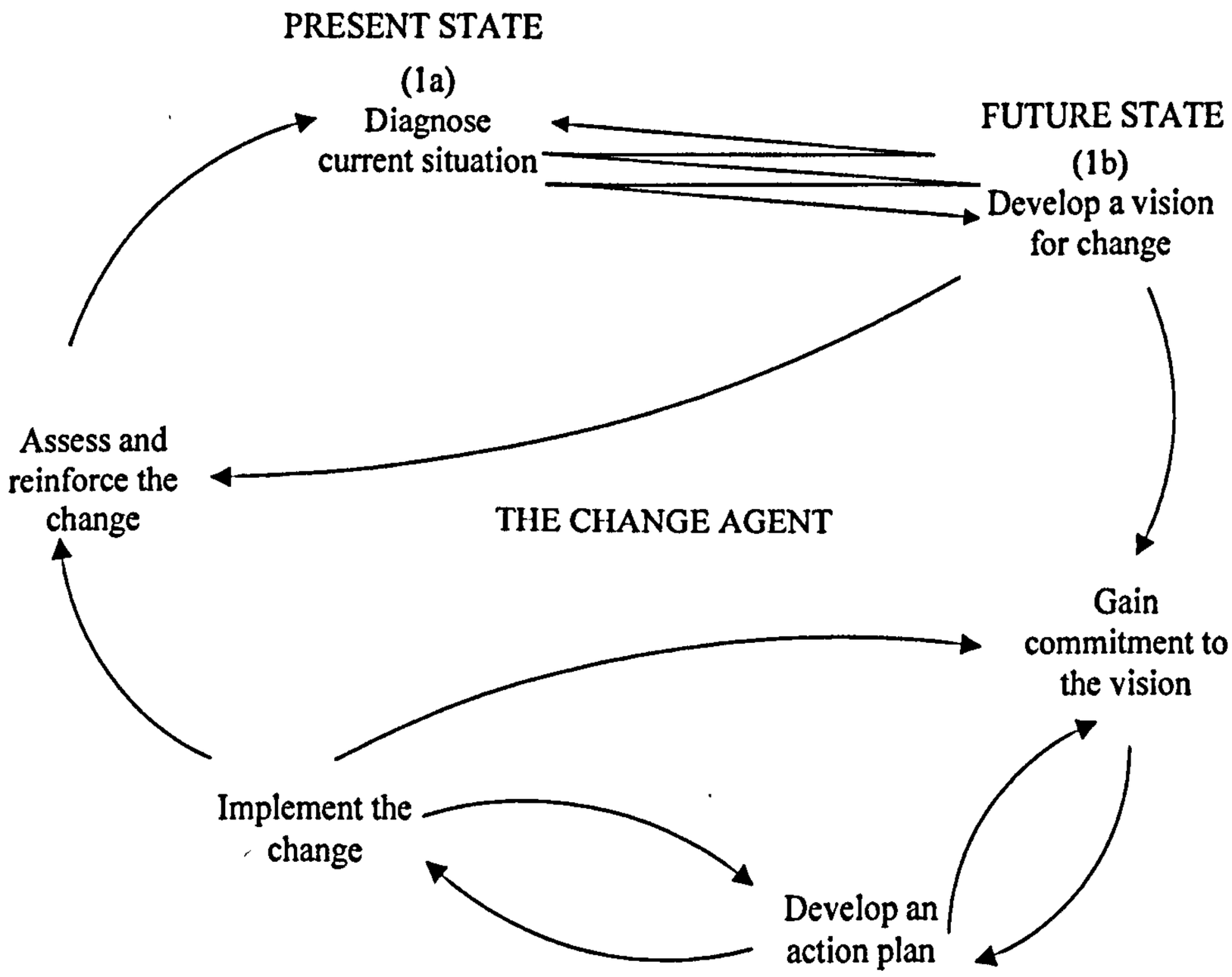
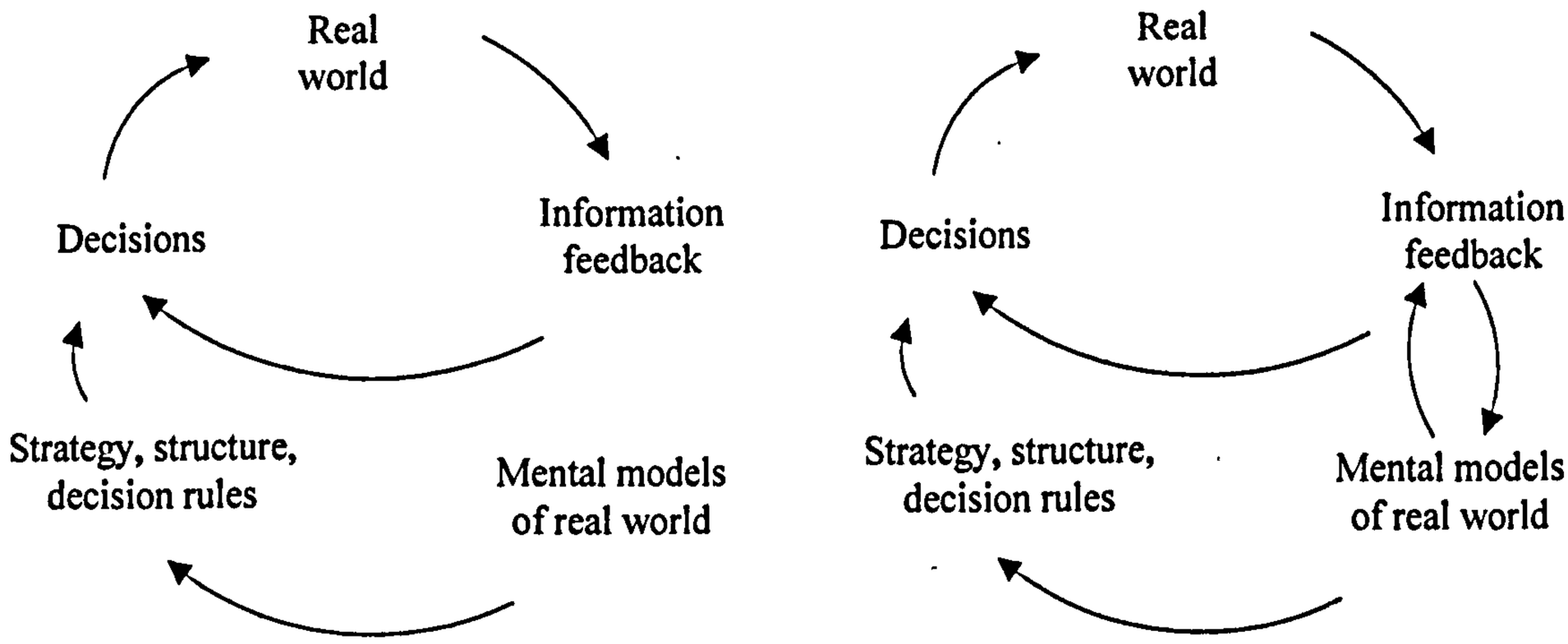


Figure 3.6 The OD Model for Change (Senior and Fleming, 2006)

Double loop learning or generative learning aims to challenge long-held assumptions and to create new ways of looking at the world, therefore, it not only alters the decisions made for the organization but also feeds back to the mental models of the real world (Senge, 1992; Sterman, 2000; Argyris, 1985; Paton and McCalman, 2000).

Senge's work (1992) on learning organizations is considered to have led to the development of the five disciplines aimed at enhancing an organization's creative capability: Personal mastery, mental models, building a shared vision, team learning, and systems thinking.



Single loop learning **Double loop learning**

Figure 3.7 Single and Double Loop Learning (Sterman, 2000)

3.3.5 Tools Used to Introduce Organizational Change in Construction Organizations

The organizational change management concept has strong links with human resource management, risk management, organizational learning, strategic management, information technology management and quality management concepts and overlaps with organizational development and organizational dynamics. Some organizational changes are known by their specific names according to the level they serve. Business process reengineering (BPR) and Total Quality Management (TQM) are examples of these changes. Although these changes are introduced at different levels, they require a well organized and planned change management implementation in the organization.

3.3.5.1 Introducing change through Business Process Reengineering (BPR)

As defined in reports by Latham (1994) and Egan (1998), the pressure on the construction sector to increase its productivity and improve quality is growing. Construction organizations are focused on the outcome and success of individual projects, with relatively little consideration of how to achieve at least the same, but preferably better, results repeatedly and consistently. To increase the quality of the end product and productivity, they should focus on the processes followed and the elements and the sub-elements constituting the processes. The aim of BPR

implementation is quick and substantial gains in organizational performance by starting from scratch in designing the core business process (Attaran, 2000).

It has been found that there is a lack of common and standardised terms and definitions for BPR, and other types of improvements related to it. This has reflected negatively in organizational perceptions of BPR concepts and practices (Al-Mashari et. al, 2001). Besides, BPR is criticised by many researchers because of its deficiencies in establishing proper change management at organizational level (Al-Mashari et. al, 2001; O'Connor, 1994; Ruessman et. al, 1994; Vakola and Rezgui, 2000a, Cao et. al, 2001). It is not possible to isolate process reengineering from the structural, cultural or political aspects of organizational change; and it has been suggested that either its usage should be limited to those situations where process dominates, or a holistic view is needed that helps to deal adequately with change situations where different types of organizational change occur (Cao et. al, 2001). Likewise, suggesting that BPR is weak in human and organizational issues and is not cost effective, a European ESPRIT-funded project, CONDOR project sought to address these deficiencies (Vakola and Rezgui, 2000a). The project also studied organizational learning and innovation aspects combined with BPR (Vakola and Rezgui, 2000b) as well as the selection, design and implementation of a new information system through a BPR approach (Vakola et. al, 2000).

There are several barriers to successful reengineering implementation: poor top management support and involvement, lack of flexibility, lack of effective organizational communication, lack of proper training, failure to cope with people resistance, failure to assign organization's best employees to reengineering effort, misunderstanding and misapplication of the concept, failure to test the process (Attaran, 2000). Although there have been some improvements in human and people issues, BPR fails to provide the organizational change management expectations since the results do not go beyond the process level.

3.3.5.2 Introducing change through maturity models

The maturity concept originated in the quality principles of Philip Crosby describing five evolutionary stages in adopting quality practices. Later on, this framework was modified for the software processes (Humphrey 1987, 1988) and was developed to

include the Capability Maturity Model (CMM) for software, which is the most popular maturity model in the literature. CMM describes five levels of increasing maturity for software process improvement. The maturity of the organization increases for each level and each maturity level provides a layer in the foundation for continuous process improvement as shown in Figure 3.8.

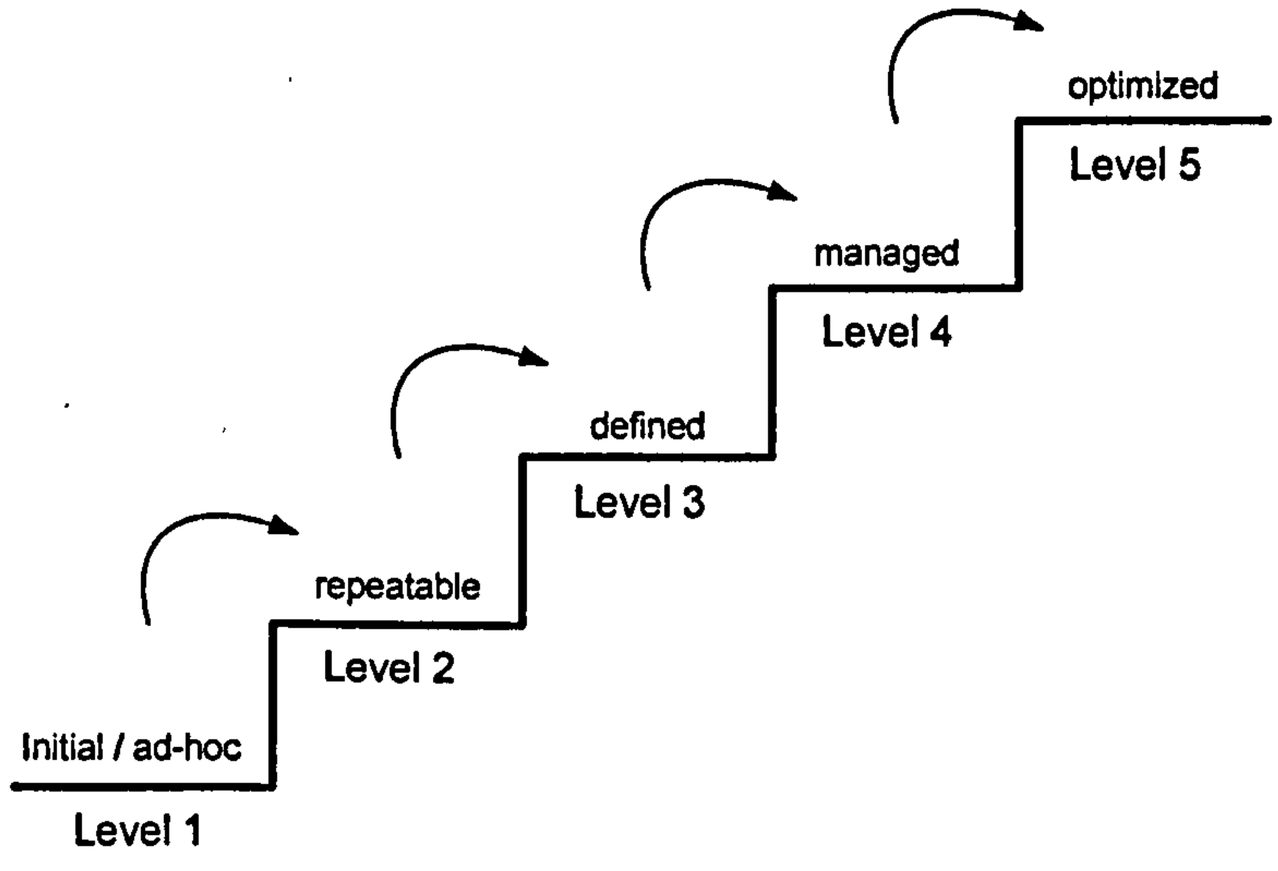


Figure 3.8 Maturity Levels in CMM

Each level comprises a set of goals that, when satisfied, stabilise an important component in the process, resulting in an increase in the process capability of the organization (Paulk, 1993). The five levels defined in CMM are briefly explained below (Humphrey 1987, 1988; Paulk, 1993):

Level 1- Initial/ Ad-hoc:

Project visibility and predictability are poor. There is an unstable environment for developing and maintaining products. Delays in the project time and cost overruns occur frequently. Successes depend on the individual efforts rather than the team/organization.

Level 2- Repeatable:

The organizations tend to meet their schedule commitments but cost is not as controllable as the schedule. The organization has some policies for managing projects and established a structure to implement these policies.

Level 3- Defined:

The organizations in this level have standard processes defined and allocated resources for developing and sustaining and improving these processes. The organizations can be said to have stable and repeatable cost, schedule and quality performances. Some organization-wide training programs are implemented.

Level 4- Managed:

The organizations generally meet or exceed the defined quality goals by operating within predictable quantitative performance levels. Process measurement systems are also established at this level.

Level 5- Optimised/Optimising:

This is the optimum maturity level for organizations. The improvement goals in this stage are established. The organizations' objective turns out to be "continuous process improvement" in this level. In order to achieve this, regular defect prevention methods are carried out and weaknesses of the processes are determined and eliminated continuously.

The implementation of the maturity concept in construction is investigated in some projects. Research carried out at the University of Salford categorises the process capability and IT capability of construction companies and the construction industry as a whole and offers a hypothetical mechanism to explain how these capabilities may mature, alone or in combination (Hinks et. al, 1997). Standardised Process Improvement for Construction Enterprises (SPICE) is another research project undertaken at the University of Salford which was concerned with the implementation of the maturity concept in construction. It set up a framework based on the principles of the CMM model for software and focused on upgrading the construction companies from level 1 to level 2 (Sarshar et.al, 2000; Finnemore et. al, 2000). All the case studies in which SPICE was implemented had results supporting the concept. However, the maturity concept fails to provide the organizational change management expectations since most construction companies are still at the first level.

3.3.5.3 Introducing change through TQM

Total quality (TQ) is defined as meeting customer requirements where the customers are both internal and external customers of the organization and it comprises a change invoked through four key components (Rye, 1996):

1. Systems: The systems refer to the offline and online quality concepts and after the change has taken place the quality of the operations will be supported by quality Control, quality assurance and fool proofing.
2. Processes: TQ regards every activity of an organization as a part of a process. Therefore, it encourages the constant review of processes through continuous improvement, waste elimination and process chain reengineering.
3. People: TQ companies value their employees as individuals and also for their contribution to the growth of the company.
4. Management: The management concept in TQM is related to the vision and mission, critical success factors, organization for quality, championing, and empowerment.

When organizations implement TQM, they are engaged in, inter alia, continuously improving operations, meeting customer requirements, reducing rework, thinking long range, increasing employee involvement, redesigning processes, conducting competitive benchmarking, measuring results constantly, and fostering closer relationships with suppliers (Singh and Smith, 2004).

Irani et. al (2004) discuss the concept of corporate culture, and place this social construct within the arena of TQM and conclude that the core concept of TQM, customer focus, linked with a continuous improvement plan that is supported by innovation can build a strong culture, which can positively improve an organization's competitiveness and performance.

The main aim in TQM is to improve the organization without making major changes; therefore, TQM has a high deficiency in achieving radical results. Most of the time it fails in reaching solutions beyond organizing documentation and information transfer. TQM is not considered a very efficient organizational change management tool.

3.3.6 Leading the Change

Leading the change is a very important dimension in organizational change management and therefore the persons in charge of change should be carefully chosen. As explained in Section 3.4.4.2, the person leading the change can be called a change agent, problem owner, problem facilitator, master of change or change champion (Cummings and Worley, 2005; Warner Burke, 1994; Paton and McCalman, 2000).

Most changes are introduced by the analysis-think-change approach, which seems like the best scientific approach. Firstly, data collection and analysis are carried out on problems, solutions or progress. Secondly, the analysis results are investigated and a selection is made from the ideas consistent with the needed change. Finally, the chosen ideas are implemented. However, scientific approaches might not always be the best way to manage changes involving people. Kotter (2002) lists three limitations of an approach starting with an analysis stage:

1. In most cases big analysis reports are not necessary to understand that something is not working.
2. Analytical tools work best when parameters are known, assumptions are minimal and the future is not fuzzy.
3. Good analysis changes the thoughts of people but does not motivate them in a big way.

Kotter (2002) suggests that in order to get people involved in the changes or to get people to follow the changes introduced, the see-feel-change approach works better than the analysis-think-change approach. The see-feel-change approach is targeted at helping people see by visualising the problems or solutions through the use of eye-catching, compelling and dramatic situations (Kotter, 2002). These visualisations provide useful ideas which will hit the emotions and these emotionally charged ideas change behaviour or reinforce changed behaviour (Kotter, 2002).

Eight stages are proposed by Kotter (2002) in order to achieve a large scale change using this see-feel-change approach. Table 3.7 explains these eight stages and the

new behaviours created by the actions at each stage.

Table 3.7 Kotter's Eight Stages to Achieve a Large Scale Change

Step	Action	New Behaviour
1	Increase urgency	People start telling each other, "Let's go, we need to change things!".
2	Build the guiding team	A group powerful enough to guide a big change is formed and they start to work together well.
3	Get the vision right	The guiding team develops the right vision and strategy for the change effort.
4	Communicate for buy-in	People begin to buy into the change and this shows in their behaviour.
5	Empower action	More people feel able to act, and do act, on the vision.
6	Create short term wins	Momentum builds as people try to fulfil the vision, while fewer and fewer resist change.
7	Don't let up	People make wave after wave of changes until the vision is fulfilled.
8	Make change stick	New and winning behaviour continues despite the pull of tradition, turnover of change leaders, etc.

Another framework for managing organizational changes is proposed by Jick and Peiperl (2003). This framework consists of ten stages which are called as "The ten commandments of implementing successful organizational change". These ten stages are:

1. Analyze the organization and its need for change;
2. Create a shared vision and common direction;
3. Separate from the past;
4. Create a sense of urgency;
5. Support a strong leader role;
6. Line up political sponsorship;
7. Craft an implementation plan;

8. Develop enabling structures;
9. Communicate, involve people, and be honest;
10. Reinforce and institutionalize change.

The frameworks by Jick and Peiperl and by Kotter show resemblances in some of the stages. However, there are some differences. Jick and Peiperl's ten commandments can be considered as a combination of both the see-feel-change and the analysis-think-change approaches whereas Kotter follows only the see-feel-change approach in his eight stages. The ten commandments focus on defining the need for change and creating a vision before creating the sense of urgency unlike Kotter's approach. Jick and Peiperl focus more on the role of a strong leader whereas Kotter stresses on the importance of a guiding team in charge of the change implementation rather than one person having a leader role. In this thesis, Kotter's approach of having a guiding team in charge of the change is followed.

3.3.7 Resistance to Change

"Organizations do not change-People do. Change happens person by person, and you cannot change people: They change themselves.", Quirke (1996)

Organizations will not be able to implement the change successfully unless it is accepted by the employees. Resistance from the employees is inevitable. In order to manage this resistance, the leaders should appreciate the different ideas or priorities of the employees, understand its causes and try to create a resolution (O'Connor, 1993). Based on this idea the following sections discuss how individuals react to change, the causes of resistance, different forms of resistance and how they can be overcome.

3.3.7.1 Reactions of individuals to change

There have been many attempts to model the change reactions of people and the way they cope with change. Carnall (1990) defines five stages of change implementation: denial, defence, discarding, adaptation and internalization. How people's performance and self esteem vary with time during these five stages are shown in Figure 3.9.

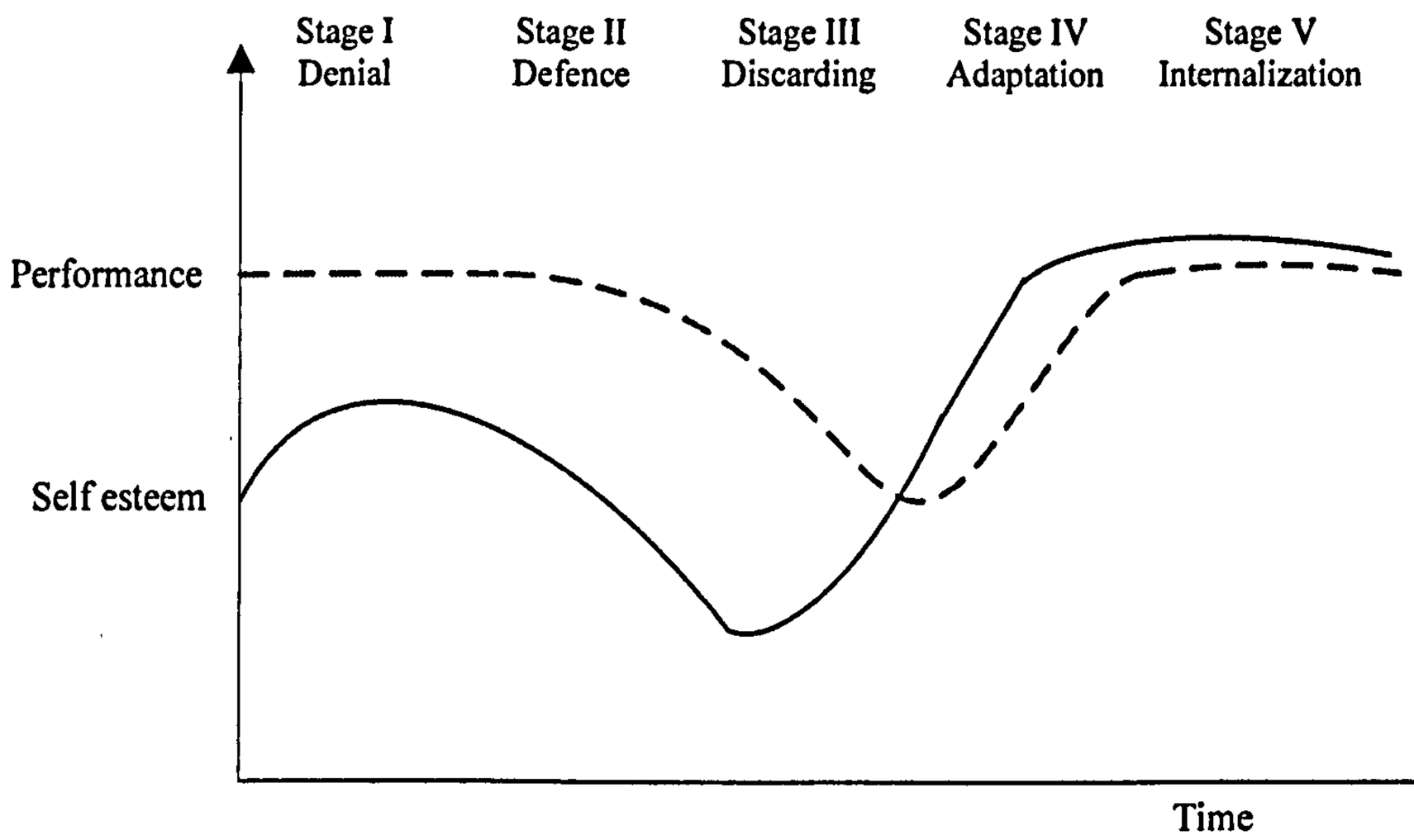


Figure 3.9 The Coping Cycle (Carnall, 1990)

Conner (1993) suggests that people's response to change varies according to the initial perception of change, and proposes two different response-time relationships: negative response to change and positive response to change.

In the negatively perceived change shown in Figure 3.10, the initial reaction is a shock and there is an immobilization stage due to the removal of the stable environment. This stage is followed by a denial stage, where the change related information is often rejected or ignored with the hope that change will fade away if it is ignored. The next stage is the anger stage. The targets for anger are most of the time the people at the closest distance. When it is realised that it is no longer possible to avoid confrontation with reality, people begin negotiating in order to avoid the negative impact of change. This bargaining stage is followed by a depression stage since the full weight of the negative change is finally acknowledged. People get over this depression stage by regaining a sense of control through acknowledging the new limitations and exploring ways to redefine goals. This stage is called the testing stage and is followed by the acceptance stage where people respond to the change realistically and accept the change even if they do not like it.

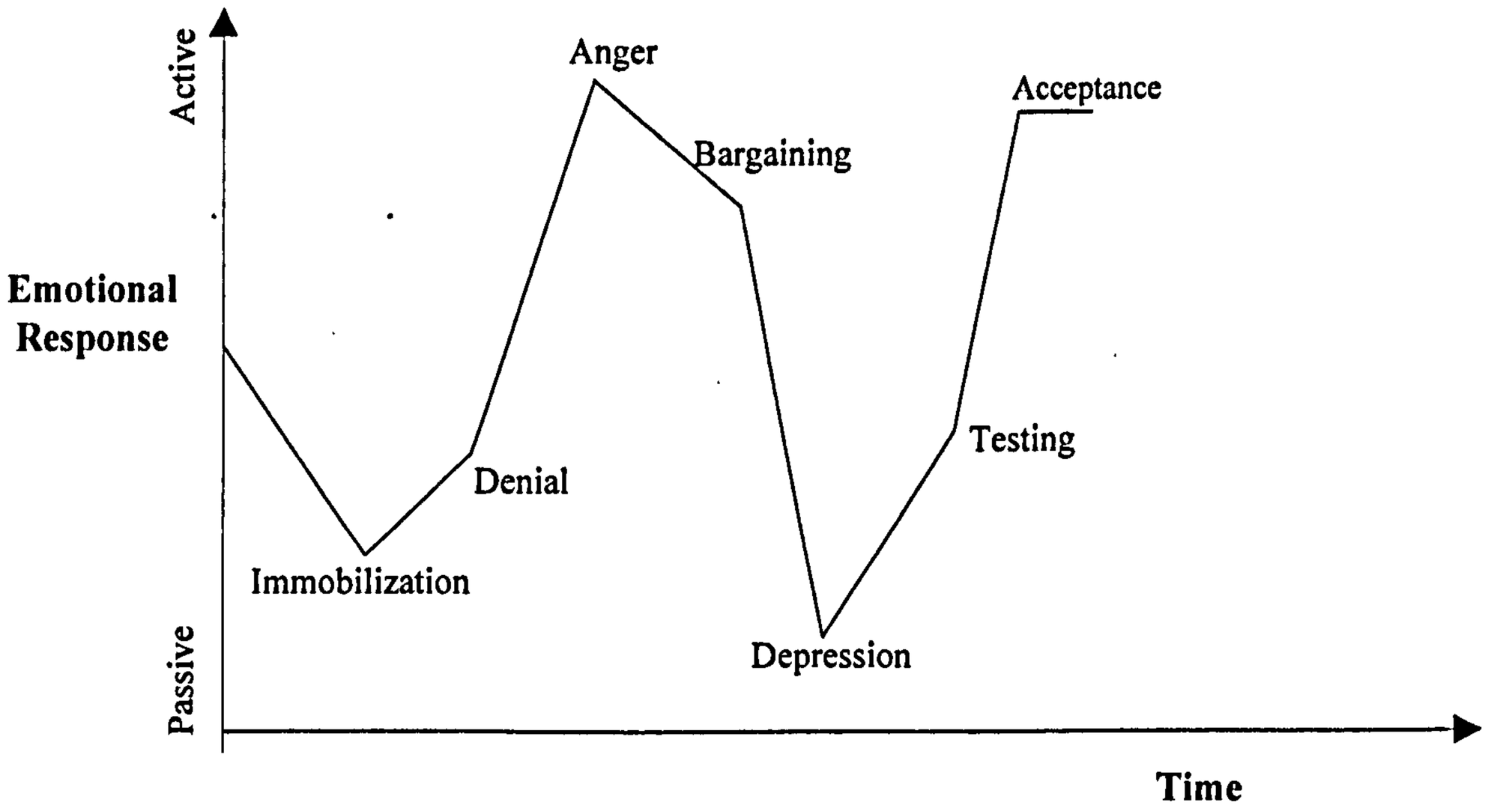


Figure 3.10 Negative Response to Change (Conner, 1993)

When the initial reaction to change is positive, the pessimistic approaches to change will vary with time as shown in Figure 3.11. When the change is first met, it is welcomed by an uninformed optimism, and the pessimism scale will be very low. As time passes, the individuals will start discovering some of the real prices for the initial decision. Although the overall change is still accepted as a good decision, the unexpected effects accompanying the change result in an informed pessimism phase. However, each individual has a tolerance limit to pessimism. If the pessimism level exceeds the tolerance limits, then it could be decided to withdraw from the change decision, which is shown as 'checking out' in the figure. If the noticed problems are investigated and start to be solved, then checking out will not occur and the pessimism level will start going down through a hopeful realism stage. As more and more problems are solved, individuals proceed from the hopeful realism phase to informed optimism phase. The pessimism level continues to go down and in the completion phase, the pessimism level is very low.

Jick and Peiperl (2003) propose two frameworks to explain individuals' reactions to change. The first framework involves a risk taking approach and has similarities with Conner's (1993) negative response to change approach. It is suggested that individuals pass through four stages during a change implementation: shock, defensive retreat, acknowledgement, adaptation and change. In the shock phase, the

individuals feel threatened by the change and become immobilized in an attempt for no risk taking. This phase is followed by an anger phase and they try to hold on to the way they were used to. Risking is still considered unsafe. Eventually, it is acknowledged that things are changing and they start letting things go. Although the mourning for the lost accustomed approaches still continues, the pros and cons of the new situation are explored and the risk taking potential increases. Each taken risk that succeeds increases the confidence. The final phase is the adaptation and change phase, where the individuals now feel comfortable with the change and have an energy for risk taking.

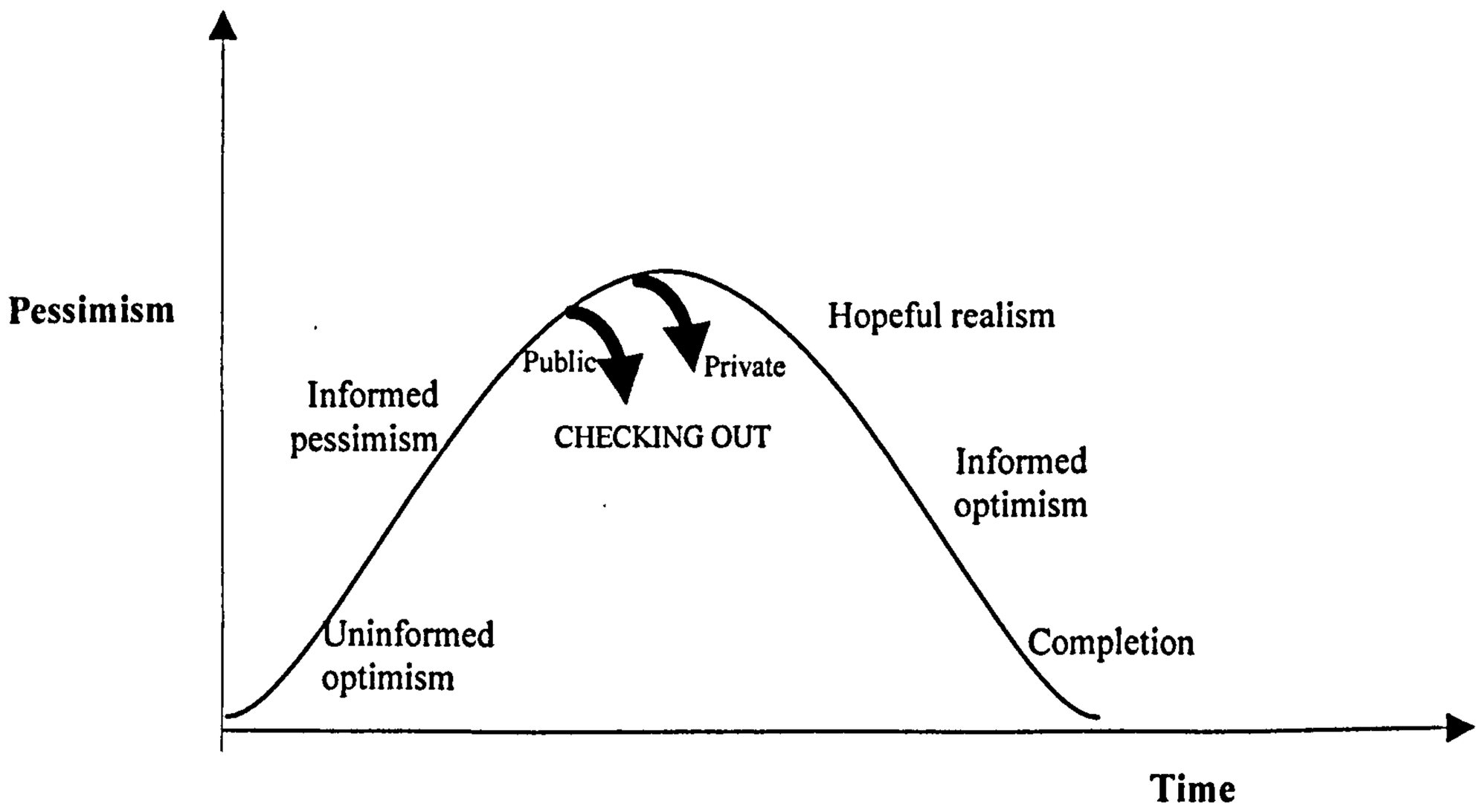


Figure 3.11 Positive Response to Change (Conner, 1993)

The second framework by Jick and Peiperl (2003) tries to explain how people respond and cope with change based on three transition stages:

1. Ending phase - letting go of the previous situation;
2. Neutral zone -completing endings and building energy for beginnings ;
3. New beginnings - new possibilities or alignment with a vision.

Understanding the stages the individuals are going through during a change is one of the first steps of dealing with resistance. The second one is understanding the reasons behind the employee resistance.

3.3.7.2 Reasons for employee resistance

Resistance is a result of differences, whether on ideas, motives, plans or priorities (O'Connor, 1993). Sources of resistance to change have been studied by many researchers and the reasons proposed by these sources are found to be related to five areas: need for change, risk, goals and targets, leaders, and threats to status. The reasons in each area are shown in Table 3.8.

Table 3.8 Reasons for Employee Resistance (O'Connor, 1993; Quirke, 1996; Ford et. al, 2002; Proctor and Doukakis, 2003)

Source of reason	**Reasons for change**
Need for change	A lack of belief or understanding of the need for change
	Lack of perceived benefits
	Different descriptions of the need for change
	A misunderstanding of the change
Risk	Fear of the unknown
	Uncertainty regarding the change outcomes
	Fear of failure
Goals / targets	No agreement about goals for change
	Lack of belief that the goal is attainable
	A belief that the proposed change is not aligned with company's core values
	A belief that change is not in the best interests of the organization
	A lack of, or a different sense of, the context or environment
Leaders	A lack of trust in the people introducing or managing the change
	A lack of belief that leadership is serious about making changes
	A lack of belief that the leadership is capable of making change happen
Fears for status quo	A perception that the change is unfairly selective
	Threats to status
	Internal politics (such as elitism and interdepartmental rivalry)
	Lack of information/knowledge/skill

3.3.7.3 Different behaviours during resistance

Since each individual has different characteristics, the way they resist change will also be different. O'Connor (1993) defines two types of resistance behaviours based on whether the employees express their feelings openly or not. If the lack of support for change is concealed or undefined, this behaviour is termed covert. If the people who resist change express their views and why they disagree with the change openly, then this behaviour is termed overt. The second categorization for the resistance behaviours is done based on whether the individuals are conscious or unconscious of their actions (O'Connor, 1993). O'Connor also defines four different behaviour types based on different combinations of overt/covert reactions and conscious/unconscious reactions: survivors, saboteurs, zombies, and protesters. These are explained in Figure 3.12.

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UNCONSCIOUS	**SURVIVOR** ▪ do not realize they undermine the change ▪ do not know they fail to meet targets ▪ do not understand the implications of their behaviour ▪ do the job in the way they know how to do ▪ are difficult to detect due to the higher profile projects' masking them ▪ are as surprised and disappointed as anyone in the management, When their lack of adaptation to change is discovered.	**SABOTEUR** ▪ undermine change while pretending to support it ▪ believe not doing anything other than verbal support will make the change initiative go away / disappear. ▪ intend to sabotage the plan for their own benefit ▪ are very common in highly competitive environments
	ZOMBIE ▪ are extreme cases of survivor ▪ verbally agree to do whatever is asked of them, they have neither the will nor the ability to create change ▪ gradually and openly they revert back to previous ▪ simply avoid the change until they are reminded again to alter their behaviour	**PROTESTER** ▪ believe that their refusal to change is a positive contribution to the company. ▪ never give up pointing out the failings of change. ▪ are the easiest and the most interesting kind of resisters to manage since it is possible to discuss their position clearly and rationally.

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Figure 3.12 Categories of Behaviour: a Matrix (adapted from O'Connor, 1993)

The way to deal with the employee resistance will change according to the type of the resistance behaviour. Since they are conscious of what they are doing, starting an open debate to find out the reasons for resistance and overcoming the obstacles to change will be helpful when dealing with saboteurs and protesters whereas when dealing with survivors and zombies, managers should choose to help the employees become aware of what they are doing and why (O'Connor, 1993). Often, the resistors are also as aware of a need for change as others but they might have their own ideas on how it should be done (Smale, 1996). Whilst implementing organizational change, the resistance can be managed by following five key principles (Conner, 1993):

1. Understand the basic mechanisms of human resistance;
2. View resistance as a natural and inevitable reaction to the disruption of expectations;
3. Interpret resistance as a deficiency of either ability or willingness;
4. Encourage and participate in overt expressions of resistance;
5. Understand that the resistance to positive change is just as common as resistance to negatively perceived change and that both reactions follow their own respective sequence of events, which can be anticipated and managed.

The people leading the change should always remember that the resistance of the employees is towards the change not to the person implementing the change and should approach the resistance from a humorous perspective rather than resisting the resistance (O'Connor, 1993). Reacting forcefully to change will create two poles where nobody at any pole will like to give way to the other. Communication of change plays a very important role in managing employee resistance.

3.3.8 Communicating Change

"Change does not happen because a chief executive or other top management figure says it should; change happens because the majority of the people involved willingly or unwillingly agree to change their behaviour." (Conner, 1993)

According to O'Connor (1993), too often plans are made by one company group and then implemented by a different group, traditionally at a lower status than the first group, with minimum communication between the two. The separation of these two activities generally results in communication breakdown, end-goal misunderstanding and failed aspects of implementation (O'Connor, 1993). Therefore, communication of change and its timing play a vital role in the success of organizational change management since it convinces and encourages the employees to change themselves.

Balogun and Hope Hailey (2004) stress the early communication of change with the employees based on four arguments:

1. Employees prefer to learn about change from management rather than as a rumour;
2. Early communications allow employees time to understand and adjust;
3. Employees prefer honest and even incomplete announcements to cover ups; and
4. Employees learn about changes despite policies of silence.

Paton and McCalman (2000) propose five step-guidelines to be followed for communicating change:

1. Customize the message;
2. Set the appropriate tone;
3. Build in feedback;
4. Set the example; and
5. Ensure penetration.

The nature of information/message, appropriateness of communication medium and the likely consequences if inappropriate medium is used should be considered before sending a message to the employees (Weiss, 2001). O'Connor (1993) advises three different methods to deliver messages:

1. A general announcement on a noticeboard / loudspeaker / in a public meeting;

2. An individual memo for each person affected by the change;

3. Person-to-person communication for important changes (1-to-1 interviews).

Presently, the medium for the first two methods is most likely to be through electronic communication. Whichever medium or method is chosen, the selected method should suit the company/group culture or work habits and it should enable the capture of feedback as well as information transmission. For example, newsletters, brochures and videos are very common tools used to inform the employees of the changes. However, they cannot be considered as effective change communication tools since change communication is not just a one-way information transfer, it is mutual information sharing providing an opportunity for understanding, feedback and debate (Quirke, 1996).

3.4 Summary

This chapter has reviewed change and change management concepts in construction. It is found that change management occurs at the project level and at the organizational level. The classifications of the changes and the nature of changes were reviewed and the enablers, barriers for managing the changes at each level were discussed together with the theories and tools used in previous research.

There are many previous studies that have focused on project change management in construction with the aim of increasing the benefits and minimising the costs. On the other hand, although there has been a lot of research on organizational change management, very little of this is focused on the construction industry and it does not go beyond implementations of TQM, BPR and maturity concepts with a slight mention of organizational issues. There has been very little research in construction on organizational change management due to the implementation of information technologies or collaboration environments.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

The Concise Oxford Dictionary (1990) defines research as "*the systematic investigation into and study of materials and sources etc. in order to establish facts and reach new conclusions*". Research is considered as a 'voyage of discovery', whether anything is discovered or not (Fellows and Liu, 2003). This chapter describes the research methodology for this study. It first presents the concepts related to research design in general and then explains the research methodology adopted for each stage of this research.

4.2 Research Design

This research design dimensions are presented using three models developed by Crotty (1998), Kagioglou et. al (2000) and Saunders et. al (2003). According to Crotty (1998), research should be designed considering the answers to four questions:

1. What epistemology informs the research?
2. What theoretical perspective lies behind the methodology in question?
3. What methodology governs our choice and use of methods
4. What methods do we propose to use?

These research design elements defined by Crotty (1998) are explained in Table 4.1 where some examples are also provided.

Table 4.1 Research Design Elements-as defined by Crotty (1998)

Research Design Dimensions	**Explanation**	**Examples**
Epistemology	theory of knowledge embedded in the theoretical perspective	objectivitisim, subjectivitism, constructionism
Theoretical perspective	philosophical stance	positivitism and postpositivism, interpretivism, critical inquiry, feminism, postmodernism
Methodology	strategy or plan of action that links methods to outcomes	experimental research, survey research, ethnography, phenomenological research, grounded theory, action research, discourse analysis
Method	techniques and procedures	questionnaire, interview, focus group, case study, statistical analysis, cognitive mapping

Kagioglou et. al (2000) had a similar research design approach and proposed a nested approach to research modelling shown in Figure 4.1. The outer ring represents the research philosophy which guides the research approaches and research techniques illustrated in the inner circles. Research approaches refer to the methods for theory generation and testing such as case study, action research, survey, and experiment whereas research techniques refer to the data collection techniques such as interview, questionnaire, focus group, and observation.

The research design model proposed by Saunders et. al (2003) introduced three additional layers to the nested research model. This model was referred to as the research onion since the six layers of the model resembled to rings of an onion. The research onion is illustrated in Figure 4.2.

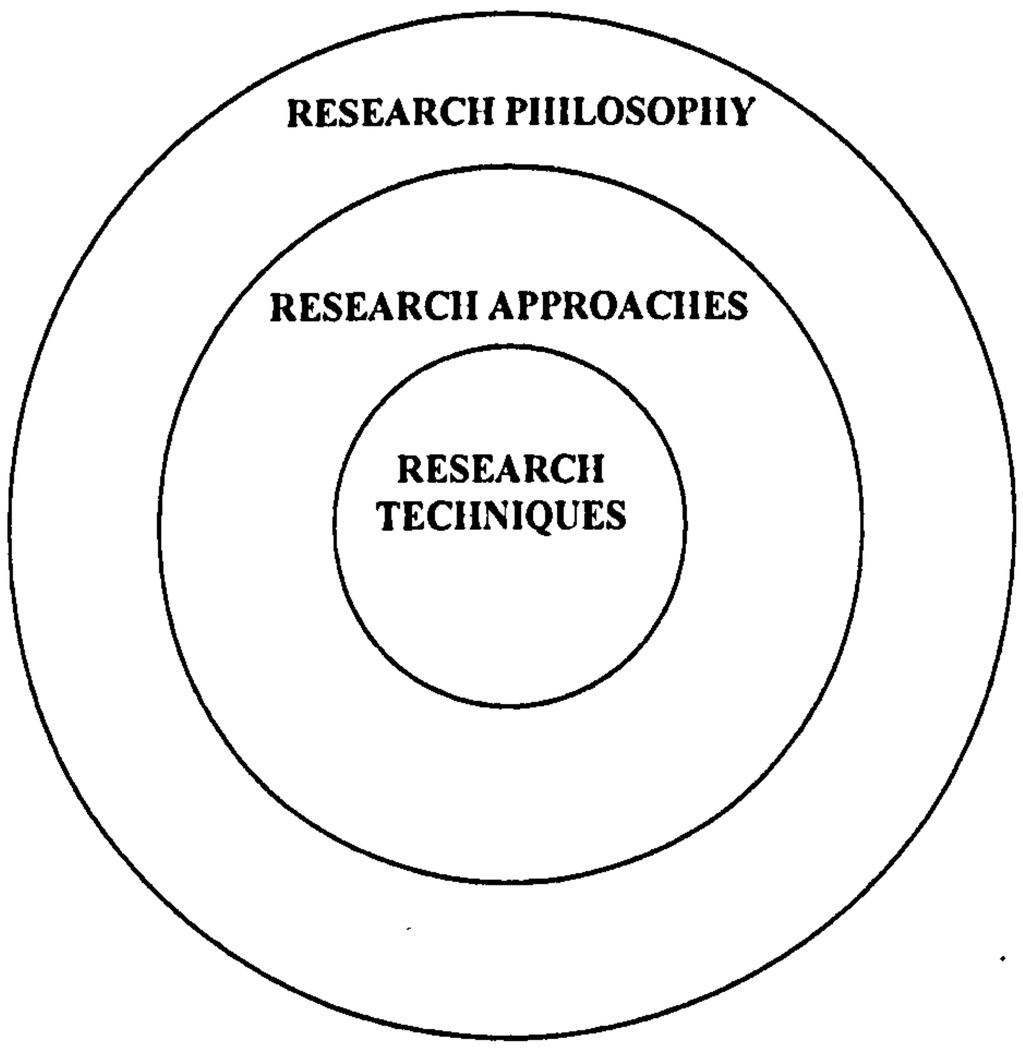

Figure 4.1 Nested Research Model (Kagioglou et. al, 2000)

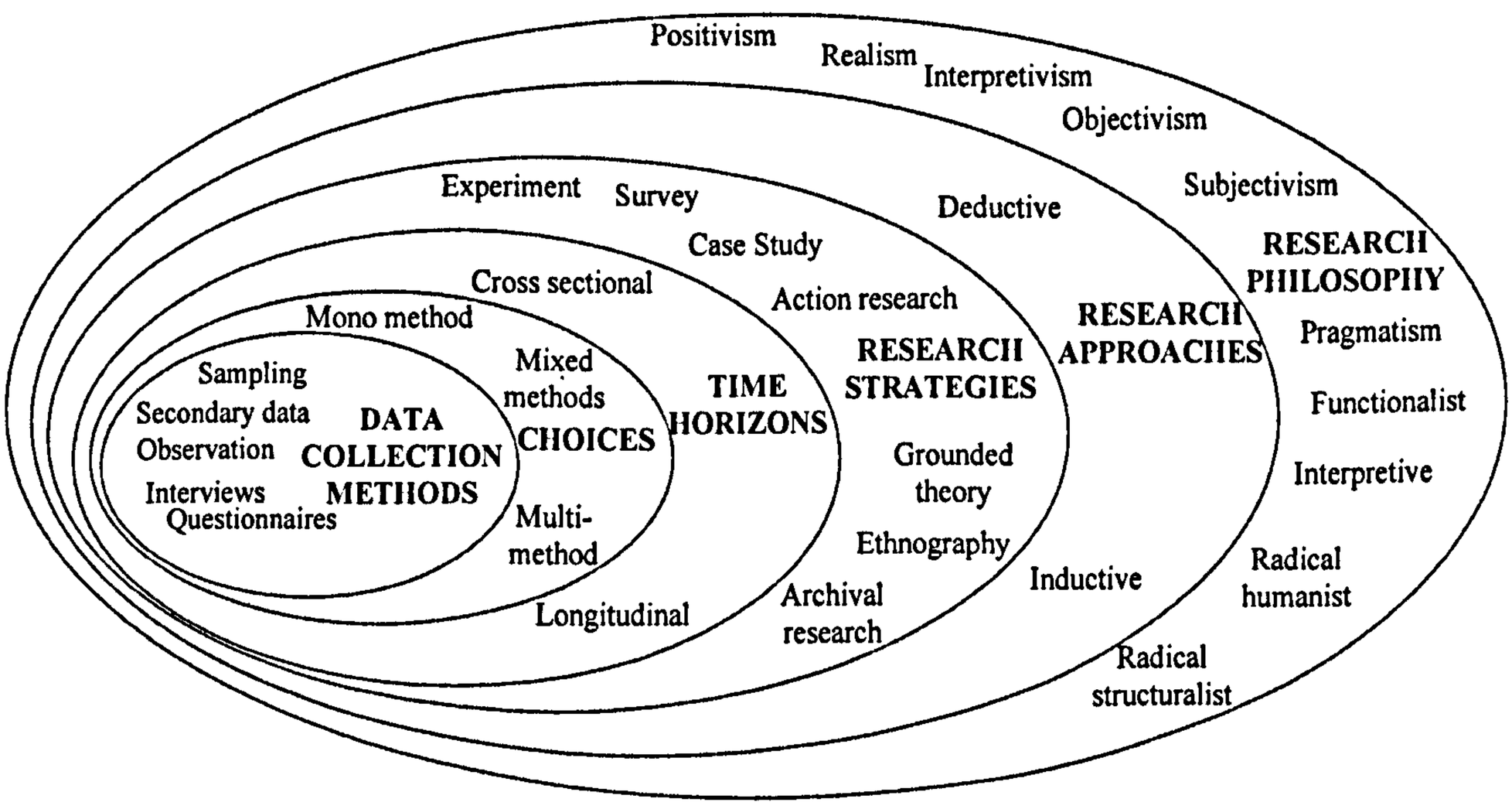

Figure 4.2 The Research Onion (Saunders et. al, 2003)

When all of these three models are investigated, the similarities and differences are easily noticed. Although there is a "Research Approaches" layer in both of the nested research model and the research onion, they refer to different concepts. The research approaches in the nested research model correspond to the research strategies in the research onion. Table 4.2 shows how the research design elements in the models proposed by Crotty (1998), Kagioglou et. al (2000) and Saunders et. al (2003) overlap.

Table 4.2 The Comparison of Elements in the Three Research Design Models

Ring onion (Saunders et. al, 2003)	**Nested research model (Kagioglou et. al, 2000)**	**Research Design Elements (Crotty, 1998)**
Research Philosophy	Research philosophy	Epistemology Theoretical perspective
Research Approaches		
Research Strategies	Research Approaches	Methodology
Choices		
Time horizons		
Data collection methods	Research Techniques	Method

The six layers of the research onion model will be used as an outline for the explanation of the research methodology design.

4.2.1 Research Philosophy

Research Philosophy refers to the development of knowledge and the nature of that knowledge (Saunders et. al, 2003). There are three major ways of thinking about research philosophy: epistemology, ontology, and axiology.

Researchers are found to relate research philosophies differently. For example, Saunders et. al (2003) relate ontology with objectivism, subjectivism and pragmatism whereas Sexton (2003) relates ontology mainly with realism and idealism, and maps objectivism and subjectivism in relation to the ontology and epistemology as shown in Figure 4.3. The way Sexton (2003) approaches the research philosophy is used as a guide for this chapter whilst introducing the ways of thinking about research philosophy. As seen from the figure, epistemology and ontology are interpreted as two axes. The two extreme ends of the epistemology axis are shown as positivism and interpretivism whereas the two extreme ends of ontology are realism and idealism. The research approaches following the objectivism are located at the intersection of realism and positivism whereas subjectivist approaches are at the other corner, where idealism and interpretivism intersect.

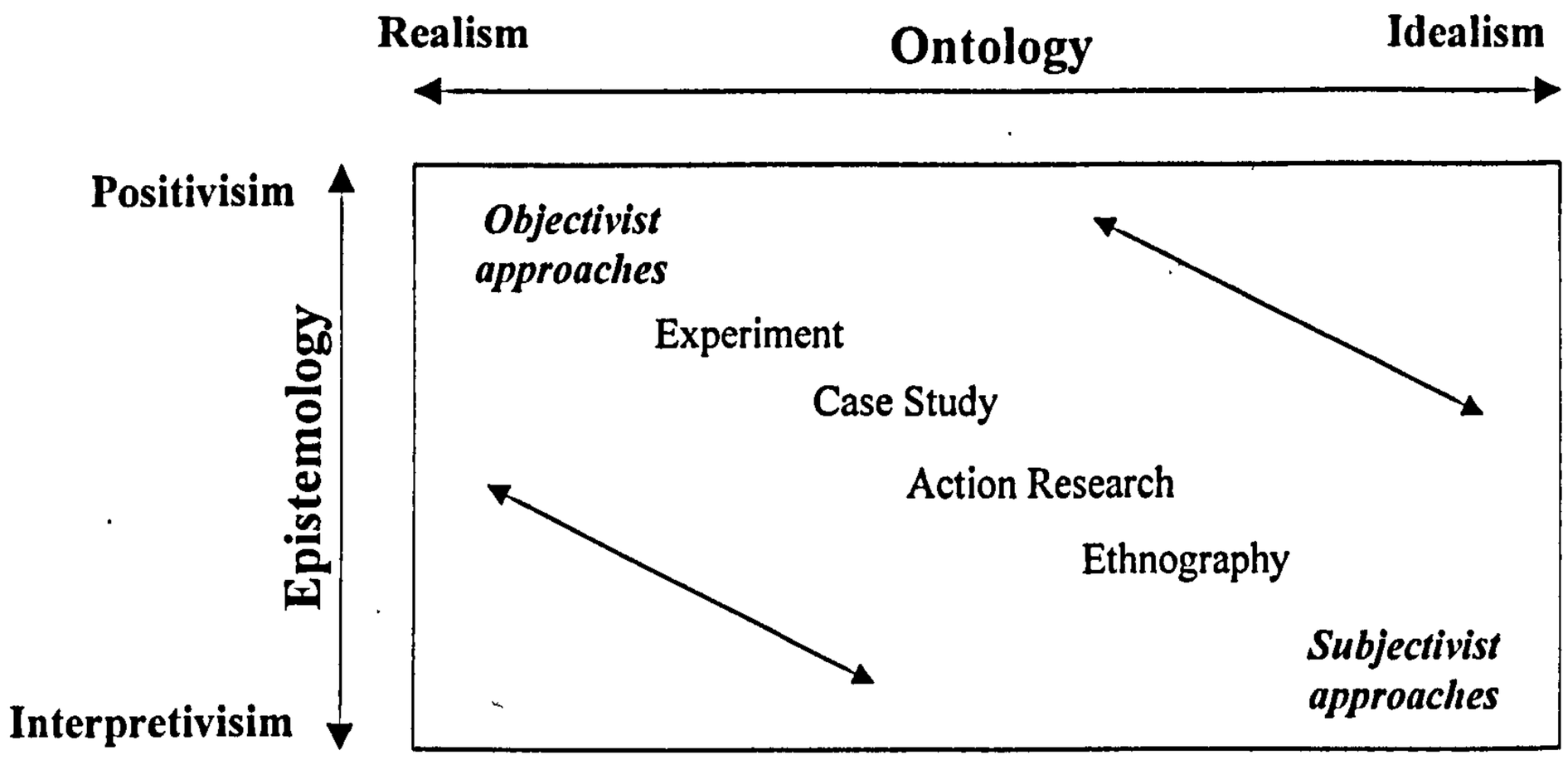

Figure 4.3 Dimensions of Research Philosophy and Some Located Research Strategies (Sexton, 2003)

Axiology is a branch of philosophy studying judgements about value, which are more related to the fields of aesthetics, ethics and justice (Saunders et. al, 2003; Sexton, 2003).

Epistemology is concerned with what constitutes acceptable knowledge in a field of study (Saunders et. al, 2003). It deals with the nature, possibility, and the general scope of knowledge. There are two most distinguished research philosophies related with the epistemology: Positivism and interpretivism (phenomonology). Positivism refers to a search for general laws and cause-effect relationships by rational means whereas interpretivism refers to a search for explanations of human action by understanding the way in which the world is understood by individuals (Sexton, 2003). Only the non-metaphysical facts and observable phenomena are recognised by positivism and there is a strong relationship between positivism and quantitative research methods (Fellows and Liu, 2003). Table 4.3 shows the comparison of positivism and interpretivism carried out by Blumberg et. al (2005).

The third major way of thinking, *ontology*, is concerned with the nature of reality and the assumptions made about the nature of reality (Saunders et. al, 2003; Sexton, 2003). There are two poles in ontology: realism and idealism. *Realism* refers to a commonly experienced external reality with predetermined nature and structure whereas *idealism* refers to an unknowable reality perceived in different ways by individuals (Sexton, 2003).

Table 4.3 The Comparison of Positivism and Interpretivism (Blumberg et. al, 2005)

	Positivism	**Interpretivism**
Basic Principles		
View of the world	The world is external and objective	The world is socially constructed and subjective
Involvement of researcher	Researcher is independent	Researcher is part of what is observed and sometimes even actively collaborates
Researcher's influence	Research is value-free	Research is driven by human interests
Assumptions		
What is observed?	Objective, often quantitative, facts	Subjective interpretations of meanings
How is knowledge developed?	Reducing phenomena to simple elements representing general laws	Taking a broad and total view of phenomena to detect explanations beyond the current knowledge

4.2.2 Research Approaches

Research approaches form the second ring of the research onion. There are two research approaches according to the place where theory is introduced: deductive approach and inductive approach. Theory is defined as "*a formulation regarding the cause and effect relationships between two or more variables, which may or may not have been tested*" (Gill and Johnson, 2002). In the *deductive approach*, firstly the theory and the hypothesis are developed and then the research strategy is designed to test the hypothesis whereas in the *inductive approach* theory will be developed as a result of the data analysis (Saunders et. al, 2003). The major differences between deductive and inductive approaches to research are given in Table 4.4.

Table 4.4 The Major Differences between Deductive and Inductive Research Approaches (Saunders et. al, 2003)

Deduction emphasizes	**Induction emphasizes**
• Scientific principles • Moving from theory to data • The need to explain causal relationships between variables • The collection of quantitative data • The application of controls to ensure validity of data • The operationalization of concepts to ensure clarity of definition • A highly structured approach • Researcher independence of what is being researched • The necessity to select samples of sufficient size in order to generalise conclusions	• Gaining an understanding of the meanings humans attach to events • A close understanding of the research context • The collection of qualitative data • A more flexible structure to permit changes of research emphasis as the research progresses • A realisation that the researcher is part of the research process • Less concern with the need to generalise

Deduction is generally criticised by followers of the inductive approach because of the tendency for a rigid methodology that does not allow alternative explanations of what is going on (Saunders et. al, 2003). In inductive approaches, certain phenomena are observed and some conclusions are derived which try to explain what is going on (Sekaran, 2003). Each approach has its advantages and disadvantages, therefore, it is not always clear which approach should be followed. As a rule of thumb, Creswell (2003) suggests that if there is a rich literature available on a research topic and if it is possible to define a theoretical framework, that topic is more likely to be approached with a deductive approach.

Most researchers choose to classify the research approaches as qualitative and quantitative approaches rather than inductive and deductive, and mention induction and deduction while focusing on the role of theories in research methods or link these concepts with the research philosophy (Creswell, 2003; Fellows and Liu, 2003; Gill and Johnson, 2002; Blumberg et. al, 2005). This classification is made according to the research methods adopted. *Quantitative research* aims at gathering factual data and studying the relationships between facts and how these facts and relationships fit

with the theories and previous research findings whereas *qualitative research* aims at gaining an understanding and collecting data which will contribute to the emergence of new theories (Fellows and Liu, 2003). Although both types are concerned with causal explanations to a degree, their perspectives are different. Maxwell (1996) exemplifies the approaches of qualitative and quantitative researchers to the causal relation between *x* and *y* as follows: Quantitative researchers are interested in "*whether and to what extent variance in x causes variance in y*". Qualitative researchers, on the other hand, tend to ask "*how x plays a role in causing y, what the process is that connects x and y*".

If both qualitative and quantitative methods are used in a research, then that approach is referred as *mixed approach* which is also called *triangulated approach.*

4.2.3 Research Strategies

This is the third ring of the research onion where the strategy for research is chosen according to the characteristics of the problem. The most commonly used research strategies are explained in the sections below according to their relationship to the quantitative, qualitative or mixed research approaches:

4.2.3.1 Research strategies related to quantitative approaches

The two most commonly used quantitative research strategies are experiments and surveys.

a) Experiments

Experimental research is usually carried out in laboratories where there is full control on the variables and it aims to test the relationships between identified variables, ideally holding all variables constant and changing only one variable to examine the effects on the dependent variable (Fellows and Liu, 2003). The experiment is considered a trial since the answer is not known beforehand, and also an observation since the result is carefully recorded (Melville and Goddard, 1996). Experiments can also be carried out in the natural environment in which work goes on as usual, but treatments are given to one or more groups (Sekaran, 2003). Compared to the other techniques, experiments are generally easier to replicate, less expensive and less time

consuming (Neuman, 2005; Blumberg et. al, 2005).

b) Surveys

Surveys operate on statistical sampling, which is choosing a representative sample from a population (Fellows and Liu, 2003). The data collection is done using questionnaires or interviews with an intent to generalize from the sample to a population (Babbie, 1995). The interviews can be face-to-face or telephone interviews. The questionnaire is anonymous and helps to avoid interviewer bias, however, the researcher does not have any control on the conditions under which the questionnaire is completed (Neuman, 2005). In case of face-to-face interviews, the topics can be explored to a great depth, there is a high degree of interviewer control and maximum interviewer flexibility for unique situations (Blumberg et. al, 2005). Telephone interviewing has become popular due to the low cost of this method compared to face-to-face interviews. However, both interview types are subject to interviewer bias (Blumberg et. al, 2005).

4.2.3.2 Research strategies related to qualitative approaches

a) Ethnographies

In ethnographic research, the researcher participates overtly or covertly in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions, collecting whatever data are available to enlighten the research issues focussed on (Flick, 2006). The characteristics of ethnographic research, defined by Atkinson and Hammersley (1998), are given below:

- There is a strong emphasis on exploring the nature of a particular social phenomenon, rather than setting out to test hypothesis about them;
- There is a tendency to work primarily with unstructured data since the data are not coded at the point of data collection;
- Only one case or a small number of cases are investigated in detail;
- When data are analysed, it involves explicit interpretation of the meanings and functions of human actions. Therefore, the analysis results are mainly in the form of

verbal descriptions and explanations. Even if there is any accompanying quantification or statistical analysis, they play a minor role.

b) Grounded theory

Grounded theory seeks to develop theory out of the data collected at multiple stages during the study (Leedy and Ormrod, 2001; Fellows and Liu, 2003). Through the use of grounded theory, the processes can be explored systematically and there is no requirement for large sample sizes (McKenzie et. al, 1997). During the data collection process, the researcher also carries out a data analysis, results of which are used to inform and shape further data collection (Charmaz, 2006). The two primary characteristics are the constant comparison of data with emerging categories and theoretical sampling of different groups in order to maximise the similarities and differences of information (Creswell, 2003). The data collection methods used for grounded theory are interviews, observations, documents, historical records, videotapes, and anything potentially relevant to the research question.

c) Case studies

A case study is an empirical inquiry investigating a contemporary phenomenon within its life context; when the boundaries between the context and the phenomenon are not clearly known (Yin, 2003). Case studies are preferred when the research question is in the form of "how" and "why", when the researcher has little control over events and when the focus is on a current phenomenon within some real life context (Yin, 2003). Case studies involve in-depth, contextual analyses of a situation or similar situations where the nature and definition of the problem happen to be the same as the experienced in the current situation (Sekaran, 2003; Yin, 2003). Case studies operate through theoretical generalisation (Fellows and Liu, 2003). If a case study strategy is used, it is very likely to benefit from triangulation of multiple sources of data (Saunders et. al, 2003). The data collection methods include but are not limited to interviews, observations, past records and audiovisual materials.

Yin (2003) defines two dimensions to categorise the case study research strategy. The first dimension is related to the number of cases included in the research. A *single case* is used if it represents a critical case or an extreme, unique case. *Multiple cases*

are incorporated with an aim to generalise the findings. Yin's second dimension refers to the unit of analysis. If the research focuses on one organization as a whole, then that company is treated as a *holistic case study*. If the research also focuses on a number of logical sub-units, then the unit of analysis will be more than one and the case study will be termed as an *embedded case study*.

d) Phenomenological research

Phenomenological research aims at understanding people's perceptions, perspectives at particular situations (Leedy and Ormrod, 2001). The essence of human experiences on a phenomenon are identified by the researcher as described by the participants in a study (Creswell, 2003). Therefore, the research is more focussed on the subjectivities of people.

e) Narrative research

Narrative research is a form of inquiry in which lives of individuals are investigated by the researcher by asking one or more individuals to provide stories about their lives (Creswell, 2003).

f) Action research

Action research is a constantly evolving project with interplay among problem, solution, effects or consequences, and new solution (Sekaran, 2003). The researcher generally participates actively in the process under the study and follows a cycle of "research question-diagnosis-plan-intervention-evaluation" (Fellows and Liu, 2003; Sekaran, 2003, Saunders et. al, 2003). The researcher begins the research with a problem which has been already defined, and tries to find a tentative solution to the problem. When this tentative solution is implemented, the effects and consequences of this implementation are evaluated, and then, the cycle starts from the beginning. The core characteristics of action research compared to the other types of research are given in Table 4. 5.

Table 4.5 Characteristics of Action Research Compared with Those of Other Research Methods (Blumberg et. al, 2005)

Action Research	**Other Research Methods**
Addresses real life problems and is bounded by the context	Address real life as well as scientific problems, and attempt to identify general principles and their contingencies
Collaborative venture of researchers, participants and practitioners	Clear division of roles between researchers, participants and practitioners
Continuous reflecting process of research and action	Usually, clear division between the research process and implementation processes
Credibility- the validity of action research is measured on whether the actions solve the problems and realise the desired change	Credibility- the validity of research is established by statistical core figures and successful replications

The fact that the findings produced are considered as anecdotal evidence and the knowledge obtained is most of the time not transferable from one project to another is the main criticism for action research (Reason, 1993).

4.2.3.3 Research strategies related to mixed method approaches

All methods have limitations. The use of mixed method approaches have started with an attempt to neutralize or cancel the biases of a single method by using another one (Creswell, 2003). Creswell (2003) also mentions three different forms of mixed method approaches: sequential, concurrent and transformative procedures. Sequential procedures are used with an aim of elaborating on or expanding the results of one method with another one. Concurrent procedures refer to collecting both qualitative and quantitative data at the same time in order to provide a comprehensive analysis. Transformative procedures are the sequential or concurrent methods where a theoretical lens or perspectives such as gender, lifestyle, race/ethnicity, and class are used.

4.2.4 Time Horizons

Research projects may be cross-sectional or longitudinal. Research investigating a particular phenomenon at a particular time is called cross-sectional whereas a research investigating a change and development over a time period is called

longitudinal (Saunders et. al, 2003; Sekaran, 2003)

4.2.5 Choices

The way chosen by the researcher in combining the research methods is referred to as the research choice (Saunders et. al, 2003). As explained before in Sections 4.3.2 and 4.3.3, a research project can implement either qualitative or quantitative methods, or a mixed (triangulated) method.

Denzin (1970) identified four types of triangulation in social research:

1. Data triangulation: occurs when data is collected in different context and settings at different times;
2. Investigator triangulation: occurs when more than one researcher/evaluator investigates the same situation;
3. Theory triangulation: occurs when a number of alternative or competing theories are used whilst examining data;
4. Methodological triangulation: occurs in two ways. First one is the "within-method" approach which is applying the same method on different occasions or using multiple techniques within a given method. The second one is the "between-methods" or "across-methods" approach, which is the actual mixing of methods in a single research design.

A comparison of single method and mixed method approaches is given in Table 4.6.

4.2.6 Research Techniques/ Data Collection Methods

There are many data collection methods including observation, sampling, interviews and questionnaire. The relevant techniques for this research will be explained in the next section.

Table 4.6 Quantitative, Qualitative and Mixed Methods Procedures (Creswell, 2003)

Quantitative Research Methods	**Qualitative Research Methods**	**Mixed Methods Research Methods**
Predetermined	Emerging methods	Both predetermined and emerging methods
Instrument based questions	Open-ended questions	Both open-ended and closed questions
Performance data, attitude data, observational data, and census data	Interview data, observation data, document data, and audiovisual data	Multiple forms of data drawing on all possibilities
Statistical analysis	Text and image analysis	Statistical and text analysis

4.3 Adopted Research Methodology

This research aims at explaining the introduction of collaboration environments to construction organizations and how to manage the changes required to obtain full benefits. The research methods adopted to achieve this aim are presented below.

4.3.1 Literature Review

Reviewing previous research in the research area and seeking any potentially relevant theories form an essential early part of every research (Blumberg et. al, 2003; Fellows and Liu, 2003). The extent of knowledge and the main issues informing and providing the rationale for the research which is being undertaken are referred to as the 'state of the art' (Fellows and Liu, 2003).

Fellows and Liu (2003) recommend that researchers do not to express their personal opinions during the critical review of literature or consideration of the theories but to present thematic discussions through synthesis and evaluation of the abstracted alternate views and findings.

According to Creswell (2003), the literature can be used in three different ways in a qualitative study. It can be used to frame the problem in the introduction in all qualitative study types provided that there are some literature available. It can also be presented in a separate section as a "review of the literature". This approach is often

acceptable to an audience most familiar with the traditional, positivist approach to literature review. Thirdly, the literature can be presented at the end of the study to compare and contrast with the findings of the study. This approach is most suitable for the inductive process of qualitative research.

In this research, the research process started with the review of previous research on collaboration environment implementation in construction. The key issues for the success and failure of collaboration environment implementations derived through the previous research identified a possible need for organizational change management during the implementation of collaboration environments. Therefore, a second review was carried out on change management with a focus on organizational change management. The literature review process is illustrated in Figure 4.4.

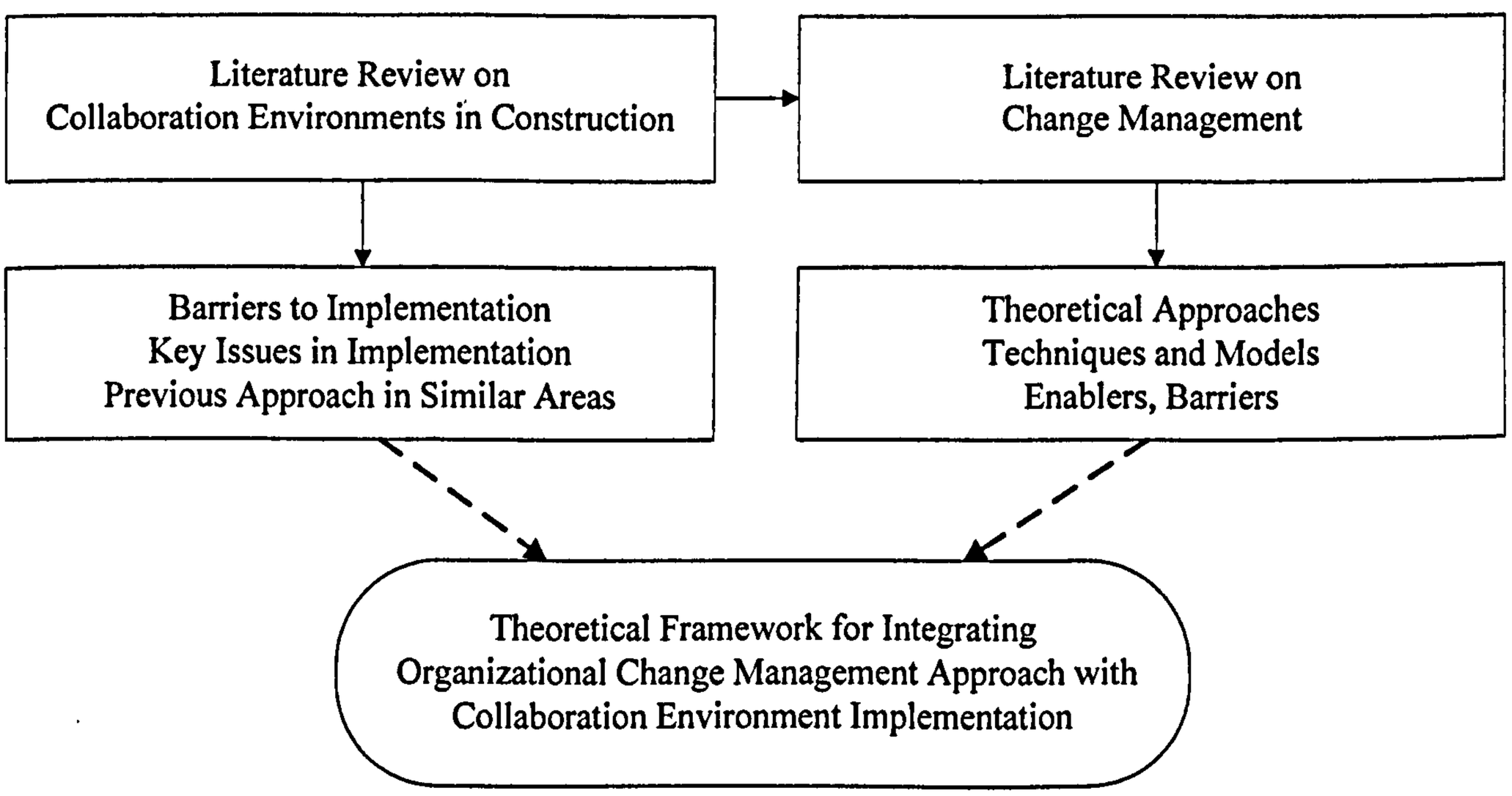

Figure 4.4 The Literature Review Process for the Research

The focus on collaboration in construction projects through the use of IT enabled environments was not a very old concept. Therefore journal and conference papers published recently were the most valuable sources for the review of collaboration environment implementations and their use and success in construction projects. Although some books were used to explain the previous research attempts aiming to combine technical and social factors in the design of information systems, rest of the review on collaboration environment in construction was carried out based on journal and conference papers.

Organizational change management has been a research topic in the social sciences for over a decade, the roots of which can be traced back to Taylor's work and Hawthorne's studies in the early years of the twentieth century (See Section 3.3.3). There was a considerable amount of literature and theories available on organizational change management in terms of books, journal papers, reports and conference papers.

From the first review, it was found that the failure of collaboration environments to achieve the full benefits expected was related to the underestimation of organizational and people issues. The results also led the researcher to think that there is potential to benefit from organizational change management concepts in order to enable the key issues for collaboration environment implementation determined in the review. On the other hand, the review on organizational change management provided a huge amount of previous research in the area, especially in the social sciences. However, none of these studies focused on how to manage the change resulting due to a collaboration environment implementation. The specific aim and objectives of the research were determined combining this gap in organizational change management area with the idea that the key issues in collaboration environment implementation can be achieved through an organizational change management approach.

The literature review was a continuous process which continued during the case study, framework development and prototype development stages. Another review was carried out on research methodologies for the research design.

4.3.2 Case Studies

The research design adopted for this research is shown in Figure 4.5. The details for all decisions are explained under individual titles.

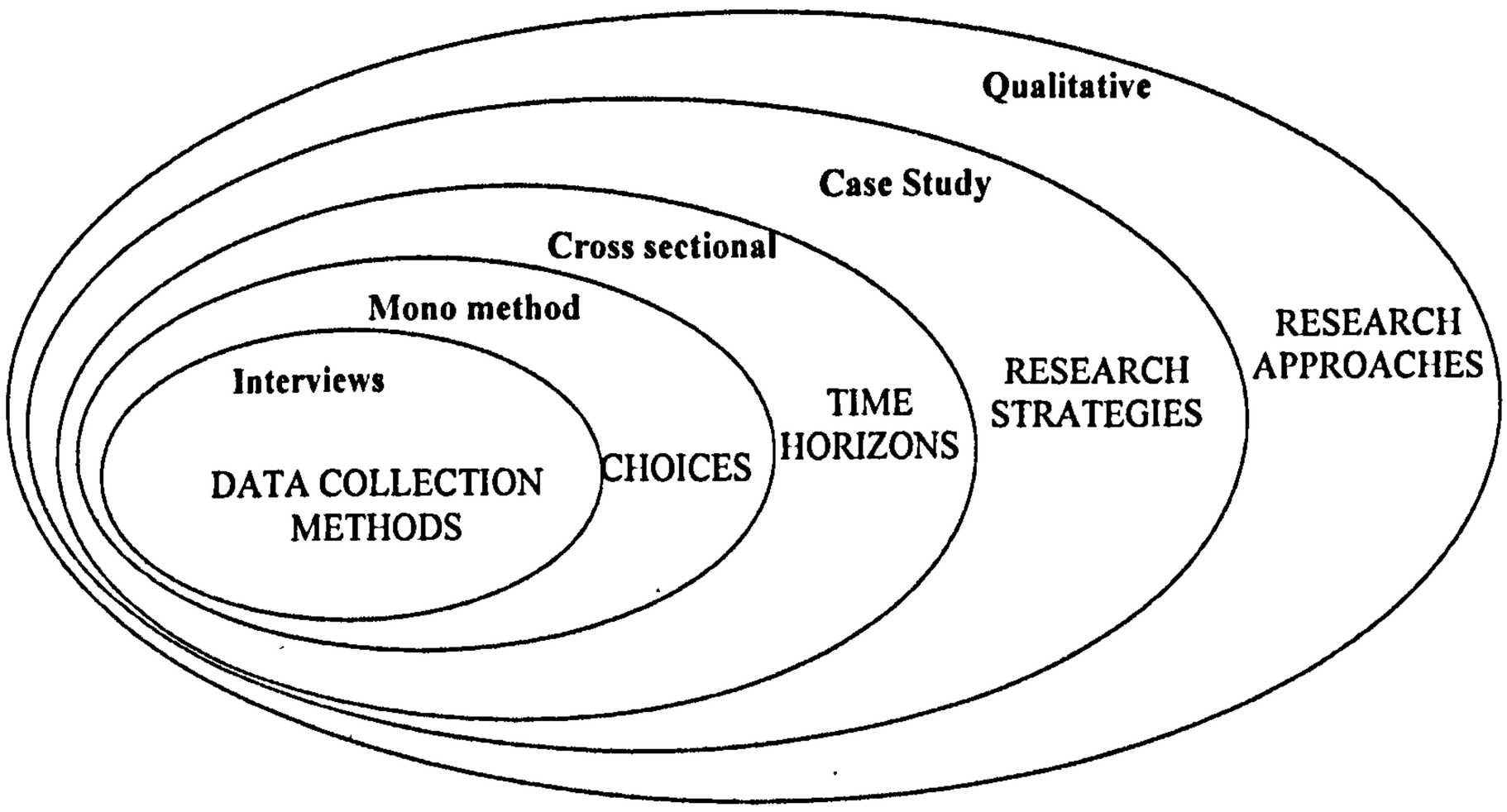

Figure 4.5 Research Design

4.3.2.1 Research approach

Maxwell (1996) defines five particular research purposes for which qualitative studies are especially suited in:

1. Understanding the *meaning*, for participants in the study, of the events, situations, and actions they are involved with and of the accounts that they give of their lives and experiences;
2. Understanding the particular *context* within which the participants act, and the influence that this context has on their actions;
3. Identifying *unanticipated* phenomena and influences, and generating new grounded theories about the latter;
4. Understanding the *process* by which events and actions take place; and
5. Developing causal explanations.

In this research, after the research problem was defined, it was decided to review the current collaboration environment (CE) implementation and collaborative working approaches in construction companies and to explore the factors that may have contributed to the success or failure of collaboration environments and the causal relations between these factors. These objectives are in parallel with the fourth and fifth purposes listed above. Therefore, the research approach chosen was qualitative

due to the nature of the problem defined based on the literature review findings presented in Chapters 2 and 3.

4.3.2.2 Research strategy

According to Sekaran (2003) case studies that are qualitative in nature are useful in applying solutions to current problems based on past problem solving exercises, in understanding certain phenomena, and generating further theories for empirical testing. Therefore, implementing a case study strategy was chosen in order to obtain in-depth data which will help to understand the phenomena and obtain causal relations, if there are any, which will generate further theories on organizational change management for collaboration environment implementation.

The next decision was to determine whether there would be a single case or multiple cases. Since the research was focussed on the collaboration in construction projects, it was clear that there would be more than one case study, otherwise it would not be possible to investigate project organization level collaboration or the factors affecting the collaboration between parties. Therefore a multiple-case study strategy was decided.

Whilst selecting the cases, it was decided to get a representative company from different types of organizations collaborating on a construction project. Therefore, it was decided to carry out case studies in contracting, architecture and consultancy companies. After three case studies, it was also decided to include the technology providing companies in order to understand how they contribute to the collaboration process in a project. The total number of cases were decided during the case study implementations. After each case study, a quick analysis was made in order to outline the major issues mentioned in the case study. Comparing and contrasting it with the previous case studies, it was explored whether it would be enough to make generalisation with the amount of data obtained so far. If it was not enough, a new case was selected in order to achieve either a literal or a theoretical replication following the guidelines by Yin (2003). Yin (2003) states that in multiple case studies, each case must be carefully selected so that it either predicts similar results (a literal replication) or predicts contrasting results but for predictable reasons (theoretical replication). A total of nine case studies was carried out till it was decided

that the data obtained were rich enough to explore causal relations and make generalisations. These nine companies consisted of three contracting, two engineering consultancy, two architecture and two technology providing companies. Other factors that affected the case selection are explained in Section 5.2.

4.3.2.3 Time horizon

The time horizon of research was chosen as cross sectional since it was not possible to access all of the case study organizations for a longitudinal study. If the number of cases had been reduced then it would not have been possible to obtain enough data to make generalisations. Furthermore, there were time limitations due to the PhD study.

4.3.2.4 Choice

The case studies are carried out by using mono-method interviews. According to Blumberg et. al (2005) there are three methods that can be used in case studies: interviews, documents and archives, and observation. Yin (2003) adds physical artifacts as another source of evidence for case studies. Although most case studies benefit from the triangulation of these methods, it was not possible to use methods other than interview for this research. There was not any document kept in the organizations on the areas investigated by the research, therefore, the documents and archives could not be combined with the interview. Neither direct nor participant observation was carried out since it would not be possible to get good quality data using observation in the cross sectional case studies. And as discussed before in the time horizon section, it was not possible to carry out longitudinal case studies. Artifacts were not relevant to the research area investigated. Therefore, a single method (mono method) was followed for the data collection.

4.3.2.5 Data collection method

As stated in the previous section, interviews were used as the data collection method. The interviews can have three forms according to the constraints placed on the respondent and the interviewer: structured, semi-structured and unstructured. In the structured interview, the interviewer administers a questionnaire with very little scope to ask any additional or supplementary questions whereas in the unstructured interview, the interviewer introduces the topic briefly and then records the replies

with no control on the length or scope of the response (Fellows and Liu, 2003). Semi-structured interview is in between the structured and unstructured interviews. The interviewer can have a list of topic areas where the responses are recorded or can follow predetermined standard questions with some probing for clarifications and explanations (Leedy and Ormrod, 1999; Fellows and Liu, 2003). Semi structured interviews have two main objectives: to learn and understand the interviewee's perspective on the issue and to know whether the interviewee can confirm insights and the information the researcher already holds (Blumberg et. al, 2005).

For the data collection, semi structured, face-to-face interviews lasting about one hour were carried out. A semi-structured format was chosen in order to ensure getting each interviewee respond on the same topics as well as being able to ask further questions when found necessary. A face-to-face format was chosen for the interview since all criteria defined by Gillham (2000) to test the appropriateness of a face-to-face interview were fulfilled. These criteria are shown in Table 4.7.

Table 4. 7 Is Face-to-Face Interview Appropriate, Necessary or Possible? (Gillham, 2000)

NO if	**YES if**
Large numbers of people are involved.	Small numbers of people are involved.
People are widely dispersed.	People are accessible.
Most of the questions are closed.	Most of questions are open and require an extended response with prompts and probes.
A 100 per cent response is not necessary.	Everyone is key and you cant afford to lose any.
The material is not particularly subtle or sensitive.	The material is sensitive in character so that trust is involved.
You want to preserve anonymity.	Anonymity is not an issue, though confidentiality may be.
Breadth and representatives of data are central.	Depth of meaning is central, with only some approximation to typicality.
Research aims are factual and summary in character.	Research aims mainly require insight and understanding.

Collecting data for case studies through interviews has strengths and weaknesses. These strengths and weaknesses defined by Yin (2003) are shown in a T-diagram in Table 4.8.

Table 4.8 Strengths and Weaknesses of Using Interviews for Case Studies (Yin, 2003)

Strengths	Weaknesses
• Targeted- focuses directly on case study topic • Insightful- provides perceived causal inferences	• Bias – due to poorly constructed questions • Response bias • Inaccuracies due to poor recall • Reflexivity- interviewee gives what the interviewer wants to hear

Gillham (2000) recommends pruning the list of questions and trialling them before going for the actual interview. The interview questions should be arranged in such a way that each question deals with a separate facet of the topic, however, the facets should be chosen carefully since anything that might be relevant cannot be covered due to the time limitations (Gillham, 2000).

Bias was also taken into account during the design of interview questions. Bias is known as any influence or conditions that distort the data (Leedy and Ormrod, 2001). The research must avoid bias in order to ensure accuracy and validity (Fellows and Liu, 2003). Even if the bias cannot be completely removed, it should be noted and clarified by the researcher for the accuracy of the research (Creswell, 2003).

The findings of the literature review on collaboration environments in construction and on change management were used during the design of the interview questions, which can be seen in Appendix 1. The questions were designed to understand whether the case study companies were aware of the seven key areas for implementing the collaboration environments (refer to Section 2.5) and were taking these into account during their implementations. From the change management point of view, it was investigated whether the companies had a defined procedure for managing the changes and relating the collaboration environment with the tools, organization structure, organizational processes, the users and the other projects.

The interview questions for the research were trialled many times before they had

their final form to check whether they all cover different facets of the topic, whether they are clear enough and whether there were any leading questions which might result in researcher bias. After many iterative trials, the first case study organization was used as a pilot. Based on the interviewee's feedback one of the questions was reworded.

The data collection and data analysis stages are further explained in Chapter 5 together with the findings.

4.3.2.6 Judging the quality of research design

Four tests are commonly used to test the quality of any empirical social research including case studies: construct validity, internal validity, external validity and reliability. These tests are explained below with respect to the actions taken in this research for the tests.

Construct validity is establishing the correct measures for the studied concepts and can be increased by using one of the three tactics: using multiple sources of evidence, establishing a chain of evidence and having the key informants review draft case study report (Yin, 2003). In order to increase the construct validity of this research, when the data analysis was completed, a meeting was arranged with one of the participants in the case studies (Corporate Service Head for Quality in Case 3). The draft case study report and the causal loop diagram were reviewed and validated by the participant in this meeting.

Internal validity is the extent of a research design and data to enable the researcher draw accurate conclusions about cause and effect and other relationships within the data (Neuman, 2005). Internal validity is used as a test for only explanatory and causal studies (Yin, 2003). This research fell into this category, therefore internal validity was considered during the research design. In order to increase the internal validity, each case was analysed individually for some causal relations and compared with the other cases to make sure that the relationships obtained are not due to case specific conceptual variables.

External validity is the ability of a research to generalize the findings and is related to the domain, specific setting or small group chosen for the study (Yin, 2003;

Neuman, 2005). In this research, in order to increase the external validity multiple cases were carried out considering the replication logic. The number of cases necessary for generalization was decided during the case study implementations. A total of nine cases were carried out till it was decided that each case chosen provided either similar results or contrasting results but for predictable reasons.

Reliability is the extent to which the operations of a study can be repeated with the same results (Yin, 2003). In this research, in order to be able to carry out the same procedure for each case, a case study protocol was developed. The overview of the case study project, the investigated questions and the used procedures were documented in this protocol.

4.3.3 Framework Development

The third objective of the research was to develop a conceptual organizational change management framework to implement collaboration environments. This objective was achieved using the literature review findings and the case study findings.

From the literature review, it was found that the main problem in the implementation of collaboration environments is not related to technical issues but people and organizational issues. Therefore the framework was developed to introduce an organizational and people perspective into collaboration environment implementation starting from the planning. The literature review also provided theories which were used as guidelines and rationale for some stages of the framework development.

The case studies determined the key factors affecting the success of collaboration environments and the causal relations between them. It was justified in the case study results that there are two levels that should be focussed on during the implementation of a collaboration environment for a construction project: project organization level and organizational level.

Based on these findings from both literature review and case studies, the ICEMOCHA (Implementation of Collaboration Environments and Management of Organizational Changes) framework was developed. ICEMOCHA consists of two integrated models:

1. ICE is a methodology which will guide the organizations collaborating on the construction project in planning and implementation of collaboration environments
2. MOCHA is a methodology which will guide each organization to come up with an organization specific organizational change management approach.

Each model has five stages which are further broken into their sub-processes using an IDEF0 modelling approach. The rationale behind the framework development, the framework development approach and the framework are presented in detail in Chapter 6. The framework evaluation process is explained in Chapter 8.

4.3.4 Rapid Prototyping

Prototyping is a process of building an experimental system quickly and at a low cost for demonstrating to the users so that they can evaluate the system and determine further information requirements (Laudon and Laudon, 2000). The key strengths of the prototype can be defined as follows (Turban and Aronson, 2001):

1. The development time is short;
2. The feedback from the users can be obtained in a short time;
3. The users will understand the system, its capabilities and the information; and
4. The cost is low.

The prototype developed for this research aimed at automating the project organization level processes of the ICEMOCHA framework presented in Chapter 6. The prototype development environment was based on Visual Basic.net (VB.net), the selection reasons of which are explained in Chapter 7. The system architecture was decided and the ICEMOCHA framework was automated. During the development several tests were carried out by the researcher to remove any errors in the coding. When the prototype was completed, it was evaluated by thirteen industry professionals, seven of whom also participated in the case studies.

4.3.5 Evaluation

The evaluation research was carried out in order to validate the conceptual ICEMOCHA framework and to determine the appropriateness and functionality of the prototype system by the industry professionals. The evaluation methodology chosen is shown in Figure 4.6. As seen from the figure, it was decided to benefit from the triangulation of qualitative and quantitative approaches. Thus the chosen research strategy was survey and the data collection was carried out using interviews and a questionnaire.

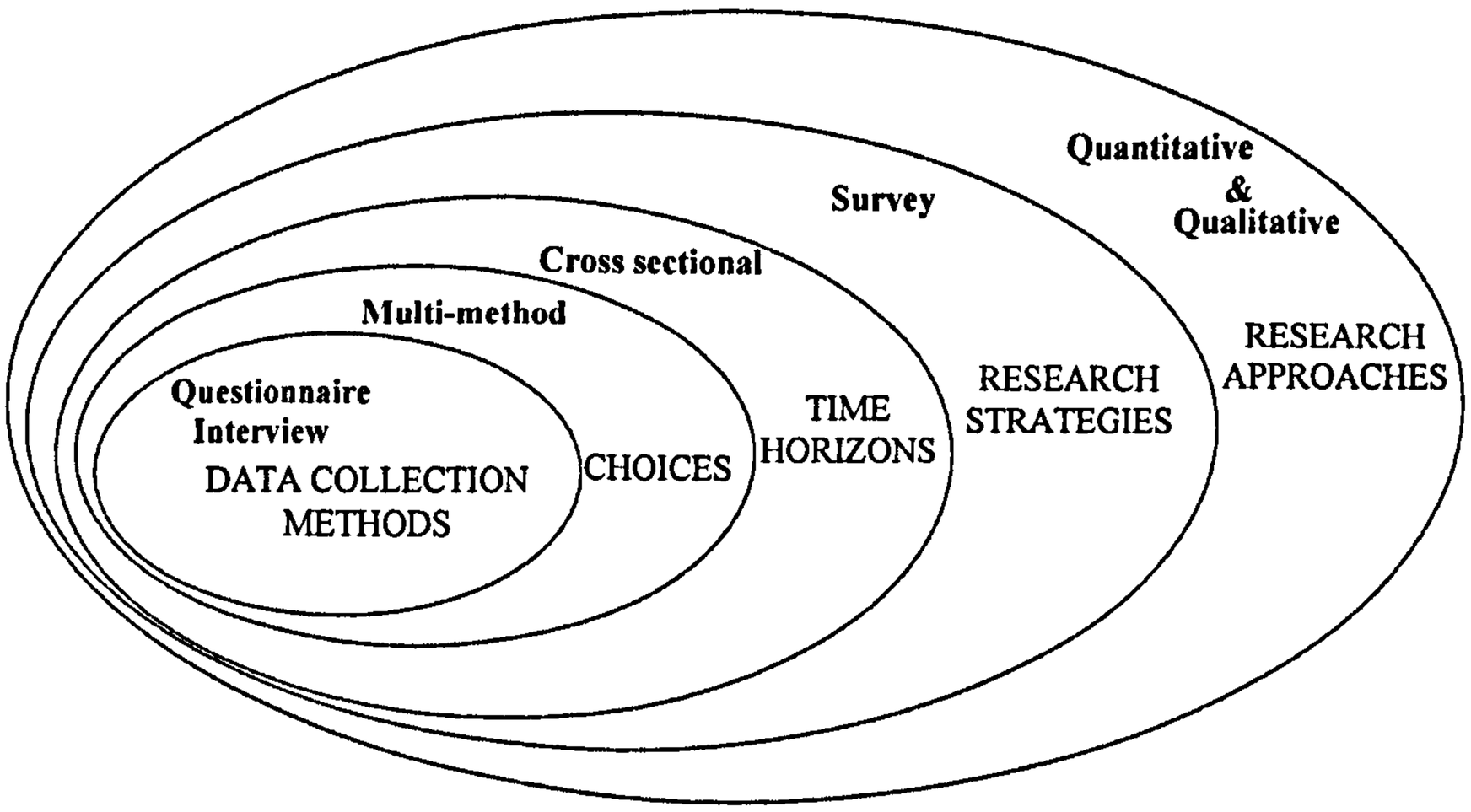

Figure 4.6 Evaluation Research Design

The interviews were of unstructured format. The framework and the prototype were presented to the respondents/interviewees and an open discussion was started. The comments of the interviewees were recorded and analysed together with the quantitative results obtained from the questionnaire.

The evaluation questionnaire consisted of closed and open-ended questions which were to be completed within ten minutes. The details of the evaluation process and the techniques used are presented in Chapter 8.

4.4 Summary

This chapter has presented the basic principles and concepts related to the research methodologies. Specifically, this chapter described how the research methodology adopted in this study was designed. The research methodology consisted of five

main sections: literature review, multiple case studies, framework development, rapid prototyping and evaluation.

CHAPTER FIVE: COLLABORATION ENVIRONMENTS FOR CONSTRUCTION: IMPLEMENTATION CASE STUDIES

5.1 Introduction

From the literature review, it was established that the main problem in the implementation of collaboration environments is not related to technical issues but people and organizational issues. This chapter presents the results of case studies carried out to obtain perspective of the construction organizations on the subjects outlined in the literature review. The case studies, which involved semi-structured interviews with senior level managers in seven construction companies and two companies providing technology solutions, are presented individually. Later, all results obtained from the cases are discussed together and interpreted following a systems thinking approach. Finally, the conclusions drawn from the case studies are summarised and the need for a detailed organizational change management approach to control all the factors affecting the success of collaboration environments is justified.

5.2 Research Methodology

In order to review the current collaboration environment (CE) implementation and collaborative working approaches in construction companies, nine case studies were carried out. The specific aims of the case study research were to gather information on:

1. Collaboration environment implementation procedures in construction organizations;
2. Barriers and difficulties in the implementation of collaboration environments and collaborative working procedures;
3. The extent to which collaboration environment implementations undertaken so far have been successful; and
4. Thoughts and experiences of industry professionals regarding the transformation of the organization during the implementation of a new collaboration environment.

For the case studies, semi-structured face-to-face interviews with senior level managers in construction organizations were arranged. Extra attention was paid during the course of arranging interviews to ensure that the interviewees had been involved in the implementation of the collaboration environments, actively participated in the collaboration environments, experienced the difficulties and barriers, and made decisions to overcome them.

The case study companies are given in Table 5.1. The choice of these companies was done on the basis of three factors: Firstly an opportunistic approach was followed. The target companies of Case 1 and Case 2 were industrial partners on a research project on planning and implementation of effective collaboration in construction at Loughborough University. The contracting company in Case 4 was an industrial partner in a previous research project; therefore, access to the company was easy. Although the availability and accessibility to these companies was the main reason for their selection, all three companies were very good targets for the case studies since they had all been involved in many construction projects where various types of collaboration environments were implemented. Secondly, a search in the UK industry was made among the large scale construction organizations which have been involved in large scale projects in which many construction companies collaborated. Cases 3, 5, 6 and 7 were found using this method. Thirdly, the technology providing companies were chosen since most of the construction companies in the previous cases had referred to the technology providing companies in Cases 8 and 9. Therefore in order to obtain the perception of the technology companies these two companies

were included in the case studies.

Table 5.1 Summary of the Interviewees

Case No	Company type	Job of Interviewees
Case 1	Consultancy	Collaboration Consultant
Case 2	Consultancy	Senior Consultant
Case 3	Contracting	Corporate Service Head for Quality
Case 4	Contracting	Project Collaboration Analyst
Case 5	Contracting	Project Director
Case 6	Architecture	Associate of Practice
Case 7	Architecture	Associate of Practice
		Information Manager/Document Controller
Case 8	Technology	Head of Corporate Communications
Case 9	Technology	Director in Executive Management Board

During the interviews, the interviewees were asked both open-ended and closed questions (See Appendix 1 for the questions used). Each interview lasted approximately one hour. The interviews were recorded using a digital recorder and then fully transcribed and analyzed. During the interviews and the analysis stages, some disadvantages of the adopted approach were noticed. The biggest difficulty was the time spent in transcribing the interviews. The transcriptions consisted of a huge amount of textual data which slowed down the data analysis stage. Furthermore, the raw textual data was highly unstructured since the interviewees referred to the same subject category in various questions, making interpretation difficult. Despite the difficulties, the adopted approach was necessary since it allowed the researcher to explore the topic in-depth. It was important for the researcher to be able to ask follow-on questions on issues raised by the interviewees, if they were found important or interesting for the research.

The qualitative findings from each company were analyzed using a combination of qualitative coding, interpretation and cross-case analysis whereas the responses to closed questions were analyzed quantitatively (as appropriate). Coding techniques were used in order to organize the raw unstructured textual data. Coding is the process of identifying and recording one or more discrete passages of text or other

data items that cover the same theoretical or descriptive idea (Gibbs, 2002). As part of an analytical process, attaching codes to data and generating concepts enable the researcher to review what the data is saying (Coffey and Atkinson, 1996). Coffey and Atkinson (1996) also state that coding is usually a mixture of data reduction and data complication since it is used to break up and segment the data into simpler, general categories and is used to expand and tease out the data in order to formulate new questions and levels of interpretation. Following the coding principles, the textual data in each transcript was broken into main subject categories by the researcher. For some categories containing very complex and complicated data, Nvivo (a software for qualitative data analysis) was used for coding while other parts were coded manually.

According to Delamont (2001) the coded text should be searched for patterns, themes, regularities as well as contrasts, paradoxes and irregularities. Keeping this principle in mind, after the coding of interview data, each category was further investigated in order to transform the coded data into meaningful data through the processes of comparing and contrasting the data from each transcript. The aim was to capture common characteristics and to explore possible relationships, which formed a basis for the interpretations. Interpretation captures the essence of "What were the lessons learned?" (Lincoln and Guba, 1985). These lessons can be the researcher's personal interpretation, a meaning derived from a comparison of the findings with literature review findings or existing theories (Creswell, 2003). Therefore, the analysis of the interview data was completed by the interpretation of the results which was later combined with a systems thinking approach to create a causal loop diagram (See Section 5.5.1) reflecting the organizational issues in implementing a collaboration environment for construction projects. All of these data collection, coding and analysis stages were carried out by one researcher. Therefore, the results were not influenced by the variance between researchers in the values and expectations they could bring to the study. The researcher tried to be objective and paid special attention to avoiding leading questions to the interviewees in order to reduce the bias and the reactivity in the research.

5.3 Results of Case Studies

This section summarises the data obtained from the case studies which are categorised under 5 main areas:

1. Background information: Some brief information on the case study organization and the interviewee are provided in this section.

2. Collaboration environment implementations in the company: This section lists the IT tools implemented in the contracting, consultancy and architecture companies to enhance collaborative working. This section is not used for Cases 8 and 9 since they are technology providing companies.

3. Success level and success criteria of collaboration environment implementations: This section explores what percentage of collaboration environments implemented in the company have failed to provide the full benefits expected and investigates how the success of the collaboration environments are evaluated and whether there are any defined success criteria for this.

4. User involvement during collaboration environment implementation stages: This section presents the results obtained from a matrix- question filled by the interviewees. The matrix was designed to understand who are actively involved in different steps of the collaboration environment implementation procedure. The technology providing companies were not asked this question since they would not be able to respond based on their own experience.

5. How the collaboration environments were implemented and the factors affecting their success: For each of the first seven case studies, this section tries to identify how the collaboration environments were implemented in the company and whether the implementations were accompanied by any change management efforts. The most and the least successful collaboration environment implementations in the company within the last 5 years are investigated to understand the factors affecting the success. Apart from these factors, the collaboration environment implementation approaches of the

company are investigated to find further success factors and failure reasons specific to the company. Employee resistance is considered as a separate issue. The technology providing companies also had this section but the results are less structured compared to the first seven cases. Since the responses of these two companies are based on the implementation experiences in various companies, each of the factors mentioned by them is presented as an individual heading, where appropriate.

Wherever found necessary, the original expressions of the interviewees are used. These quotes from the interviewees are written in italic to differentiate them from the rest of the text.

5.3.1 Case 1

5.3.1.1 Background information

Case 1 was a consultancy firm and the interviewee had been working in this company for the last 4 years. The interviewee held an EngD degree and was familiar with academic research.

5.3.1.2 Collaboration environment implementations in the company

The company uses project extranets (provided by Buzzsaw, BIW, Asite or 4Projects), Plan Weaver, shared drives, net meeting, video conferencing, whiteboards and collaborative 3D modelling programs to support collaborative working in projects.

5.3.1.3 Success level and success criteria of collaboration environment implementations

The interviewee indicated that between 50 to 70% of the collaboration environment implementations were found to fail in achieving expectations. On the other hand, it was seen that the company did not have any success criteria defined for IT implementations, the failure rates were judged based on perception. However, the interviewee also indicated that they were planning to establish some success criteria soon by developing a set of benchmarks or key performance indicators.

5.3.1.4 User involvement during collaboration environment implementation stages

The interviewee was given a matrix format closed question aimed at understanding who were actively involved in the different steps of the implementation procedure. The filled matrix is given as Table 5.2. As seen from the table, the end users were involved in three stages: Recognizing the need for a new system, design of the technical system and testing and evaluation. On the other hand, construction project managers were involved only in the earlier stages and left out from the rest.

Table 5.2 Case 1 - User Involvement Matrix: Implementation stages vs Employees

Case 1 User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	X	X	X		X	
Feasibility Analysis	X	X	X			
User requirements capture		X	X			
Design of the technical system		X			X	
Planning the adaptation process	X	X				
Choosing the optimum among the	X	X				
Testing and evaluation		X			X	
Implementation		X				
Fine tuning		X				

5.3.1.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

The interviewee indicated that employee resistance was observed in all collaboration environment implementations. This resistance sometimes involved a high number of end-users. But sometimes even one senior manager resisting could result in the failure of the whole implementation project. An extranet implementation between Leeds and Vauxhall was given as an example of the second case. In that project, all the arrangements were made, the project extranet was tested and all of the employees except for one senior person in the project were happy with the extranet and the way

it was set up. This senior person had "*a poor IT vision*" and "*very low computer literacy*". He was using a very old laptop, which he was not willing to change in any case. Because of the condition of the laptop, the system was working at a lower efficiency than its potential and consequently some problems and failures occurred. The interviewee was in charge of that project; however, neither him nor the other IT people involved in the project could get this senior person to accept that the system might not be working well because of the limitations of his laptop and convince him to use a better computer. "*So he kept on blaming the system for being slow and for the crashes. Therefore he continued using only e-mail for communication and the other employees had to respond to him via e-mail.*"

Another problem observed in the same case was the employees changing their minds after the negative response of their seniors although they indicated that the system was fine during the tests.

b) The most successful collaboration implementation

The interviewee could not name a specific implementation with the reason that they had not yet started measuring the success and benefits of implementations. However, he defined the following as the common factors of their very successful collaboration implementations:

1. Leadership;
2. User involvement;
3. Allowance of time;
4. Considering failure as a learning process; and
5. Resources.

c) The least successful collaboration implementation

The least successful collaboration implementation undertaken was Collaborative Prototyping, which was an integration of several CAD packages aided by team working principles. The aim was to create a collaboration environment through the use of a shared 3D model. The technology used consisted of several off the-shelf packages – "*which were unable to deliver the promises made by the vendors*".

The technical factors affecting the success of the implementation were interoperability issues and loss or corruption of data integrity, which were caused by non technical factors, the most important of which were:

1. Lack of leadership;
2. Lack of resources; and
3. Lack of experience and expertise.

d) Implementing collaboration environment and company specific success / failure reasons

The interviewee indicated that there was no proper change management in the implementation of collaboration environments in their organization. He was of the view that IT systems are enablers not drivers, therefore the team or the company should first get the collaborative processes and the culture right and then use the IT system to enable more efficient collaborative working. However, the change management efforts for collaboration environment implementation in the company were often limited to asking some users to test the system and training the end-users. Therefore, once the system was installed, in the case of a negative criticism, the only thing they could do was to invite the complainers to another training session.

The organizational structure did not allow the implementation of proper teamwork. Hierarchical relationships were very dominant in the organization and the members of a team could not act on an equal basis. Furthermore, there had been some cases where the comments of the project manager and IT champion were different and even conflicting.

The team building approaches were not very good in the company. "*Once they put 160 people in one team and asked them to collaborate*". In order to solve this weak approach, the company was trying to introduce new approaches to collaborative working.

The company introduced the collaboration environments after a testing stage in the beginning of a project. At times, there had been 2-3 different systems in use in the company for different projects. In cases where one employee was employed in more

than one project, this also caused some problems.

Therefore reaching a consensus or establishing continuity among the 27 partner offices of the organization, which work in a decentralised way, was not possible most of the time. Even if one of the offices discovered that an off-the-shelf software failed to provide the expectations and stopped using it, another office could make the same mistake some time later since they did not communicate these issues.

5.3.2 Case 2

5.3.2.1 Background information

Case 2 was carried out in a consultancy firm and the interviewee had been implementing IT systems in that firm for 3.5 years, but had had experience in implementing IT systems and relevant changes for 7 years.

5.3.2.2 CE implementations in the company

The company uses project extranets (provided by BIW, Business Collaborator, 4Projects or Buildonline), their own electronic document management system and SAP to enable a CE in the projects.

5.3.2.3 Success level and success criteria of collaboration environment implementations

The interviewee indicated that up to 30% of the collaboration environment implementations had failed in achieving expectations. However, the company did not have any defined success criteria. The success level was decided by looking for answers to the questions, *"Do they work better than the previous?"*, *"Are they more efficient or more useful than the previous solutions?"*. Thus, there was no defined methodology for measuring the performance. It was measured perceptually. The interviewee stated, *"In my experience the performance measurements are normally established at the outset to make a benefits case and are kind of ignored. We get on and do the job and only a good well afterwards, we go and look again whether it has actually achieved the outcome we are looking for."*

5.3.2.4 User involvement during collaboration environment implementation stages

The interviewee was given a matrix format closed question aimed at understanding who were actively involved in the different steps of the implementation procedure. Table 5.3 summarises the situation in Case 2.

Table 5.3. Case 2 – User Involvement Matrix: Implementation Stages vs Employees

Case 2 User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	X	X	X		X	X
Feasibility Analysis	X	X			X	
User requirements capture	X	X			X	
Design of the technical system	X	X		X		
Planning the adaptation process	X	X				
Choosing the optimum adaptation alternative	X	X				
Testing and evaluation	X	X		X	X	
Implementation		X		X		
Fine tuning	X	X		X	X	

5.3.2.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

There was some friction with the employees due to poor user-friendliness of the systems or other problems appearing in the post-implementation stage. When there was friction, they first tried to find the source of the problem and solve it. But if they could not do anything to solve the problem, the users had to use the system since they were not given the option of using or not using it. The interviewee said if they could not change the user interface, they told the employees, *"There is nothing we can do about it. So let's just agree that it is not very user-friendly. Try to get used to it and cope with it."*

Another point mentioned by the interviewee was how the criticality of the collaboration environment use had an effect on the implementation. When the collaboration environment implementation was critical for the success of the project, the top level managers were more involved during the implementation stages to ensure that the collaboration environment was used by the employees. Likewise, if the only way of doing things in the project was using that system, the employees did not have any other choice but to use the system regardless of how user-unfriendly or how complicated the system was.

Another observation of the interviewee was that the employees were not actually rejecting the technologies, they were rejecting the overall IT policies that mandated the implementation. When they modified the policies, they realised the resistance was less.

b) The most successful collaboration implementation

Both project-specific extranets and SAP implementation were very successful. In an example of project specific extranets, the technology used was an off-the-shelf product at the core but they did a lot of development on it. The reasons why it was more successful than the others were defined as follows:

1. It was designed well, tested and refined;
2. The system was an opportunity for the organization to make more money quite directly. This opportunity provided considerable motivation to get the implementation right; and
3. The client was also involved in the project.

SAP, a program with time sheets and invoicing, was another very successful implementation. It was a generic off-the-shelf system configured to suit the way organizations want to work. One of the main success reasons for this project was that everybody used the tool since the collaboration was fundamental and critical for the project. The interviewee expressed this as, *"It is a bit like a heart surgery, you put a lot of effort in to make it go right. Because if you don't succeed, the person dies.*[It was] *the same way with that* [implementation]. *We can't go in doing that half way.".* Since it was critical, matters of planning, disaster recovery planning, and focus on

the project increased. There was also a contingency plan in case something went wrong.

The opportunity to make more money through the use of SAP provided a motivation. But the first tool developed did not satisfy the expectations of the organization. It was found out that what the organization expected it to do and what the developers thought it should do were different. After this first failure, everything was mapped again in detail and the IT company and the organization worked together to match the expectations. After fine-tuning and refining, they started to use it and the outputs obtained after SAP implementation were better than previously.

c) The least successful collaboration implementation

The least successful implementation example was not a collaboration environment implementation but an IT tool for process management, called Control. The failure reasons were stated as:

1. They could not get people to use it;
2. Championing and available commitment within the organization were insufficient;
3. The use of the system was not critical to the project, therefore it was left optional;
4. The structure of the processes was not complete and useful; and
5. Dissemination of the updated information and documents were not considered in the design stage. The problems appeared after the implementation. It was not web-based and could not be posted, so people did not have easy access to the process concept.

d) Implementing collaboration environment and company specific success / failure reasons

The company was aware that technology alone was not successful unless accompanied by some policy changes. It was realised that if there was an employee resistance, the reason was down to the policies not to the IT tool. If the policies were rejected, the technology was not adopted. However, it was observed that the

efforts during the collaboration environment implementations did not aim to change the organizational structure, therefore the implementations were seen as automation of some of the processes which were done manually before.

Communication during implementation and adoption of a collaboration environment was found difficult by the company. As mentioned in the most successful collaboration environment implementation section, it was observed that if the change was critical and fundamental for business, then the change was accepted relatively easier than an optional change which was non-critical for business.

Regarding the user requirements capture, the interviewee indicated that there was no established way of capturing the users' needs and further commented that what the users wanted might not be the same with what they actually needed. The interviewee was of the view that the users might ask for some needs which have low value for the business case. Likewise, there might be gaps between what the organization expected and what was provided by the technology companies.

They rarely introduced a new system halfway through a project. In sharing project documents, CAD standards or systems, or financial systems the strategy taken was to start with a new project. On the other hand, if they decided that this will take a very long time, then they chose to implement the system in a big bang approach and at a certain time they would start using one system.

The company carried out a considerable amount of training and got feedback from the users. Where they could make something to change the system, they would change the system in the light of the feedback. But if they could not do anything to change, say the user interface, they would simply tell the employees to accept it and to try to get used to it.

5.3.3 Case 3

5.3.3.1 Background information

Case 3 was carried out in a contracting firm and the interviewee had been working in the company for the last 22 years.

5.3.3.2 Collaboration environment implementations in the company

The company uses project extranets provided by BIW Information Channel, an internal collaborative accounting system called MENTOL, and an intranet system.

5.3.3.3 Success level and success criteria of collaboration environment implementations

The interviewee indicated that up to 30% of the collaboration environment implementations had failed in achieving the expectations. In the past they had not defined any success criteria and had not measured the performance of their implementations. For example, in the BIW implementation, they simply bought the tool and implemented it. The only performance measurement they did was to ask people whether they worked any better after the implementation.

The company was planning to adopt a methodology called Prince2. Using Prince 2 project deliverables would be set down before the implementation and the processes audited according to these specifications during and after the implementation.

5.3.3.4 User involvement during collaboration environment implementation stages

The interviewee was given a matrix format closed question aiming at understanding who were actively involved in the different steps of the implementation procedure. The interviewee said they did not have a formal approach before the new internal collaboration project which was being implemented following the Prince 2 methodology. The matrix in Table 5.4 was filled according to the new project implementation.

5.3.3.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

The biggest problem in the implementation of collaboration environments was indicated as cultural change. Getting people accept to work with it, and change the way they work were considered as cultural change by the interviewee. "*People, especially older people, cannot understand why we are changing something which*

has been working so well for so many years. And they have the attitude of "If it is not broken, why are we trying to fix it?""

Table 5.4 Case 3 - User Involvement Matrix: Implementation Stages vs Employees

Case 3 User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	X	X			X	
Feasibility Analysis	X	X				
User requirements capture	X	X	X	X	X	
Design of the technical system		X		X		
Planning the adaptation process	X	X			X	
Choosing the optimum adaptation alternative	X		X		X	
Testing and evaluation	X	X	X		X	
Implementation	X		X		X	
Fine tuning	X	X				

b) The most successful collaboration implementation

The most successful implementation was the extranet implementation on a renovation project for all branches of a British Bank. This was managed centrally by the case study organization but had operational projects all over the country. By using EDMS, all the information was held centrally but was accessible from all of their regional offices. They used the experience they gained in this project for another project and included the subcontractors in the extranet too. This project had been working very successfully for about 18 months.

All offices included in the project were communicating via the extranet and using it efficiently. That it was used by everyone made these implementations more successful than the others. The specific reasons are listed below:

1. The customer wanted a completely transparent process. There was complete buy-in from everyone.

2. All parties were from the same supply chain and they did not have any compatibility problems.
3. The speed was very high so the information could be distributed very quickly and was accessible to all parties

Another successful collaboration environment implementation was for another British Bank. This project was a framework contract stating that BIW should be used as the collaboration environment since the project managers of the bank had already started to use BIW in the design stage. That it was stated in the contract resulted in buy-in from all parties. The buy in from the client and all other parties was a very important factor in the success of the collaboration.

c) The least successful collaboration implementation

The interviewee could not identify a specific collaboration environment implementation project that could be called the least successful implementation but listed the following factors to be common in their less successful implementations:

1. Insufficient training: They were training a large number of employees in 3-4 hours-long training sessions which had not been categorised according to the level of the users;
2. The culture of the organization;
3. Ability to use the system; and
4. The resistance from a significant number of older employees who were very experienced but had very little computer literacy.

d) Implementing collaboration environments and company-specific success / failure reasons

The organization had not been implementing collaboration environments with change management principles in mind, however the managers realised that this approach caused many difficulties. They had lots of resistance from the employees, who did not wanted to change the way they worked.

Most of the time the end-users were not informed of a new collaboration

implementation till the last stage. As soon as the employees learnt there was a new system, they had to start using it, they did not have an adoption period.

The company realised that the training of employees were not sufficient. It was decided to change their training method to one-to-one training rather than classroom training in the extranet implementations by BIW. There was a trainer in the company for a long time who walked around between the desks, told people about the system, and asked whether they had any problems or anything that they would have liked to be explained. This one-to-one training, focused and targeted, was very successful.

Looking at the previous mistakes, the company had started a new approach with their new project called "Liquid Office". Liquid Office" was an in-house collaboration system integrating the parts of the process chain, connecting departments together. In this project, they were using a project planning methodology called Prince2. First they had agreed on what the project was and what it would deliver, and set up a project initiation document, determined the deliverables, time scales and change management processes. They were trying to reach the system they set in the beginning. They involved a process sponsor, process owners, process manager, and process users in building the system. A total of 132 processes were targeted in the project.

5.3.4 Case 4

5.3.4.1 Background information

This is a contracting firm and the interviewee had been working in this company for less than 1 year.

5.3.4.2 Collaboration environment implementations in the company

The company uses project extranets provided by 4Projects and BIW together with project nets provided by Athena and Sysnet.

5.3.4.3 Success level and success criteria of collaboration environment implementations

The interviewee indicated that up to 30% of the collaboration environment

implementations had failed in achieving the expectations. The success criteria for collaboration environments were identified as *"proven business benefit balanced with the efforts and resources required to develop and then to support the system"*. The interviewee added that they had considered time savings as well.

However they were not checking the level to which the collaboration environment implementations satisfy the success criteria by using a defined methodology. They were perceptually checking whether it was any better than previous.

5.3.4.4 User Involvement during collaboration environment implementation stages

The interviewee was given a matrix format closed question aiming at understanding who were actively involved in the different steps of the implementation procedure. The completed matrix is given in Table 5.5.

Table 5.5 Case 4 – User Involvement Matrix: Implementation Stages vs Employees

Case 4 User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	X		X			
Feasibility Analysis	X	X	X			X
User requirements capture			X		X	
Design of the technical system		X	X	X		X
Planning the adaptation process			X		X	X
Choosing the optimum adaptation alternative		X				
Testing and evaluation		X			X	
Implementation		X		X	X	
Fine tuning		X			X	

5.3.4.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

The interviewee commented that the organization had been using '4Projects' for a long time so the employees were used to it and employee resistance was not

observed. The problems were mainly on big projects where they needed to bring staff from other companies of which the procedures and systems were not totally known.

b) The most successful collaboration implementation

The most successful collaboration environment implementation was the extranet implementation provided by 4Projects implemented for a project in London. The following factors were specified by the interviewee as the factors which made this implementation more successful than the others:

1. There had been an enterprise licence beforehand.
2. There were no restrictions on the data.
3. Technical factors were also considered important to make it more successful. The adequate and fit-for-purpose network infrastructure and connection through the corporate network to internet can be considered among these important technical factors.
4. There was a clear guidance prospectus and a formal structured setup.
5. The designers and users were at different levels of computer usage but there was someone putting his foot down and saying to them that they had to use the system.
6. Top level management was involved in the implementation.

c) The least successful collaboration implementation

The interviewee gave an example where there happened to be two different extranets in the project, one by BIW Information Channel, one by 4Projects. The employees got confused with which one they should use and this led to people not using one of them at all. They could not solve this problem and the project was affected very badly.

d) Implementing collaboration environment and company specific success / failure reasons

After their least successful project where they had to sell the project to another company, they realised that the client and the client's wishes have an important

role in the success of the implementations. They decided to have a fixed collaboration environment tool for each project (4Projects) and they were willing to pay for the training of the other parties on the collaboration tool and methods they use so that the employees from other companies would be compatible with their own employees.

They set up a 4Projects website for each project and communicated with the other parties on the conventions and procedures according to Avanti procedures[1]. But these principles could not be implemented properly from the beginning of the pilot project. The extranet was badly set up from the beginning and it was difficult to correct it later on the project. Although there had been so much effort put in the extranet later on, the interviewee was not happy with its performance. People from other organizations did not put the drawings and the documents they contributed into the right format or the right naming convention, which caused a big problem. There were already too many documents on the extranet and it was very difficult to go back and make revisions.

On the other hand, in another meeting three months after the interview date, one of the senior managers who is at a quite higher level than the interviewee claimed that they had problems in the beginning but these were solved, the system was working well and the project could be nominated as the most successful collaboration environment project. This high level manager added that they would be sticking to Avanti procedures in their future implementations.

In a follow up discussion for the case study, the interviewee was informed of the opinions of this high level manager and was asked whether he had changed his mind on the most successful collaboration environment implementation example. The interviewee said that he still thought the most successful project is the one he identified four months ago and the pilot project still struggled from the format and

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[1] Avanti is an approach to collaborative working enabling construction project partners to work effectively following the Avanti principles which are early access to all project information by all partners, early involvement of the supply chain, and sharing of information, drawings and schedules, in an agreed and consistent manner. (Avanti, 2006)

naming conventions and people did not get used to them yet and failed to use them properly.

This case showed how performance might be evaluated in a completely different way from the eyes of a very high level senior manager and from a person involved in day-to-day activities. The interviewee thought that the new procedure was not user-friendly and the potential descriptive fields in the extranet were not utilised by the users. He added that the emphasis in the new procedure had not been towards getting users to upload themselves, but rather pass to the document controllers to upload. The interviewee thought this could create bottlenecks against the collaborative principle of an extranet. Another factor mentioned by the interviewee regarding the unsuccessful implementation of these new procedures was that senior managers often lack experience in fully embracing of new technologies or processes, especially extranets.

5.3.5 Case 5

5.3.5.1 Background information

This is a contracting organization and the interviewee had 10 years of IT implementation experience.

5.3.5.2 Collaboration environment implementations in the company

The company uses project extranets provided by Asite and 4Projects, and Lotus Notes as electronic document management system internally. The principal extranet provider for the company was Asite, but from time to time they also used 4Projects and Sysnet.

5.3.5.3 Success level and success criteria of collaboration environment implementations

The interviewee indicated that up to 30% of the collaboration environment implementations had failed in achieving the expectations. The organization did not have any success criteria defined and they were checking the performance perceptually after the implementation and trying to understand whether it had been

worth the investment. When the interviewee was asked how the business was affected if it was found unsuccessful after the implementation, the answer given was, *"You cannot undo it. You've given the people the equipment and the tools. If they decide not to use it, they decide not to use it. You cannot take and shoot them, can you? If they decide not to use it, the implementation just underachieves."*

5.3.5.4 User Involvement during collaboration environment implementation stages

The user involvement matrix of the company shown in Table 5.6 and the responses to the open ended questions during the interview showed that the company was not putting their users to the focus. There was a waterfall type of decision mechanism in the collaboration environment implementations. The users were not even involved in the user requirements' capture.

Table 5.6 Case 5 – User Involvement Matrix: Implementation Stages vs Employees

Case 5 User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	X					
Feasibility Analysis	X	X	X			
User requirements capture		X	X			
Design of the technical system	X	X				
Planning the adaptation process		X				
Choosing the optimum adaptation alternative	X	X				
Testing and evaluation	X	X				
Implementation	X	X	X			
Fine tuning		X	X			

5.3.5.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

The interviewee was of the view that employees would always resist and the way to

get them to use the system was to threaten them by using his authority and hierarchical power. This was limited to the employees who were direct employees of the interviewee's firm. He stated that, "*When the resisting people are our direct employees, they do what they are told and they work. If they are from our supply chain, we do not have the same opportunity.*". Coercion was seen as the only way of dealing with the employee resistance in the company.

b) The most successful collaboration implementation

The most successful collaboration environment implementation project was a Lotus Notes implementation on a big motorway project. The interviewee indicated that the attitude of the implementation leader was very important and said, "*It* [the Lotus Notes implementation] *was more successful than the other implementations, because I was in charge of it and I am a bit of an IT nuts and I made people use it.*". He used coercion to get the people to use the system with a "*Use the system or you are out*" approach. Some people decided to leave but the ones who chose to stay accepted the rules. When the interviewee was asked whether this approach created any employee resistance or any friction, he gave an example of the worn out keyboards. In that project people had to use the system without any objection, but whenever they met a problem in the system they were hitting the keys very hard. The reasons which made the implementation more successful, according to the interviewee, are as follows:

1. Senior management's approach of not leaving the employees an option other than using the system;
2. Top level commitment;
3. Training in a classroom of 6-7 people where the trainers gave the employees a hands-on experience.

c) The least successful collaboration implementation

The least successful one was an extranet implementation provided by Sysnet. They wanted to repeat the same principles and procedures of a very successful previous implementation. However, they could not get the client to use it. The designers did not use it either and some of the organizations in the building environment did not have employees capable of using the tools despite training. The interviewee could

not use the coercion he had used in his organization since the employees were not direct employees and he did not have authority over them. Since the collaboration environment was not used by all parties in the project, the collaboration was not successful.

d) Implementing collaboration environment and company specific success / failure reasons

The interviewee considered the collaboration environment implementations as a prerequisite of the business and tried to put them on all his projects and believed that anyone who could use a computer could use a collaboration software. As the employees got used to working with these technologies after a couple of projects, the company did not have pilots before the actual implementation any longer.

The company owned Asite and tried to stay with that in all the projects convincing the other parties to use this one. However, from time to time they used other client-led or designer-led extranet systems.

The company had an IT strategy. The policies were set by the information officer who collaborated with the interviewee during the formulation stage. After the policies were decided, the interviewee followed the instructions given by the information officer.

The interviewee believed that the construction industry was not a "*demand-driven industry*" but a "*solution-led industry*". He did not agree that identifying the needs of the industry and looking for solutions would work for the construction industry. According to the interviewee, the lack of money in the construction industry prevented the industry from investing in R&D and looking for solutions. The construction industry would think of implementing a new technology only if the high profit-margin-industries decided to modify the technologies, which were originally developed for their industry, according to the needs of construction and marketed their technology to construction. The interviewee commented that this was the case for the whole construction industry, not only for the company in Case 5.

5.3.6 Case 6

5.3.6.1 Background information

This was an architecture company and the interviewee had 3.5 years of collaboration environment implementation experience in the company.

5.3.6.2 Collaboration environment implementations in the company

The company used project extranets built by Buzzsaw. Buzzsaw was their main source and the company offered the use of this system to the client to be used in the project and to all the subcontractors working for the company.

5.3.6.3 Success level and success criteria of collaboration environment implementations

The interviewee indicated that between 50% to 70% of the collaboration environment implementations in the company had failed in achieving the expectations.

According to him, *ease of transfer of information, no repetition of information and ease of communication* were the characteristics that define a successful collaboration environment implementation. However, measuring the success level of a collaboration environment was found very difficult. The company was trying to measure efficiency through measuring "*how many times drawings are readdressed during the project*". According to the interviewee if there was a clean flow of information and a clean flow of communication via the collaboration environment, there should not be too many drawings going forward and backward, it should just be going forward and stepping forward.

5.3.6.4 User involvement during collaboration environment implementation stages

The user involvement matrix completed by the interviewee is given in Table 5.7. It is seen that most of the decisions are controlled by the senior managers and the IT manager of the company.

Table 5.7 Case 6 - User Involvement Matrix: Implementation Stages vs Employees

Case 6 User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	X		X			
Feasibility Analysis	X	X				
User requirements capture	X	X			X	
Design of the technical system	X	X				
Planning the adaptation process	X	X	X	X	X	
Choosing the optimum adaptation alternative	X	X				
Testing and evaluation	X				X	
Implementation		X	X		X	
Fine tuning	X	X		X	X	

5.3.6.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

The interviewee defined the company as an IT-oriented company and added that they did not meet much employee resistance in implementing collaboration environments. However, the whole office was not using Buzzsaw, as the use was limited to certain teams. They tended to use it in the detailed design process and the whole team, usually consisting of 5-6 people for this process, knew how to use it. These teams did not create any resistance in the projects. On the other hand, there was some user resistance from the individuals in the contracting companies and the subcontractors involved in the project.

The interviewee likened the source of resistance in the collaboration environment implementations to the adoption of computer aided drafting in the 1980s: "*If you have somebody who has been doing the job for 40 years and they have been doing it with pen and pencil, it is hard to convince them of the advantages or just get them in front*

of a computer or a CAD drawing."

The interviewee thought that the biggest difficulty was the education. They had got some contractors and subcontractors who wanted to use the collaboration environment and were capable of using it, but they were making some fundamental mistakes since they were not experienced in its use.

b) The most successful collaboration implementation

A regeneration project they currently had at the date of interview was considered by the interview to have the most successful collaboration environment. The technology used was Buzzsaw. The extranet was led by the case study company and had buy-in from both the consultants and the contractor involved in the project.

According to the interviewee, what made this implementation more successful than the others was the experience they gained from the previous projects on the following subjects:

1. Communication: This was considered the most important factor. With time they realised that the languages they used were not clear and concise enough to establish communication between remotely working parties. They improved their communication in this project.
2. Organizing methods and systems: They started to formalize the drawing names and conventions and tried to get the other parties to stick those conventions.
3. Reasonable time estimates: In the earlier projects they underestimated the time required, thinking that the system could do everything for them and reduce the project time significantly. This previous experience helped them to anticipate reasonable project times and make more realistic schedules in the last project.
4. Reliance on the data and ownership of the data: In the previous projects, when they downloaded data created by another party from the server, they were not sure whether the data was reliable, and started to carry out regular checks. They started to activate e-mail notifications to clarify who should take the

responsibility for the information in the server and to distinguish between draft, official and revised data.

c) The least successful collaboration implementation

The interviewee did not think that they really had a bad one, but added that their first extranet implementation was not very successful. They were collaborating with their subcontractors in South Africa using Buzzsaw. These subcontractors were doing all of the laying out of the building on site and all its coordination, and were taking the structural information and incorporating it into the detailed design. They did all of the drawings to comply with the Building Regulations. But the technology was not properly understood by the company or the subcontractor. In their communication, neither of them was clear and precise enough, which caused some problems in the collaboration.

d) Implementing collaboration environment and company specific success / failure reasons

The interviewee was of the view that the success of collaboration environment implementations is heavily dependent on the people involved in the environment. He stated they obtained different results for each project extranet built by Buzzsaw due to different collaborating parties with different organizational cultures.

The interviewee indicated the importance of having a balanced level of IT infrastructure between the collaborating parties. There are many small subcontractors working on small but very important aspects of the project but have low IT capability and knowledge. The interviewee was thought that including the subcontractors as users of the collaboration environment would improve the efficiency of the collaboration provided that the subcontractors have the appropriate skills to participate in the project extranet.

They had been using Buzzsaw for four years and had not used any other tool yet. Since they owned Buzzsaw, they offered it to the other parties in the projects they were involved in. However, the interviewee also stated that they could use tools other than Buzzsaw as long as they were easy to use and suitable to the culture of the

organization.

Four years ago, the company realised that they were at a threshold. The company had grown too fast and could not cope with the amount of the work coming in. Consequently, they started to use subcontractors for the jobs abroad. In order to have an organized formal communication medium and to control the jobs done by the subcontractors they introduced extranets. They introduced the changes very slowly, using two of their very small projects as pilots to see what benefits and problems may arise. They had problems in the beginning but analysing them thoroughly, they understood the problems were not related to the system but to the way they were working. Over the last four years, they kept improving the way they work to increase the success level. They fixed their conventions, created a manual and started to give it to the parties they were collaborating with.

They had the most difficulty in the detailed design stage during the redlining process. When they first bought the system they thought the system would solve all their problems, but they realised that they had to take extra measures. They tried to refine the redlining system, defining some common conventions for symbols, and imposed these conventions system on their subcontractors from Day 1.

They had a work group investigating collaborative working, the use of Buzzsaw and how they can improve things using the benefits of Buzzsaw. They regularly reviewed and improved the process and were currently producing a manual to further formalise their systems.

5.3.7 Case 7

5.3.7.1 Background information

There were two interviewees in this architecture company. The first one was an Associate of the practice with an architecture background who gave a broader perspective; and the second one was a Document Controller who answered the questions related to day-to-day activities.

5.3.7.2 CE implementations in the company

The company used project extranets built by BIW, 4Projects, Buildonline, Project Web, Project Net , and Cadweb .

5.3.7.3 Success level and success criteria of collaboration environment implementations

The Associate indicated that up to 30% of the collaboration environment implementations had failed in achieving the expectations.

He also indicated that they did not have success criteria defined for the collaboration environment implementations and was of the view that they were not saving any money in using collaboration environments. The Document Controller, on the other hand, indicated that ease of use was considered the main success criterion but they did not have any measures to check it. They had a perceptual performance measurement for the collaboration environments implemented.

5.3.7.4 User involvement during collaboration environment implementation stages

Stating that the company had not actually been involved in the implementation of collaboration environments but participated in the environment (via the Document Controller) after everything had been set up by either the client or the contractor, the interviewees did not fill in the user involvement matrix. None of their employees were involved in any of the decisions regarding collaboration environment implementations other than agreeing on protocols and file formats to be used.

5.3.7.5 How the collaboration environments were implemented and the factors affecting their success

a) Employee resistance

The interviewees stated that they had had some employee resistance in the early days of extranet implementation but that this had evaporated. They had been using extranets for some time and the employees had become used to them. On the other hand, they had some user resistance in the redlining process due to the difficulties of

online redlining.

b) The most successful collaboration implementation

The Associate was not able to identify the most successful collaboration environment saying their experiences in all of them were pretty much the same. On the other hand, the Document Controller, who was more involved in day-to-day activities, was aware of some differences. In the projects with the most successful collaboration environment implementations, the extranets were set using BIW and led by either the contractor or the consultant. The main reason for the success was the ease of use. The high speed available in the system also played an important role in the success.

c) The least successful collaboration implementation

Integration, the first implemented collaboration tool in the company, was considered the least successful implementation. It was implemented in 2000-2001. The poor design and planning of the system resulted in many problems after the implementation. There were several connectivity and speed problems which resulted in the failure of the system. The system also suffered due to confidentiality issues; for example, a confidential financial document was sent to everybody due to the lack of necessary security checks.

d) Implementing collaboration environment and company specific success / failure reasons

The company had the greatest difficulty in the redlining process. They did not find the online redlining process practical due to the poor user interfaces and the incapability of the current technologies to support the high resolution required by the architects in the process. They preferred to mark up on the paper, scan the paper and upload the scan to the system.

Half of the projects delivered by the company involved extranet implementations, but the company had never led the collaboration on a project; it was either the client or the contractor taking the lead. They had thought of developing their own system and offering it to their clients, but they neither made a plan nor took any action regarding this issue since they thought that the contractors would not be very pleased with

giving the control to another party. They had some trust issues when the extranet was led by one of the parties in the construction project. The interviewees considered the existence of a third party setting up and managing the extranet objectively as the best option to overcome the trust issue.

It was interpreted from the overall interview that the extranet was conceived as a database system rather than a live communication and collaboration system. Although some collaboration environment implementations were considered to be more successful than others, they were generally considered to provide similar outputs with similar efficiencies. They did not put any effort into the change management process during the implementation. Likewise they did not have any feedback mechanism in the design, implementation or post-implementation stages. After the extranet was implemented, the employees were expected to ring a helpline if they had difficulties in using the system. However, this helpline was not considered a feedback means for fine tuning the system.

The company did not change the way they were working when they started to implement extranets. They had been issuing paper documents from the Document Control Department before the extranets were implemented in the company. After the implementation of the extranets, the electronic documents were issued through the same path.

In the previous extranet implementations, the training lacked the depth which the users would need. Another problem involved bringing the employees together for the training. The architects did not attend most of the training sessions with the reason that *they had more important things to do* or *they actually got work to do*. They were observed to be more reluctant in using the technology if it was not mandatory for them to carry out their own tasks. Therefore, the architects kept to their own methods of working; their outputs were transferred to Document Control and from there to the other parties involved in the project. Likewise, the company did not like to be forced to use some specific document types for information transfer. They wanted the collaboration environments to be as flexible as the way they normally work as much as possible.

5.3.8 Case 8

5.3.8.1 Background information

This company was providing a collaboration technology which was widely used in the construction industry. The interviewee had a sociology background but had been working in the construction industry for 17 years, 6 years of which was in the case study organization. He had not been implementing collaborative technologies directly but he had worked with project teams throughout that time and visited project sites regularly. He had received considerable feedback from the construction industry practitioners through project review meetings.

5.3.8.2 Success criteria for collaboration environments

The perceptual analysis they do for the success of their collaboration environments is checking whether companies implementing them are satisfied and whether they plan any future implementations.

The interviewee said that they were using the following questions as objective measures to find out what cost savings might have been achieved compared to the conventional method, where they used a paper based system:

- Tangible benefits such as savings on print distribution, storage and management and drawings: "*How many drawings were produced?*", "*How much would it have cost to produce those drawings and distribute them in paper-based form*?"

- Intangible benefits: "*Did we have more or less rework*?", "*Did we have more or less drawing revisions?*", "*Did we have more or less RFI's*?", "*How long did it take to resolve our RFI's*?".

5.3.8.3 How the collaboration environments were implemented and the factors affecting their success

a) The most successful collaboration implementation

The most successful collaboration environment implementation was on a project with the Ministry of Defence. The project had a prime contracting approach, where a

group of construction companies got together under the leading of one company. The technology company made data available to every team member through a secure, project-specific Web site. They could use the tool to flag up issues very quickly and to get people sharing the same information. Emergency issues were often resolved in a matter of minutes rather than hours of meetings. The reasons which made this implementation more successful than the others were:

1. They had a very strong partnering charter/ethos;
2. All participants in the project committed to having an open and transparent plane of sharing information;
3. There was someone to wield the stick if necessary;
4. It was written into the contract that a collaboration environment will be implemented and used by all partners;
5. The technology usage started at the very beginning of the project;
6. People and processes were aligned accordingly;
7. They trained the trainers, who then became an effective local source of help for other users within the company.

b) The least successful collaboration implementation

The interviewee could not identify a particular project that was unsuccessful. He commented that the least successful ones had the following common characteristics:

1. People reverted back to confrontational, adversarial attitudes. Some employees refused to use the system or tried to bypass it in some way. These issues resulted in the failure of the system.
2. The contractors (particularly) were not comfortable with the transparency of the system; it was both a trust issue and a cultural issue.

c) Employee resistance

According to the interviewee, most of the employee resistance in construction resulted from unfriendly user interfaces. The interviewee believed that his organization had moved well away from unfriendly user interfaces and managed

to offer interfaces according to the user needs and requirements. Therefore, the company did not observe much company-wide employee resistance in the companies implementing the technology. If there was any employee resistance, it was mainly on an individual basis and the reasons were down to: *culture, individual training, professional training, attitude, and ability to change.* The interviewee was of the view that dealing with individual resistance was not very difficult if all the other project team members were committed to making a change. The project team has to overcome that individual's resistance, basically *by moving the employee out of the project team altogether because he has been an obstacle and replacing him with someone who is much more willing to use the system.*

Based on his experience in the previous projects where resistance from the old employees were observed, the interviewee suggested that employee resistance could be related to the age and professional attitude of the employees. Getting the employees to see that using the new system is an added value to the success of the project, and effective training were considered to play an important role to overcome this resistance. The interviewee believed in the importance of involving these experienced people in the collaboration although their adaptation would be slower and more difficult.

Top level management commitment, 'someone putting the foot down', and collaboration champions with enthusiasm were listed as the ways to handle employee resistance. The interviewee also underlined the problems of current performance measurement systems in construction stating that *the performance measurements* [of the employees] *were mainly based on their personal/individual endeavour rather than their ability to be a team player.*

d) Training

The company offered the companies implementing their technology a different training approach. Firstly, a number of employees from the company implementing the technology were trained by the technology company giving them probably more knowledge than they would need to use the system. These first recipients of the training then became trainers for the other employees when they got back to their

organizations.

e) Collaboration environment approaches according to types of construction organization

The interviewee thought that one of the biggest difficulties in the collaboration environment implementations on a construction project was to get the architecture companies to use the system. According to the observations of the interviewee, the architecture companies would use a collaboration environment only if the contractual agreement with the client obliged all team members to use the collaboration system. He was of the view that this unwillingness to use the technology resulted from the incapability of the technology to allow them work in their ways, especially in the redlining process. The resolution in the current systems was found insufficient for the marking up by the architects.

The interviewee also observed that most architecture companies chose to do the work (especially the redlining process) in the traditional way, without using the collaboration environment, and to delegate the role of inputting all of their comments, sketches and mark ups to the system to a junior member of staff rather than doing it themselves.

The interviewee did not find much difference between contractors and consultancy companies in the collaboration environment implementation approaches. However, the transparency of the system was found to affect the approach of the contractors more than the other participants in a project. The more transparent the collaboration environment got, the less trust was observed in the contracting companies by the interviewee.

f) Timing of collaboration environment implementation in the project

Another factor mentioned by the interviewee affecting the success of the collaboration environment was the timing of the implementation during the project. If collaboration environment was introduced to a project team which was already formed from employees who had not used a collaboration tool before, the adoption would be difficult. If it was introduced to this team when the project was already

somewhere down the line, the result would most certainly be disastrous.

g) Learning curve

The experience of users on the collaboration environment influences the success of the collaboration. As the project team moves from one project to the next one with the same collaboration technology, they go through a learning curve. As they get more familiar with the technology, if other conditions are similar, the success of the collaboration environment will increase.

h) Implementation stages

When the organization starts a new implementation, an initial workshop involving the project team would be organized to get the project team members to agree on their project protocol-similar to the PIX (Project Information Exchange) protocol[2]. Learning the processes and the procedures in the company and getting some common agreement on the system to be implemented, the collaboration environment is tailored by the technology providing company. The user interface is developed to be flexible in order to let the individual users adapt.

i) Role of project champion / top level management

The interviewee underlined the importance of the project champions in motivating the employees to collaborate and to use the system. He added that not only the individual performance but collaborating in a team to increase the overall project performance should be rewarded. On the other hand, there should be someone, either the project champion or someone from top level management, putting the foot down to ensure that the collaboration tool is the only way of working in the organization.

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[2] Pix protocol is a negotiated communications protocol for construction projects which aims to find the best fit between the information systems of the client and its advisors, the project team and supply chain involved in the project. It has a checklist for information such as what applications are currently used, what tools and which versions are being used, and what file format is preferred for information exchange, mark-up, naming and numbering conventions (Pix Protocol, 2006).

5.3.9 Case 9

5.3.9.1 Background information

The interviewee had been working in the company for 6 years. Before joining the case study company, he had worked in another technology providing company for 5 years, involved in data exchange, working standards, and running project groups.

5.3.9.2 Success criteria for collaboration environments

According to the interviewee, the key success criteria were whether people had started to trade electronically, whether they were happy with it and whether they wanted to do more of it. On a single implementation project, the objective success criterion was set as 'on time and on budget delivery'. The interviewee underlined the difficulty of specifying a universal cost. Therefore, the measures looked for were answers to questions such as *"How many companies use the technology?"; "How many people are trading?"; "How many documents are sent electronically?", "How many people and supply chains are connected?". "How much has been saved by communicating through these systems rather than traditionally sending paper documents to people?".*

5.3.9.3 How the collaboration environments were implemented and the factors affecting their success

a) The most successful collaboration implementation

The most successful implementation was on a project aiming to integrate the BP back office systems into the collaboration system where they could initially send invoices through to some of the contractors to buy bitumen from them. The reasons that made this implementation more successful than the other implementations were specified by the interviewee as follows:

1. The company had gained considerable experience in implementing that specific collaboration system by the time they worked with BP;
2. The client was very structured about their approach. Therefore, there was a very good match between the client and the technology providing company.

They had a project kick-off meeting, at which they identified the project teams on both sides. They had review meetings whilst implementation went forward and they had a sign-off meeting at the end;

3. They determined some rules before the start of the project and they stayed with those rules during the implementation.

b) The least successful collaboration implementation

This involved the same collaboration system as above but on another project. The extranet was designed and the actual testing was successfully carried out. However, just before the implementation was to be launched, one of the companies imposed additional requirements which had not been previously mentioned and which the case study organization could not incorporate into the system. The other company in the project was not happy with the additional requirements and the new conditions arising from them. The interviewee stated that, *"It was very difficult, because contractually we have done everything we were required to, but they weren't going to make progress until those issues from them were resolved."*. Although they thought all requirements were fixed before they started, they were not. Therefore, the case study organization started a self audit and questioned whether they asked all the questions to the companies that they should have asked or whether this requirement was not an issue in the beginning but became an issue as they got further down the road. There was a pause in the project and there was a discussion between the two companies on whether to use the system and the case study organization could do nothing about it. Eventually the two companies managed to reach a consensus and the case study organization finished the project. The project was running smoothly at the date of the interview.

c) Employee resistance

The interviewee thought that the employee resistance problem was not as big as it used to be 2-3 years ago or 5 years ago when collaborative technologies were new. In some previous projects, the interviewee observed employee resistance having a negative impact on the project, almost trying to end the process purely because they did not like the idea of a collaboration tool. The interviewee was of the view that the case study organization had moved from resistance to engagement, involving the

users in the design process. According to him, there was still some resistance from the employees but not to the extent of employees working almost intentionally to stop the collaboration environment making any progress. He did not think that there was a big amount of employee resistance in the construction industry since people were getting much more comfortable and familiar with the technology being used.

In his experience, the age of the employees did not make a difference in the amount of resistance. The companies that work with this case study organization mostly had old employees who were aware of the importance of the technology for the success of the work they were doing and were actually looking for someone who would work closely with them and give them support. Some of them were not able to assimilate the technologies as quickly as a younger employee would but this did not mean that they could not constructively engage with the technology providers who could help them cut the costs or increase the success of a project.

d) User involvement

The case study company believed in the importance of determining the user needs before the implementation, to understand how they did the things in the organization, what the requirements were, what the processes for approval and sign off were and what they expected the collaboration environment to achieve. The interviewee believed that there was a big chance that the collaboration environment would crash if these were not sorted out.

When a construction company wants to implement the case study organization's technology, people from three levels in that company are engaged in the requirements capture and interface design stages. The first one is the business owner (i.e. the one who is spending the money and who is therefore the main decision maker). The second is normally a technical person, or IT contact, to arrange the resources for work. The third person should be an operational person who will use the system.

e) Training

Training was tailored according to the customer requirements. Some customers wanted an upfront training before they actually made a commitment with the technology company, and the actual training after the product was designed to

generate customer-specific functionality. However, in most cases there was only one training session which tended to happen in the post implementation stage.

f) Learning curve

The construction people were observed by the interviewee to become more familiar and more comfortable with the technology since the technology had been used for a while and they expected more from the system and tried to adapt the approach to different projects in an enhanced way. Each project was more successful than the previous one and less resistance was observed.

g) Top level commitment

It was indicated by the interviewee that it was necessary to involve top level managers in the implementation to facilitate the adoption. However, he also gave an example of a difficulty he witnessed in a big collaboration project for which two senior people in the company at the same level were responsible. These two people had a conflict on an issue and the project had to be suspended until the conflict was resolved.

5.4 Discussion of Results

The findings from the analyses are discussed under four headings:

1. Collaboration technologies implemented;
2. Success level and success criteria of collaboration environment implementations;
3. User involvement during collaboration environment implementation stages;
4. Factors affecting the success of the collaboration environment.

5.4.1 The Collaboration Technologies Implemented

The most common collaboration environments implemented by the interviewed companies were project extranets provided by various technology providers. The collaboration technologies implemented in the companies interviewed are

summarised in Table 5.8.

Table 5.8 The Collaboration Technologies Implemented in the Last 5 Years.

	Collaboration tools used
Case 1	Project Extranets (Buzzsaw, BIW, Asite, 4Projects) Plan Weaver Shared drives Net meeting Video conferencing White boards 3D modelling
Case 2	SAP Extranets (BIW, Business Collaborator, 4Projects, Buildonline) Their own EDM
Case 3	Extranet systems by BIW Information Channel, MENTOL (an accounting system) Intranet system by Inter-link
Case 4	Extranets by 4Projects (all the time), BIW Project nets by Athena, Sysnet
Case 5	Project extranets (Asite is the principal one, 4Projects) Lotus Notes as EDMS
Case 6	Project extranets built with Buzzsaw
Case 7	Project extranets by BIW, CADWeb, 4Projects, Project Net, Project Web, Buildonline

5.4.2 Success Level and Success Criteria of Collaboration Environment Implementations

When the interviewees were asked about the success rate of the collaboration technologies, it was found that up to 30% of the collaboration technologies implemented failed to provide the full benefits expected whereas in Cases 1 and 6, a

higher failure rate range of 50-70 % was specified.

With regard to the success criteria for their collaborative IT implementations and how they measure the extent to which implementations satisfy these criteria, the interviewees revealed that they mostly did a perceptual analysis of whether their employees worked better than previously and whether they were more efficient or more effective than previously. Compared to previous projects, the decrease in the number of complaints from the employees, in the number of requests for information, in the amount of rework or decrease in the amount and extent of problems during the project, were some examples of their perceptual success analysis. However, these indicators are not only related to the success of the collaboration environment; they are affected by many other organizational and project level factors. Therefore this perceptual analysis does not measure the success of the collaboration environment alone. In Cases 4 and 6, the success of collaboration environment was assessed by calculating the tangible benefits in terms of cost savings or time savings via comparisons with cases where paper-based systems were used. However, these comparisons would fail in measuring the efficiency of the collaboration tool since, sometimes, the documents are exchanged electronically via e-mail or ftp without the use of the collaboration tool. Furthermore, the values calculated this way would only reflect the benefits obtained due to the automation of the communication and not necessarily the collaboration tool.

Measuring the intangible benefits such as the savings due to decrease in rework and requests for information (RFI's) due to the use of the system was found difficult by the companies. When they needed to measure these, they either chose to do a perceptual analysis or measure the construction project instead of the collaboration tool against a number of benchmarks or key performance indicators defined at the very beginning of the project.

The technology providers stated that specifying a universal cost saving was difficult and hence they chose to carry out perceptual analysis for the success of collaboration environments (and hence their success) by trying to identify whether companies implementing them were satisfied and whether they plan any future implementations.

The architecture company in Case 6 defined 'ease of transfer of information', 'no

repetition of information' and 'ease of communication' as the characteristics that define a successful collaboration environment implementation. The company was measuring "*how many times drawings are readdressed during the project*" in order to assess the efficiency of the collaboration environment. According to the interviewee, if there is a clean flow of information and a clean flow of communication via the collaboration environment, there should not be too many drawings going forward and backward, it should just be going forward and stepping forward.

None of the perceptual analyses carried out by any of the companies managed to judge the performance accurately. They were mostly subjective and did not include the views of the end users. These analyses failed to provide results that could be used as feedback for future implementations.

5.4.3 User Involvement during Collaboration Environment Implementation

Many authors divide the collaboration environment implementation process into a number of different steps. In the light of the previous research, nine steps were defined in this research for the collaboration environment implementation process:

1. Recognizing the need for a new system;
2. Feasibility analysis;
3. User requirements capture;
4. Design of the technical system;
5. Planning the adaptation process;
6. Choosing the optimum among the adaptation alternatives;
7. Testing and evaluation;
8. Implementation; and
9. Fine tuning.

The interviewees were given a list of users consisting of 1) senior managers; 2) IT manager; 3) construction project manager; 4) external IT specialists; 5) end users; 6) external change agent/consultant, and were asked to identify who were actively

involved in the different steps of the implementation procedure. The technology providing companies were not asked this question since they would not be able to respond based on their own experience. Likewise, Case 7 did not answer this question stating that the company had not actually been involved in the implementation of collaboration environments but participated in the environment via the Document Controller after everything had been set up by either the client or the contractor. The company was not involved in any of the decisions in the collaboration environment implementations other than agreeing on protocols and file formats to be used. None of the employees other than the Document Controller actually used the collaboration environment. All the work regarding the collaboration environment such as uploading or downloading a file to the system was carried out by the assigned Document Controller.

The results obtained from six cases are shown in Table 5.9. The numbers in the boxes indicate the number of companies stating that the user listed in that column is involved in the collaboration environment implementation step shown on the left side of the box. For example, all companies answering this question stated that senior managers and IT managers were involved in "Feasibility Analysis" stage, therefore these boxes have the number '6' meaning that "6 out of 6 companies". The number of companies stating that construction project managers are involved in this stage was 3 whereas for end users and external change agents it was only 1 company.

As seen from Table 5.9, it was found that IT Managers were involved in almost all stages. In Cases 4 and 6, they were not involved in "Recognizing the need for a new system", this was left to the construction project managers. Likewise in Case 3, "Choosing the optimum alternative among the alternatives" was left to the senior managers of the company rather than the IT manager. In both of the consultancy companies (Cases 1 & 2) and in Case 3, the end-users were also involved in recognizing the need for a new system. In Case 6, the senior managers and the construction project managers were involved.

Table 5.9 User Involvement in Collaboration Environment Implementation Steps (Total number of companies=6)

User Involvement Matrix	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system	6	3	4	0	3	1
Feasibility Analysis	6	6	3	0	1	1
User requirements capture	3	5	4	1	4	0
Design of the technical system	3	6	1	3	1	1
Planning the adaptation process	4	5	2	1	3	1
Choosing the optimum adaptation alternative	5	5	1	0	1	0
Testing and evaluation	4	5	1	1	5	0
Implementation	2	5	3	2	3	0
Fine tuning	3	6	1	2	3	0

In the design of the technical system, planning of the adaptation process and choosing the optimum from the adaptation alternatives, the main decision makers were IT managers and senior managers, whereas in the user requirements capture either the construction project managers or the end users were also involved in the decision making.

The case studies showed that the involvement of end users was limited to user requirements capture, and to the testing and evaluation of the system if the implementation involves any. In all cases, end users were involved mainly at the training stage after the system had been implemented. Most companies have started using a different method of training to improve quality. Instead of training a large number of employees in one classroom together, they now train them at different levels and changed the training process from a theoretical to a practical basis. When they start on the job, the trainers stay in the company during the adoption stage and

help the users. This method initially costs more than the classroom training but in the long term the costs decrease since the users get used to the system quicker and the complications or problems during the adoption stage are solved faster. This new type of training will also result in employees creating better work. On the other hand, in the architecture companies, most architects working under strict deadlines did not want to attend the training sessions with the reason that they needed to use that time for the project they were currently working on. This is one of the reasons why document controllers have an important role in the collaboration environments in the architecture companies.

When the overall information was analyzed, it was seen that the IT managers had a very active role in almost all stages of collaboration environment implementations. This situation is one of the results of "too much focus on IT" approach in the collaboration environment implementations. And the more IT people are involved in the implementations, the more focus on IT is observed. On the other hand, this situation can be used positively if the IT managers can be influenced to consider people and organizational factors more in the implementation. If IT managers consider the change management concepts in the design and implementation of the collaboration environments, they may play a more important role in the adoption process.

5.4.4 Factors Affecting the Success of the Collaboration Environment

Various failure reasons were identified by each interviewee and most of these were found to be interrelated when investigated together. These include: employee resistance, inconsistency of the contract terms regarding the collaboration tool to be used, and insufficient training. Cultural problems, lack of trust, and unsatisfied user requirements were also mentioned by all of the interviewees as failure reasons.

The case study results are discussed below with respect to the key issues for collaboration environment implementations highlighted earlier in Chapter Two.

5.4.4.1 User Involvement

When the companies were asked how they implement a new collaboration environment, and how they handle the changes occurring in the system, the

organization and processes, the responses were mainly limited to *training*. In parallel with the findings from the literature review, it was observed that the companies that do not involve the users in the requirements capture stage complained more about user resistance.

The importance of *top level commitment* as a success factor was underlined by most of the interviewees. If a change is to be introduced to an organization, the top level managers should first believe that this is necessary and act accordingly. They will have two roles: first act as collaboration chiefs and manage the implementation, and secondly ensure that the employees in the organization use the system. If an implementation is left optional, the employees will continue to follow their old ways. They will not make an effort to get used to a new system. Therefore, the senior manager must make it very clear that the new system has to be used in the organization. On the other hand, especially in Case 5, it was seen that if this push was implemented in terms of coercion, then the employee resistance to change would not be observed but it might be transformed into a hidden rage which might create more problems in the future. Pushing users to use the system should not be by coercion, but may involve making people know that they will have to face the consequences if they are not using the system, which is referred to as "waving the stick" by many interviewees.

The technology providing companies in Cases 8 and 9 indicated that in projects where more than one senior manager was in charge of managing collaboration, the implementation was adversely affected if they had conflicting opinions. Sometimes, it resulted in long delays in the project until the conflict was resolved.

The case studies showed that there was no formal way of obtaining end user *feedback* throughout the implementation in any of the organizations. In some of the organizations, if the implementation included any testing or validation stage, the end-users were involved.

5.4.4.2 User Resistance to Change

Early user involvement, *user friendly interfaces* and *training* were found to be the critical success factors for reducing user resistance to change. While organizations

may not be able to change the user interface of a given system, they can have direct impact on the timing of end-user involvement and the quality of the training provided.

5.4.4.3 User Requirements Capture

It was found that the companies did not have a formal method for capturing user requirements and only 3 companies focused on a sample of end users in order to get feedback after the CE was implemented.

5.4.4.4 Proper Planning / Project Management

Lack of agreement between parties was found as the main failure problem in this category. It is necessary for the collaborating organizations *to agree on the common formats, types and conventions* for the information exchange before the collaboration environment is set up, to provide consistency and avoid possible confusion. *Incompatibility of the processes*, lack of *contract clauses* regarding the collaboration use, and lack of *clear guidance and prospectus* were found as other factors affecting the success of collaboration environments.

5.4.4.5 Technical Factors

The *interoperability* problems, *IT incompatibility* of the collaboration environment, *unfriendly user interfaces, low speed of transfer* and *data security problems* were mentioned as the main failure reasons from the technical point of view.

5.4.4.6 Buy-in from all parties

All of the interviewees stressed the importance of the collaboration tools being used by all parties for the success of the whole project and they stated that it should be ensured either by mutual agreement or included as contract terms. The importance of contract terms regarding the collaboration environment used for external communication was particularly emphasized by companies. The contract should be binding for all companies participating in the project to make sure there are consistent procedures for the use of the systems. Issuing the documents through the Document Control Department, as in Case 7, could not be considered as a complete buy-in.

5.4.4.7 Trust factor

Enabling trust between the collaborating parties and the security of data were mentioned by all interviewees. It is important to ensure that the data on the system can be accessed only by the appropriate parties. Furthermore, the transparency of the system should be adjusted to a level that each private organizational data is safe on the system. This was considered as a very important factor especially by contracting companies since they did not want to lose their bargaining power and their benefits from the claims for additional work carried out or similar work. It has been interpreted from the case studies that the reservations will be less if the type of information to be shared and the extent of sharing are fixed at the beginning. The architecture company in Case 7 thought that the trust issue could be solved if the collaboration environment was implemented and led by a third party whereas the other architecture company (Case 6) suggested that the collaboration environment should be led by the architecture companies since they are involved in the project from the very beginning and stay till the end.

To summarise, the success of collaboration is found to be affected by a number of factors related to organization, people or technical issues. When the effects of these factors were investigated one by one, based on the views of the interviewees, it was found necessary to categorize them into two groups: factors affecting the collaboration at the organization level, and factors affecting the collaboration at the project organization level. These factors are shown in Figure 5.1.

The interdependency of some of the factors shown in Figure 5.1 was mentioned directly by the interviewees. Further relationships were revealed after the analysis of the case studies. These relationships were interpreted using the systems thinking approach and a causal loop diagram (CLD) was developed in order to represent the current situation regarding the organizational dynamics during the introduction of a new collaboration environment to an organization. The CLD and the steps followed to develop it are explained in the next section.

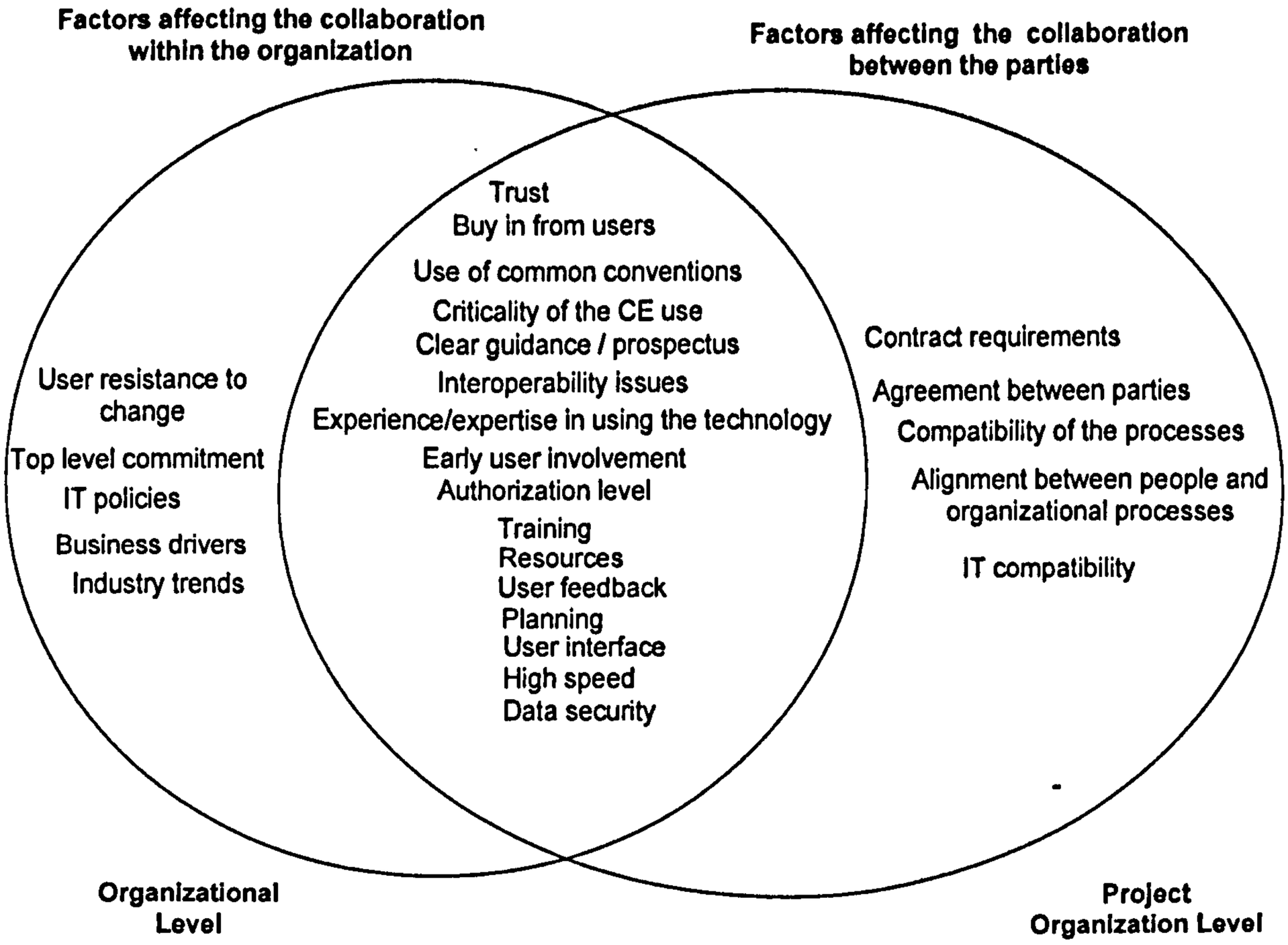

Figure 5.1 Factors Affecting the Success of Collaboration at the Organization and at the Project Organization Level

5.5 Systems Thinking Approach

5.5.1 Systems Thinking Concept

Systems thinking is a method to enhance learning in complex systems and is fundamentally interdisciplinary. It is based on the ideas, *"You cannot just do one thing"* and "*Everything is connected to everything else*" (Sterman, 2000). According to systems thinking there are no side effects; there are just effects and feedbacks. The feedback structure of systems are represented by causal loop diagrams which are considered to be excellent for (Sterman, 2000):

1) quickly capturing the hypothesis about the causes of the dynamics;
2) eliciting and capturing mental models of individuals or teams;
3) communicating the important feedbacks that are believed to be responsible for a problem.

CLDs provide a significant level of assistance to thinking by introducing circular causality and providing a medium by which people can externalize mental models and assumptions and enrich these by sharing them (Wolstenholme, 1999). The causal loop diagram elements and their explanations are explained in Table 5.10 The links are assigned focusing on the relationship between two parameters only and ignoring the interaction of all other parameters.

Table 5.10 CLD Elements (adapted from Sternan, 2000)

Notation	Name	Explanation
E 	Positive Link	All else equal; if X↑ →Y↑ if X↓ → Y↓ (∂Y/∂x>0)
	Negative Link	All else equal; if X↑ →Y↓ if X↓ → Y↑ (∂Y/∂x<0)
	Positive/Reinforcing Loop	The loop starts with an increase and ends with an increase (or vice versa)
	Negative/Balancing Loop	The loop starts with an increase but ends with a decrease (or vice versa)

In order to explain the causal loop diagrams, an example focusing on the population from the birth and death rate perspectives is presented in Figure 5.2.

Provided that the other parameters affecting birth rate are ignored, if the fractional birth rate increases, the birth rate increases. If there is a decrease in the fractional birth rate, then the birth rate decreases. Therefore the relationship between these two parameters are shown by a positive link.

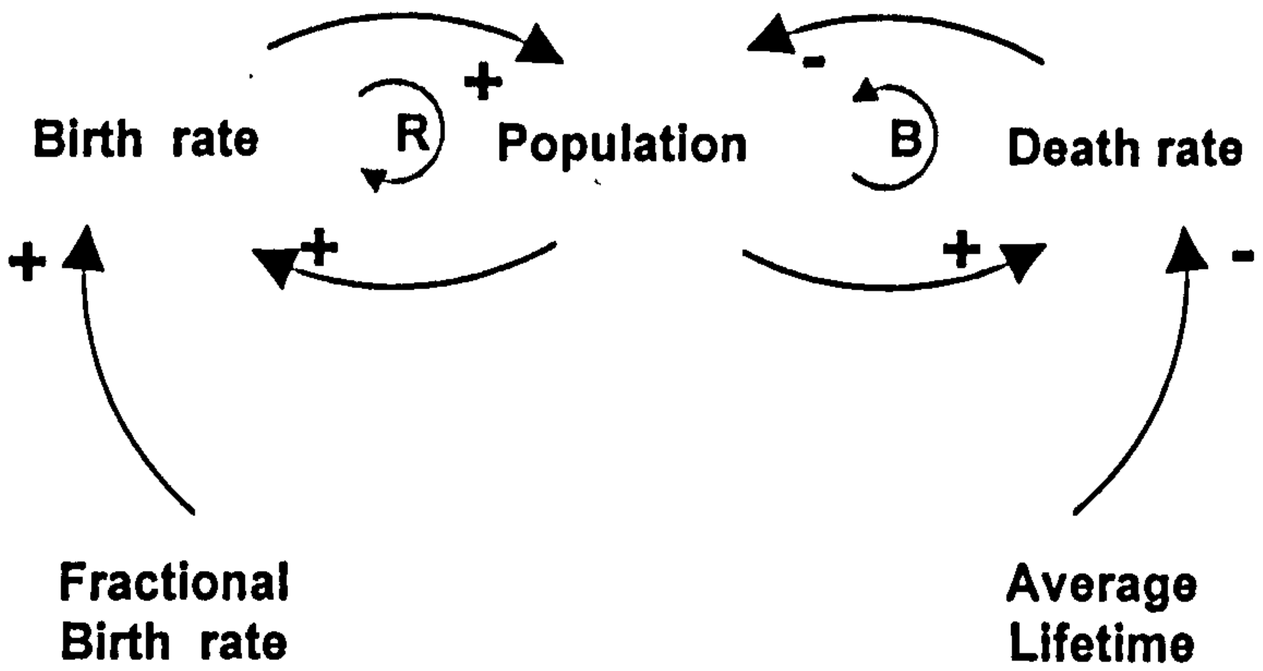

Figure 5.2 CLD for Population (Sternan, 1993)

If the birth rate increases, the population increases. Likewise if the birth rate decreases, then the population decreases. Since these two parameters change in the same direction, the link is a positive link.

Focusing on the relationship between average lifetime and death rate, it is seen that any increase or decrease in average life time is reflected on death rate in the opposite direction. This relation is indicated by a negative link in the CLD.

Any change in death rate makes the population change in the opposite direction. A decrease in the death rate will increase the population whereas an increase will decrease the population. Because of the tendency in the opposite direction, the relation is shown by a negative link.

Whilst the population is affected by the changes in the birth and death rates, any change in the population also affects the birth rate and death rate in the same direction with the change, which will lead to positive feedback links for both rates. These feedback loops will result in two loops.

The first loop is the birth rate-population-birth rate loop, which is a reinforcing loop. If the birth rate increases, the population increases. This increase in the population is reflected on the birth rate as an increase. Therefore the increase in the birth rate will result in a further increase to the birth rate after the loop. Likewise, a decrease in the birth rate will decrease the birth rate after the loop. Since this loop reinforces the tendency in the beginning whether it is a decrease or an increase, this loop is a reinforcing loop.

The second loop is the death rate-population-death rate loop. If the death rate increases, the population decreases. This decrease in the population is reflected on the birth rate as a decrease. Therefore the increase in the death rate ends up as a decrease at the end, therefore it balances the first tendency. If the death rate decreases then the population increases, which increases the death rate, balancing the first decrease. Therefore this loop is a balancing loop.

5.5.2 Systems Thinking for Organizational Issues in Collaboration Environment Implementation

The main organizational issues for the successful collaboration environment implementations, derived from the analysis and interpretation of the case studies are listed below:

1). Criticality of the collaboration environment (CE) implementation for the project success;
2) Binding clauses in the contract regarding the use of collaboration environment;
3) Agreement between parties on the use of a CE;
4) Trust factor: trust between the organizations and trust to the system;
5) Security of organizational data;
6) Top level commitment (collaboration chief role + waving the stick);
7) User resistance to change;
8) Early user involvement;
9) User friendly interface;
10) Training;
11) Consistency of data format and types between organizations;
12) Use of common conventions; and
13) Efficiency of the CE.

These factors are linked to each other. A change in one of the factors influences the

other factors in a positive or negative way. The relationship between two factors is investigated independent of the rest of the factors and is shown by a negative or a positive link. The causal loop diagram in Figure 5.3 shows these relationships and dependencies. For example, top level commitment is found to have dependency on 4 factors as follows:

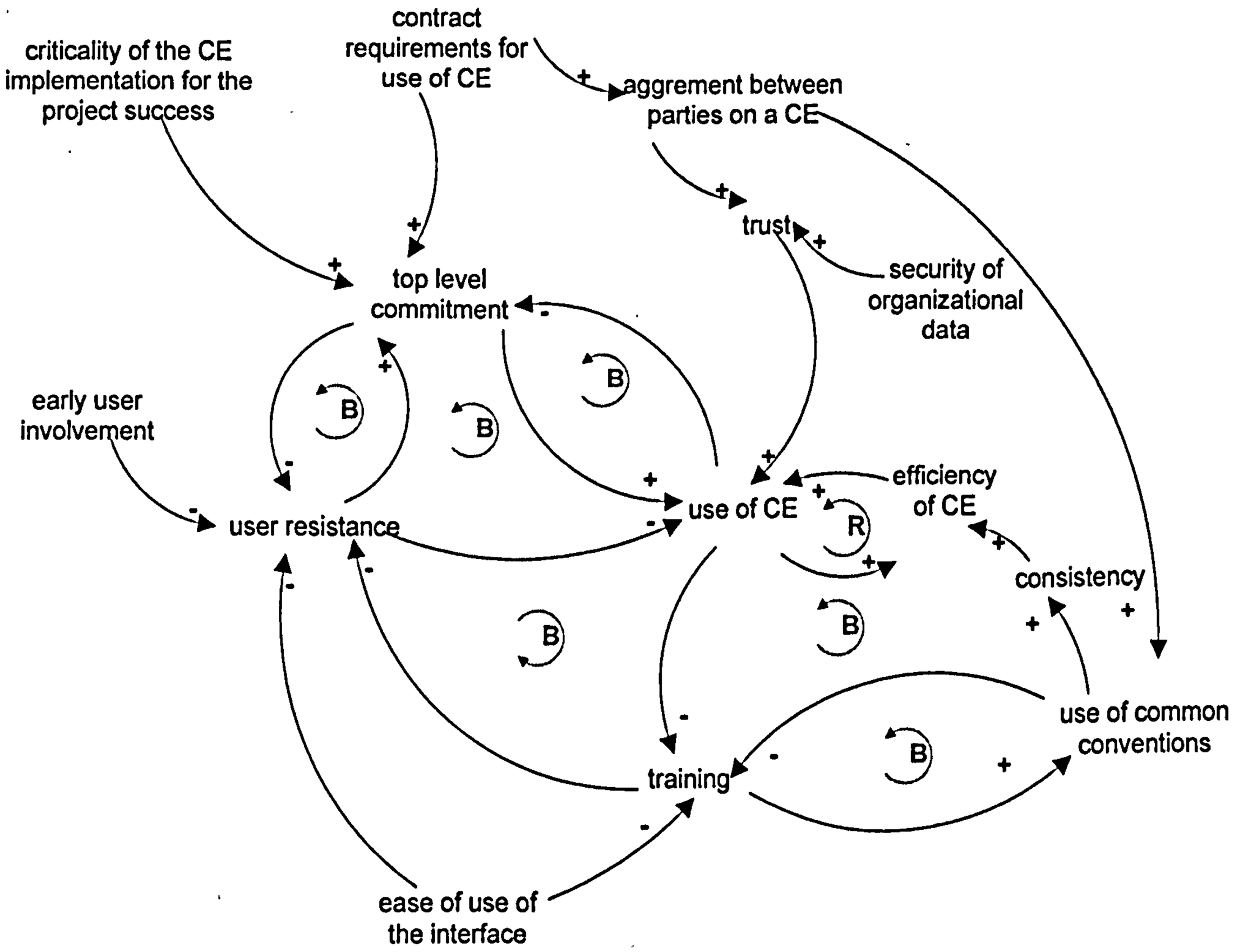

Figure 5.3 Organizational Issues in Collaboration Environment Implementation: Causal Loop Diagram

1) If the use of CE is critical for the success of the project, the top level commitment will increase to ensure the success of the CE and the construction project. If the use of CE is less critical, than the top level commitment will decrease. A positive link is used to represent this directly proportional relationship between these two factors.

2) If there is a legally binding statement in the contract, the top level managers will be more committed to make sure that the organization will not fail to meet their legal responsibilities. If the statement in the contract is less binding, then the top level commitment will decrease. This relationship is shown by a positive link in the CLD.

3) When the top level commitment increases in an organization, the user resistance will be less. As discussed in the case study results section, top level commitment is expected to be a combination of a collaboration chief role and 'waving the stick' role. The employees will be encouraged to use the CE by the collaboration chief. Besides, they will be aware of the negative personal consequences if they do not follow the agreed collaboration method. Top level managers should make sure that there is only one way of doing things in the organization, which is the collaboration method agreed by all parties at the beginning of the construction project. Since a change in the top level commitment affects the user resistance in the opposite direction of change, the relationship is shown by a negative link in the causal loop diagram. Not only the user resistance is affected by the top level commitment; top level commitment is also affected by the user resistance level. When the user resistance increases, top level management will be more involved to solve the problems and to remove the barriers for success. When the resistance decreases, top level management will be more relaxed and less committed. Therefore, the feedback from the user resistance factor to the top level commitment is represented by a positive link due to the directly proportional relationship. The negative link from top level commitment to user resistance and the positive feedback form a balancing loop and is therefore shown with a "B" sign in the diagram.

4) If the top level commitment increases, the use of CE will increase. Likewise, a decrease in the top level commitment will be reflected on the use of CE as a decrease. On the contrary, the feedback from the use of CE to the top level commitment is a negative link. Top level commitment and use of CE relationship will form a balanced loop due to the positive link from top level commitment to the use of CE and the negative feedback link from the use of

CE to top level commitment.

The same approach was applied to the rest of the factors in order to understand the organizational dynamics during the CE implementation. As seen from Figure 5.3, CLD involves 6 balancing and 1 reinforcing loops as follows:

1) Balanced Loop of top level commitment-use of CE-top level commitment;
2) Balanced Loop of top level commitment-user resistance-top level commitment;
3) Balanced Loop of top level commitment-user resistance- use of CE – top level commitment;
4) Balanced Loop of training-user resistance- use of CE- training;
5) Balanced Loop of training – use of common conventions – training;
6) Balanced Loop of training-use of common conventions- consistency – efficiency of CE – use of CE – training; and
7) Reinforcing Loop of efficiency of CE – use of CE – efficiency of CE.

It can be seen from the figure that use of a CE is directly or indirectly linked to each of the factors in the loops or feeding the factors in the loops. In the explanation of the top level commitment, a positive link has been assigned between the contract requirements for the use of CE and top level commitment. The existence of a legally binding statement in the contract also influences the agreement between the parties on a CE through a positive link. When there is an agreement between the parties on a CE, the trust between the parties is enhanced and strengthened and also the use of common conventions is facilitated. The trust factor in the CLD includes trust in the CE as well as the trust between the collaborating parties. The trust in the CE increases when the security of organizational data increases. The trust factor has a direct impact on the use of CE. Therefore, when the trust that the collaborating parties develop for each other and for the CE increases, the use of the CE increases.

The training factor has an impact on two factors: user resistance and use of common conventions. Training reduces the user resistance if it is carried out appropriately and increases the use of common conventions. Training and the use of common

conventions are linked to each other with a balancing loop due to the positive link from training to use of common conventions and the negative feedback link in the opposite direction.

Other than this feedback link from the use of common conventions, training is affected by the ease of use of the interface and use of CE factors. If the interface of the CE is user friendly, then the amount of training required will be less. A user friendly interface will also reduce the user resistance.

The use of common conventions will increase the consistency in the CE which will increase the efficiency of CE. The more efficient the CE is, the more it will be used in the organizations and the more it is used the more efficient the CE will become. When the use of CE increases in the organization, then the need for training will decrease since people will not need any more training.

5.6 Summary

This chapter has presented the results of a case study research in order to establish the current practice of the CE implementations and their success level in UK construction organizations. The conclusions drawn from the analysis of the case studies are summarised below:

- The data collection focused on the overall picture for collaboration implementation in construction projects and approached the problem from the perspective of the whole project. Therefore, the data collected from architecture, contracting and consultancy companies did not differ from this perspective. The differences observed in the data were down to the organizational and cultural characteristics of the organizations and the characteristics of the projects rather than the work area or the type of projects.

- All companies were found to be failing in achieving the full benefits of CE implementations because of the under-estimation (or ignorance) of the people and organizational issues.

- The case study results were discussed with respect to the failure reasons for IT

implementations found from literature and some additional issues that relate specifically to the implementation of CE were introduced.

- For the success of the whole project, the collaboration tools should be used by all parties in a project. The criticality of the tool for the success of the project will play an important role in the extent of use. Secondly, the contract terms regarding the CE to be used should be clear and binding for all parties to obtain commitment and consistency;

- The transparency of the data in the CE should be arranged carefully to prevent any possible reservations by the parties to use the system;

- The common formats, types and conventions for the information exchange should be agreed before the CE is set up.

- User interfaces of CEs should be user-friendly.

- Senior management commitment by means of a "collaboration chief" accessible to the end-users should be balanced with "waving the stick".

- The results have shown that there are strong links between the success of the CE implementations and user involvement, and between employee resistance and user needs capture. It has been shown from the results that the more and the earlier the users are involved in the design and implementation of the CEs, the better will the user requirements be captured and the less resistance will occur.

- Employee resistance should be dealt with appropriately depending on the sources and extent of resistance. Early user involvement and training are key mechanisms for avoiding or reducing this.

- The changes brought about by the CEs should be managed at organizational level.

The main failure in the CE implementations does not result from "what is implemented" but from "how it is implemented". Using a systems thinking approach it has been shown that there is a need for a detailed organizational change management approach to control all the factors affecting the success of CEs

simultaneously. This will inform the development of an organizational change management framework for CE implementations in construction projects.

CHAPTER SIX: ORGANIZATIONAL CHANGE MANAGEMENT FRAMEWORK FOR IMPLEMENTATION OF COLLABORATION ENVIRONMENTS

6.1 Introduction

Both literature review findings on collaboration environment implementations and the exploratory case study results showed that the full benefits expected out of the collaboration environments have never been achieved in construction industry due to ignorance or underestimation of the effect of organizational and people issues on the success of collaboration environments. It has been shown that there is a need for a structured approach to collaboration implementation and management, together with a detailed organizational change management approach to control all the factors affecting the success of collaboration environments.

This chapter presents the ICEMOCHA framework developed to address this need. ICEMOCHA is an abbreviation that stands for "Implementation of Collaboration Environments and Management of Organizational CHAnges". ICEMOCHA aims to improve the collaboration in the construction projects through collaboration environment implementations at project organizational level, and to guide the adoption process at the organizational level through organizational change management approaches. The chapter first gives an overview of the framework, outlining the background and rationale for the framework, aims and objectives, and framework development approach. This is followed by a detailed explanation of the framework where each process is explained. The chapter ends with a summary.

6.2 Overview of the ICEMOCHA Framework

6.2.1 Background- PIECC Project

PIECC project (Planning and Implementing Effective Collaboration in Construction) is a research project carried out at Loughborough University. It aimed at developing a strategic decision making methodology that guides organizations in the planning for effective collaborative working practices and the implementation of suitable tools and techniques (Shelbourn et. al; 2005, 2006). The outcome of the project was a framework guiding the project team members' work on 4 key areas in order to develop a common collaboration strategy. These key areas are:

1) Develop a joint **business strategy;**
2) Develop a **collaboration brief** for the project ;
3) Guide the team to **plan the solution** to be introduced;
4) Provide guidance to **implement the solution** into the project.

The performance measurement, reflection and feedback on the collaboration and external support obtained during and after the implementation of the framework are accepted as the lessons learnt and are used for the improvement of the future collaborations. The framework defines processes to follow in these key areas to achieve the goal and explains who should be involved in each process, why and how should the process be accomplished. Figure 6.1 shows the outline of the PIECC framework.

The PIECC framework is a generic collaboration implementation guide in construction, specifically targeting the strategy formulators and managers of construction projects involving collaborative working.

ICEMOCHA framework can be described as a specific implementation of the generic PIECC framework. Although both of them work towards the same objective, they are very different in terms of motives, perspectives, target levels and representation methods. PIECC follows a strategic management perspective whereas ICEMOCHA approaches the problem from a change management perspective.

Therefore, whilst PIECC provides guidance in planning a collaboration strategy, ICEMOCHA focuses on implementing collaboration environments and managing the related organizational changes. Unlike the PIECC project which is developed for strategic level, ICEMOCHA activates at the tactical and operational levels. The representation methods used are also different. PIECC follows a generic flowcharting approach whereas ICEMOCHA uses IDEF0 modelling.

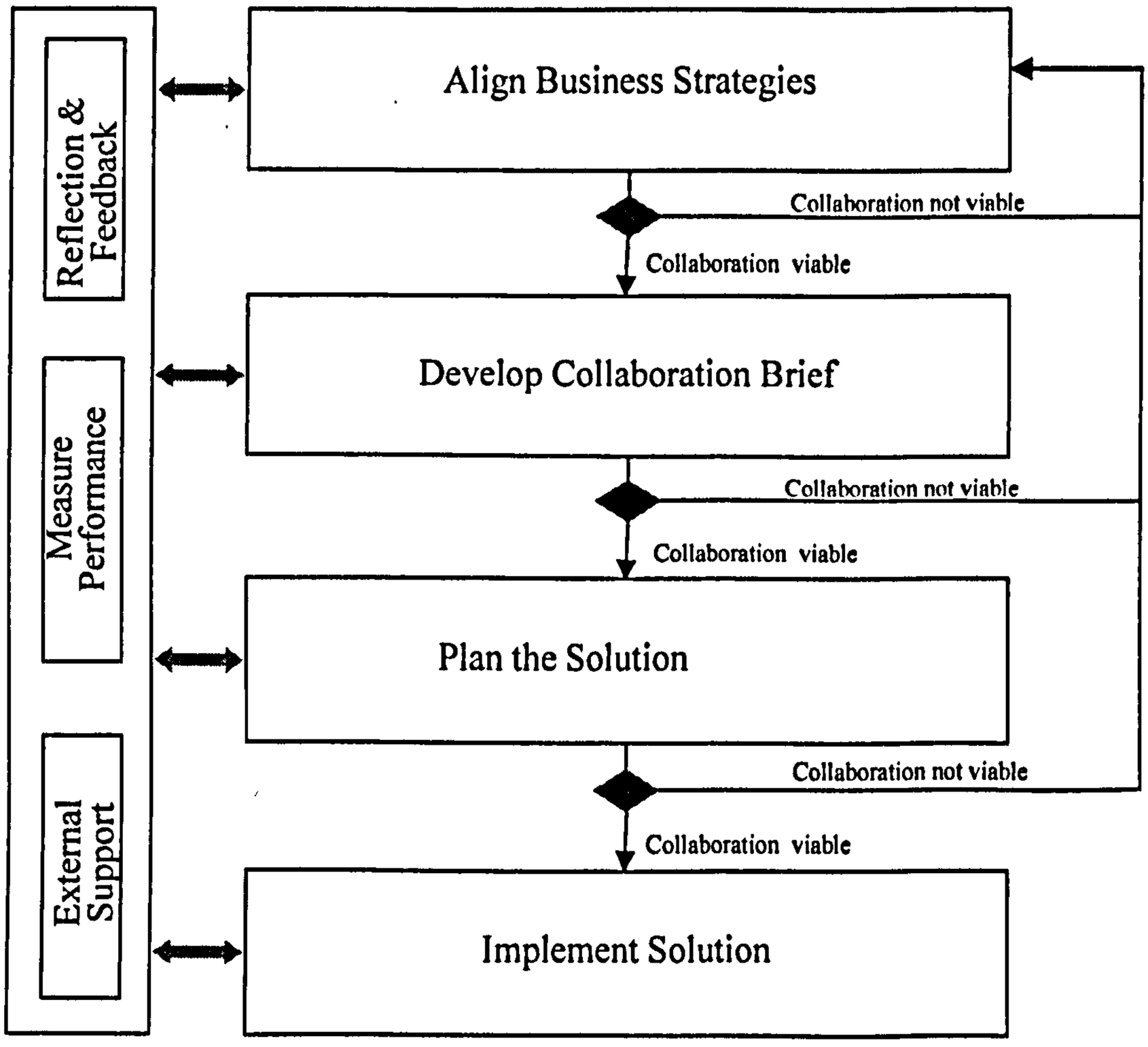

Figure 6.1 Key Stages of the PIECC Framework (adapted from PIECC, 2006)

6.2.2 Background- Rationale for ICEMOCHA Development

The rationale behind the ICEMOCHA development involves on a combination of factors which are listed below:

- Both previous research and case study results indicate that the reason for the failure of the collaboration environments is not technical but related to organizational and human issues. ICEMOCHA is developed to respond to the need for a methodology which will increase the focus on these factors.

- From the review of previous research, the key issues in implementing the collaboration environments have been found to be user requirements capture, overcoming user resistance to change, user involvement, proper planning/project management, strategic IT implementation, buy-in from all parties and trust. Case study results have also supported these findings. ICEMOCHA uses an organizational change management approach to manage these key issues.

- The literature reviews also revealed that the success of collaboration environments does not only depend on "what is introduced to the organization" but is also related to "how it is introduced". ICEMOCHA provides a methodology to manage how the collaboration environments are introduced to the organizations.

- There has been very little research in construction on organizational change management due to the implementation of information technologies or collaboration environments. ICEMOCHA aims at filling in this gap in literature linking the organizational change management and collaboration environment implementation processes.

- From a theoretical point of view, ICEMOCHA explains the need for the strategic management of the collaboration environment implementation at the project organization level using systems theory. All organizations participating in the construction project and the dynamics between them are assumed to form a system. If one of the parties fails in efficient adoption of collaboration environment for any reason, this will affect the whole system.

- From a theoretical point of view, ICEMOCHA explains the need for an organizational change for the implementation of collaboration environments in each organization using contingency theory. When a new collaboration environment is introduced to an organization, it results in a change in two contingencies: a new working approach and a new technology. The organization has to adapt its characteristics according to these new contingencies. Therefore, introduction of new collaboration environments should be managed through an organizational change management approach in order to fit the organization to the changing contingencies.

- The case studies indicated the need for a model acting at two levels since the results showed that the factors affecting the success of collaboration environments occur at project organization level and organizational level.

Based on these underlying principles, the specific aims and objectives of ICEMOCHA were developed and are presented in the next section.

6.2.3 Aim and Objectives of ICEMOCHA

ICEMOCHA aims to achieve effective implementation of collaboration environments in construction projects. Since it is impossible to obtain the full benefits expected from the collaboration environments unless they are accompanied by some organizational changes, ICEMOCHA also aims to provide a methodology, a procedure to guide this organizational change management. The specific objectives of ICEMOCHA can be listed as:

1. To manage the changes brought into construction organizations by the introduction of a new collaboration environment,
2. To increase attention on the people and organizational issues in the planning and implementation of collaboration technologies,
3. To prevent/manage resistance to change and to cope with other barriers to implementation of collaboration environments,
4. To improve collaboration across construction projects by improving the efficiency of the collaboration environment and collaboration tools considering different dimensions such as strategy, technology, organizational processes and people.

6.2.4 End-Users of ICEMOCHA Framework

It is intended that construction organizations working on collaborative projects using modern IT tools to create a collaboration environment should use the framework. The framework should be used by the middle level management but mainly by the senior level management. The people to use ICEMOCHA can be business managers, project managers, IT managers, research and development department managers and

employees, collaboration champions, team leaders and a sample of end users.

6.2.5 Framework Development Approach-IDEF0

6.2.5.1 IDEF Techniques

The Integrated DEFinition (IDEF) methodology is a family of modelling methods that supports a paradigm capable of addressing the modelling needs of an enterprise and its business areas. IDEF techniques were developed by U.S. Air Force Program for Integrated Computer Aided Manufacturing (ICAM) after a need for better analysis and communication techniques for people involved in improving manufacturing productivity was identified during the 1970s (IDEF, 1993). The IDEF techniques are summarised in Table 6.1

Table 6.1 IDEF Techniques

Name of technique	Model developed	Explanation
IDEF0	Function model	Represents the functions, activities or processes in a structured way
IDEF1	Information model	Represents the structure and semantics of information
IDEF2	Dynamics model	Represents behavioural characteristics varying with time
IDEF1X	Semantic data model	IDEF1 Extended Enhanced version of IDEF1

6. 2.5.2 IDEF0 Technique

IDEF0 technique is based on SADT™ (Structured Analysis and Design Technique)[3], developed by Douglas T. Ross and SofTech, Inc (IDEF,1993). IDEF0 can be used to

[3] Refer to Dickover et. al (1977) for further information on SADT methodology.

model a variety of automated or non-automated systems by using hierarchical series of diagrams, text, and glossary cross referenced to each other (IDEF, 1993).

The single unit of an IDEF0 model is a diagram (IDEF, 1993). The main features in an IDEF0 diagram are the boxes representing the functions (activities) and different types of arrows indicating inputs, controls, outputs and mechanisms (ICOMs). These main features are shown and explained in Figure 6.2.

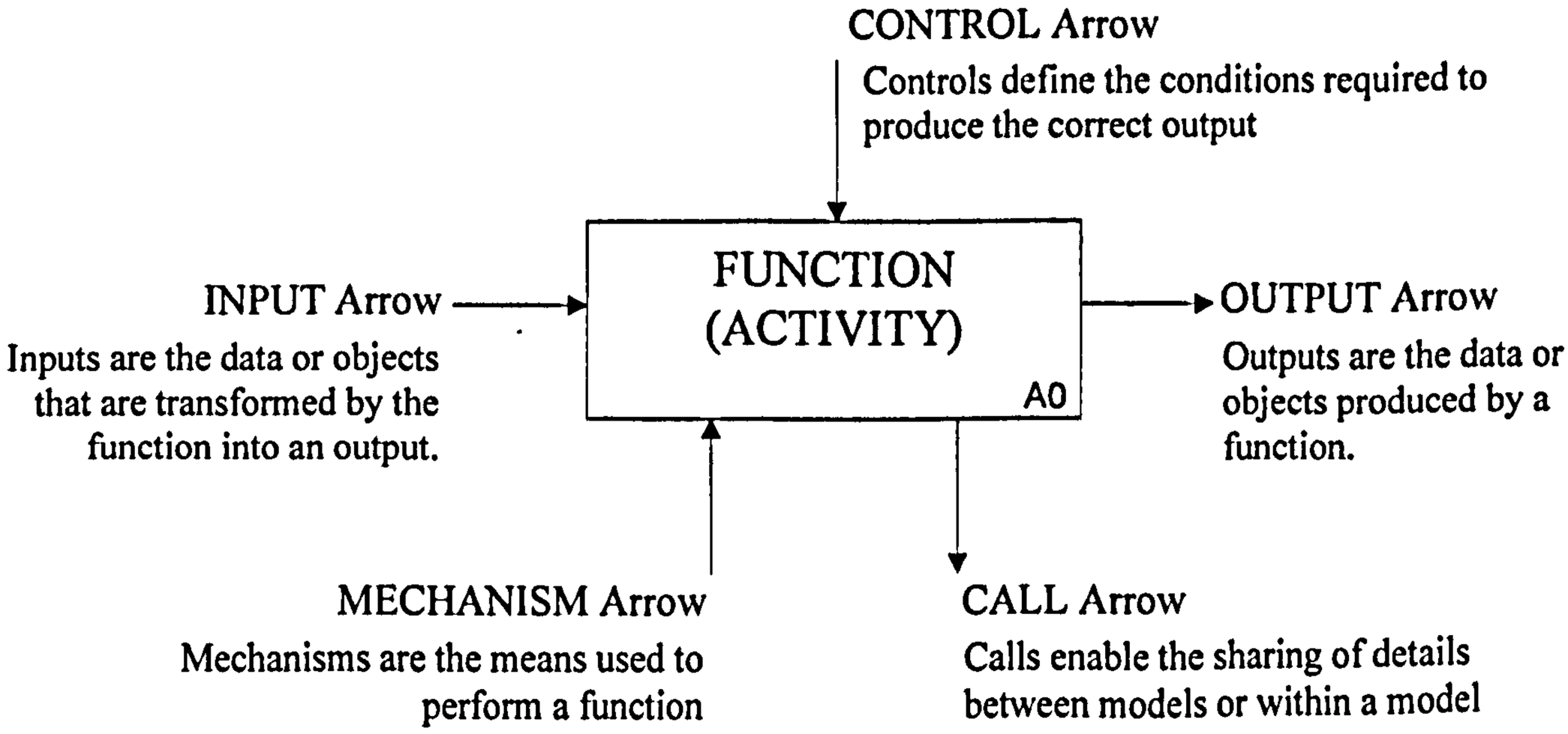

Figure 6.2 Activity Box and ICOMs (adapted from IDEF, 1993)

An activity shown in a diagram can be broken down into further activities and can be shown in a separate diagram, which is called as a child diagram. Figure 6.3 shows an example of detailing activities in an IDEF0 model. As seen from the figure, each diagram has a diagram node number shown at the lower left corner of the frame. The top level activity is shown as a one-box IDEF0 diagram which has the node number as A-0. This top level activity is detailed as 3 processes in a diagram with the node number A0. Each process has a node number shown in the right bottom corner of the box to specify its position in the model hierarchy. If a process is detailed in a child diagram, a node reference is also assigned to the process, which is shown below the box. The second function box in the A0 diagram in the figure is an example to this. This function has a node number A2 shown below the box on the right indicating that this process is detailed in a child diagram. Since this child diagram details the A2 process, the node number written in the diagram frame is A2. The first activity in the A2 diagram is detailed in a child diagram with node number A21.

An IDEF0 model can include 5 different types of diagram: A-0 Diagram, context diagram, parent diagram, child diagram, and for exposition only (FEO) diagram. The explanations for the IDEF0 diagrams are given in Table 6.2.

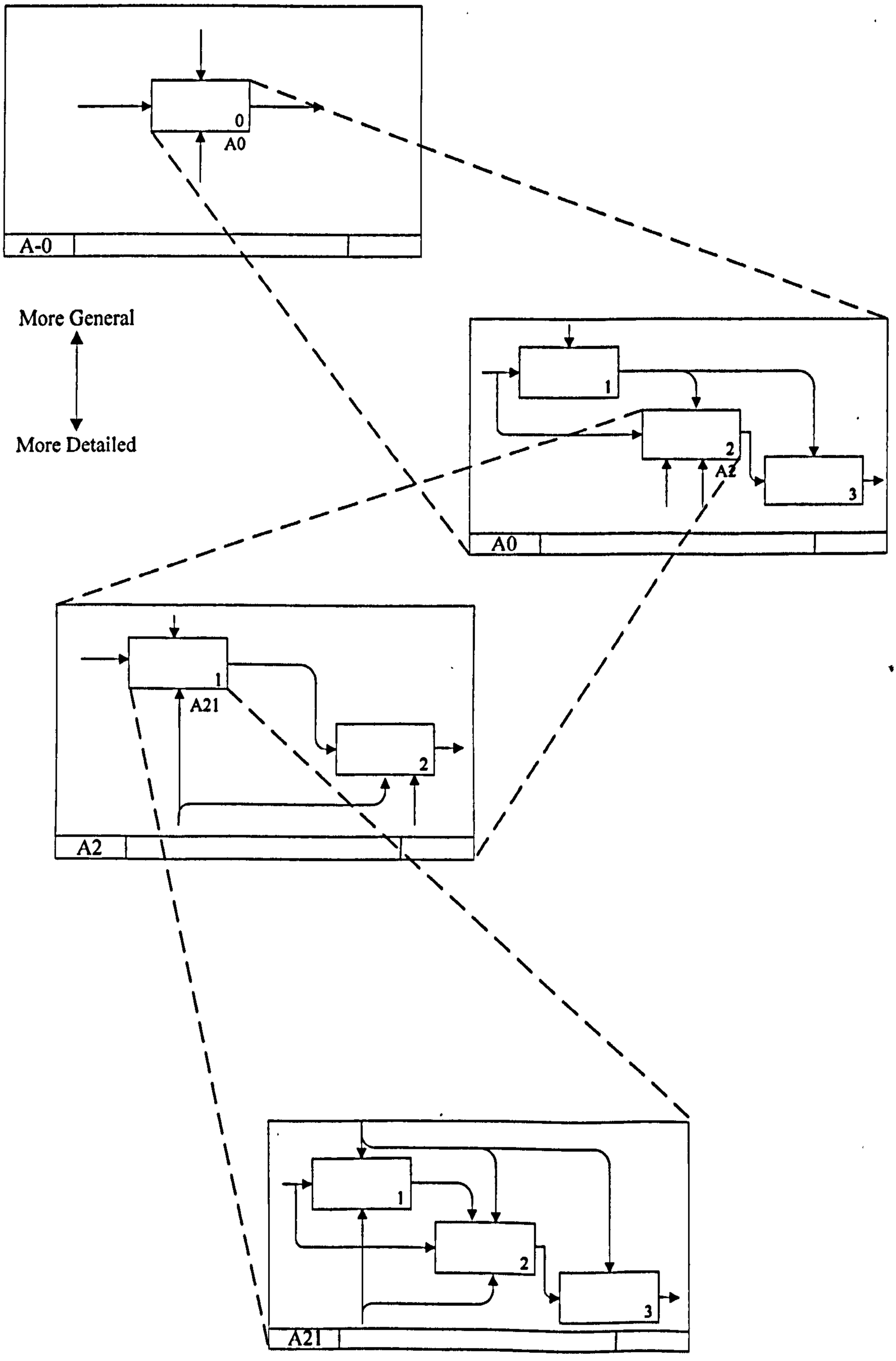

Figure 6.3 Detailing an Activity in a Child Diagram

Table 6.2 IDEF0 Diagram Types and Definitions (IDEF, 1993)

Diagram Type	Definition
A-0 Diagram	The special case of a one-box context diagram, showing the top level function and its inputs, controls, outputs and mechanisms (ICOMs).
Context Diagram	A diagram presenting the context of a model with a node number A-n (n≥0).
Parent Diagram	A diagram containing a box which is detailed by a child diagram.
Child Diagram	A diagram detailing a parent box.
For Exposition Only (FEO) diagram	A graphic description, which does not need to comply with the IDEF0 rules, used to expose or highlight some specific facts about an IDEF0 diagram.

The IDEF0 technique was chosen as the modelling approach for the ICEMOCHA framework since it allowed different levels of details through the processes and sub-processes presented in parent and child diagrams. Besides, construction industry professionals are familiar with the IDEF0 technique, therefore choosing IDEF0 would enable the construction industry professionals to understand and use ICEMOCHA easily.

6.3 Features of the Framework

6.3.1 Conceptual Framework

The ICEMOCHA framework is based on the idea that for the success of the project collaboration, all organizations involved in the project should participate in the collaboration environment and should follow the same procedures. Each organization needs to manage the organizational changes brought about by the new collaboration environment in order to adjust their current processes and get their employees to use the new system properly. The amount of the required change will depend on how familiar the organization is with the new collaboration technology, tools or methodologies, and their level of compatibility with the current organizational processes and the organizational working culture.

It has been justified in the case study results that there are two levels that should be focussed on during the implementation of a collaboration environment on a construction project: project organization level and organizational level. Therefore, ICEMOCHA works at both project organization level and organizational level. These levels can be seen in Figure 6.4.

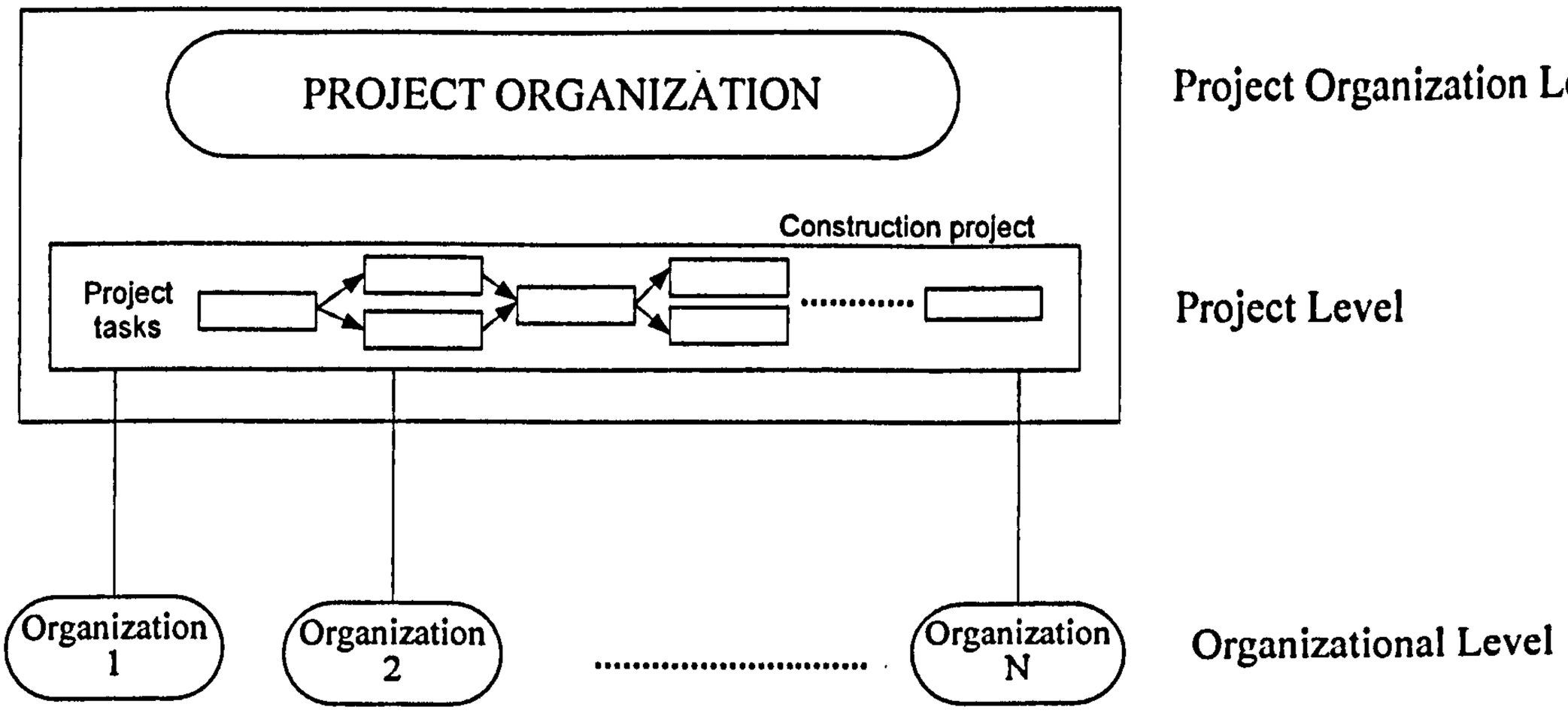

Figure 6.4 ICEMOCHA Level Explanations

Project organization is a term used in ICEMOCHA to refer to the virtual temporary organization formed when all organizations collaborating on a project come together in order to make decisions regarding the overall project. The project organization level decisions for the project are made in the presence of representatives from each organization, and the agreed collaboration solution and related decisions are binding for all organizations. Therefore, these procedures should be adopted by each organization, and it should be ensured that the common decisions are followed by all of their employees. To achieve an efficient adoption, an organizational change management approach is required. The organizational level processes of ICEMOCHA provide a methodology which will enable each organization to come up with an organization specific organizational change management approach. These processes should be carried out by each organization individually since the required change will be organization specific due to different organizational cultures and varying organizational procedures and processes.

ICEMOCHA is a combination of two interlinked process models: Implementation of Collaboration Environments (ICE) Model, at project organization level, and

Management of Organizational Changes (MOCHA), at organizational level. An overview of the ICEMOCHA framework is shown in Figure 6.5. Both models follow a scientific problem solving approach that involves five stages. These steps are used for collaboration management at the project organizational level and for change management at the organizational level. The first stage is called the initiation stage where the need for collaboration and for organizational change is defined. The second stage focuses on defining vision. In the ICE model, a shared collaboration vision is developed whereas in the MOCHA model, a change vision is developed. At the third stage, a collaboration solution is in ICE and an organization change management plan in MOCHA. The fourth stage focuses on implementing the solutions defined at the third stage while the last stage focuses on evaluating the performance of the implementation.

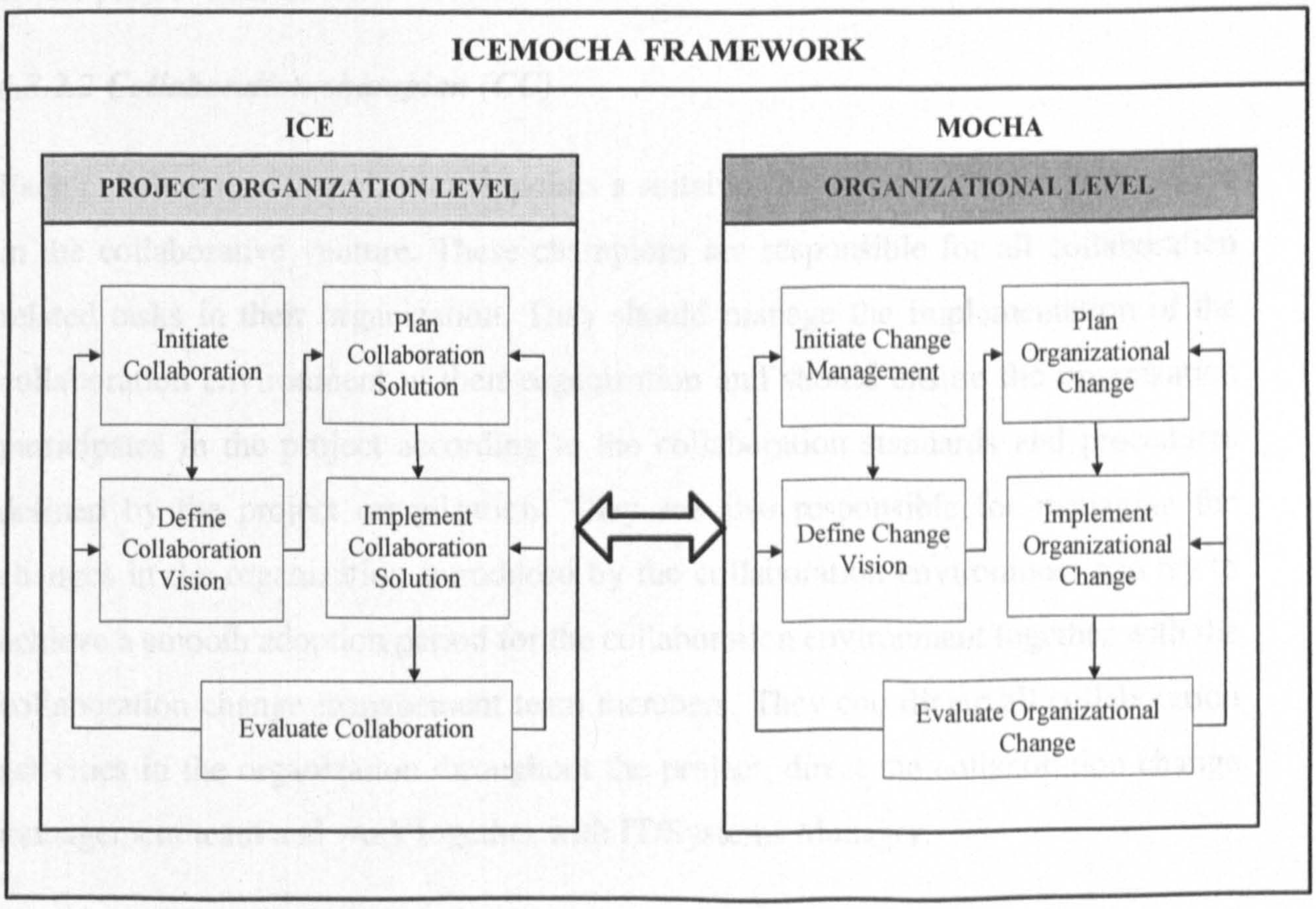

Figure 6.5 ICEMOCHA Framework Overview

The conceptual ICEMOCHA framework is modelled using the IDEF0 process modelling approach. The actors of the framework who are shown as mechanisms in the IDEF0 model are based on the literature review findings in Chapter 3. The responsibilities of the change champion/agent role is carried out by the collaboration

champion together with the collaboration responsibilities. The collaboration change management team is developed based on the guiding team approach introduced by Kotter (2002). Collaboration management team is similar to the collaboration management team used in the PIECC project. These actors are explained in detail in the next section.

6.3.2 Actors in the Framework

6.3.2.1 Project Director (PD)

The Project Director is the head of the construction project and is the highest level manager in the project who is responsible for the whole project. He/she communicates with all parties through the collaboration champions and coordinates all the project activities.

6.3.2.2 Collaboration champion (CC)

Each collaborating organization appoints a suitable champion as their representative in the collaborative venture. These champions are responsible for all collaboration related tasks in their organization. They should manage the implementation of the collaboration environment in their organization and should ensure the organization participates in the project according to the collaboration standards and procedures defined by the project organization. They are also responsible for managing the changes in the organization introduced by the collaboration environment and try to achieve a smooth adoption period for the collaboration environment together with the collaboration change management team members. They coordinate all collaboration activities in the organization throughout the project, direct the collaboration change management team and work together with IT/Systems Manager.

6.3.2.3 Collaboration Management Team (CMT)

The CMT is basically a decision making board managing the collaboration at the project organization level. The team is responsible for coming up with some agreements on collaboration and collaboration related decisions implementation of which will be binding for each organization. The smallest CMT consists of the collaboration champions from all involved parties. Since collaboration related

decisions will also be related to technology and processes from many levels and departments, the CMT should ideally include representatives from each organization who can give satisfactory feedback on the discussed topic. These representatives might be the organizations' IT personnel or some key personnel that know the processes being discussed. The CMT might also include some of the collaboration change management team members (See below).

6.3.2.4 Collaboration Change Management Team (CCMT)

The CCMT consists of a sample of users in each organization appointed by the collaboration champion and/or senior management to enable the link between the users and the collaboration champion. It might include representatives from operational level, technology level and senior management level.

The CCMT is one of the key elements of the organizational change management framework and is a result of a user involvement approach. The team plays an active role in capturing user and organizational requirements, communication of change, determining the changes in the organization due to the collaboration environment. It also participates in all processes in the implementation and evaluation of the collaboration environment. Having representatives involved in the implementation of a change that will affect them will help the adoption of the change since that change will no longer be seen as a change imposed on them. Having a right to speak on the change directly or indirectly through CCMT will give the users a feeling of ownership of the change.

6.3.2.5 Senior Management

Senior management refers to a team of high level organizational managers who have the responsibility for the day-to-day activities of the organization. The senior management appoints a collaboration champion to represent the organization in the project. They might also select the CCMT members or leave this decision to the collaboration champion. Some members of the CCMT will be from the senior management. This will also show top level commitment during the implementation of the collaboration environment, as this would help to decrease user resistance and increase the use of the collaboration environment.

6.3.2.6 Systems Manager

A systems manager is a senior manager who is in charge of all ICT activities and facilities within an organization. He/she may also be called an "Information Systems Manager" or "IT Manager" in some organizations. If there is a specific IT department in the organization, the systems manager would be the head of this department with a staff of technicians, programmers, database administrators, and systems analysts reporting to him/her.

Unlike the traditional approach where the systems managers are fully responsible for the introduction of collaboration environments and are therefore involved in all stages, in ICEMOCHA, the systems managers are restrained to the implementation and evaluation of collaboration environments. However, the CCMT might include the systems manager or some of his staff to address the technical factors during the requirements capture, collaboration vision and solution planning stages.

6.3.3 ICEMOCHA – IDEF0 Process Modelling Overview

As explained in Section 6.3.1, ICEMOCHA consists of two main processes acting at the project organization level and organizational level. For each level, an IDEF0 model is created and therefore ICEMOCHA is represented as the combination of two IDEF0 models named ICE and MOCHA. The A-0 level process of ICE model is called "Implement Collaboration Environments at the Project Organization Level" and The A-0 level process of MOCHA model is called as "Manage Organizational Change due to Implementation of a Collaboration Environment". The A-0 level processes of ICE and MOCHA are shown in Figure 6.6. and Figure 6.7 respectively. As seen from the figures, the node number for A-0 diagram for the ICE model is indicated as ICE/A-0 whereas the representation is MOCHA/A-0 for the MOCHA model.

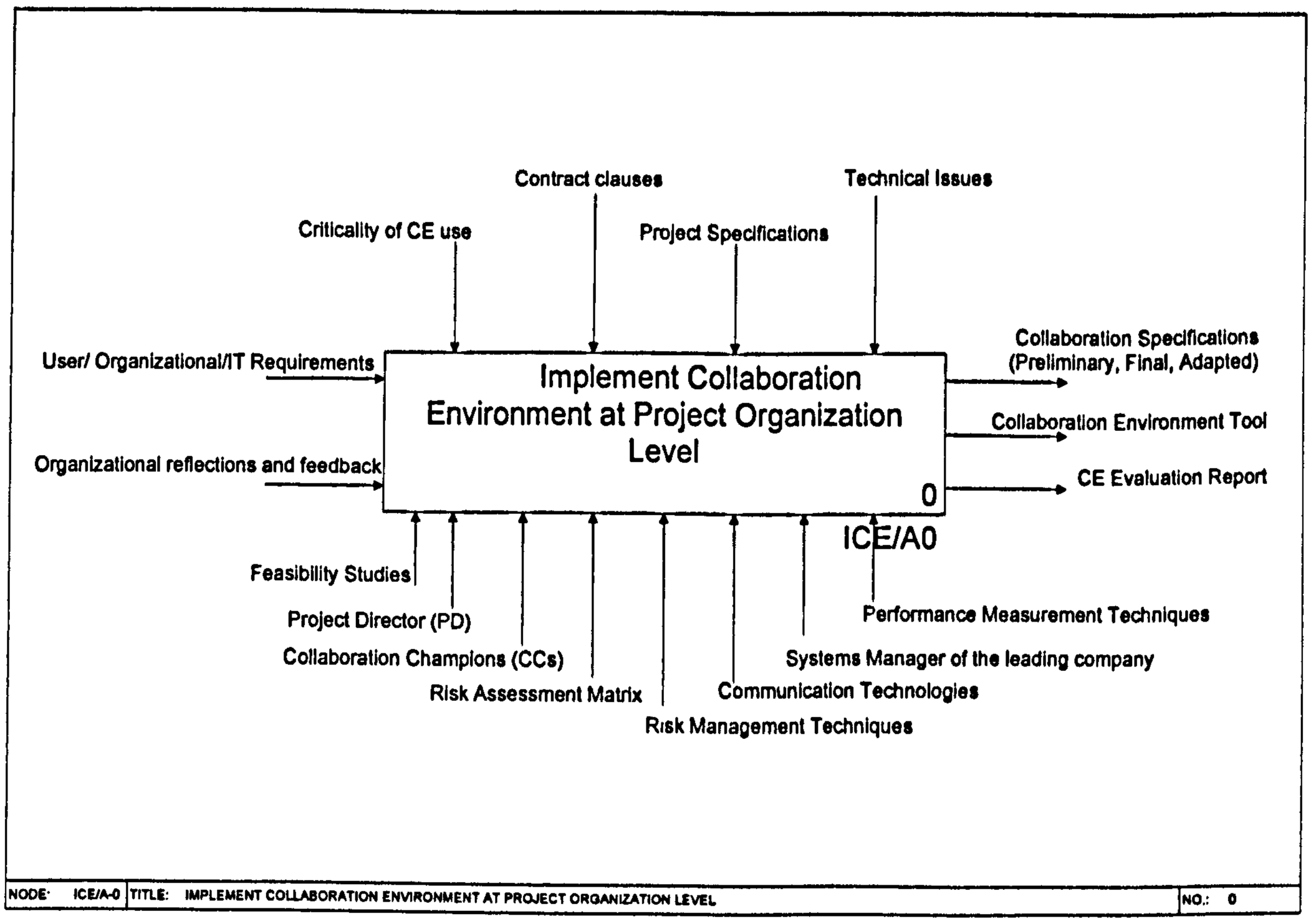

Figure 6.6 ICE Model- A-0 Process

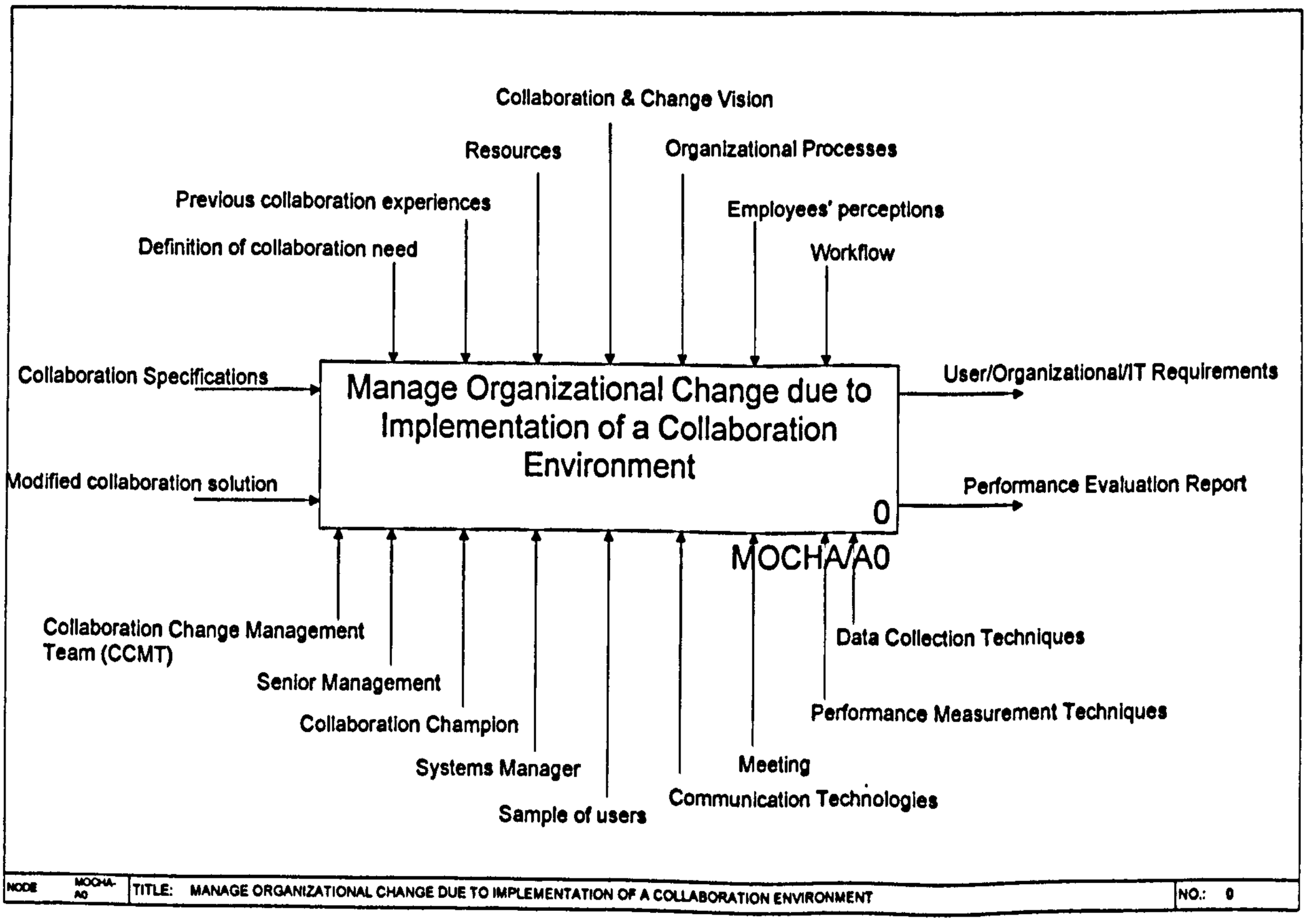

Figure 6.7 MOCHA Model- A-0 Process

As previously explained, ICEMOCHA follows a five stage scientific problem solving approach. When developing the IDEF0 models for ICE and MOCHA, these stages are considered as the five main sub-processes of the A0 diagram of ICE and MOCHA. The A0 diagrams for ICE and MOCHA are shown in Figure 6.8 and Figure 6.9 respectively. In the IDEF0 diagrams prepared for this research, (f.PL) and (f.OL) symbols are used to differentiate an input or a control which is coming from the other level. (f.PL) is used for the parameters at organizational level and it indicates that parameter was an output of a process in the ICE model, at the project organization level. (f.OL) is used for the parameters at project organization level and it indicates that parameter was an output of a process in the MOCHA model, at the organizational level.

The five main sub-processes are further broken into some sub-processes. The organizational issues in collaboration environment implementation and the relations between these issues determined through the interpretation of the case study results are considered whilst developing the sub-processes. All of these processes are shown in Table 6.3 as a node index, which is a listing showing all nodes in an IDEF0 model in an outline order. The node index is also referred to as the node tree in the IDEF0 terminology.

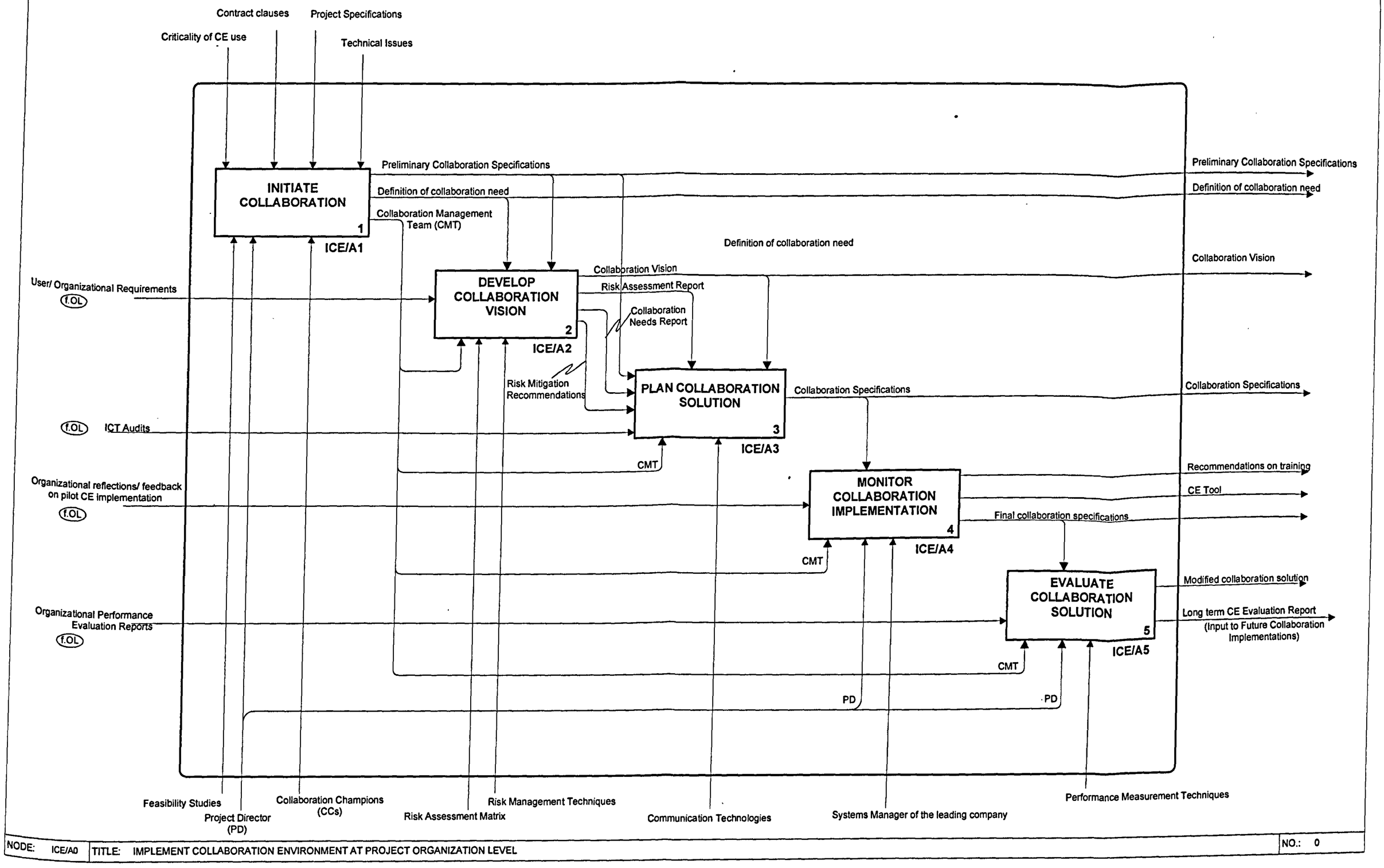

Figure 6.8 ICE Model – A0 Process

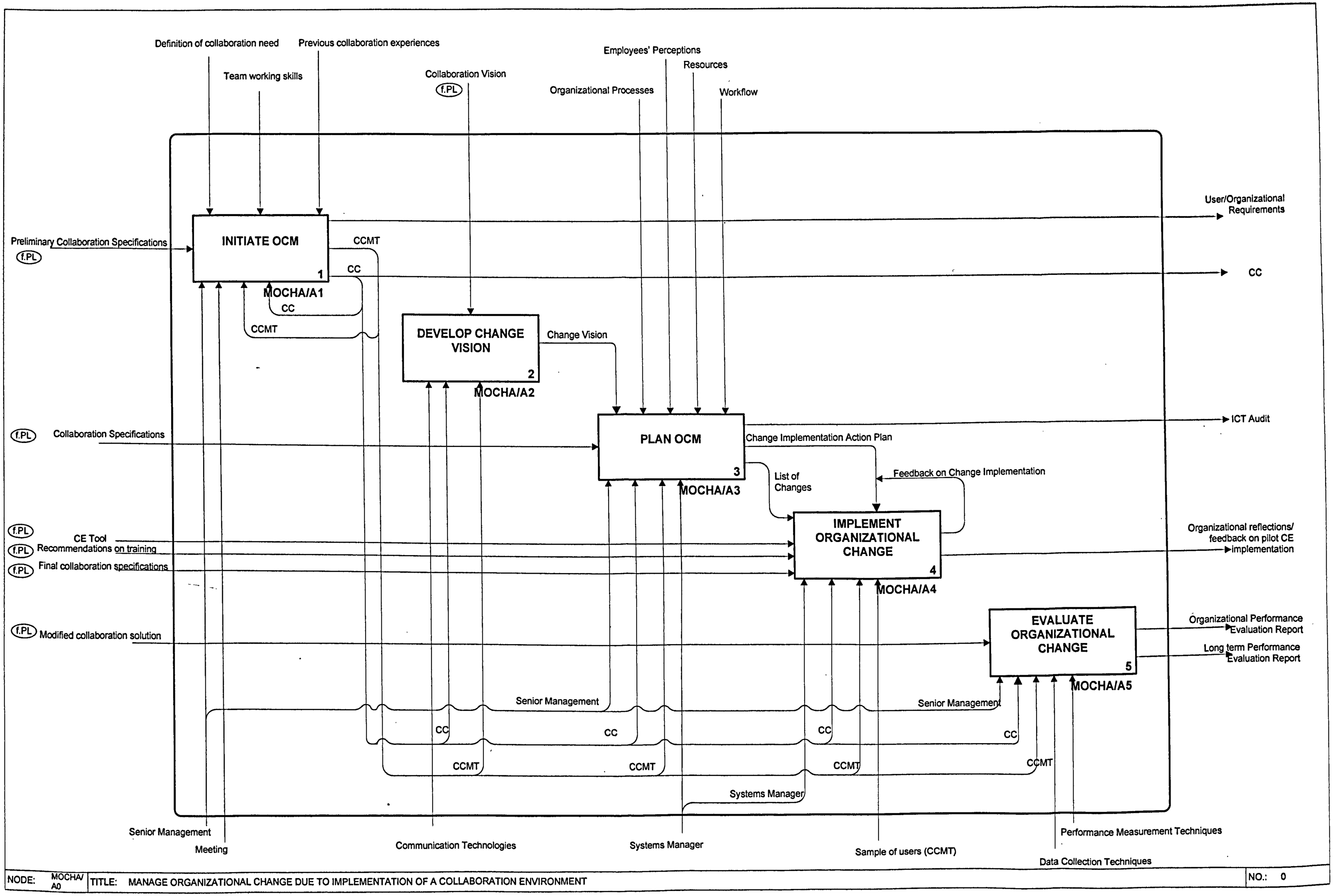

Figure 6.9 MOCHA Model – A0 Level

Table 6.3 Node Index for the ICEMOCHA Model

Diagram Reference	Description & Included Activities	
ICE/A0	**Implement Collaboration Environment at Project Organization Level**	
ICE/A1	Initiate Collaboration	
	A11	Define the need for collaboration
	A12	Prepare initial collaboration specifications
	A13	Build the guiding team
ICE/A2	Develop Collaboration Vision	
	A21	Develop a shared collaboration vision
	A22	Conduct risk assessment
ICE/A3	Plan Collaboration Solution	
	A31	Plan for people in the project
	A32	Plan data/ work flow
	A33	Plan technology solution
	A34	Define collaboration standards and procedures
	A35	Disseminate procedures
ICE/A4	Monitor Collaboration Implementation	
	A41	Identify/ recruit participants
	A42	Purchase tool/ technology
	A43	Monitor training as necessary
	A44	Monitor pilot CE implementation
	A45	Monitor CE implementation
ICE/A5	Evaluate Collaboration Solution	
	A51	Obtain short term results on collaboration
	A52	Alter collaboration solution
	A53	Evaluate long term results

Table 6.3 Node Index for the ICEMOCHA Model (continued)

Diagram Reference		Description & Included Activities
MOCHA/A0		**Manage Organizational Changes due to Implementation of a Collaboration Environment**
MOCHA/A1		Initiate Organizational Change Management
	A11	Build the change implementation team
	A12	Communicate initial change
	A13	Capture user and organizational requirements
MOCHA/A2		Develop Change Vision
	A21	Define the need for organizational change
	A22	Define change vision
	A23	Communicate change vision
MOCHA/A3		Plan Organizational Change Management
	A31	Define current ICT tools and ICT needs
	A32	Identify required organizational changes
	A33	Plan organizational change
MOCHA/A4		Implement Organizational Change
	A41	Pilot and refine change
	A42	Conduct training
	A43	Implement change
MOCHA/A5		Evaluate Organizational Change
	A51	Obtain short term results on collaboration
	A52	Implement altered collaboration solution
	A53	Alter change management procedures
	A54	Evaluate long term results
	A55	Fit the change into organization culture

It was also found necessary to present two additional figures in order to show the dependencies and flows between ICE and MOCHA models. Figure 6.10 shows the flows between the five main sub-processes of the two models. Figure 6.11 further details these five main sub-processes and shows the flows at a more detailed level.

6.3.4 IDEF0 Model of ICE

This section explains all the sub-processes of the ICE model, the IDEF0 diagram of which was shown in the previous section in Figure 6.6 and Figure 6.8 for A-0 and A0 level processes.

6.3.4.1 Initiate collaboration- ICE/A1

This process is the first process of ICE where collaboration is initiated and consists of 3 sub-processes. The IDEF0 diagram for this process is given in Figure 6.12.

a) Define the need for collaboration

This process is carried out by the project director. Ideally, the construction project contract should include clauses regarding the collaboration between the parties. These clauses might state the need for collaborative working in a general sense or might specify the detailed procedures and specifications for collaboration. If there are contract clauses binding the parties regarding collaboration, then the need is automatically established. If there is no binding clause, then the project director should investigate whether the use of a collaboration tool is critical for the success of the project. Feasibility studies for the use of a collaboration environment are also carried out and are, therefore, shown as a mechanism in Figure 6.12. The output for this process is the definition of collaboration need, which is used as a control in the Develop Collaboration Vision process (ICE/A2) at the project organization level and in the Initiate Organizational Change Management process (MOCHA/A1) at the organizational level.

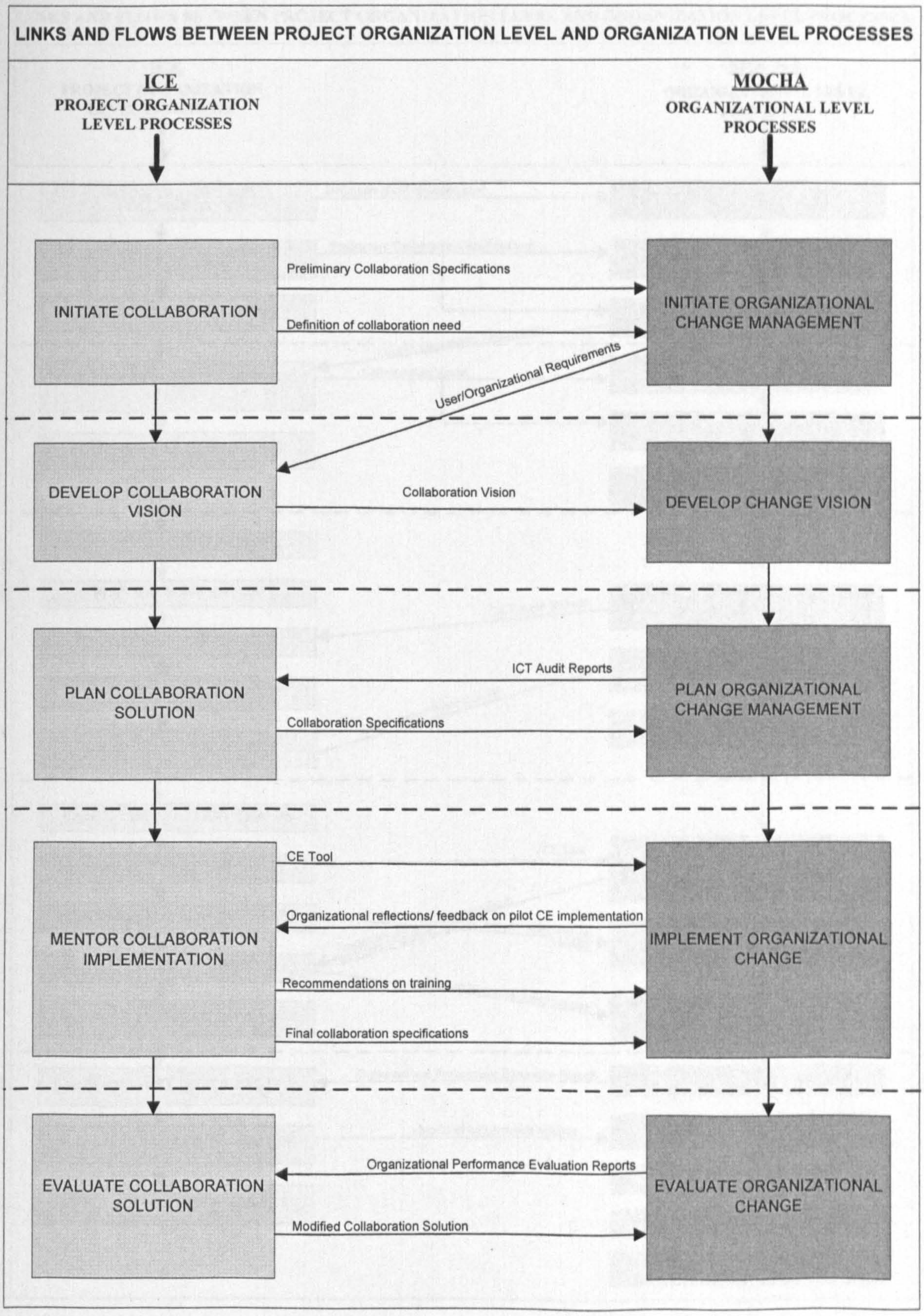

Figure 6.10 Links and Flows between ICE and MOCHA Main Sub-processes

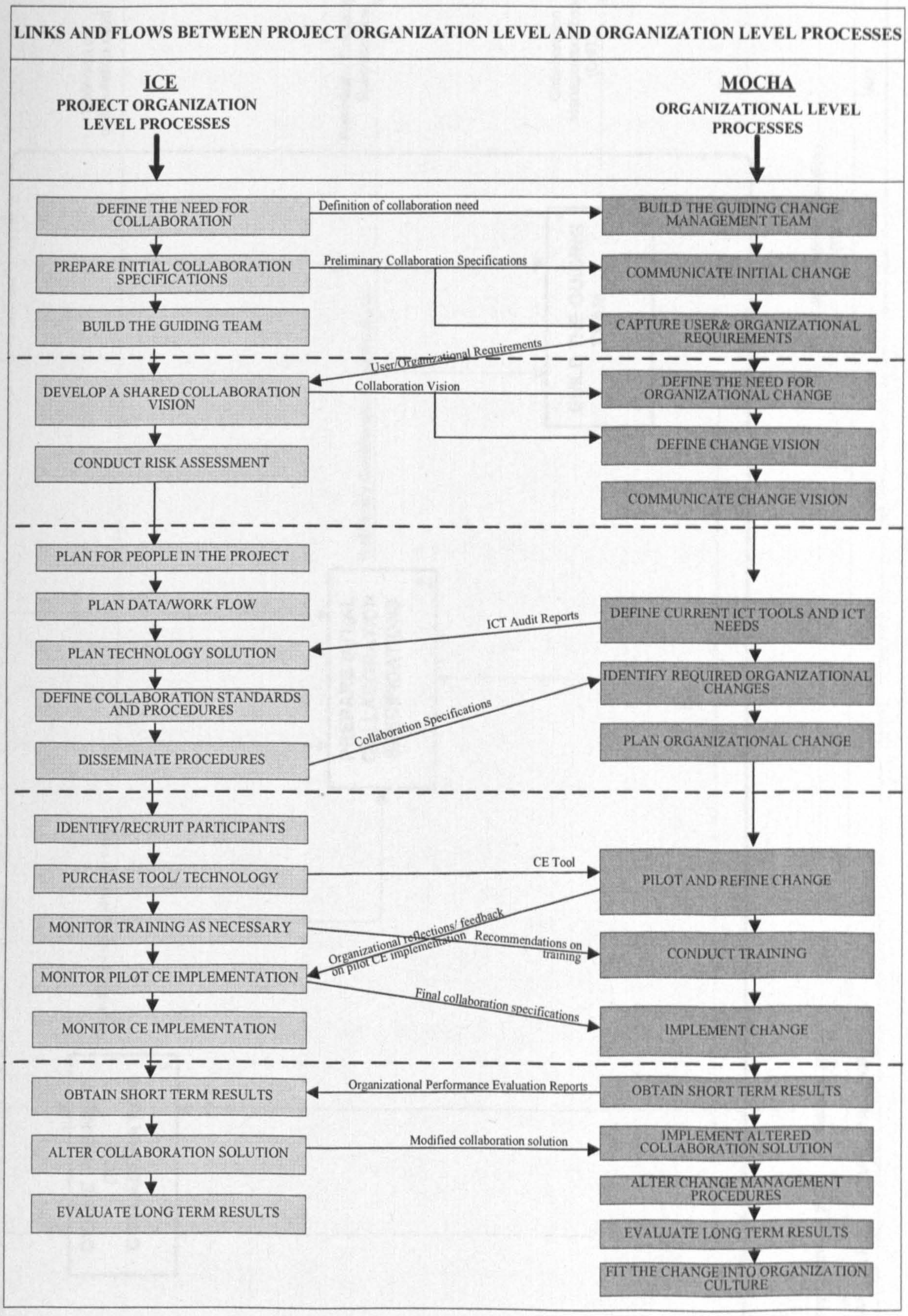

Figure 6.11 Links and Flows between ICE and MOCHA 2nd Level Sub-processes

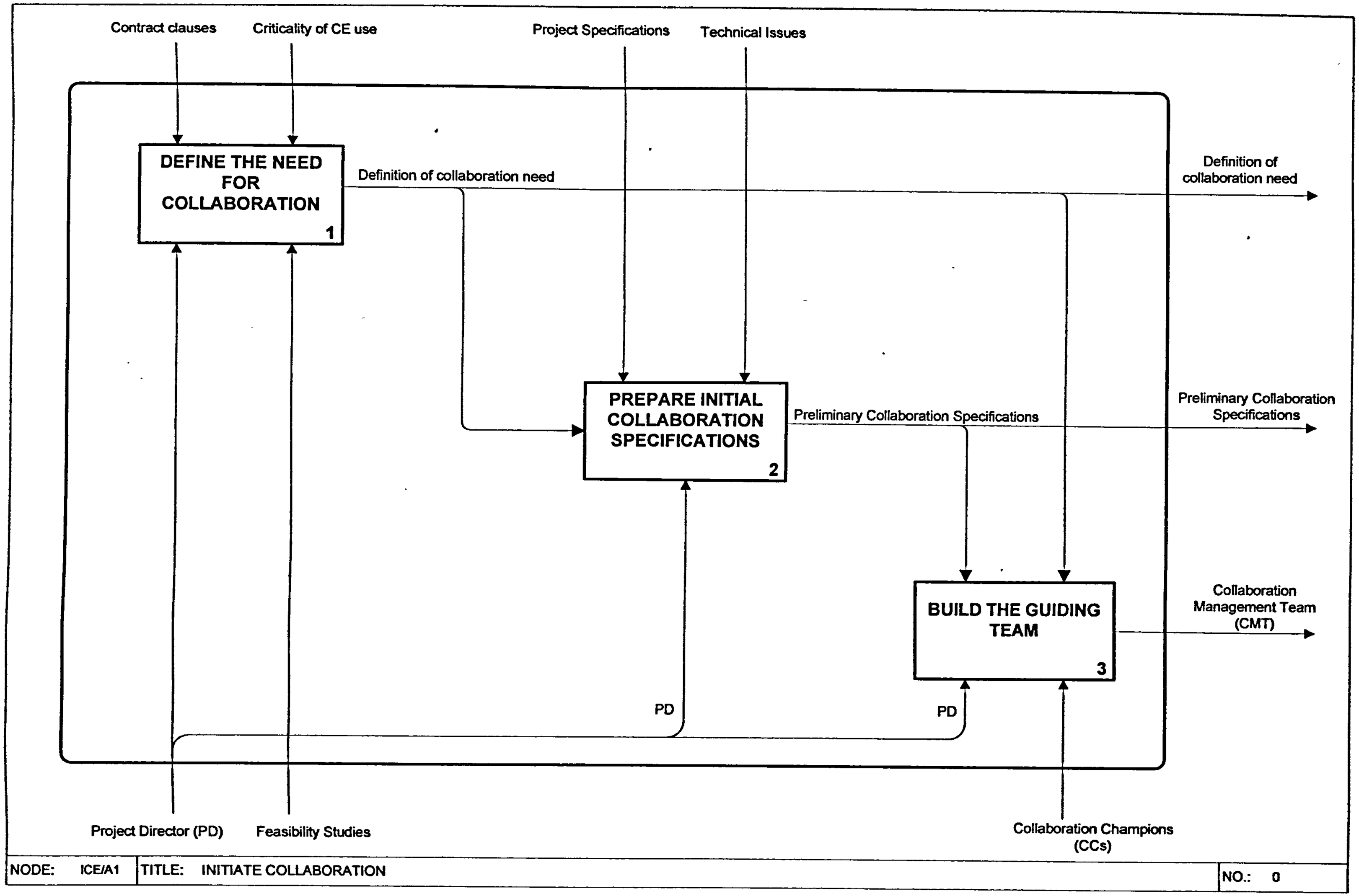

Figure 6.12 ICE/A1 Initiate Collaboration

b) Prepare initial specifications

When the need for IT-enabled collaboration is established, the Project Director starts to prepare the preliminary collaboration specifications taking into account the project specifications and technical issues. These specifications are never the final collaboration specifications. They should be discussed by the organizations participating in the project and are very likely to be changed according to the organizational requirements and expectations. However, this stage is still necessary since it provides a basis for discussion. These preliminary collaboration specifications are communicated with each organization so that they can start communicating the change and gathering the user and organizational requirements for collaboration.

c) Build the guiding team

The Project Director and collaboration champions chosen by the organizations start building the collaboration management team. They can ask for some specific people from each organization or they might inform the organizations on the type of people needed for the CMT and let the organizations choose their own representatives. Ideally, the CMT members and CCMT members should have some common members.

6.3.4.2 Develop collaboration vision- ICE/A2

The second stage of ICE aims at developing a shared collaboration vision and conducting a risk assessment for collaboration. Each of these aims are represented by a process with the same name as the aim. IDEF0 diagram for ICE/A2 is shown in Figure 6.13.

a) Develop a shared collaboration vision

If a shared vision can be developed at the project organization level, it will be easier for the parties to agree on further decisions regarding the collaboration since the main goals and the basic principles will be well known by each party. Therefore, CMT members try to come up with a vision which would reflect the views of all the organizations. The user and organizational requirements (MOCHA/A13) are used as an input and definition of collaboration need (ICE/A11) and preliminary

collaboration specifications (ICE/A12) are used as controls in this process. The outputs of this process are the collaboration needs report and collaboration vision which are used in ICE/A3 and MOCHA/A2.

b) Conduct risk assessment

According to the preliminary collaboration specifications (ICE/A12) and the defined collaboration vision (ICE/A21), the CMT conducts a risk assessment for collaboration in the construction project using the risk assessment matrix and risk management techniques. During this process, the collaboration risks are identified. The probability of occurrence for each risk and the severity of the impact if that risk occurs are determined, and how that risk can be mitigated is discussed. The risk assessment report and risk mitigation recommendations are the outputs of this process.

6.3.4.3 Plan collaboration solution- ICE/A3

This process aims at defining a collaboration solution which will be accepted and agreed by each organization for use in the project. The CMT plays a very important role in this process and it is advisable to include representatives from each organization related to the issues discussed in this process even if they are not members of the core CMT and are not present in the other ICE processes. If the CMT includes members that know their organizations' processes and working methods well, they can try to influence the common conventions to suit their own working methods as much as possible. Although it is not always possible to have all parties pleased with the conventions, it is important to create an environment where everyone has a right to speak and convey their needs and wishes so that no party will feel that the conventions of another party are imposed on them against their will. When the meeting is over and the CMT members return to their organizations, they should leave with some gain for their organization and should be aware that the accepted collaboration solution will increase the success of the overall project.

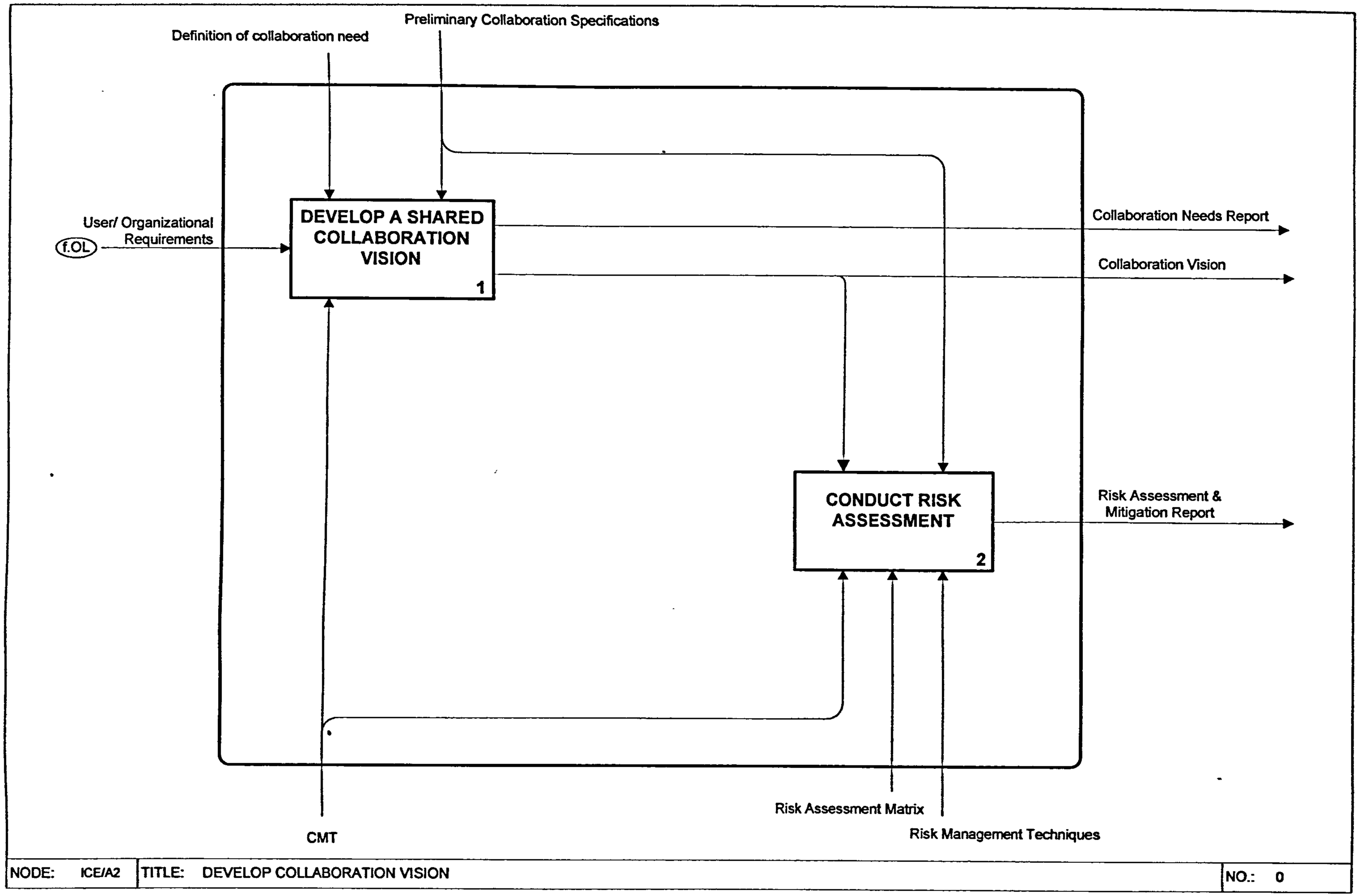

Figure 6.13 ICE/A2 Develop Collaboration Vision

The collaboration solution consists of agreements on four main areas: People specifications, project lifecycle data/work flow, technology specifications, and collaboration standards and procedures. The collaboration vision is used as a control for all four processes, therefore all attempts in these processes should be aligned with the shared collaboration vision. The IDEF0 diagram of ICE/A3 is shown in Figure 6.14.

a) Plan for the people in the project

The roles and responsibilities of the individuals from each collaborating organization should be clearly defined in order to prevent possible confusions during the collaboration. In this process, the CMT defines the specifications for the key people to work on the project using collaboration needs report (ICE/A21) as input, and considering collaboration vision (ICE/A21) and risk assessment and mitigation report (ICE/A22) as controls. In order to define the people specifications, the key roles and responsibilities which are important for the collaboration are defined, and the essential and desirable skills and qualifications required to carry out these roles and responsibilities are determined. These are all shown in a people specifications table as an output of the process.

b) Plan data / work flow

This process determines the project lifecycle processes using the collaboration needs report (ICE/A21) as an input and considering the collaboration vision (ICE/A21) and risk assessment and mitigation report (ICE/A22) as controls. The output of the process is a data flow diagram where all processes in the project, their prerequisite processes, the parties responsible for this process and the outputs of the process are identified.

c) Plan technology solution

In this process, using the collaboration needs report (ICE/A21), data flow diagram (ICE/32) and ICT audit reports (MOCHA/A31) as inputs, the common data environment and the IT tools to be used in the collaboration are decided. The intention is to come up with an agreement on standard procedures for each task, therefore the versions of the software, and the file format used for exchanging the

output between parties are also determined. The output of this process is the agreed collaboration tool and technology specifications.

d) Define collaboration standards and procedures

This process defines common rules for the information exchange during collaboration. Preliminary collaboration specifications (ICE/A12), collaboration needs report (ICE/21), and data flow diagram (ICE/A32) are the inputs for this process whereas the collaboration vision (ICE/21), risk assessment and mitigation report (ICE/22), and agreed collaboration tool and technology specifications (ICE/A33) are the controls. The CMT starts the discussion on the preliminary collaboration specifications defined by the project director. The discussions will lead to many changes in these specifications since all inputs and controls for this process are shaped in the previous processes according to the requirements and expectations of each party in the collaboration. Therefore, unless there are some standards defined in the contract which entered the preliminary collaboration specifications, the collaboration standards created as an output of this process might be completely different from the preliminary collaboration specifications. At the end of the discussions, there should be some agreements on: units convention, spatial coordination, standard method and procedure (if there is one), document naming convention, and layer naming standards.

e) Disseminate procedures

People specifications table (ICE/A31), agreed collaboration tool and technology specifications (ICE/A33) and collaboration standards (ICE/A34) are gathered together by the CMT under one single document called "Collaboration Specifications", and this document is disseminated to each organization using various communication technologies.

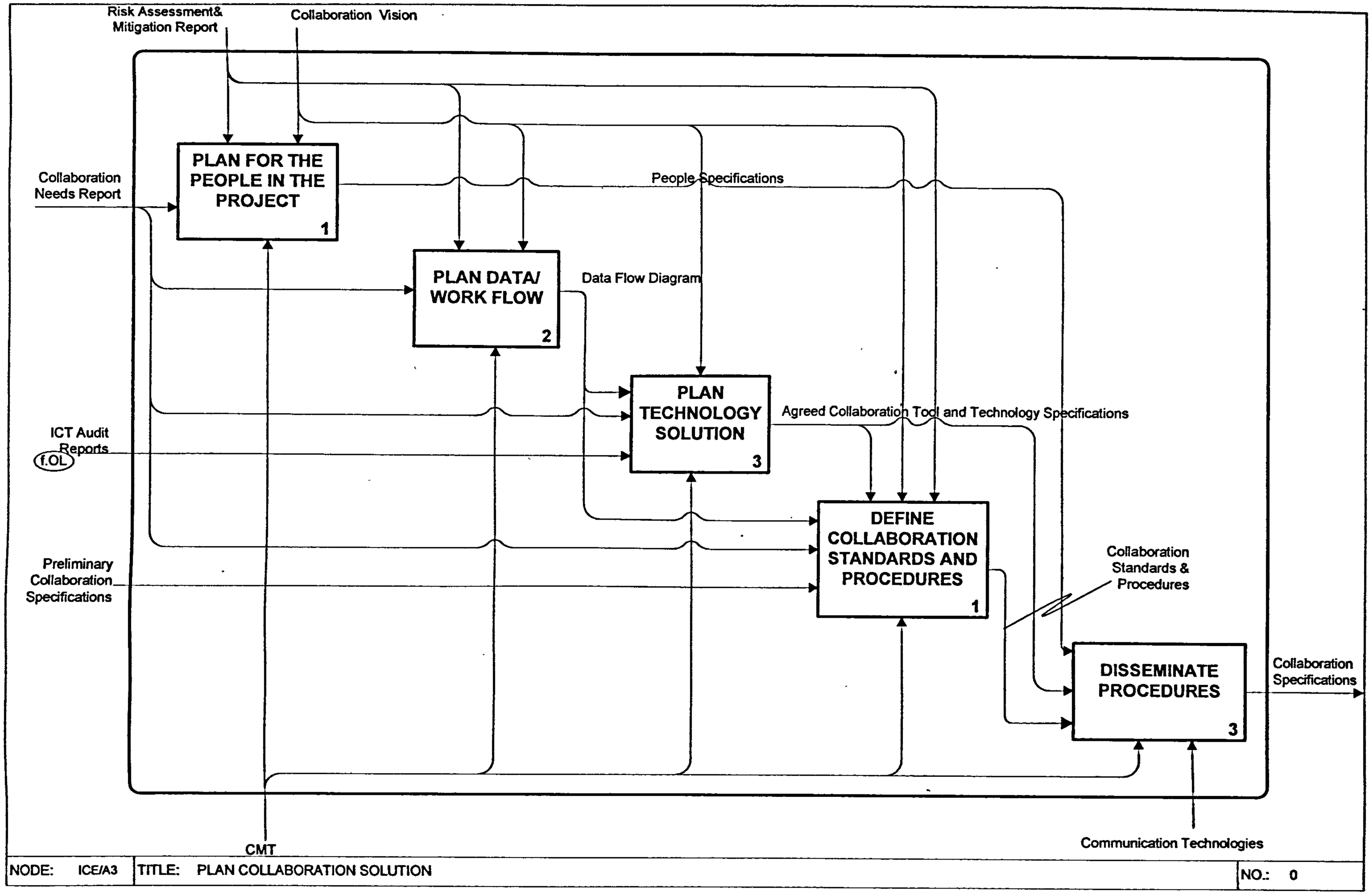

Figure 6.14 ICE/A3 Plan Collaboration Solution

6.3.4.4 Monitor collaboration implementation- ICE/A4

This process basically monitors the implementation of the collaboration environment in the collaborating organizations through monitoring many dimensions such as recruitment of participants, purchase of collaboration tool and technologies, training, pilot implementation and actual implementation of collaboration environment. The collaboration specifications defined in ICE/A3 act as a control for this process. The IDEF0 diagram for ICE/A4 is shown in Figure 6.15.

a) Identify / recruit participants

This process focuses on recruiting the key participants to work on the construction project according to the collaboration specifications defined in ICE/A3. This recruitment should be carried out at the project organizational level to make sure that the people assigned to the key roles are capable of carrying out the roles defined in the collaboration specifications.

b) Purchase tool / technology

If there is a need to purchase any tools or collaboration technology for the common data environment, it is purchased at this stage by the systems manager of the company leading the collaboration. Therefore, the output of this process is the collaboration environment tool.

c) Monitor training as necessary

The CMT is expected to provide the organizations with recommendations on training considering the collaboration specifications (ICE/A3) and collaboration environment tool (ICE/A42) as controls. This is an ongoing process until the actual start of the collaboration and can continue during the collaboration if it is needed. Mostly, the training decisions will be made at the project organizational level which will be carried out in all collaborating organizations. One-to-one training, classroom training, booklets, and manuals are some training methods/tools used in construction industry.

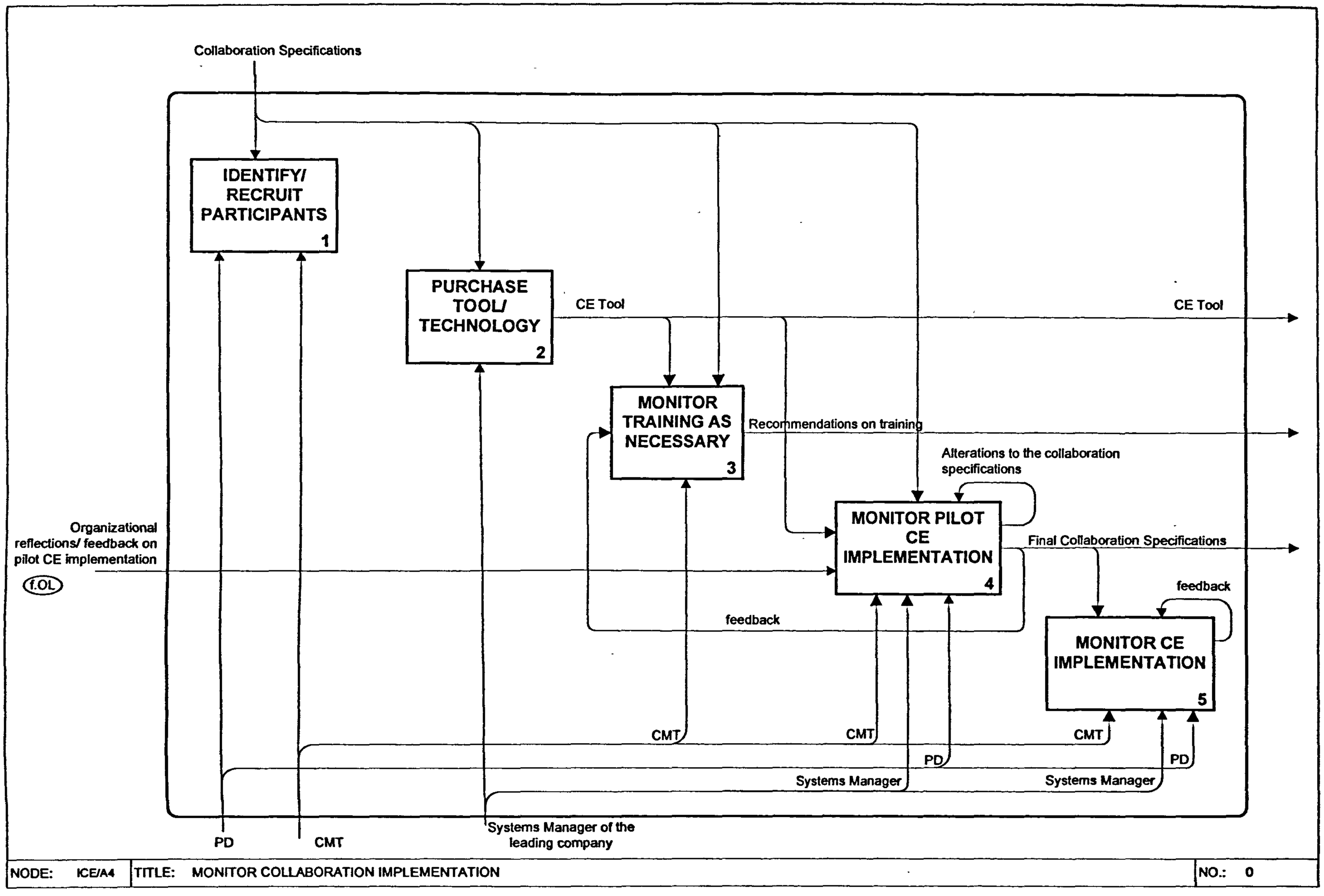

Figure 6.15 ICE/A4 Monitor Collaboration Implementation

d) Monitor pilot collaboration environment implementation

The collaboration specifications determined in ICE/A3 are not the final collaboration specifications unless they are piloted and tested to check whether they can create a smooth and efficient collaboration environment. The pilot stage is the last stage where major changes can be made on the collaboration solution. Once the collaboration solution is agreed by all organizations and implemented on the construction project, the modifications will be limited to fine-tuning. Therefore, the pilot process is very important for the success of collaboration environments.

The pilot collaboration environment implementation should be carried out in all organizations but only by a sample of users in each organization. CCMT members would be excellent for participating in this pilot. Since they are the ones who identified the user/organizational requirements, they should also be testing the collaboration environment. Based on the organizational reflections/feedback on the pilot CE implementation (MOCHA/A41), the collaboration specifications may be altered. After a number of iterations, when all organizations are satisfied with the performance of the pilot, the final collaboration specifications are drawn up as output and all organizations agree and commit to those specifications. If necessary, the training recommendations are changed according to the final collaboration specifications.

e) Monitor collaboration environment implementation

This is where the collaboration environment is launched on the construction project. Each organization implements the collaboration environment in their organization and starts using it in the construction project during this process. The CMT, project director and systems manager of the collaboration leading company monitor this implementation according to the final collaboration specifications (ICE/A44).

6.3.4.5 Evaluate collaboration solution- ICE/A5

This process checks whether or not the collaboration environment is working in line with the collaboration vision, towards achieving the defined objectives and according to the final collaboration specifications. ICE/A5 has three sub-processes which are

shown in an IDEF0 diagram in Figure 6.16.

a) Obtain short term results on collaboration

After the collaboration environment starts to be used on the construction project, a short term performance evaluation is carried out to check whether the collaboration environment is working efficiently and whether there are any bottlenecks or barriers that should be removed in any area. This process is carried out by the CMT and project director. The processes are checked against the final collaboration specifications. The organizational performance evaluation reports (MOCHA/A51) together with the performance evaluations carried out at the project organizational level are used to create a short term evaluation report.

b) Alter collaboration solution

According to the short term evaluation results (ICE/A51), some modifications might be required on the collaboration solution. This process determines these alterations to the collaboration solution and is carried out by the collaboration management team and project director. These alterations are expected to be limited to fine-tuning. However, if the short term results show that there is a need for a major change to the collaboration solution, it means that there have been mistakes in the previous stages and therefore, it is recommended to go back to the beginning of the ICE process model and redefine a new solution after reviewing the previous stages rather than making alterations at this point.

c) Evaluate long term results

In the long term, final performance evaluation is carried out and a long term evaluation report is produced as an output by the CMT and project director. The main aim of the process is to document and save some strategic data which will be beneficial for each collaborating organization for the future implementations. The data kept include, but is not limited to, the best practices carried out for the collaboration, the bottlenecks and barriers observed and the methods to prevent or overcome them, and the lessons learnt from this collaboration. These could be recorded at any time during the project with no need to wait until the long term

evaluation is carried out. However, all data entered during the project should be reviewed and updated at the end of the project.

6.3.5 MOCHA- IDEF0 Model

This section explains all the sub-processes of the MOCHA model, the IDEF0 diagram of which was shown in Section 6.3.3 in Figure 6.7 and Figure 6.9 for A-0 and A0 level processes.

6.3.5.1 Initiate organizational change management - MOCHA/A1

This is the first of five main sub-processes of MOCHA. The IDEF0 diagram for MOCHA/A1 is given in Figure 6.17. MOCHA/A1 consists of three sub-processes details of which are explained below.

a) Build the change implementation team

After the project director defines the need for collaboration (ICE/A11), it is communicated to the organizations participating in the project. Learning the need, senior management in the organizations should start building the change implementation team in the organization by choosing a collaboration champion and members of the collaboration change management team. The people chosen for these roles must be capable of carrying out the responsibilities defined in Section 6.3.2. For CCMT, it is important to have a representative from each group in the organization which are likely to be affected by the change. The members to participate in the collaboration management team at the project organization level are also selected during this process. However, since it is assumed that they will be chosen from the members of CCMT, the CCMT is not shown as an output on the IDEF0 diagram for MOCHA/A1 in Figure 6.17. Team working skills are used as a control during this process.

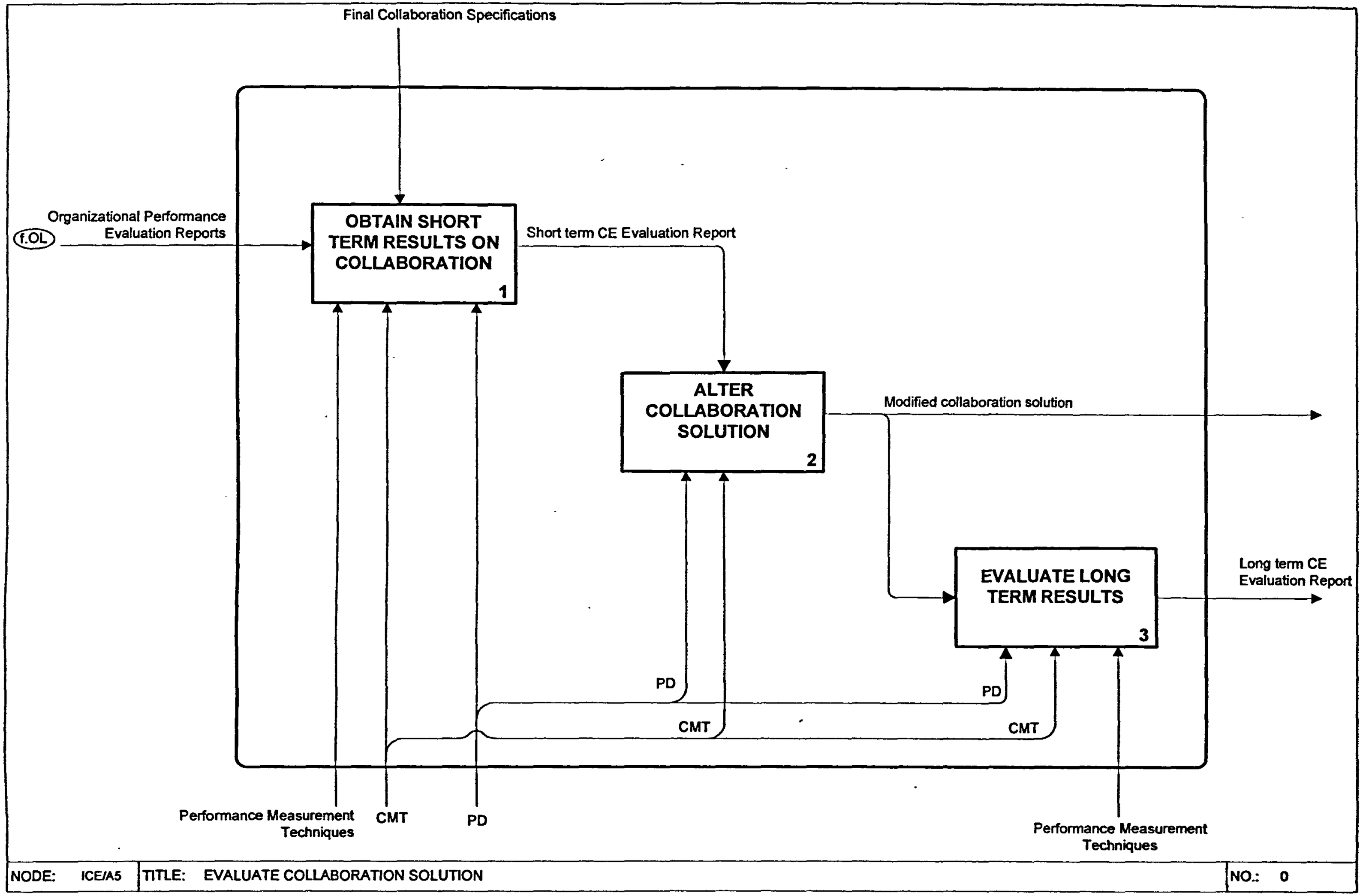

Figure 6.16 ICE/A5 Evaluate Collaboration Solution

b) Communicate initial change

After receiving the preliminary collaboration specifications (ICE/A12), it is realised that there will be some changes in the organization. These changes are not communicated in detail since the preliminary collaboration specifications are most likely to change. However, as discussed in Chapter 3, it is important to inform the employees of the changes as early as possible since early communications allow employees enough time to understand and adjust (Balogun and Hope Hailey, 2004).

The exploratory case studies also indicated the importance of user involvement at the early stages. It was interpreted from the results that the earlier the users are involved in the design and implementation of the collaboration environments, the less resistance will occur. Therefore, even if the details of the change are not known, the fact that there is going to be some change in the organization should be shared with employees.

c) Capture user and organizational requirements

This process captures the user and organizational requirements regarding the collaboration environment so that when the CMT members meet at the project organization level, they will make their decisions on collaboration considering these requirements. For this process, the collaboration champion holds a meeting with the CCMT members, where the expectations from the project collaboration and the collaboration tool are derived considering the previous collaboration experiences.

6.3.5.2 Develop change vision - MOCHA/A2

This is the second of five main sub-processes of MOCHA. This process defines the need for organizational change and consequently develops a vision for this change and communicates the vision to the employees. The IDEF0 diagram for MOCHA/A2 is shown in Figure 6.18.

a) Define the need for organizational change

After a shared collaboration vision has been developed at the project organization level (ICE/A21), it is communicated with each organization. Looking at this vision, the organization decides whether there is a need for organizational change. If

there is a need, which will happen almost in all projects, the collaboration champion and CCMT carry out this process to develop a formal definition of the need for organizational change.

b) Define change vision

The definition of need for organizational change (MOCHA/A21) is used as an input for this process which defines a change vision aligned with the shared collaboration vision (ICE/21). The actors for this process are the CCMT and collaboration champion. The change vision should be clear enough to be understood by the employees quickly (Kotter, 2002). If the right vision can be developed for the change effort, the future steps will be easier to agree on.

c) Communicate change vision

Vision and strategies are not only for the guiding team, they should be communicated for both understanding and gut-level buy-in with the goal of getting as many people as possible acting to make the vision a reality (Kotter, 2002). Once the change vision is identified, it should be communicated in the organization by the collaboration champion and CCMT. Communication technologies are used as a means of carrying out this process.

6.3.5.3 Plan organizational change management - MOCHA/A3

This is the third of five main sub-processes of MOCHA. It plans how the organizational change should be managed. The IDEF0 diagram of MOCHA/A3 is given in Figure 6.19.

a) Define current ICT tools and ICT needs

In this process, the current IT tools used in the organization are determined by the systems manager and CCMT. The tools determined are documented in an ICT audit report, which is the output for this process. Each organization sends their ICT audit reports to the project organization level so that CMT members can consider the compatibility issues whilst planning the technology specifications and collaboration standards of the collaboration solution.

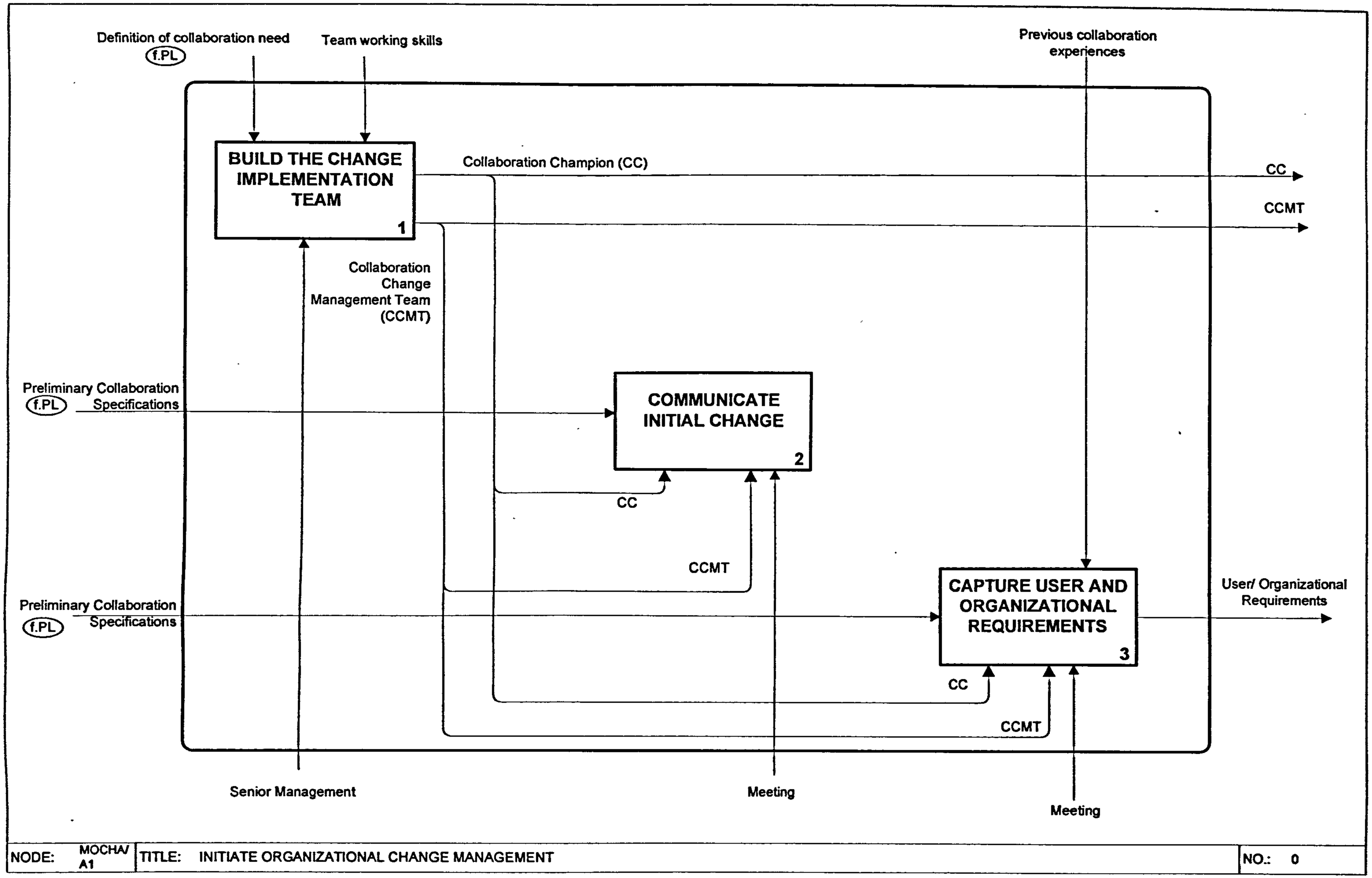

Figure 6.17 MOCHA/A1 Initiate Organizational Change Management

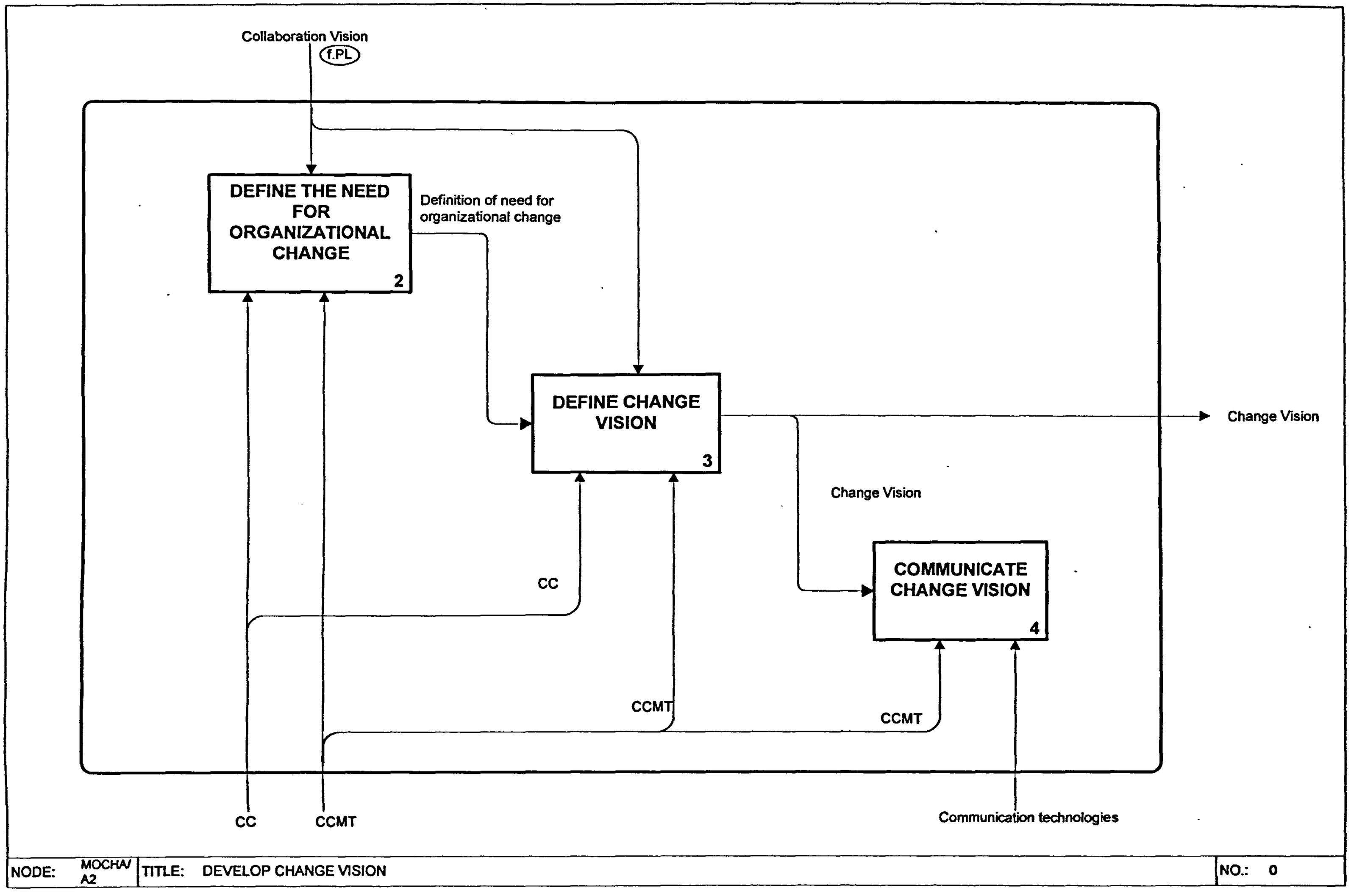

Figure 6.18 MOCHA/A2 Develop Change Vision

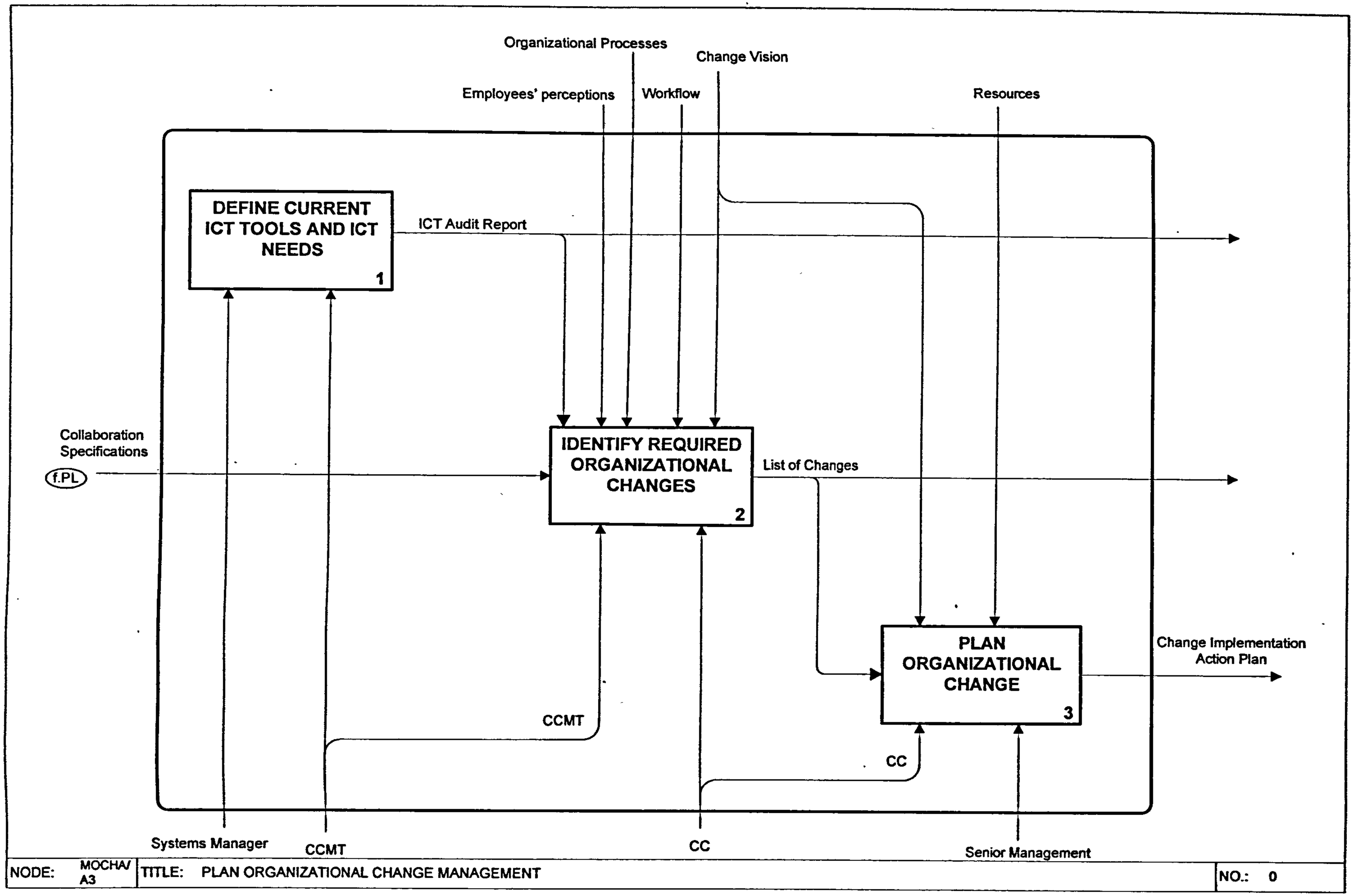

Figure 6.19 MOCHA/A3 Plan Organizational Change Management

b) Identify required organizational changes

When the collaboration specifications defined at the project organizational level (ICE/A3) are communicated to the organizations, each organization should carry out an analysis of these specifications according to their employees' perceptions, organizational processes, ICT tools and technologies, and the organizational workflow structure. Taking all these factors and the change vision into account, the CCMT and collaboration champion identify the organizational changes required to implement the collaboration specifications. The output for this process is the list of changes.

c) Plan organizational change

Once the required organizational changes are known, the collaboration champion and senior management start planning how this change will be implemented considering the change vision and the resources, which are controls for this process. The output of this process is the change implementation action plan.

6.3.5.4 Implement organizational change - MOCHA/A4

This is the fourth of five main sub-processes of MOCHA. It is aimed at finalising the collaboration solution through a pilot implementation, carrying out training, and finally implementing the collaboration solution on the project. Each of these aims are represented as sub-processes of MOCHA/A4. Details of the IDEF0 diagram for MOCHA/A4 can be seen in Figure 6.20.

a) Pilot and refine change

This process carries out a pilot of the collaboration environment implementation and the changes required for this. The changes are implemented according to the Change Implementation Action Plan. Only a sample of users are involved in the pilot and it is recommended to use CCMT members for this sample since they have already been involved in capturing user and organizational requirements and now know what is expected from the collaboration environment. Since CCMT members will be the ones who have been responsible from the pilot implementation and the change, if an error is found after the actual implementation, it would be accepted as their failure in

managing the change. Therefore, using the CCMT for the pilot will increase the likelihood of having a thorough examination of the collaboration environment. The system manager is also involved in this process to monitor the technical aspects of the pilot.

Carrying out a thorough pilot process will prevent facing an unexpected need for major changes during the implementation on the actual project. The pilot implementation is expected to provide feedback on two areas. The first feedback is related to the change implementation procedures of the organization which will be used to modify the change implementation action plan. In the next processes, this modified action plan is used as a control. The second feedback is related to the collaboration environment implementation. The organizational reflections/feedback on the pilot CE implementation constitute the output of this process which is communicated to the project organizational level to be used to determine the alterations to the collaboration solution.

b) Conduct training

Training is carried out following the recommendations on training (ICE/A43) defined by CMT. The change implementation action plan acts as a control for this process similar to the other MOCHA/A4 sub-processes. The collaboration champion and systems manager are involved in this process.

Training should be considered as a combination of training on the use of the collaboration environment tool and training on the collaboration standards and procedures agreed by the CMT. During the training, some feedback on change implementation is also obtained. This feedback is used to alter the change implementation action plan.

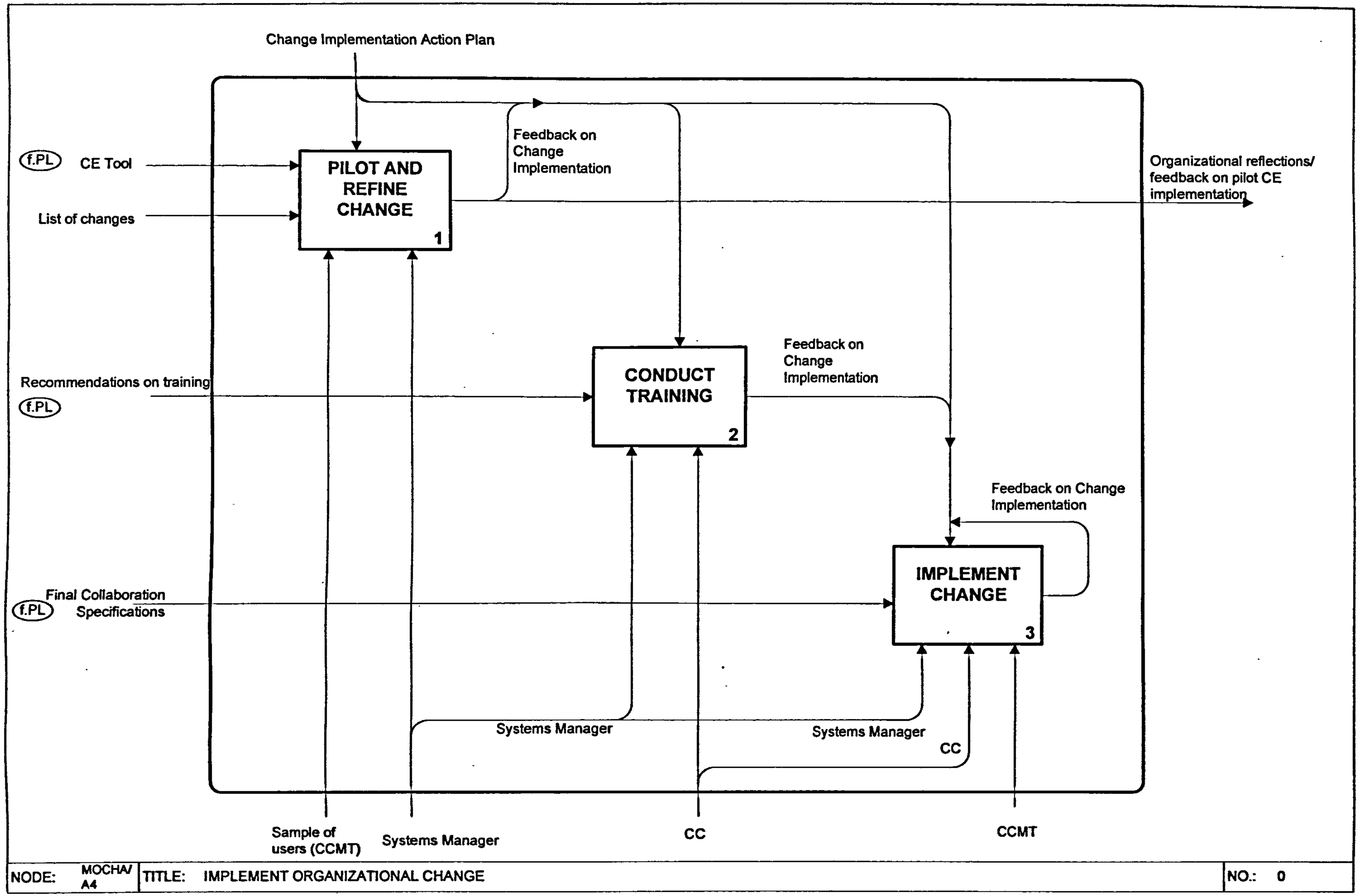

Figure 6.20 MOCHA/A4 Implement Organizational Change

c) Implement change

This process makes the start of the implementation of the final collaboration specifications (ICE/A44) fixed after the pilot implementation at the project organizational level. The systems manager, collaboration champion and CCMT are the actors for this process. This process enables the start of the collaboration environment use on the construction project. During the process, feedback on change implementation is created as an output which is used to alter the change implementation action plan which acts as a control for this process. Therefore, this process can be considered an iterative process.

6.3.5.5 Evaluate organizational change - MOCHA/A5

This is the last sub-process of the five main sub-processes of MOCHA. It evaluates the adoption of organizational change in the short term and long term, and enhances organizational learning during the implementation. The IDEF0 diagram for MOCHA/A5 is given in Figure 6.21.

a) Obtain short term results on collaboration

After the collaboration environment starts to be used on the construction project, a short term performance evaluation is carried out in each organization to check whether the collaboration environment is working efficiently and whether there are any bottlenecks or barriers that should be removed for a more efficient adoption. The organizations also evaluate whether the organizational change is accepted by the employees and there are any alterations to be made in the change implementation action plan. This process is carried out by CCMT and collaboration champion through the use of data collection and performance measurement techniques. The results are documented as the organizational performance evaluation report, which is sent to project organizational level for a further inter-organizational evaluation of the collaboration environment performance.

b) Implement altered collaboration solution

The modified collaboration solution (ICE/A52) determined at the project organizational level according to the short term performance evaluation is

implemented in this process. The actors are the collaboration champion and CCMT. The organizational performance evaluation report is used as a control.

c) Alter change management procedures

As previously stated, the organizational performance evaluation focuses on both the collaboration environment and the organizational change. The modifications required in the collaboration solution are determined at the project organizational level whereas the modifications required in change management procedures are carried out in each organization independent of the others. This process determines these modifications to the change management procedures and is carried out by the collaboration champion and CCMT. The output of the process is the altered change implementation plan.

d) Evaluate long term results

At the end or close to the end of the project, the long term results on the change management are carried out by the collaboration champion and CCMT through the use of performance measurement techniques.. The results of the evaluation are documented as the long term performance evaluation report.

e) Document organizational learning

The aim of this process is to document and save strategic data which will be beneficial for future organizational change management attempts in terms of guidelines to follow or as recommendations. During any change implementation, organizations go through a learning process with or without noticing that it is learning. All the best practices, all the required alterations, corrected mistakes are lessons learnt during the implementation. These lessons should be captured throughout the implementation. The collaboration champion and senior management carry out a final evaluation of these captured lessons at the end and document the organizational learning.

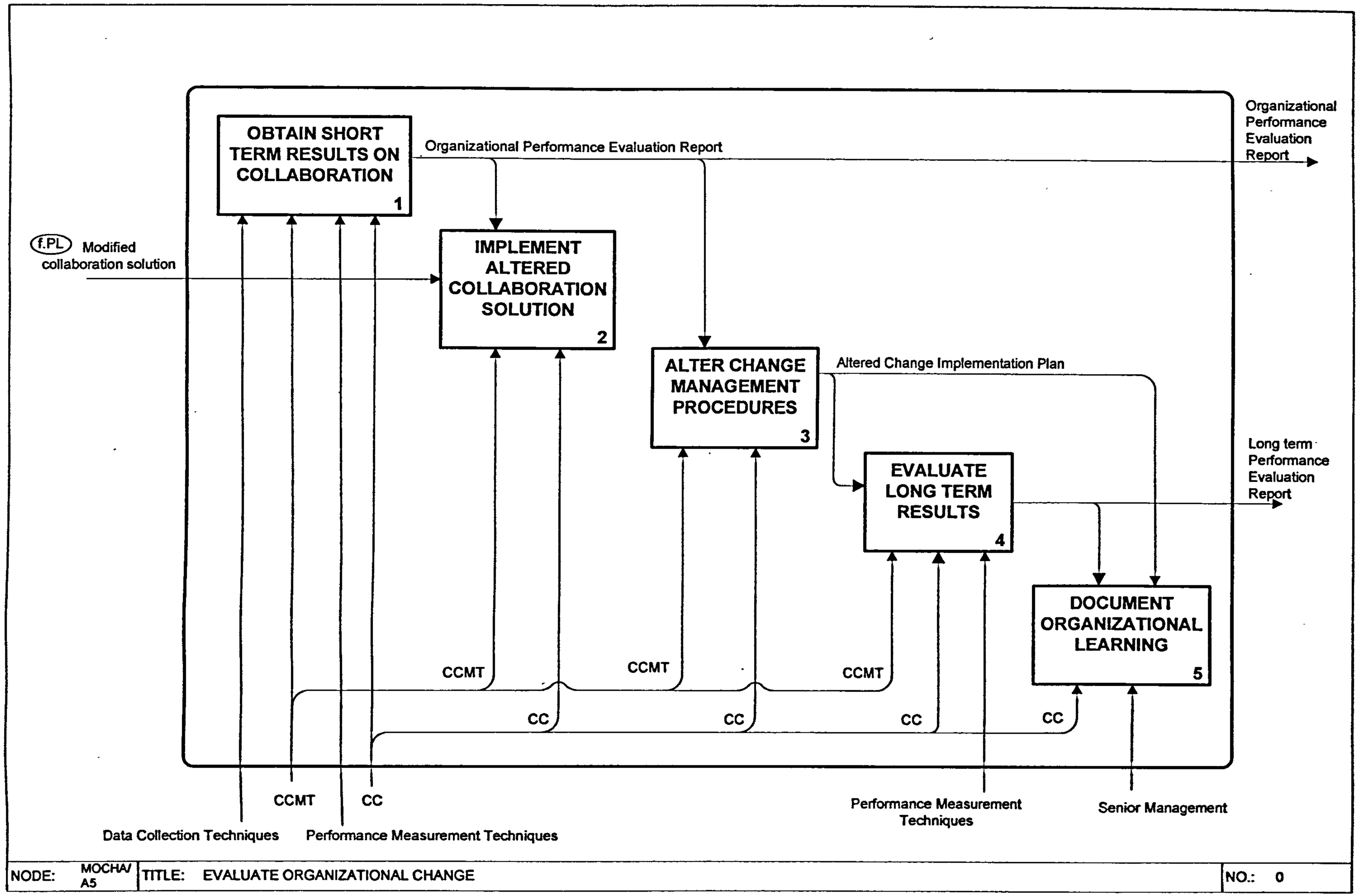

Figure 6.21 MOCHA/A5 Evaluate Organizational Change

6.4 Summary

This chapter has presented the ICEMOCHA framework developed in order to improve the collaboration in construction projects following strategic management and organizational change management principles. The model consists of two interdependent IDEF0 models acting at two different levels: ICE and MOCHA. ICE is at the project organizational level and aims at planning and implementing effective collaboration environments. MOCHA is at the organizational level and aims at guiding the adoption process in each organization focusing on the management of organizational changes required due to the collaboration environment.

In this chapter, all processes and their sub-processes covered in ICE and MOCHA models have been explained in detail together with the IDEF0 diagrams developed for each main sub-process. However, this framework is not complete without a validation. Since the ICEMOCHA framework was developed using the data collected from the case studies, it was decided to get the framework evaluated again by industry professionals. The validation results of the framework is presented in Chapter 8 together with the validation of the prototype developed in order to automate the ICE model. This prototype is presented in detail in the next chapter, Chapter 7.

CHAPTER SEVEN: PROTOTYPE FOR IMPLEMENTATION OF COLLABORATION ENVIRONMENTS

7.1 Introduction

This chapter describes the development of a prototype system that automates the conceptual ICE framework presented in the previous chapter. The prototype aims at guiding the collaboration management team members in planning and implementing collaboration environments.

The chapter first gives an overview of the development environment used for the prototype. It goes on to describe the system architecture of the prototype and provides an overview of the prototype. This part is followed by the demonstration of the prototype, where the start up page, main collaboration page and the output of the prototype are presented. The chapter ends with a summary.

7.2 Prototype Development Environment – VB.net

The prototype was developed using Visual Basic.Net (VB.net) application in Microsoft Visual Studio 2005. VB.net was chosen as the prototype development environment since it requires less coding for the appearance and location of the interface elements compared to many other environments. Figure 7.1 shows a screenshot of a windows application example created in VB.net. Some of the crucial components used to develop a prototype software are marked on the screenshot. The form is a window used to design the graphical user interface. The toolbox has many pre-built elements to be used for the interface. Buttons, checkboxes, combo boxes,

textboxes, list and table views are examples of these pre-built elements. Any of these elements can be dragged from the toolbox and be placed on the form at a desired location. These elements can be seen in detail in Figure 7.2.

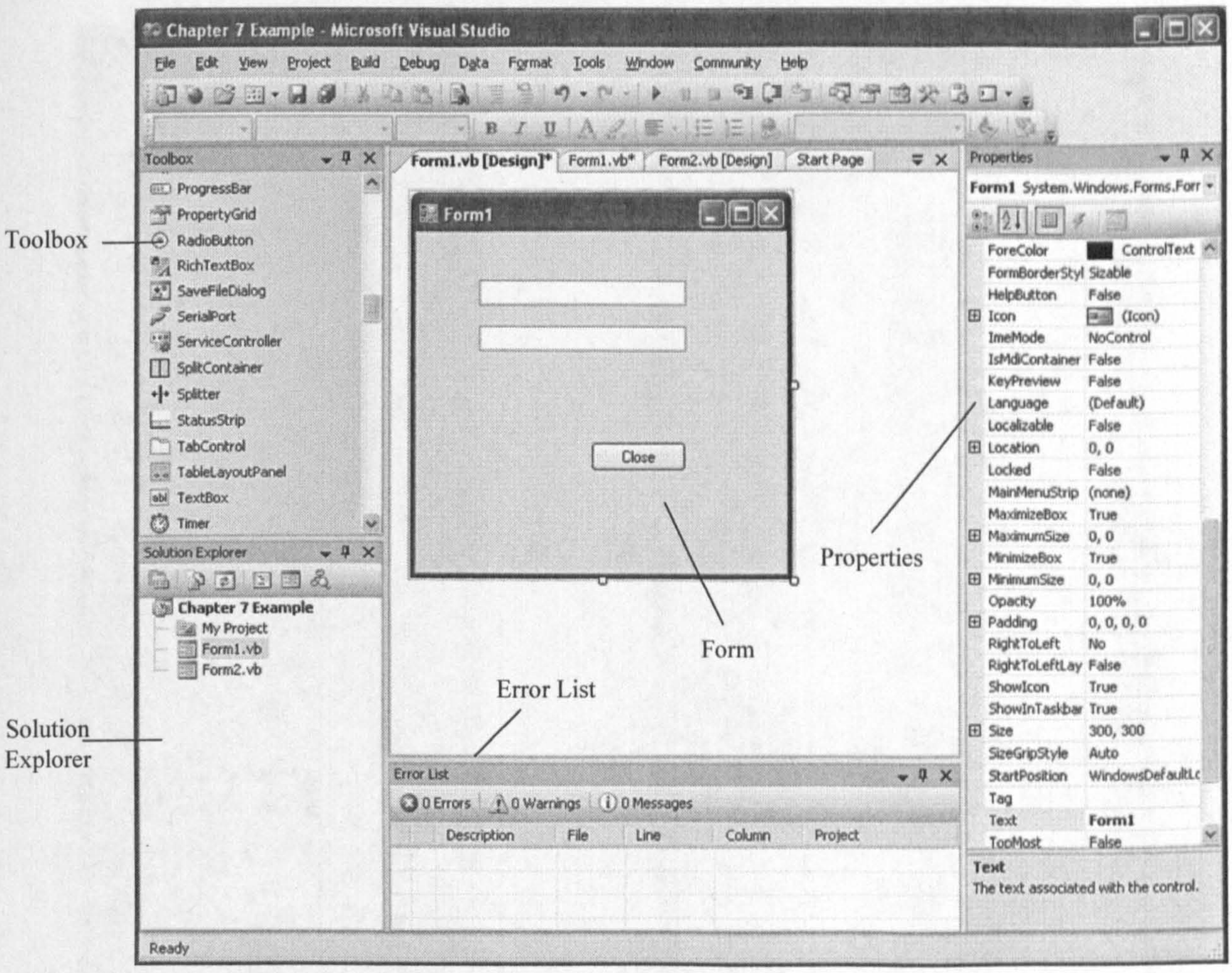

Figure 7.1 VB.net – User Interface Design Tools

Developers do not need to write a code for the type, appearance and location of the graphical user interface in VB.net, which is the main reason for the selection of VB.net as the development environment. The properties panel is used to change the appearance and location properties of the interface elements such as font type, font size, colour, max/min size, docking style, and margins. In the example, shown in Figure 7.1, two textboxes and a button have been dragged to Form1 and the text on the button has been changed to "Close" from the properties panel. Figure 7.3 shows a part of the properties panel for this button.

Although it is possible to develop a programme using only one form, most of the time a graphical user interface is designed using more than one. Solution Explorer is used to navigate from one form to another. The example shown in Figure 7.1 has two

forms, Form1 and Form2, which can be seen from the Solution Explorer. Since both forms were open in the main panel when the screenshot was taken, they can also be seen at the top of the main panel.

Figure 7.2 VB.net – Toolbox Panel

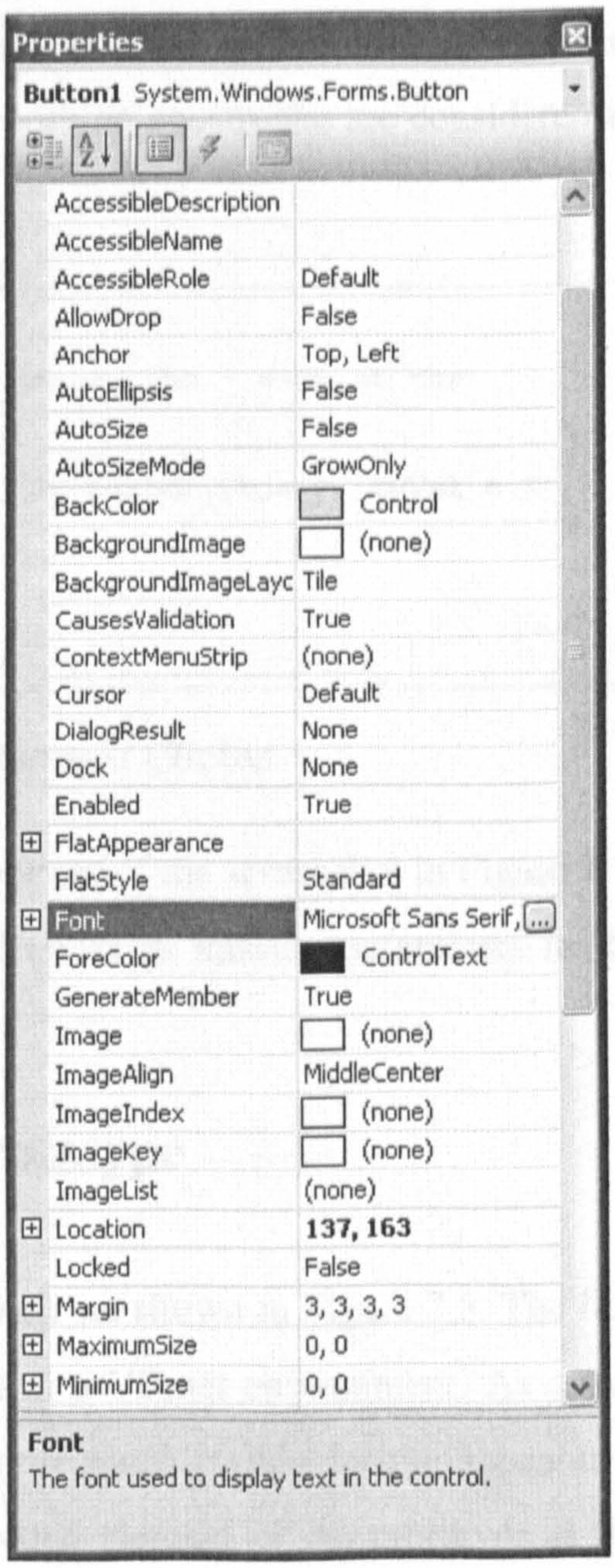

Figure 7.3 VB.net – Properties Panel

When any of the elements on the design form are clicked, a new window is opened for coding events. VB.net automatically generates a code to define the event (clicking to a button or ticking a checkbox) in this window. When the developer writes a code, VB.net links this code written to the event.

In the example shown in Figure 7.1, the "Close" button in Form1 is clicked to open the coding window. The code automatically generated by VB.net is given in Figure 7.4. When the developers want to add some explanatory statements for themselves, an apostrophe (') should be added to the beginning of the text line. The program changes the text colour of these lines to green to help the coders differentiate the code from the explanatory text. These green lines starting with an apostrophe are considered as non-existing by the program.

```
Public Class Form1

'This line will be ignored by the program due to the ' sign at the
beginning of the line

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click

    End Sub

End Class
```

Figure 7.4 VB.net –Code Created When Close Button is Clicked

The Error List panel, which can be seen at the bottom of the screenshot in Figure 7.1, is a mechanism that informs the developers of errors or missing parameters in the written code or any problems during the run.

7.3 System Architecture of ICE Prototype

The ICE prototype has three main elements, which are shown in Figure 7.5. The first one is the user interface which was developed in a VB.net environment. As stated before, VB.net was chosen since it did not require much coding for the appearance and location of the interface elements. The second element of the prototype is the database where all data entered through the interface are stored. Microsoft Office Access was chosen as the database. The third element is the report created as the output of the prototype. The medium chosen for the report creation was Microsoft Word. Microsoft Office Access and Microsoft Word were chosen since they were highly used in the construction industry and therefore, the users would not require to install an additional program to run the prototype. Besides, these two programs were available to the researcher since the university had licenses for both. The links between these three elements were established by the codes written in VB.net.

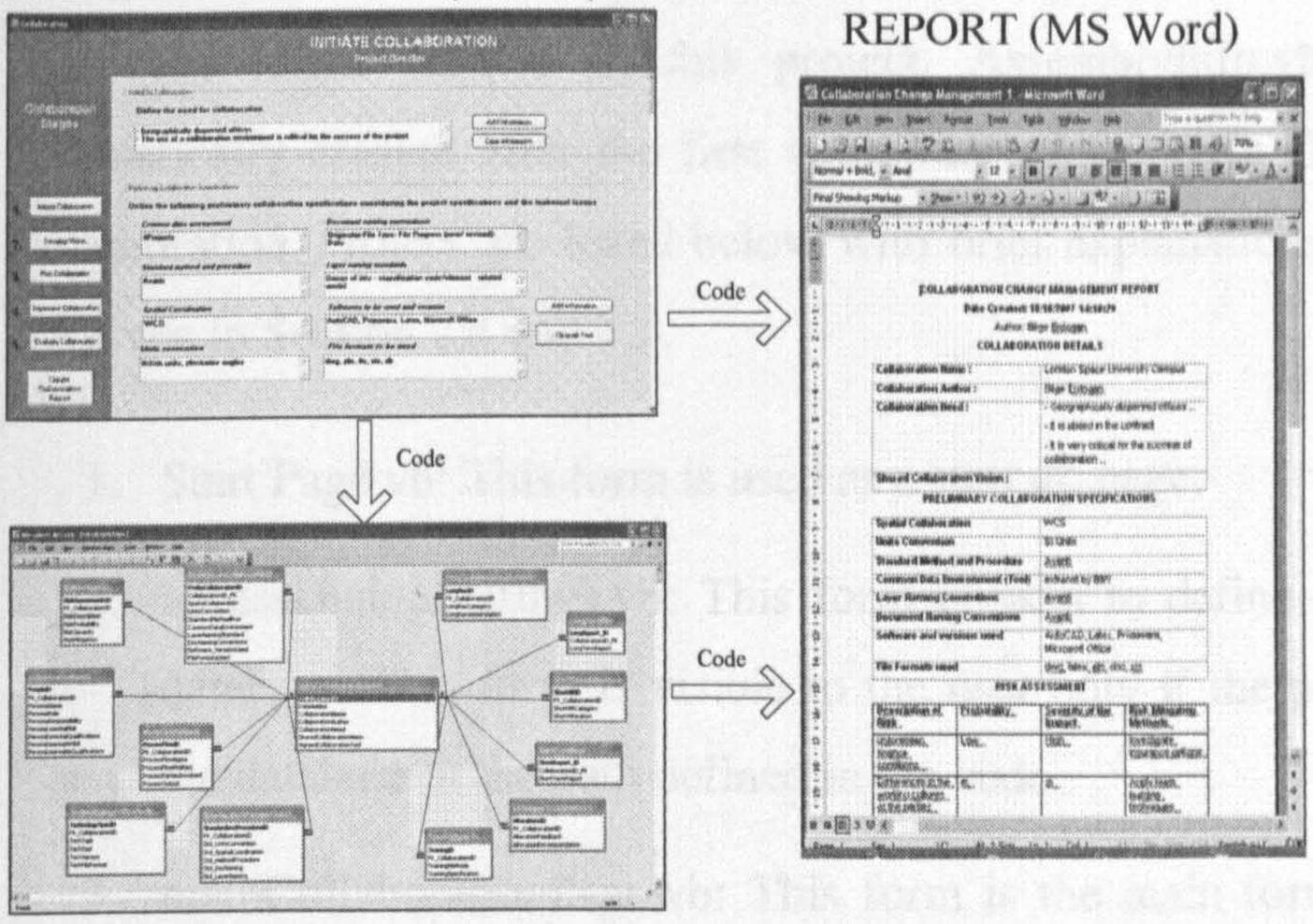

Figure 7.5 System Architecture of ICE Prototype

The user interface is designed in VB.net and is saved as "Collaboration_Project". The links between the three elements of the program are also developed by the codes written in this project. The interface is prepared using seven forms. These forms can be seen from the Solution Explorer screenshot given in Figure 7.6.

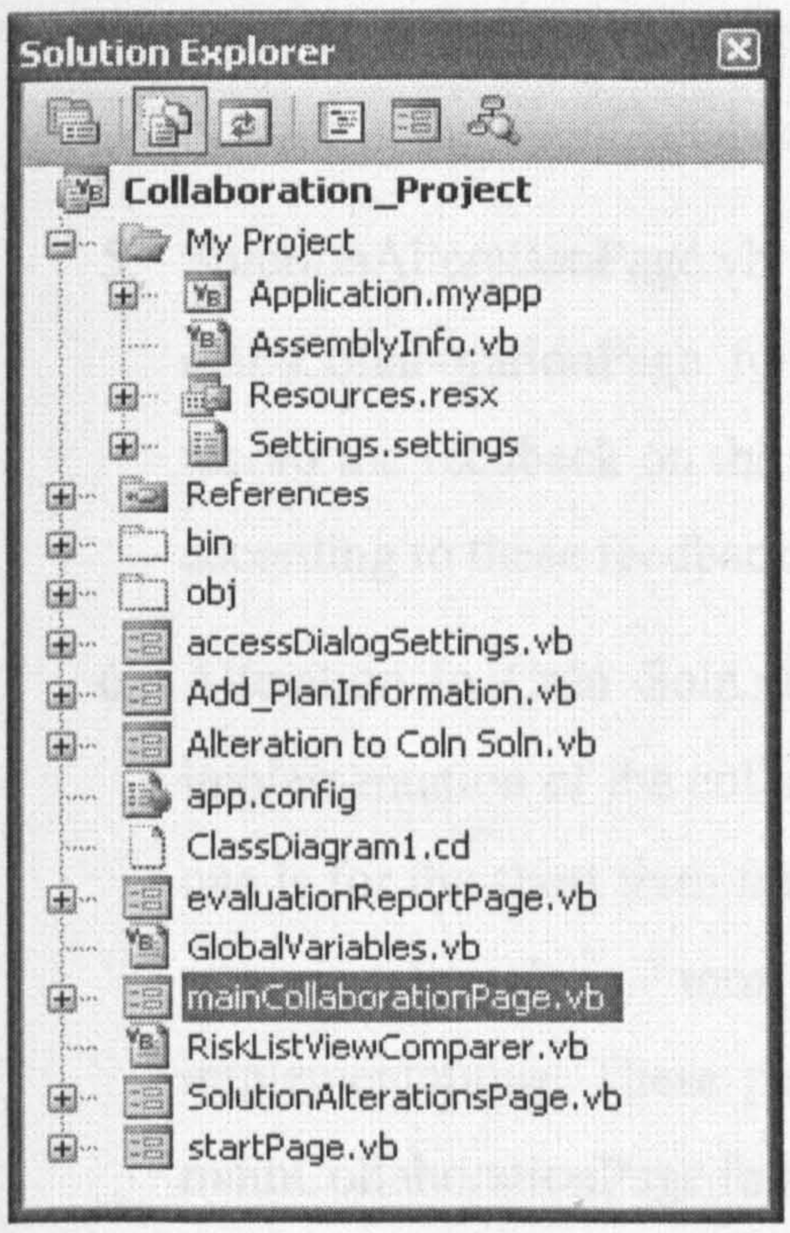

Figure 7.6 Solution Explorer Showing the Forms Used in the Project

In Figure 7.6, the files with .vb extensions apart from the AssemblyInfo.vb basically show the forms created in this project. AssemblyInfo.vb is a file which is automatically created after the first compiling of the code. The forms used in the Collaboration_Project are listed below with brief explanations. Further explanations are given in Section 7.4 and 7.5.

1. Start Page.vb: This form is used as a start up page.

2. accessDialogSettings.vb: This form is used to define the access path to the database. This form is visible to the user only if the programme cannot find the database at the path defined in the code.

3. mainCollaborationPage.vb: This form is the main form used to develop the interface. This form uses five panels to represent the five stages of ICE and guides the users through these stages, getting them to follow framework without noticing. All other forms listed below are pop up forms activated through buttons embedded in this form.

4. Add_PlanInformation.vb: This form is used to collect data for the third stage of ICE, which is the planning of the collaboration solution. It consists of four panels representing the four dimensions of the collaboration solution: people, data/ work flow, technology and standards. These panels are activated by the buttons in the mainCollaborationPage form.

5. SolutionAlterationPage.vb: This form is also activated by a button in the mainCollaborationPage form. It appears as a pop up form and is used to record the feedback on the pilot implementation and decide on the alterations according to these feedback.

6. Alteration to Coln Soln.vb: This form is used to collect feedback on the implementation of the collaboration environment. It includes two panels. First one is for the short term feedback and required alterations whereas the second one is for long term feedback and recommendations for future implementations. These panels are activated by clicking two buttons in the mainCollaborationPage form.

7. evaluationReportPage.vb: This form is used to write a report on short term evaluation and on long term evaluation of the collaboration environment. Both

of these are activated by buttons in the mainCollaborationPage form.

The data collected through these forms are saved to the database, created using Microsoft Office Access and saved as CollaborationDB.mdb. CollaborationDB.mdb has thirteen tables which are all related to each other with a unique ID number, which is called Collaboration ID. This number is automatically generated by the database when a new collaboration project is created in the start up page of the programme. Collaboration ID is referred to as CollaborationID, CollaborationID_FK or FK_CollaborationID and is assigned as a primary key in all tables. The details of the tables created can be seen from the relationships diagram shown in Figure 7.7. When saving the data entered through the interface, the command used is INSERT for entering items into a blank row and UPDATE for entering items into a row which already has some data entered from previous forms. The VB.net connection string used for Microsoft Access is OleDbConnection, and the commands related to the database are defined in the beginning of the code as OleDbCommands.

All data entered via the interface can be used to produce a report as a word document at any time during the programme use. The code was written to retrieve the required data from the database and write it on a word document with a specified format. In order to be able to link VB.net and Microsoft Word, a reference to Microsoft Office 11.0 Object Library was added to the Collaboration_Project. The following headings are used in the collaboration report:

1. Collaboration details;

2. Preliminary collaboration specifications;

3. Risk assessment;

4. Planned collaboration solution:

    a. People specifications;

    b. Workflow specifications;

    c. Agreed collaboration tool;

    d. IT tools to be used in collaboration;

e. Standardised collaboration specifications.

5. Training;

6. Pilot implementation of collaboration environment;

7. Short term collaboration environment performance evaluation report;

8. Alterations to collaboration solution – short term;

9. Long term collaboration environment performance evaluation report; and

10. Recommendations for future collaboration environment implementations – long term;

The following three sections demonstrate the operation of the prototype system. The first section, Section 7.4, explains the start up page of the system. Section 7.5 introduces the main collaboration page where all the data collection is carried out while Section 7.6 gives details on the output of the prototype, the collaboration change management report.

7.4 Start-up Page

This is the first page seen by the users. The form used to design the start-up page is startPage.vb, the screenshot of which is given in Figure 7.8. The form has a panel docked to the left of the form. Docking is a terminology used in vb.net. There are six different docking options: Left, right, top, bottom, fill and none. This left panel has two radio buttons which control the visibility of two group boxes. Each radio button controls a group-box which becomes visible when the radio button is checked. Create New Collaboration button controls the visibility of the 'Create New Collaboration group-box' whereas View Previous Collaboration Documents button controls the visibility of 'Browse Collaboration Reports group-box'. These two groups have some interface elements to enable either creating a new collaboration or viewing previous collaboration reports.

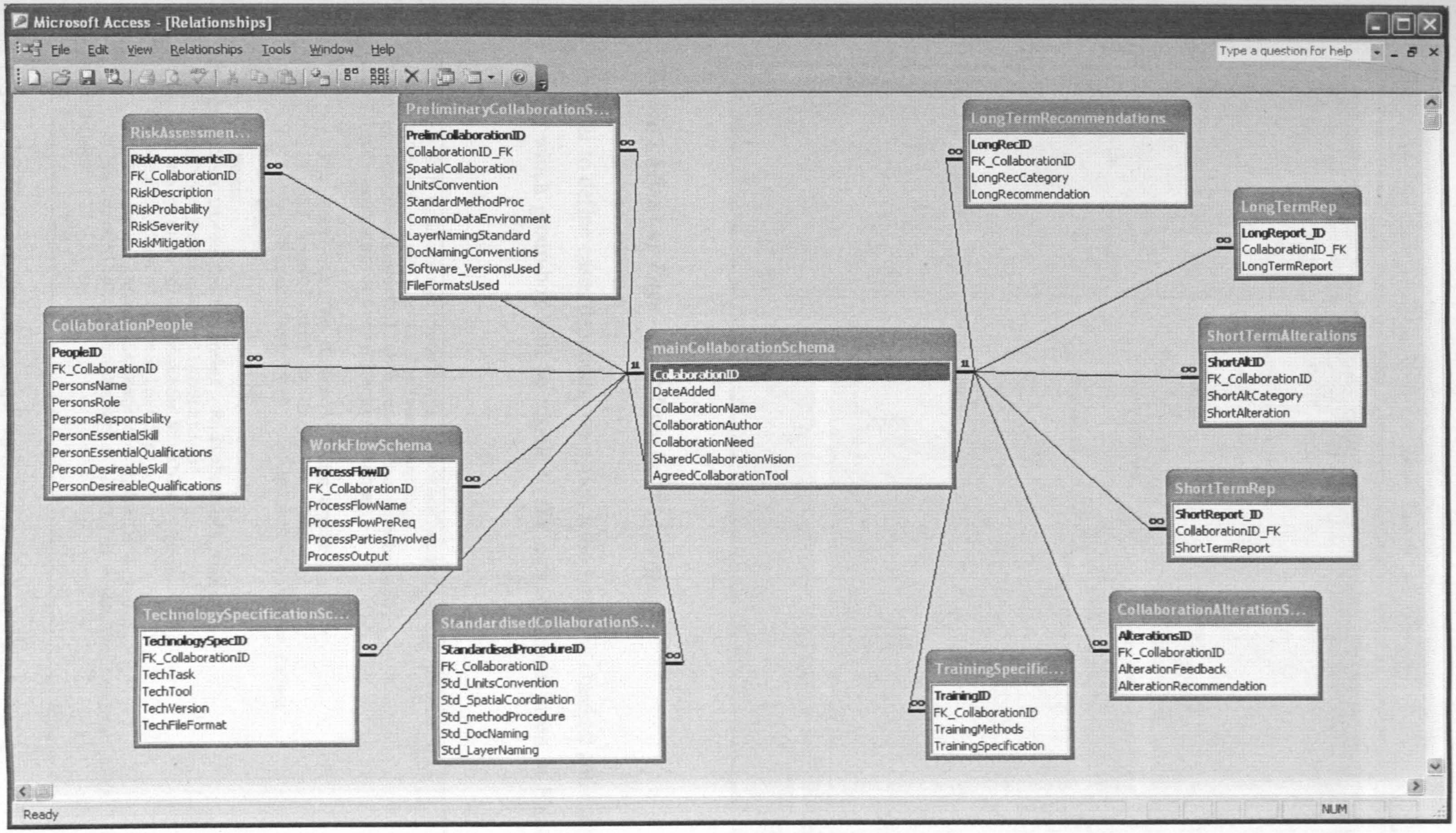

Figure 7.7 Relationships Table

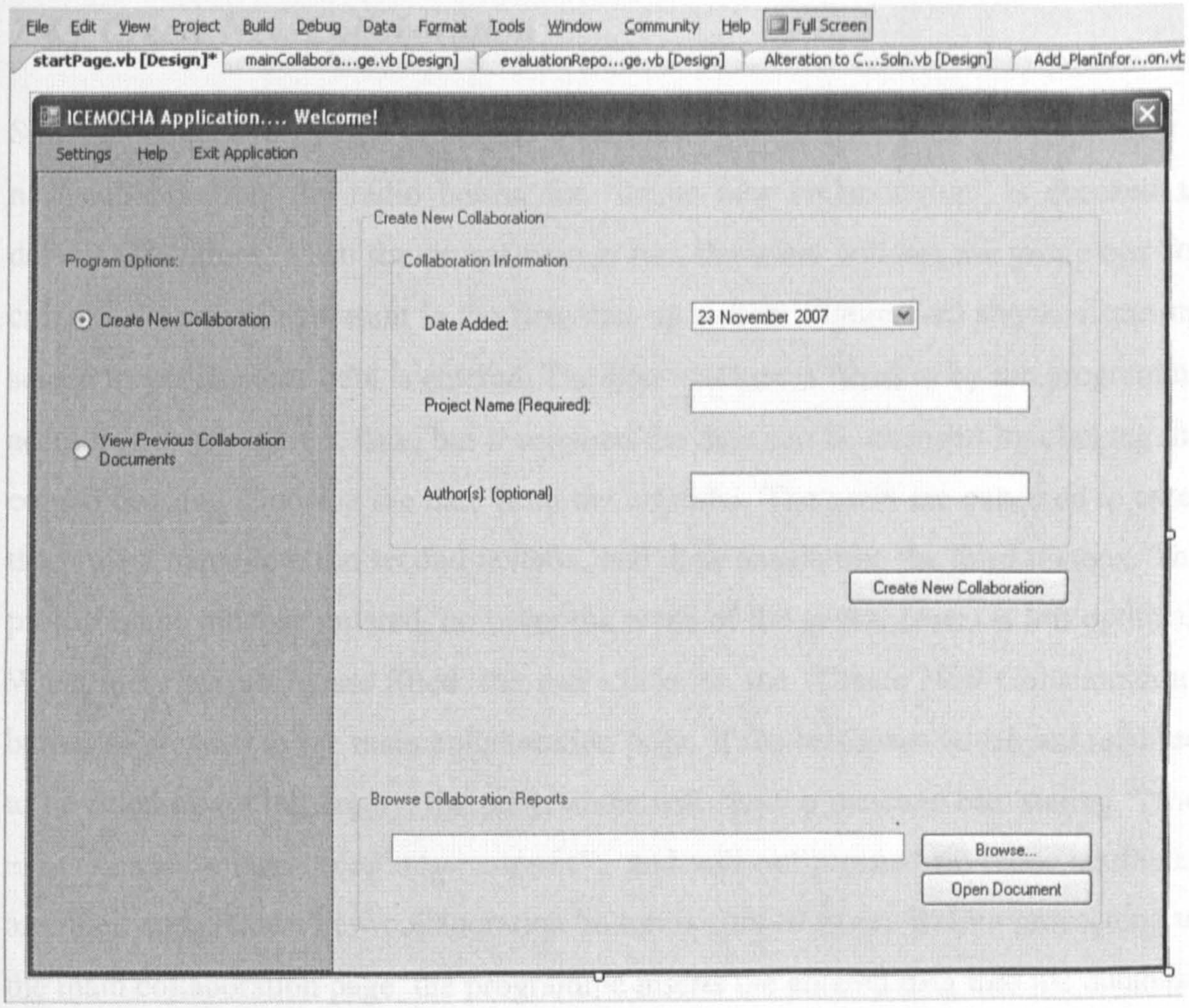

Figure 7.8 Start-up Page - Form Used for the Interface

In order to define cases depending on which radio button is checked and therefore, to define which group-box will be visible to the user, the code given in Figure 7.9 is used.

```
Private Sub CollaborationOptions_CheckedChanged(ByVal sender As
System.Object, ByVal e As System.EventArgs)
Handles rdo_CreateNewCollaboration.CheckedChanged,
rdo_ViewCollaborationDocs.CheckedChanged

        For Each ctrl As Control In Me.Controls
            If TypeOf ctrl Is GroupBox Then
                DirectCast(ctrl, GroupBox).Visible = False
            End If
        Next
Select Case DirectCast(sender, RadioButton).Name
    Case "rdo_CreateNewCollaboration"
         Me.grpNewCollaboration.Visible = True
    Case "rdo_ViewCollaborationDocs"
         Me.grpCollaborationReports.Visible = True
         Me.grpCollaborationReports.Location = New Point(230, 128)
End Select
End Sub
```

Figure 7.9 The Code for Showing Panels in the Start-up Page

7.4.1 Create New Collaboration

Since it is intended that the prototype would mainly be used to plan and implement a new collaboration, the radio button for "create new collaboration" is checked as default. Therefore, when the programme is run, the users will see the group-box for creating a new collaboration in the first start-up screen. Figure 7.10 shows a start-up screen to which some data is entered. The first text box is filled in by the programme according to the current date, but if required the date can be changed by clicking the combo box and choosing the date from the calendar. The users are expected to enter the project name into the second textbox, and their names into the third textbox. The project name must be entered, however the name of the author (user) is left optional. When these textboxes are filled, the user clicks on the "Create New Collaboration" button to proceed to the main collaboration page. If the textboxes which are required to be filled in are left empty, the programme will show a message box stating "`You must enter a name for the report`", and will not proceed till those textboxes are filled and create a new collaboration button is clicked again. Before proceeding to the main collaboration page, the programme inserts the entered data into the database following the code given in Figure 7.11.

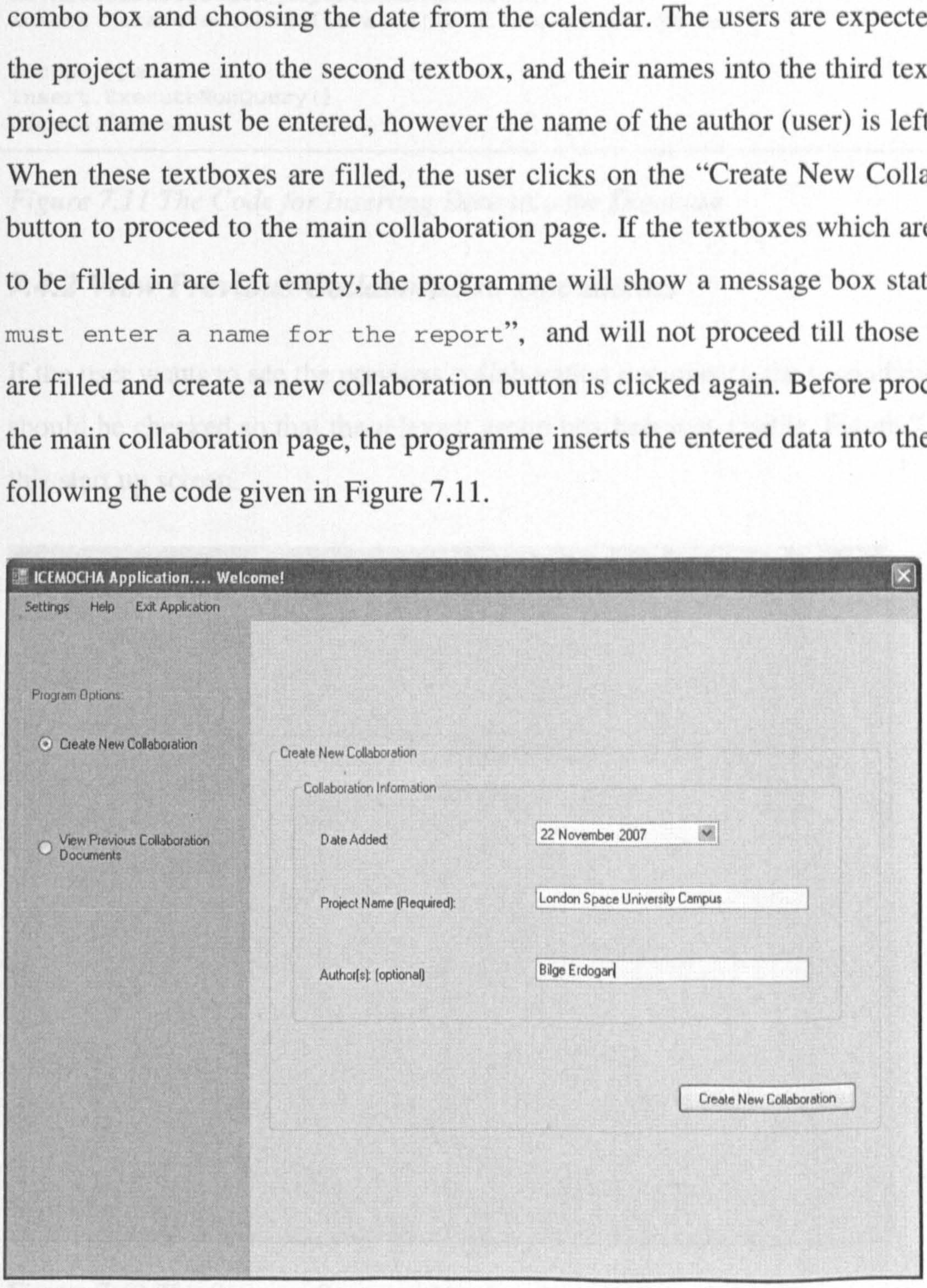

Figure 7.10 The Start-up Screen - Default

```
   Dim insertStr As String = "INSERT INTO MainCollaborationSchema
(CollaborationID,CollaborationName,CollaborationAuthor)" _
& "VALUES(@CollabID,@CollabReportName,@CollabAuthor)"

   Dim insert As New OleDbCommand(insertStr, DBconn)
   Dim author As String = Nothing

 If Me.newCollaboration_AuthorText.Text = String.Empty Then
      author = "Unspecified"
Else
      author = Me.newCollaboration_AuthorText.Text
End If

insert.Parameters.AddWithValue("@CollabID", collaborationID)
insert.Parameters.AddWithValue("@CollabReportName",
Me.newCollaboration_ReportNameText.Text)
insert.Parameters.AddWithValue("@CollabAuthor", author)

DBconn.Open()
insert.ExecuteNonQuery()
DBconn.Close()
```

Figure 7.11 The Code for Inserting Data into the Database

7.4.2 View Previous Collaboration Documents

If the user wants to see the previous collaboration documents, the second radio button should be checked so that the relevant group box becomes visible. Figure 7.12 shows this start up screen.

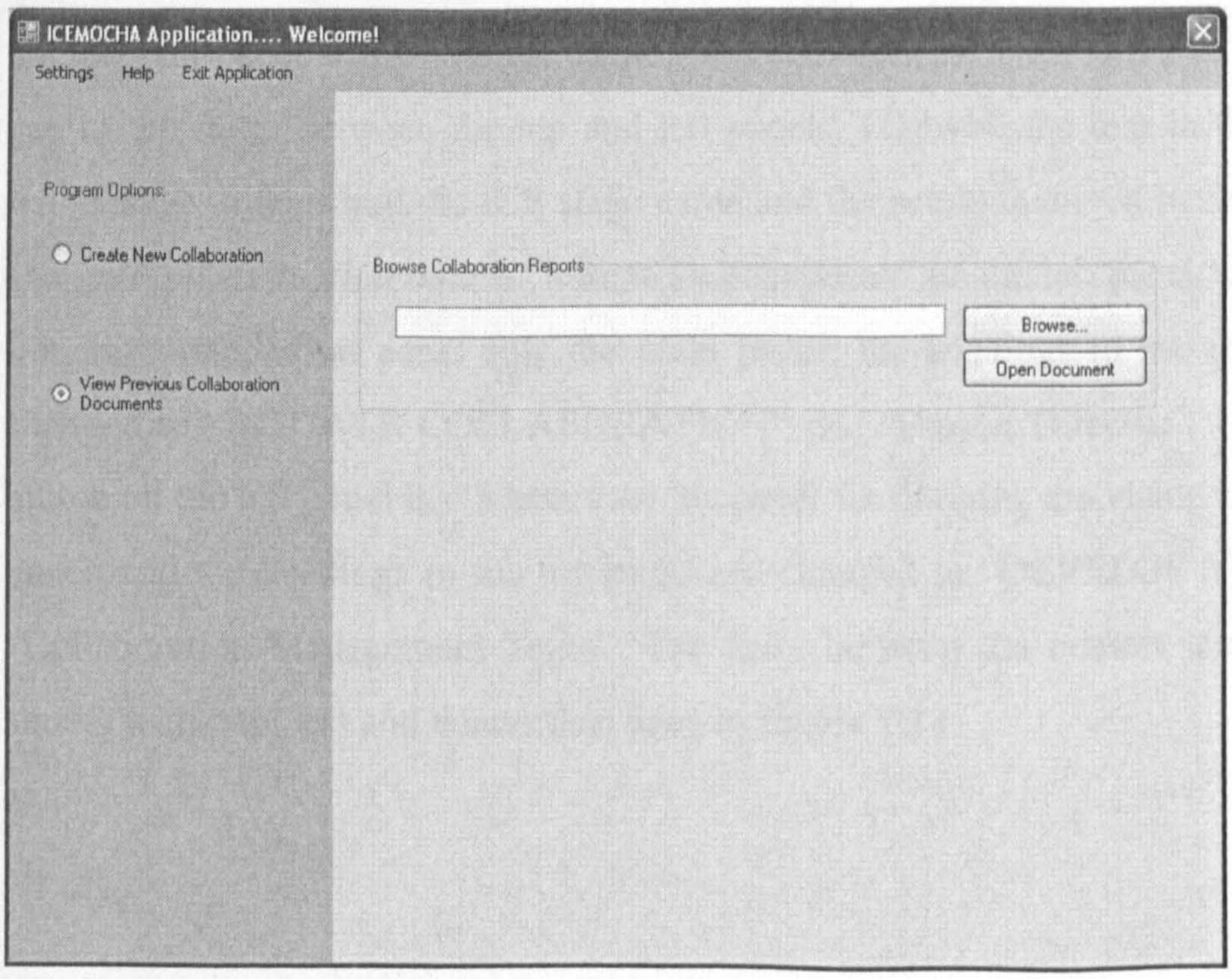

Figure 7.12 The Start-up Screen- View Previous Collaboration Documents

The access path to the required documents can be written manually or can be chosen by clicking the "Browse" button and choosing the path for the file using a windows browsing page. The file will be opened after clicking the "Open Document" button.

7.5 Main Collaboration Page

The main collaboration page, designed in the mainCollaborationPage.vb form, guides the users through the five main stages of the Implementation of Collaboration Environments model (ICE). The form consists of two panels and five table layout panels as shown in Figure 7.13. The two panels are docked to the top and left of the form. In this form, the top panel shows which process is now being carried out and who is responsible from that process. The left panel has six buttons, five of which are named after the five main stages of ICE. The sixth button is used to create a collaboration report anytime during the programme. The left panel is visible at all times when this form is open. The top panel is also visible at all times however the text written on the panel changes depending on which ICE stage is carried out.

The rest of the panels, which are table layout panels, are developed to represent the five main ICE stages. When one of the five buttons on the left panel is clicked, only the relevant panel will be visible in the form and be maximised to a size to fill in the gap in the form, between the top and left panels. Likewise the text in the top panel will change to represent the ICE stage name and the actors involved in that stage. For example, when the first button "Initiate Collaboration" on the left panel is clicked, the Initiate collaboration panel fills the main panel; the headings in the top panel are changed to "INITIATE COLLABORATION" and "Project Director". If the second button on the left panel is clicked, then the panel for defining the vision fills the main panel, and the headings in the top panel are changed to "DEVELOP VISION" and "Collaboration Management Team". The links between the buttons and panels are shown with numbers and connection lines in Figure 7.13.

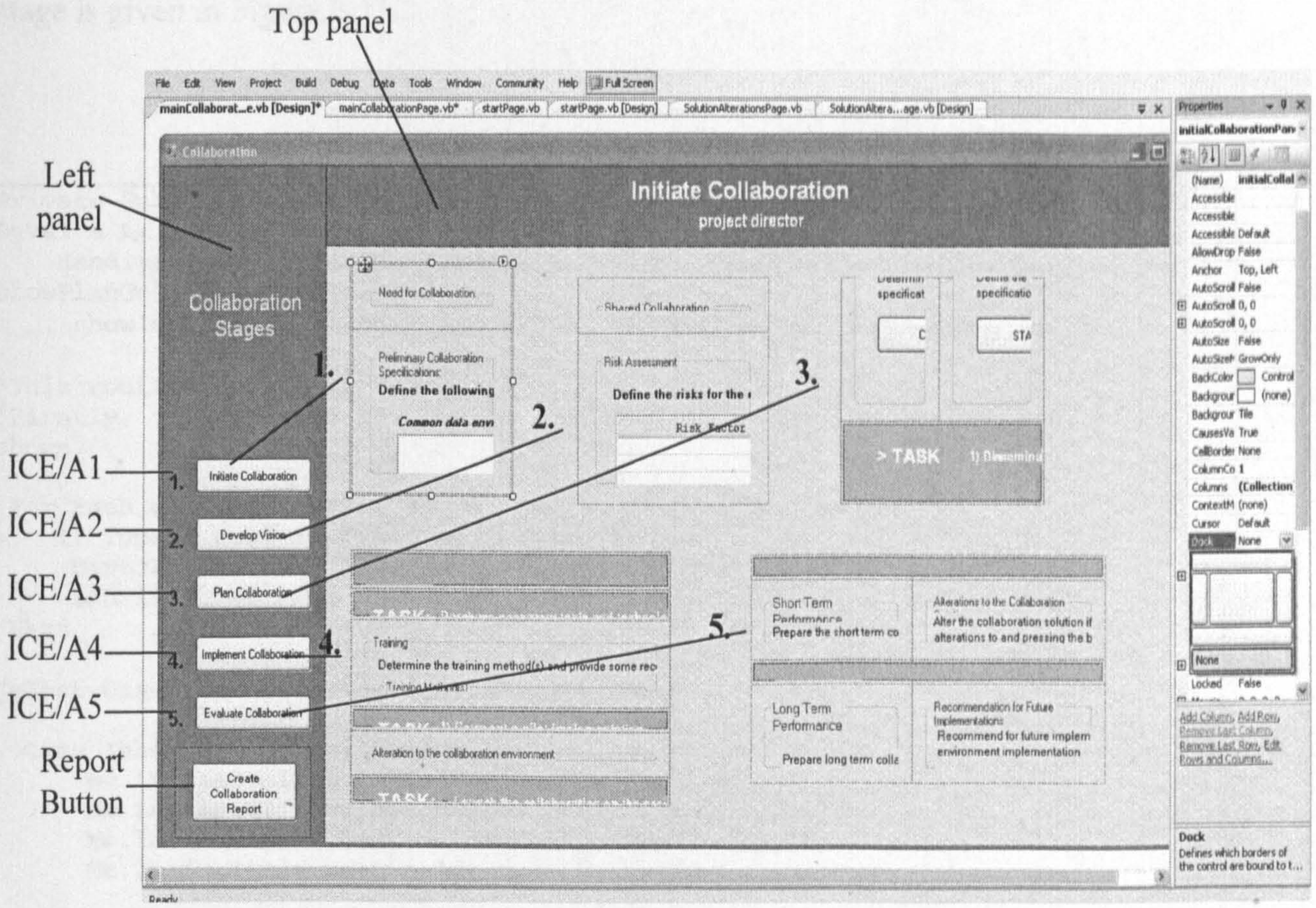

Figure 7.13 Main Collaboration Page

While coding in order to show and hide panels representing ICE stages, case definitions are used. Each of the five buttons define a different case when clicked. The code was written to check which button has been clicked and it follows a different case for each button. In each case, a panel is maximised while the other four are hidden. The text in the top panel is also changed. The code used for defining cases is shown in Figure 7.14. ShowInitiateCollaboration, showVisionCollaboration, showPlanCollaboration, showImplementCollaboration, showEvaluateCollaboration are the names of the five buttons located in the left panel.

7.5.1 Initiate Collaboration

This panel is prepared to carry out the first stage of the ICE framework. Initiate collaboration case is arranged to appear on the main collaboration page as default after the start up form. Therefore it is not necessary to click on the first button in the left panel unless the user wants to go back to the first stage whilst working on a different stage. The screenshot taken from the programme whilst entering data in this

stage is given in Figure 7.15.

```
Private Sub CollaborationStage_Change_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) _
    Handles showInitiateCollaboration.Click, showVisionCollaboration.Click,
showPlanCollaboration.Click, _
     showImplementCollaboration.Click, showEvaluateCollaboration.Click

'This routine checks to see which of the 5 main buttons was clicked.
'Firstly, it hides all the panels and then shows the one that should be
shown.

 For Each ctrl As Control In Me.clearNeedforCollab.Controls
    If TypeOf ctrl Is TableLayoutPanel Then
     DirectCast(ctrl, TableLayoutPanel).Visible = False
     End If
 Next

Select Case DirectCast(sender, Button).Name

  Case "showInitiateCollaboration"
      Me.initialCollaborationPanel.Visible = True
      Me.initialCollaborationPanel.Dock = DockStyle.Fill
      Me.lblMainTitle.Text = "INITIATE COLLABORATION"
      Me.lblSubTitle.Text = "Project Director"

  Case "showVisionCollaboration"
      Me.VisionRiskPanel.Visible = True
      Me.VisionRiskPanel.Dock = DockStyle.Fill
      Me.lblMainTitle.Text = "DEVELOP VISION"
      Me.lblSubTitle.Text = "Collaboration Management Team"

  Case "showPlanCollaboration"
      Me.planCollaborationPanel.Visible = True
      Me.planCollaborationPanel.Dock = DockStyle.Fill
      Me.lblMainTitle.Text = "PLAN COLLABORATION SOLUTION"
      Me.lblSubTitle.Text = "Collaboration Management Team"

  Case "showImplementCollaboration"
      Me.collaborationImplementationPanel.Visible = True
      Me.collaborationImplementationPanel.Dock = DockStyle.Fill
      Me.lblMainTitle.Text = "MONITOR COLLABORATION IMPLEMENTATION"
      Me.lblSubTitle.Text = "Collaboration Management Team"

  Case "showEvaluateCollaboration"
      Me.evalCollaborationPanel.Visible = True
      Me.evalCollaborationPanel.Dock = DockStyle.Fill
      Me.lblMainTitle.Text = "EVALUATE COLLABORATION SOLUTION"
      Me.lblSubTitle.Text = "Collaboration Management Team"

End Select

End Sub
```

Figure 7.14 The Code for Showing Panels in the Main Collaboration Page

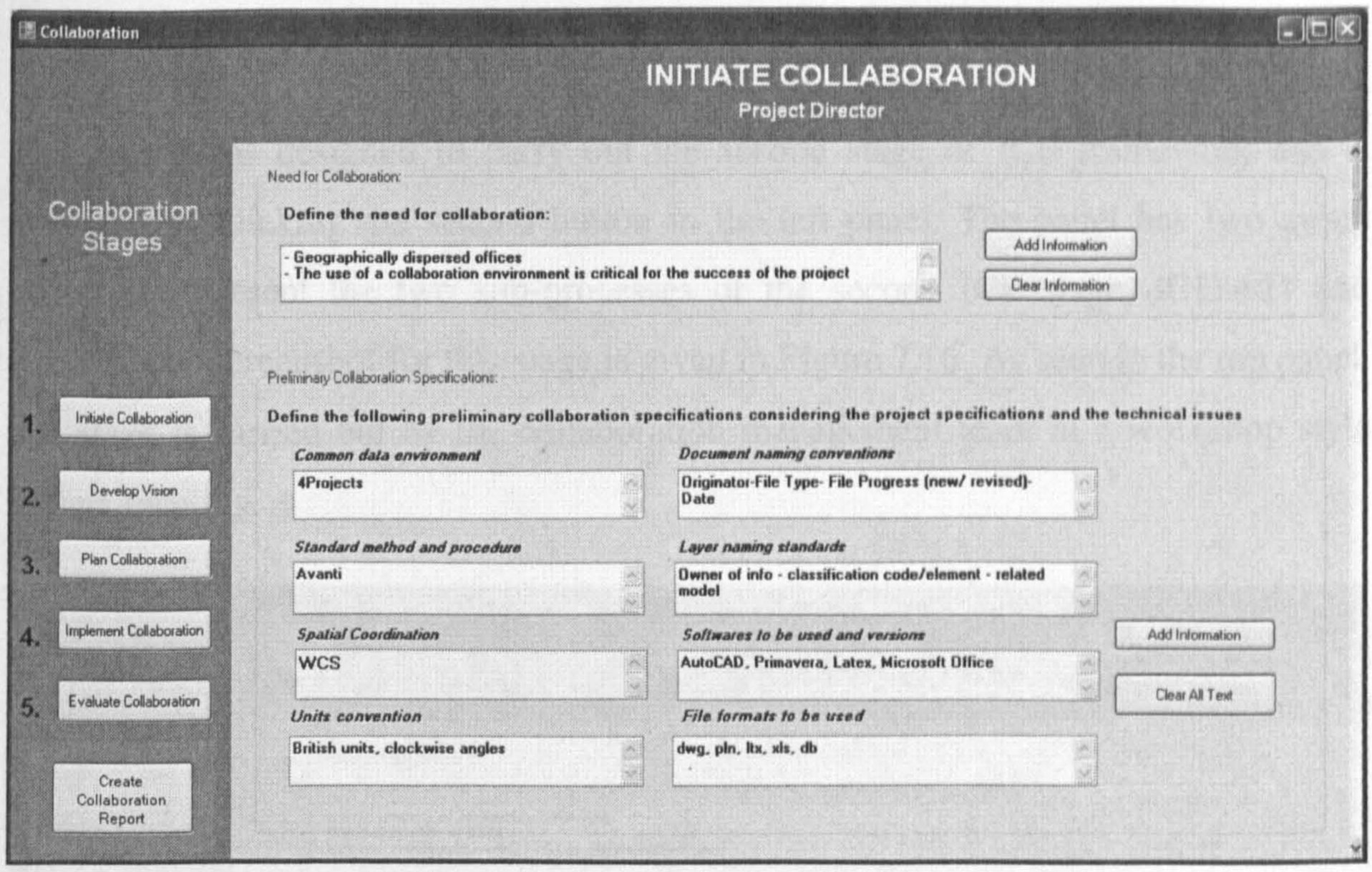

Figure 7.15 Main Collaboration Page- Initiate Collaboration

This screen has two group-boxes for data entry. The first one is called as "Need for Collaboration" and it represents the ICE/A11 process, defining the need for collaboration. The group has a textbox in which the project director is expected to define the need for collaboration and then hit one of the two buttons included in the group. "Clear Information" button is clicked if the project director wants to clear the entered data from the textbox whereas "Add Information" button is clicked in order to insert the data into the database.

The second group box, called "Preliminary Collaboration Specifications", has eight textboxes and two buttons. One of the buttons is used to clear the text in the textboxes whereas the other one inserts the data into the database. The Project Director is expected to enter some preliminary collaboration specifications which will be discussed later by the collaboration management team members. These specifications are on common data environment, standard method and procedure, spatial coordination, units convention, documents naming convention, layer naming standards, software to be used and file formats to be used. The code activated by clicking the "Add Information" button uses a similar routine with the insert code shown in Figure 7.11.

7.5.2 Develop Vision

This panel was designed to carry out the second stage of ICE framework and is activated by clicking the second button in the left panel. The panel has two group boxes to represent the two sub-processes of the second ICE stage, ICE/A21 and ICE/22. The screenshot for this stage is given in Figure 7.16. As seen in the top panel, this stage is carried out by the collaboration management team in a workshop style project meeting.

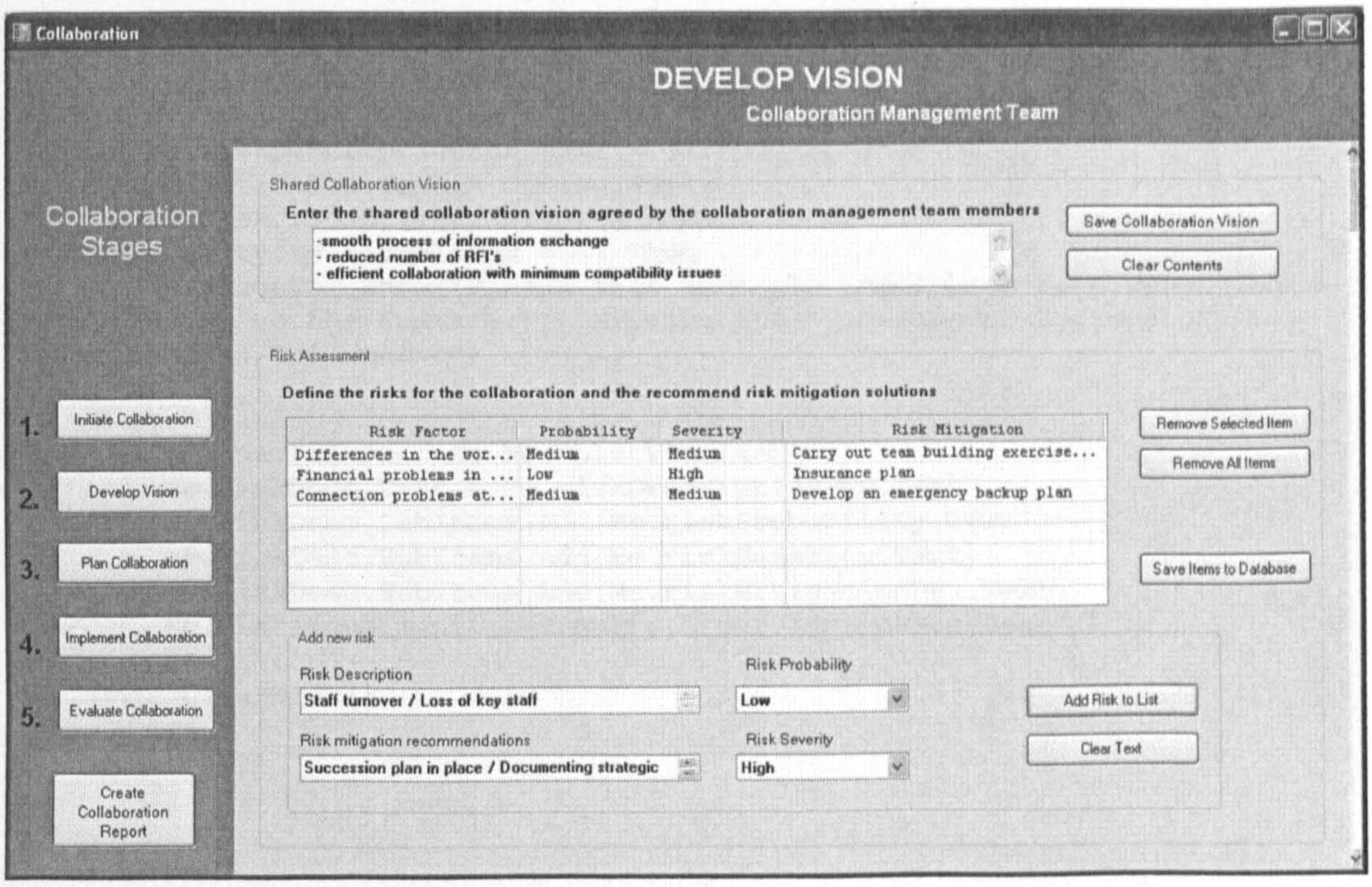

Figure 7.16 Main Collaboration Page- Develop Vision

The first group box, representing ICE/A21, has a textbox to enter the shared collaboration vision agreed by the collaboration management team members, and two buttons in order to clear the contents of the textbox or to save the contents of the textbox in the database using the INSERT command.

The second group box, representing ICE/A22, is designed using a listview, two textboxes, two combo boxes and five buttons in order to carry out a risk assessment for collaboration. The text boxes are used to enter the description of risk and recommendations for risk mitigation. The combo boxes are used in order to assign the probability and severity of those risks choosing a scale of low, medium or high. The

listview is a blank table with four columns namely risk factor, probability, severity and risk mitigation. The data entered through the textboxes and combo boxes are added to this table as a new row when "Add Risk to List" button is clicked following a code given in Figure 7.17. As seen from the code, when the button is clicked, the programme first checks whether all four boxes have been filled in. If some of the items are missing, then a message box is shown to the user reminding all items have to be specified before adding to the listview. If all four data items are present, then the items are added to the listview.

```
Private Sub addRisktoList_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles addRisktoList.Click

     If Me.riskDescriptionBox.Text = String.Empty Or
Me.riskMitigationBox.Text = String.Empty _
     Or Me.riskProbability.SelectedIndex = -1 Or
Me.riskSeverity.SelectedIndex = -1 Then
          MessageBox.Show("Please make sure all items have been specified
before adding to the summary.", "Missing Info", MessageBoxButtons.OK,
MessageBoxIcon.Information)

     Else
          Dim newRiskDesc As New ListViewItem
          newRiskDesc.Text = Me.riskDescriptionBox.Text
          newRiskDesc.SubItems.Add(Me.riskProbability.Text)
          newRiskDesc.SubItems.Add(Me.riskSeverity.Text)
          newRiskDesc.SubItems.Add(Me.riskMitigationBox.Text)
          Me.riskAssessmentListSummary.Items.Add(newRiskDesc)

     Call ClearRisk()

     End If

End Sub
```

Figure 7.17 The Code for Adding the Risk Assessment Data to the Listview

Although from the figure it looks like the listview table is limited to eight lines, it is possible to add as many risks as wanted. If the number of lines in the listview is more than the number of lines visible on the screen, the listview will automatically add a vertical scroll bar to the right of the table. Any of the data can be deleted from the table by choosing the relevant line from the listview and clicking the "Remove Selected Item" button. If the aim is to delete all data entered to the table, then "Remove All Items" button must be clicked. If collaboration management team is happy with the risk assessment, then "Save Items to Database" button must be clicked in order to save the risk assessment data to the database. The command used in the

code to carry out this function is INSERT and the routine used is similar to the code shown in Figure 7.11.

7.5.3 Plan Collaboration Solution

This panel is designed to carry out the third stage of the ICE framework and is activated by clicking the third button in the left panel. The screenshot for this stage is given in Figure 7.18. ICE/A3 has five sub-processes. Four of these processes are carried out through the pop up forms started by clicking four buttons on the plan collaboration solution panel. The fifth process is assigned as a task to the users: Disseminate procedures. There is also a task of loading the ICT audit reports of all organizations assigned to the collaboration management team to make sure that they will have the necessary documents to guide their decisions on the technology aspects of collaboration and related collaboration standards and procedures.

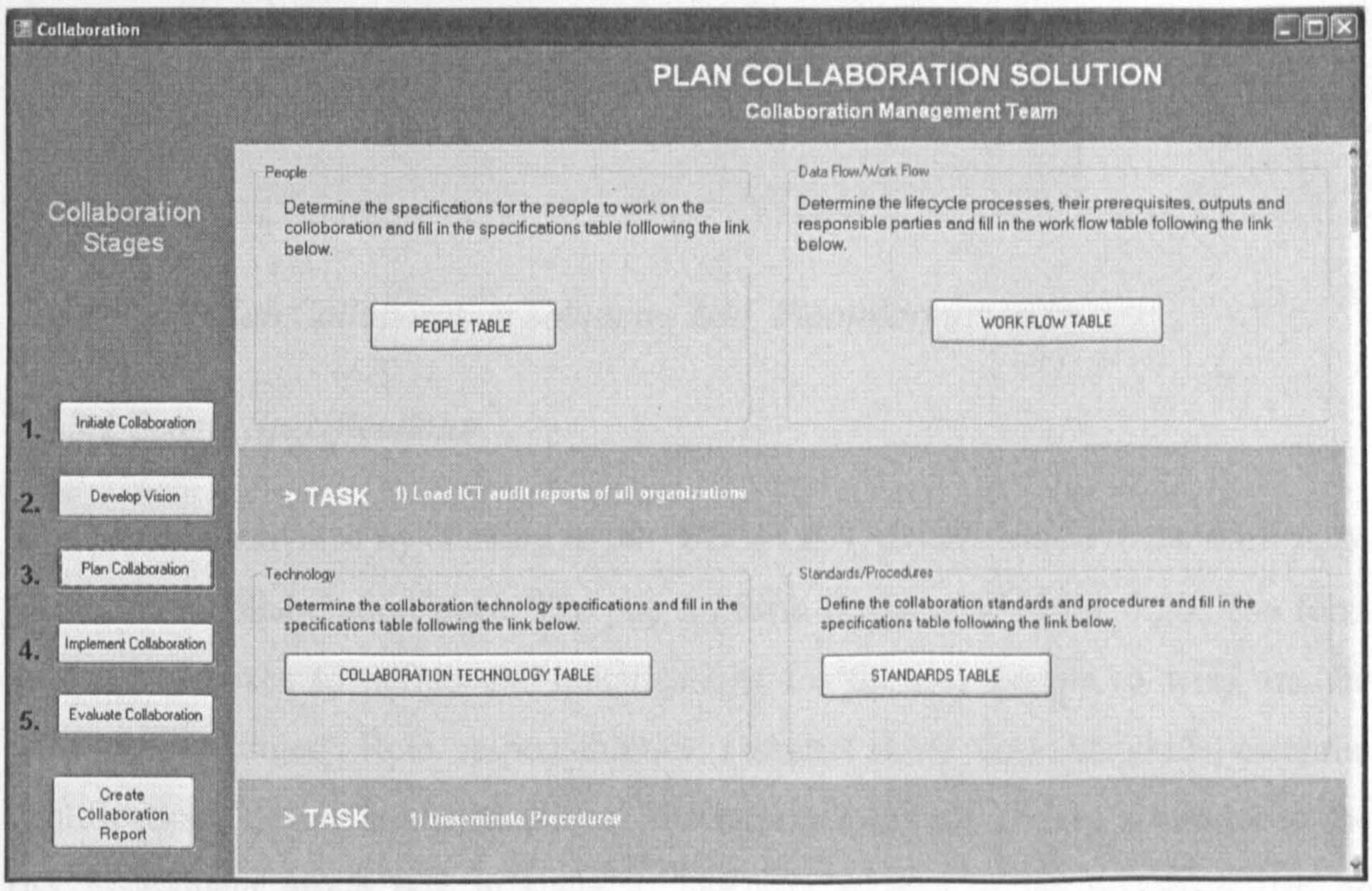

Figure 7.18 Main Collaboration Page- Plan Collaboration Solution

The four buttons represent the four dimensions of the collaboration solution: people, data/ work flow, technology and standards. The pop up screen is designed in Add_PlanInformation.vb, which has four panels for the four dimensions of collaboration solution. Add_PlanInformation.vb is shown in Figure 7.19. When one

of the buttons in the plan collaboration solution stage of the main collaboration page is clicked, the Add_PlanInformation.vb is activated in a way that the irrelevant three panels are hidden and only the relevant panel is made visible to the max size using a similar code shown in Figure 7.9 and Figure 7.14.

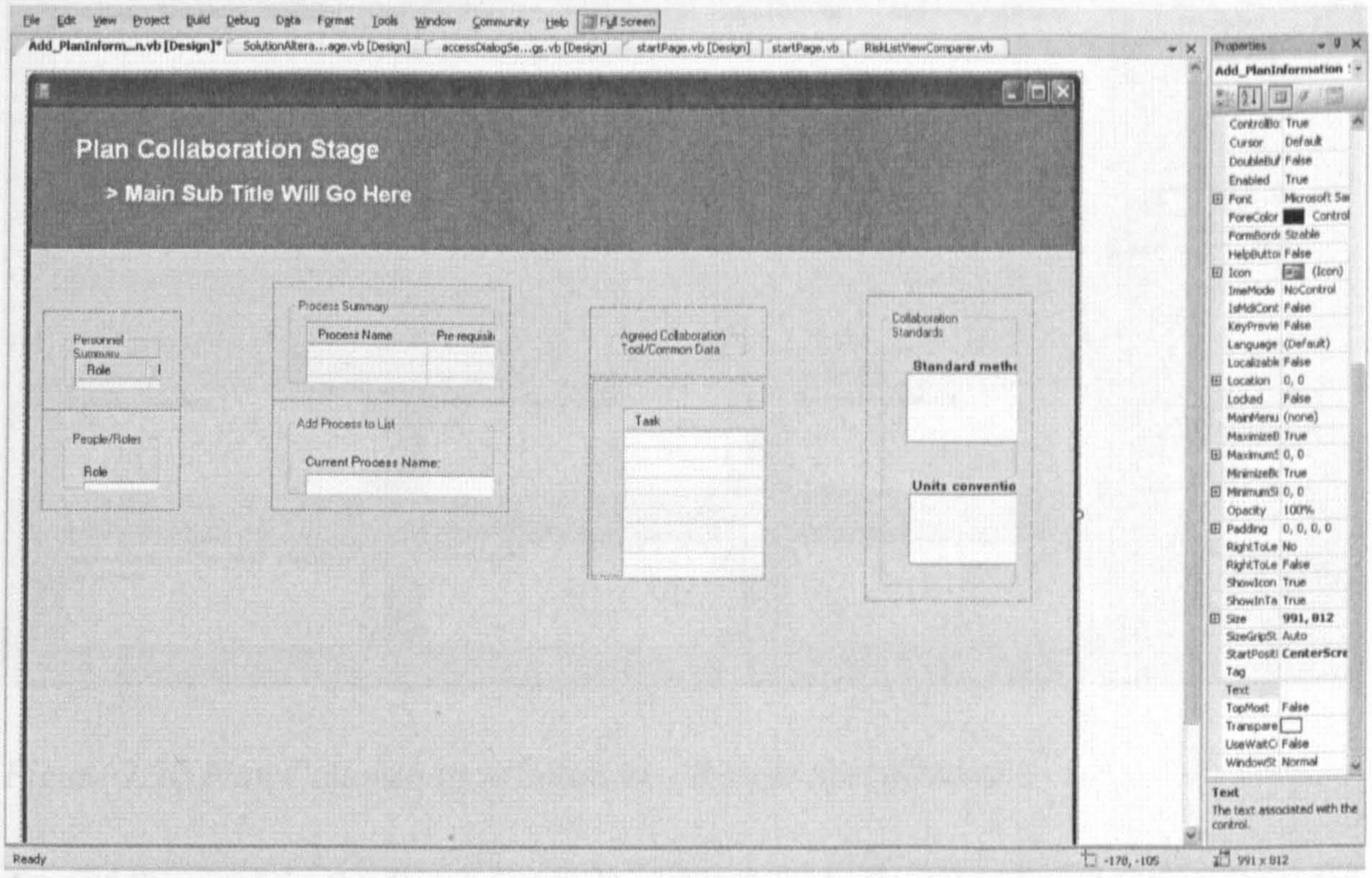

Figure 7.19 Plan Collaboration Solution - Add_PlanInformation.vb

7.5.3.1 People Specifications

This panel is activated by clicking to the "PEOPLE TABLE" button in the third stage of the main collaboration page. The pop up form is given in Figure 7.20. The form has six textboxes to define the specifications for the key people to work on the collaborative project: Role, responsibilities, essential skills, desirable skills, essential qualifications, desirable qualifications. The interface and the coding is similar to the risk assessment group box in stage 2. The text entered to the textboxes can be removed clicking the "Clear All Text" button or can be added to the listview table clicking the "Add Items to List" button. The code used to add the items to the list is very similar to the routine given in Figure 7.17.

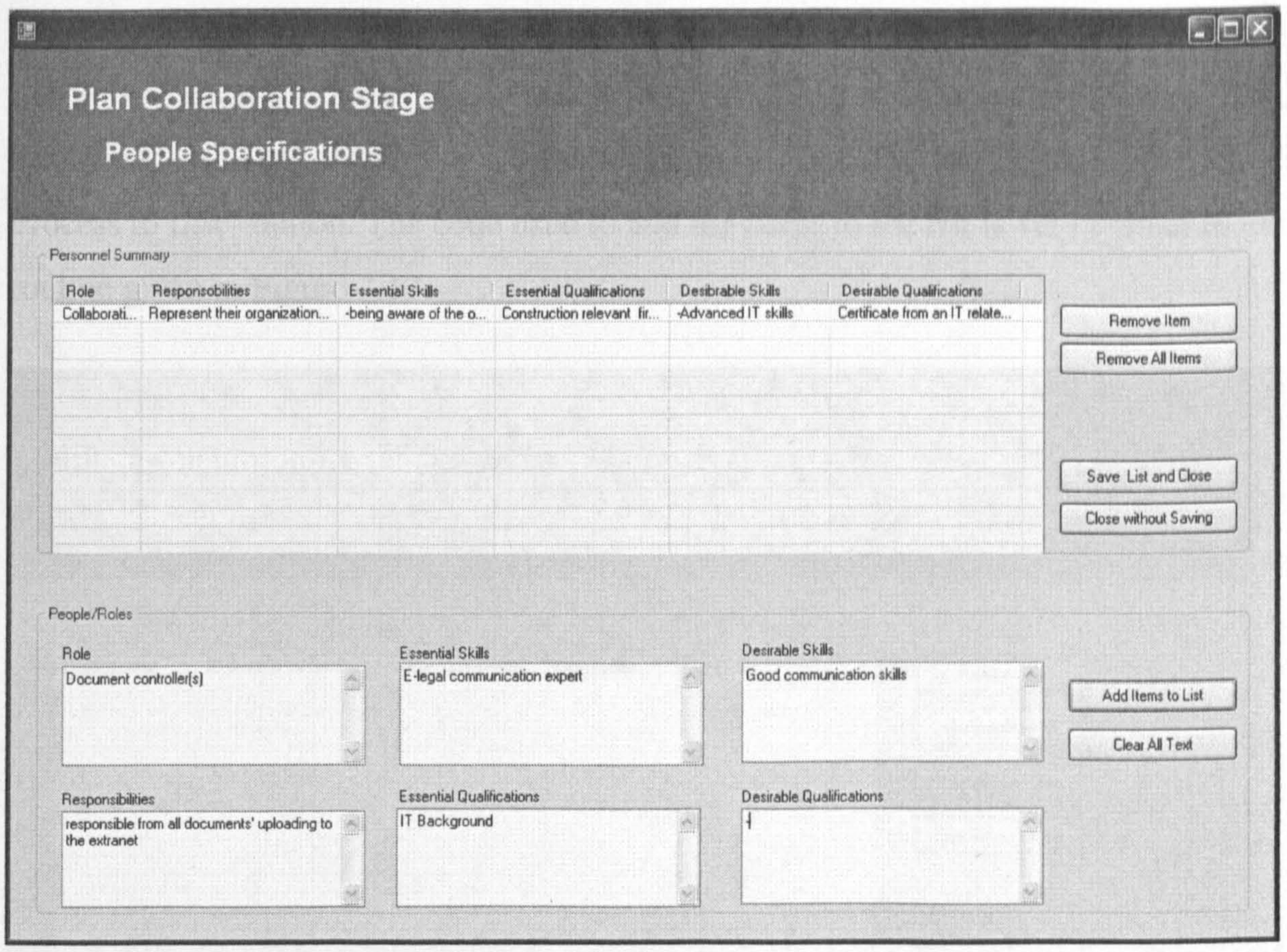

Figure 7.20 Plan Collaboration Solution – People Specifications

Any of the rows in the listview can be deleted from the table by choosing from the listview and clicking the "Remove Item" button. If the aim is to delete all data entered to the table, then "Remove All Items" button must be clicked. If collaboration management team is happy with the people specifications, then "Save List and Close" button must be clicked in order to save to the database, to close this pop up screen and return to the main collaboration page. The code used to carry out this function is similar to the code shown in Figure 7.11. In this form, the users are also given an option of closing the form without saving to the database if they want to carry out this process later on. In this case, the button to be used is "Close without saving".

7.5.3.2 Work flow / Data flow

This panel is activated by clicking on the "WORK FLOW TABLE" button in the third stage of the main collaboration page. The pop up form is given in Figure 7.21. The form aims at determining the project lifecycle processes. There are four textboxes on the form to collect data on current process name, parties involved in current process, prerequisites of the process and output(s) of the process. The

interface and the coding is similar to the risk assessment group box in stage 2 and the people specifications table. The text entered to the textboxes can be removed clicking the "Clear All Text" button or can be added to the listview table clicking the "Add Process to List" button. The code used to add the items to the list is very similar to the routine given in Figure 7.17.

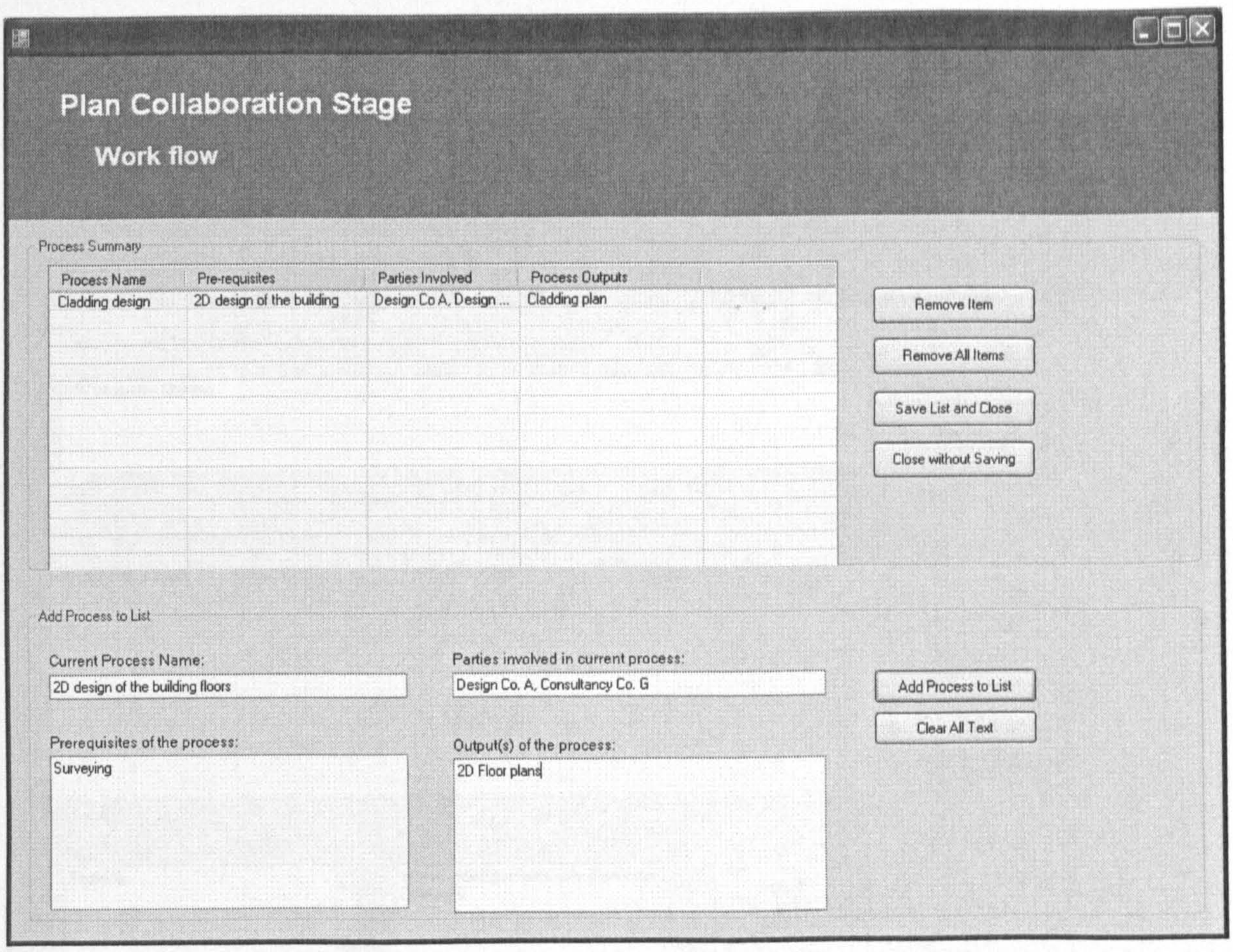

Figure 7.21 Plan Collaboration Solution – Work flow

Any of the rows in the listview can be deleted from the table by choosing from the listview and clicking the "Remove Item" button. If the aim is to delete all data entered to the table, then "Remove All Items" button must be clicked. If collaboration management team is happy with the people specifications, then "Save List and Close" button must be clicked in order to save to the database, to close this pop up screen and return to the main collaboration page. The code used to carry out this function is similar to the code shown in Figure 7.11. Similar to the people specifications table, the users are given an option of closing the form without saving to the database if they want to carry out this process later on. In this case, the button to be used is "Close without Saving".

7.5.3.3 Technology Specifications

This panel is activated by clicking on the "COLLABORATION TECHNOLOGY TABLE" button in the third stage of the main collaboration page and aims at determines the collaboration technology specifications and agreeing on the common data environment to be used for the collaboration. The pop up form is given in Figure 7.22.

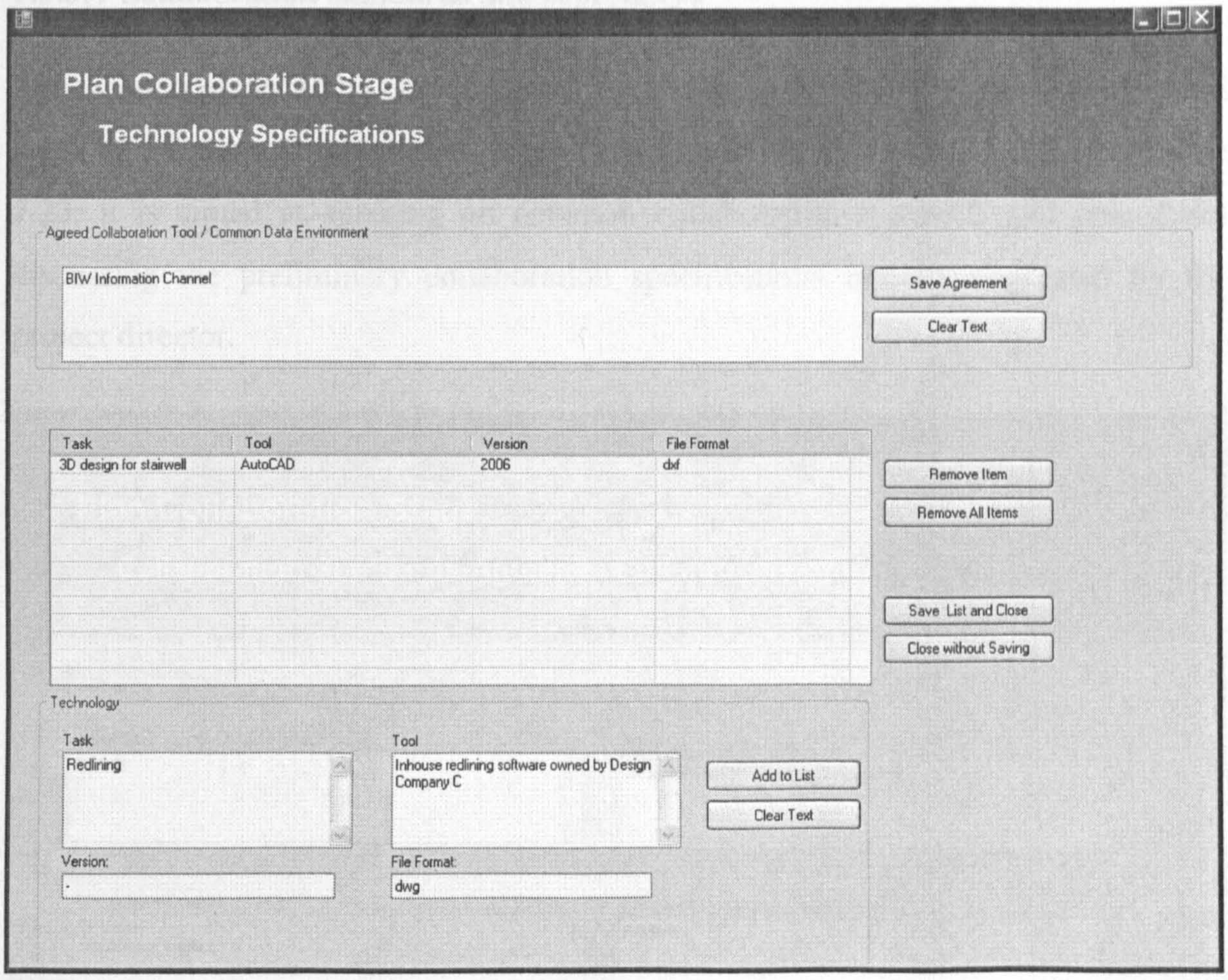

Figure 7.22 Plan Collaboration Solution – Technology Specifications

The agreed collaboration tool is entered in the textbox given at the top of the form. There are two buttons assigned to this textbox. "Save Agreement" button is used to save the agreed collaboration tool to the database whereas "Clear Text" button is used to clear the contents of the textbox.

In order to determine the technology specifications, a group of four textboxes are used. These textboxes are used to indicate which version of which IT tool will be used for which task, and what file format will be used for the output. The interface

and the coding is similar to the risk assessment group box in stage 2, the people specifications panel and workflow panel. Therefore there is a listview where the data in these four textboxes are added. There are also "Add to List", "Clear Text" "Remove Item", "Remove All Items", "Save List and Close" and "Close without Saving" buttons which have the same functions as the previous collaboration solution planning panels and they follow a similar code.

7.5.3.4 Collaboration standards and procedures

This panel is activated by clicking on the "STANDARDS TABLE" button in the third stage of the main collaboration page. Through the pop up screen, shown in Figure 7.23, it is aimed at agreeing on common collaboration standards and procedures discussing the preliminary collaboration specifications initially suggested by the project director.

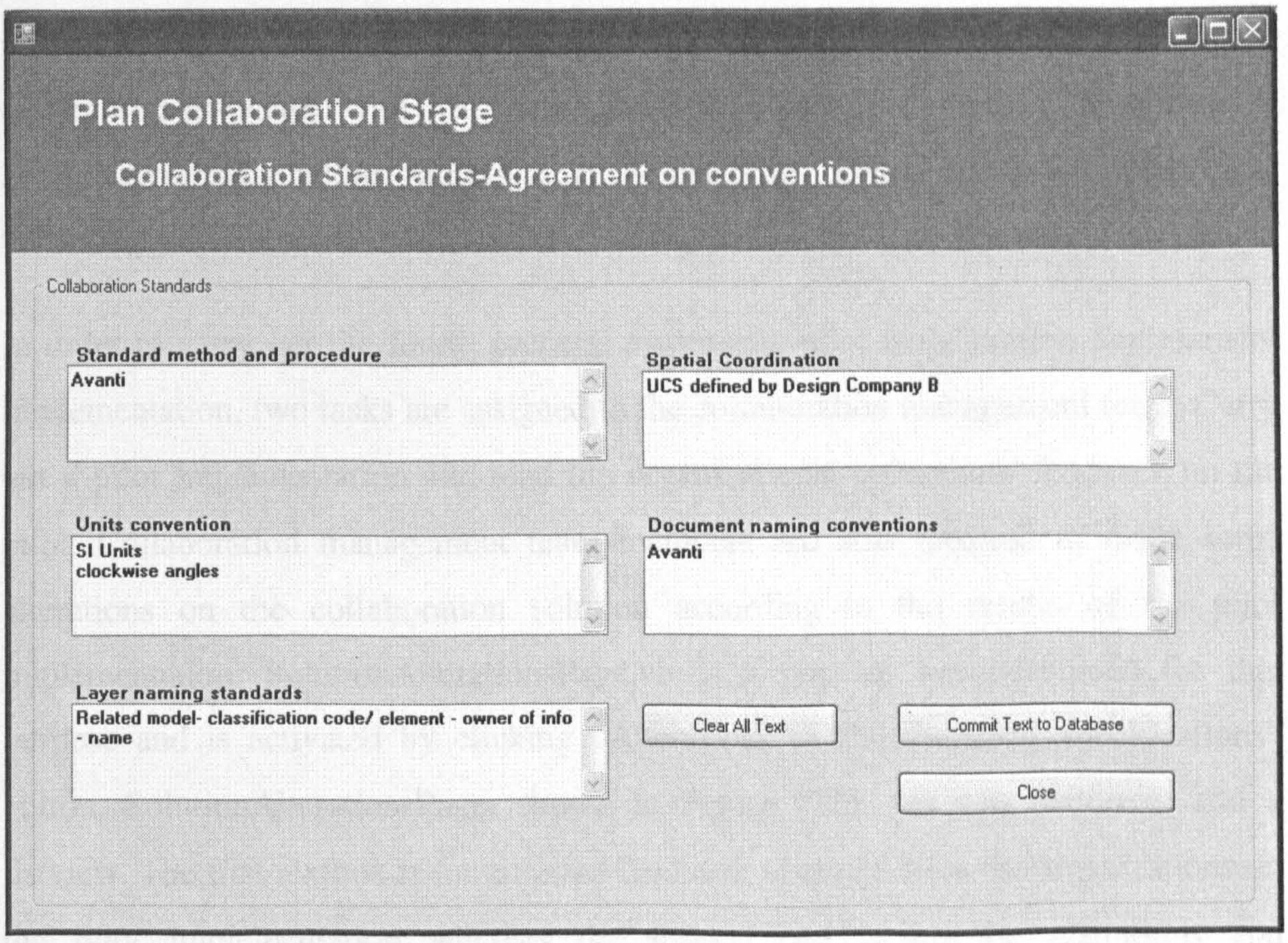

Figure 7.23 Plan Collaboration Solution – Collaboration Standards and Procedures

As seen from the figure, there are five textboxes on the form used to collect data on standard methods and procedure, spatial coordination, units convention, document naming conventions, and layer naming standards. The text entered to these textboxes

can be saved to the database clicking "Commit Text to Database" button. The textboxes can be cleared clicking the "Clear All Text" button and the form can be closed clicking the "Close" button.

7.5.4 Monitor Collaboration Implementation

This panel is designed to carry out the fourth stage of the ICE framework and is activated by clicking the fourth button in the left panel. The screenshot for this stage is given in Figure 7.24.

ICE/A4 has five sub-processes. The first two processes are assigned to the collaboration management team as tasks: recruit the participants according to people specifications, and purchase necessary tools and technologies. For the third process, monitoring training as necessary, four training methods are given on the form and the user is expected to choose the training methods to be used for the collaboration. There is also a textbox where any recommendations on training can be entered. There are two buttons associated with the training data. "Save" button saves the training method and the recommendations on training to the database. "Clear" button is used to clear the training data entered to the textbox.

In order to carry out the fourth process, monitoring pilot collaboration environment implementation, two tasks are assigned to the collaboration management team: Carry out a pilot implementation and load the organizational reflections/ feedback on the pilot. Collaboration management team members are also required to make some alterations on the collaboration solution according to the results of the pilot implementation. SolutionAlterationsPage.vb is a pop up form designed for this purpose and is activated by clicking "Alterations to Collaboration Specifications" button. SolutionAlterationsPage, shown in Figure 7.25, has two textboxes and a listview. The first textbox is for entering feedback obtained from the organizations on the pilot implementation whereas the second one is for the alterations and recommendations on collaboration specifications based on the feedback. The text entered in these textboxes are added as a row to the listview table by clicking "Add to List" button. Like the other listview elements used in this programme, there is also a "Remove Item" button in order to remove the selected line from the listview, a "Remove All Items" button in order to remove all data in the listview, and a

"Save and Close" button in order to save the data in the listview to the database, close the pop up screen and return to the fourth stage of the main collaboration page.

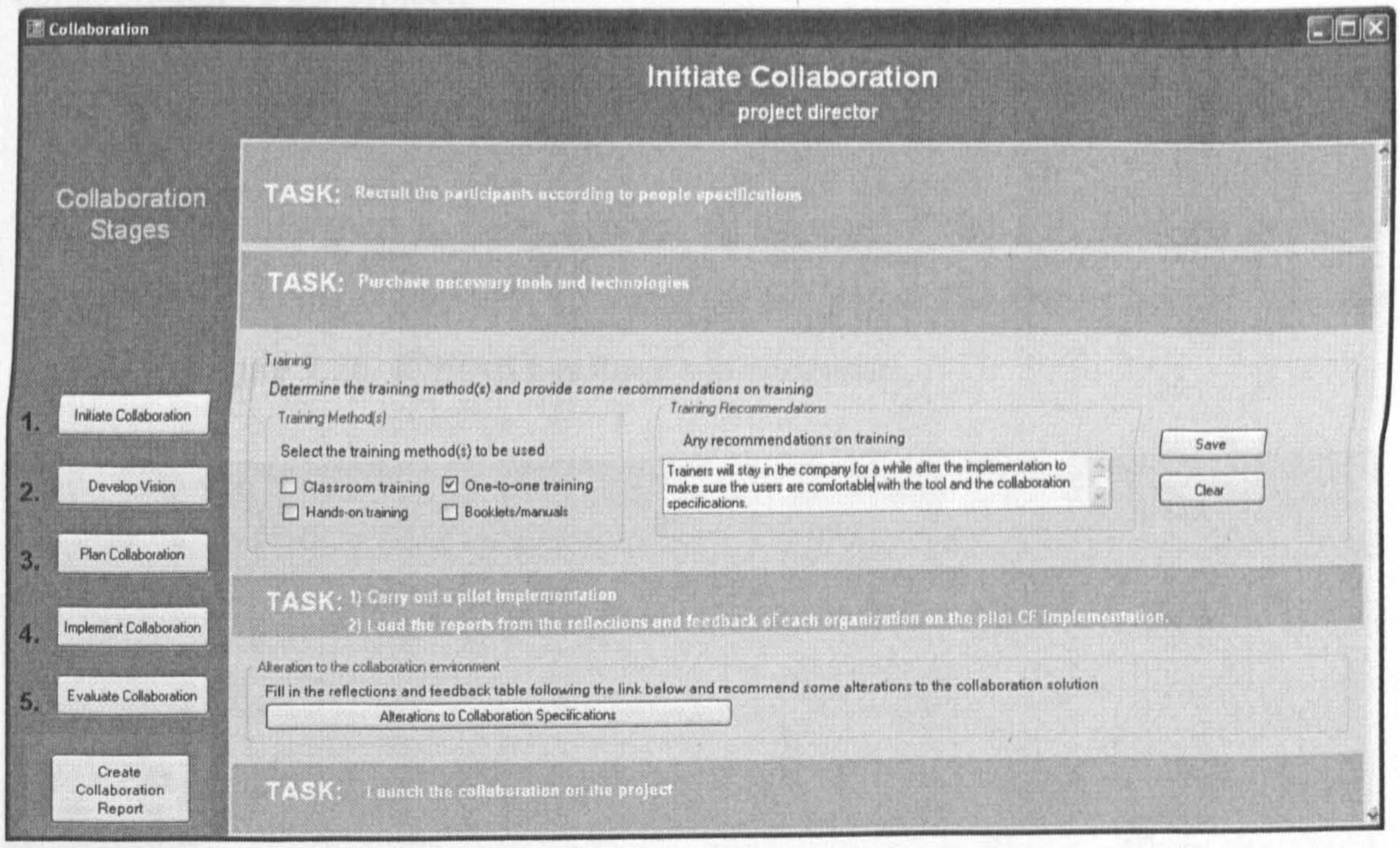

Figure 7.24 Main Collaboration Page – Monitor Collaboration Implementation

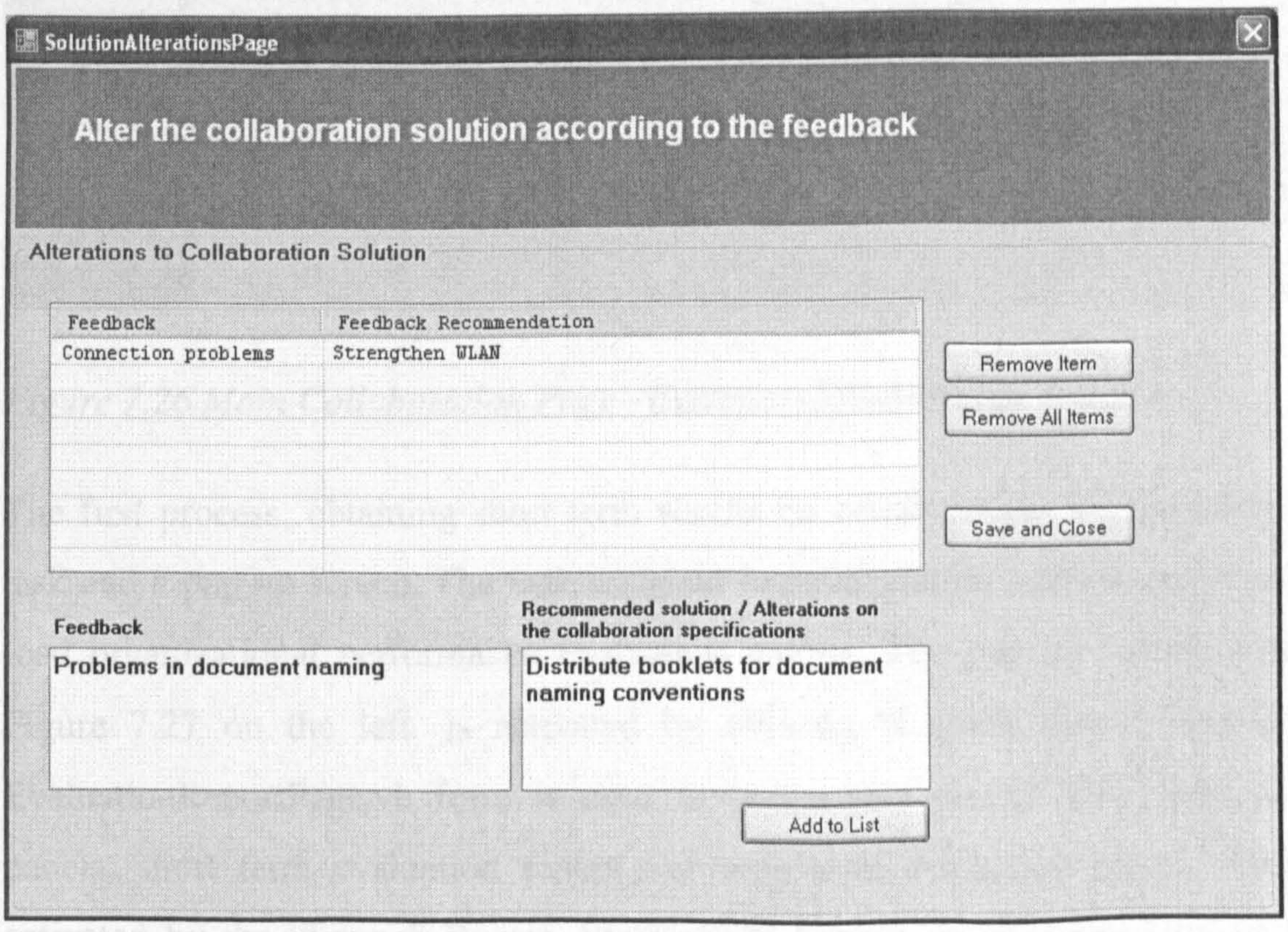

Figure 7.25 Feedback on Pilot Implementation and Alterations

The fifth process, monitor collaboration environment implementation, is also assigned to the collaboration management team members as a task: Launch the collaboration on the project.

7.5.5 Evaluate Collaboration

This panel is designed to carry out the fifth stage of the ICE framework and is activated by clicking on the fifth button in the left panel. The screenshot for this stage is given in Figure 7.26. ICE/A5 has three sub-processes.

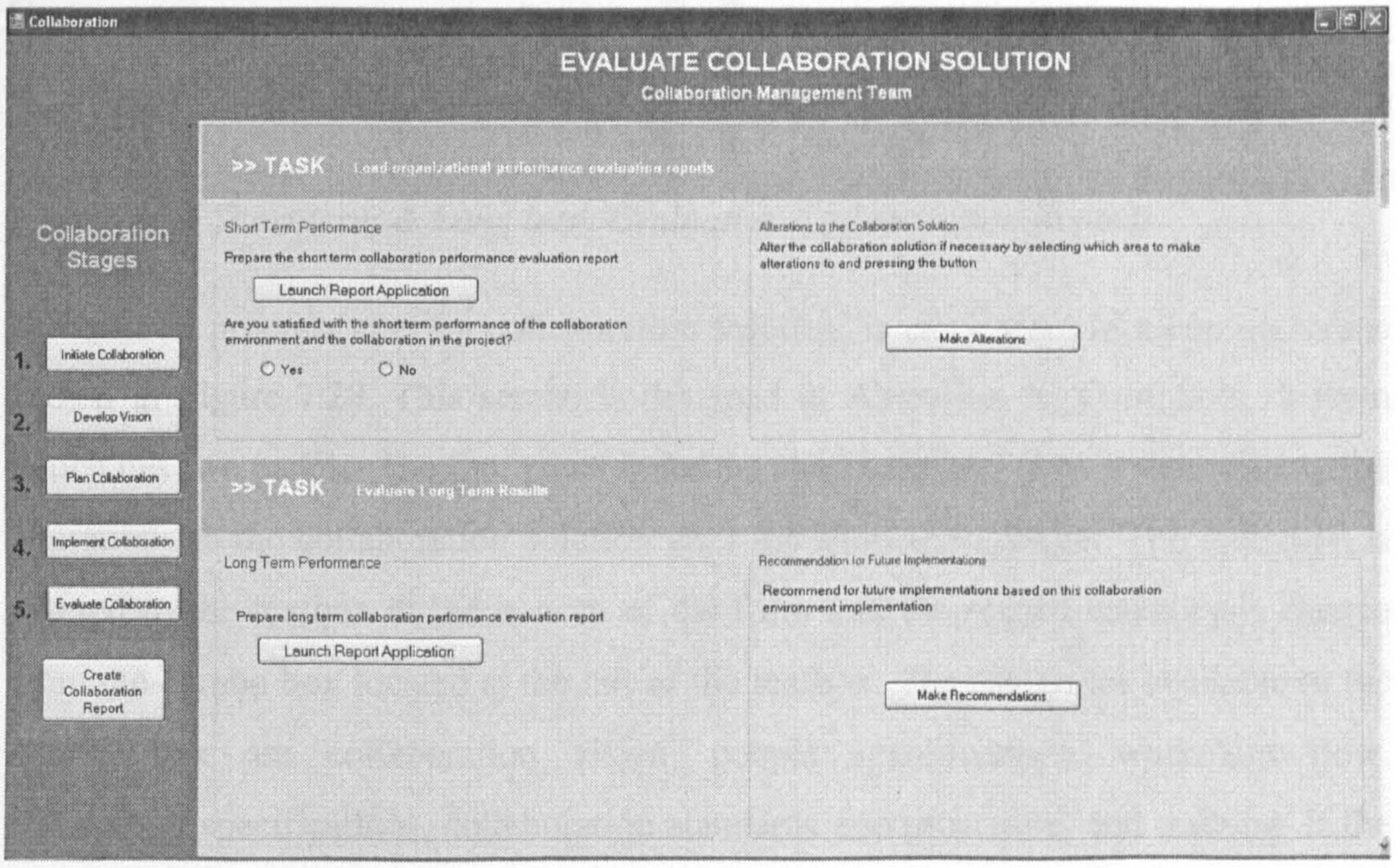

Figure 7.26 Main Collaboration Page –Evaluate Collaboration Solution

The first process, obtaining short term results on collaboration, is represented by a task and a pop up screen. The task assigned to collaboration management team is to load organizational performance evaluation reports. The pop up screen, shown in Figure 7.27 on the left, is activated by clicking "Launch Report Application". EvaluationReportPage.vb form is used to design this screen. This form has two panels, short term evaluation report and long term evaluation report, which are activated by the "Launch Report Application" buttons in the related group boxes. Collaboration management team members are expected to write a report on the short term results of the collaboration environment implementation based on the organizational performance reports loaded as a result of the previous task. This

report is created filling in the textbox on the screen. When the "Save and Close" button on the form is clicked, the created short term report is saved in the database and the pop up screen is closed.

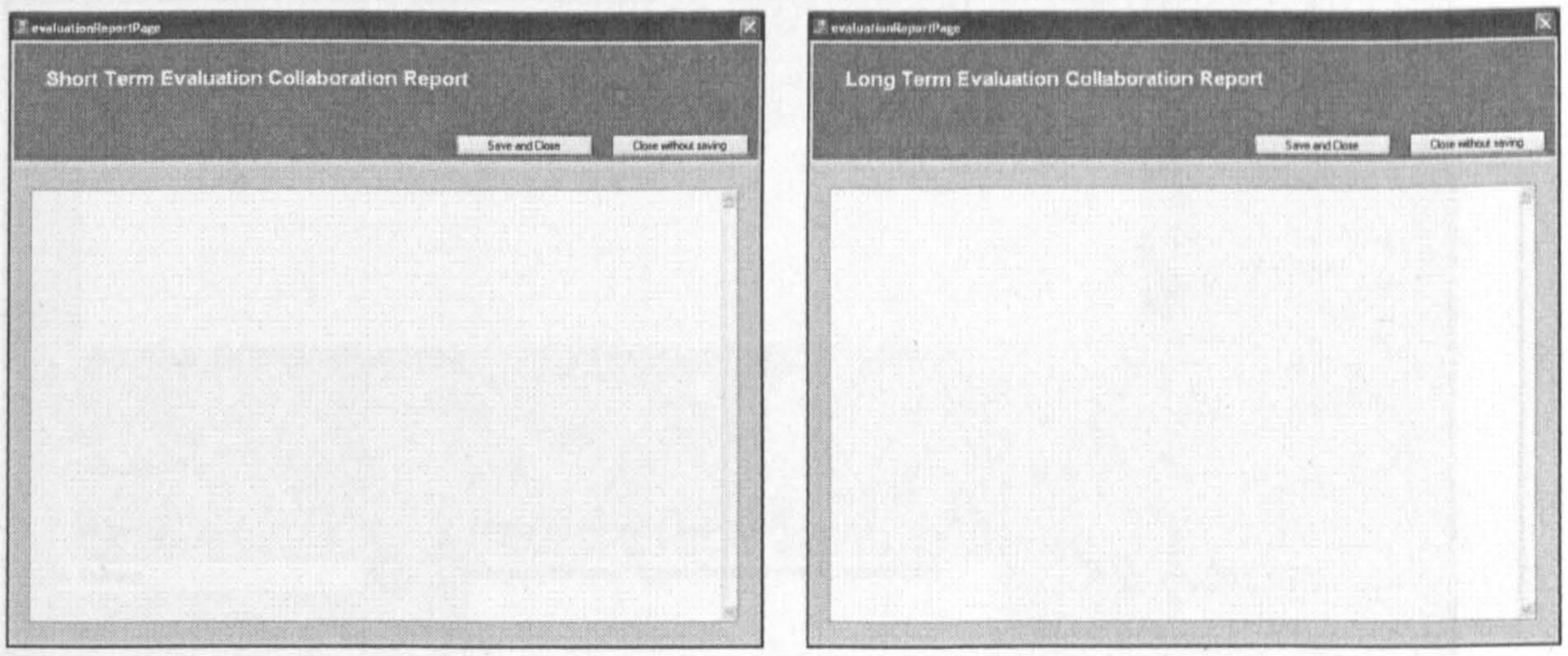

Figure 7.27 Short term & Long term Evaluation Collaboration Reports

The second process, altering collaboration solution, is carried out in a pop up screen shown in Figure 7.28. This screen is designed in Alteration_to_Coln_Soln.vb form which has two panels. The first panel is for the short term and aims at determining the alterations to the collaboration solution after the short term results. The alteration is entered to the textbox at the bottom of the form and the related category is chosen from the combo box located at the left of the textbox. The categories available in the combo box are collaboration vision, people specifications, work/data flow, technology specifications, collaboration standards and procedure, and training. If the alteration is not related to any of these categories, the users can choose the seventh option, which is "other". These alterations and their categories are added to the listview, located above the textbox and the combo box, clicking the "Add Change to List" button. The textbox can be cleared clicking "Clear Current Text" button. There are two buttons associated with the listview: "Remove Item", which is used to remove the selected row from the listview, and "Save and Close" button which is used to save the data in the listview to the database, close this form and return to the fifth stage of the main collaboration form.

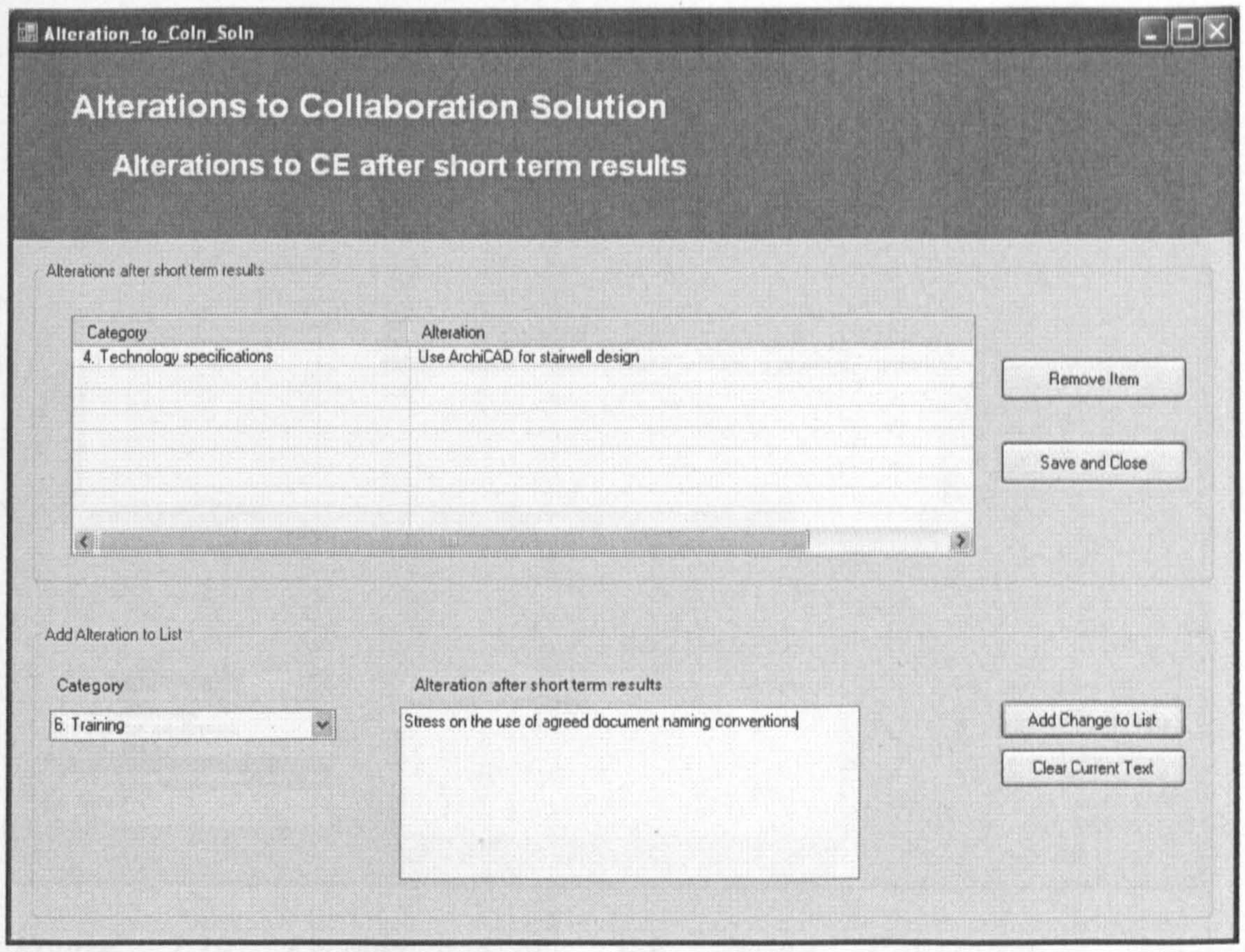

Figure 7.28 Alterations to Collaboration Environment after Short Term Results

The third process, evaluating long term results, is represented by a combination of a task and two pop up screens. The task assigned to the collaboration management team is to evaluate the long term results. The first pop up screen, shown in Figure 7.27 on the right, is activated by clicking "Launch Report Application". This screen uses the second panel, long term evaluation report panel, in evaluationReportPage.vb form. The panel is designed in the same way as the short term evaluation report panel, therefore all the buttons used and the code run are similar. The second pop up screen, shown in Figure 7.29 is designed as the second panel in Alteration_to_Coln_Soln.vb form. This screen determines the recommendations for future implementations and recording the lessons learnt during the collaboration implementation. This panel is the same as the panel designed to determine the alterations to the collaboration solution after the short term results. The only difference is that the alterations word in the short term are replaced with recommendations for future implementations in the long term.

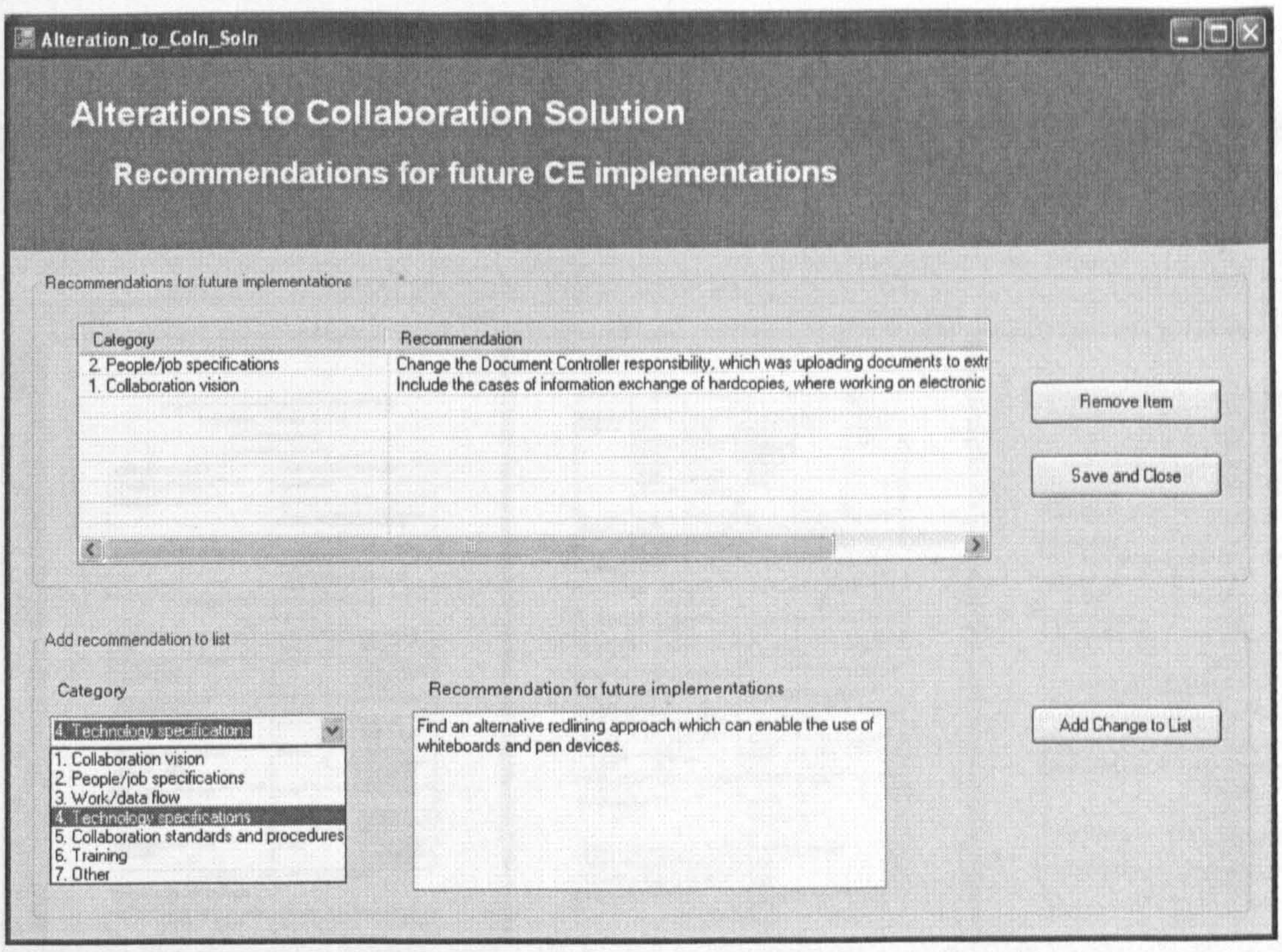

Figure 7.29 Recommendations for Future Collaboration Environment Implementations

7.6 Collaboration Change Management Report

At any time while the programme is running, the prototype is able to produce a detailed report on the planning and implementation of collaboration environment carried out up to that moment. The report function is activated by clicking on the "Create Collaboration Report" button at the bottom of the left panel in the main collaboration page. The created report is called as "Collaboration Change Management Report". Figure 7.30 shows a screenshot from an example report, which can be seen in detail in Appendix 2. As seen from the figure, the report is 3 pages long; however, this document will be much longer in the real implementation.

The report can be used as a reference document for the organizations participating in the collaboration. Since all decisions made for the collaboration environment implementation, the results and outcomes of those decisions, and the difficulties met during the implementation are recorded, the document will save some strategic data for the future implementations. The lessons learnt from this project will not only exist in the minds of the key personnel but will be available to the other employees

working on other collaboration projects.

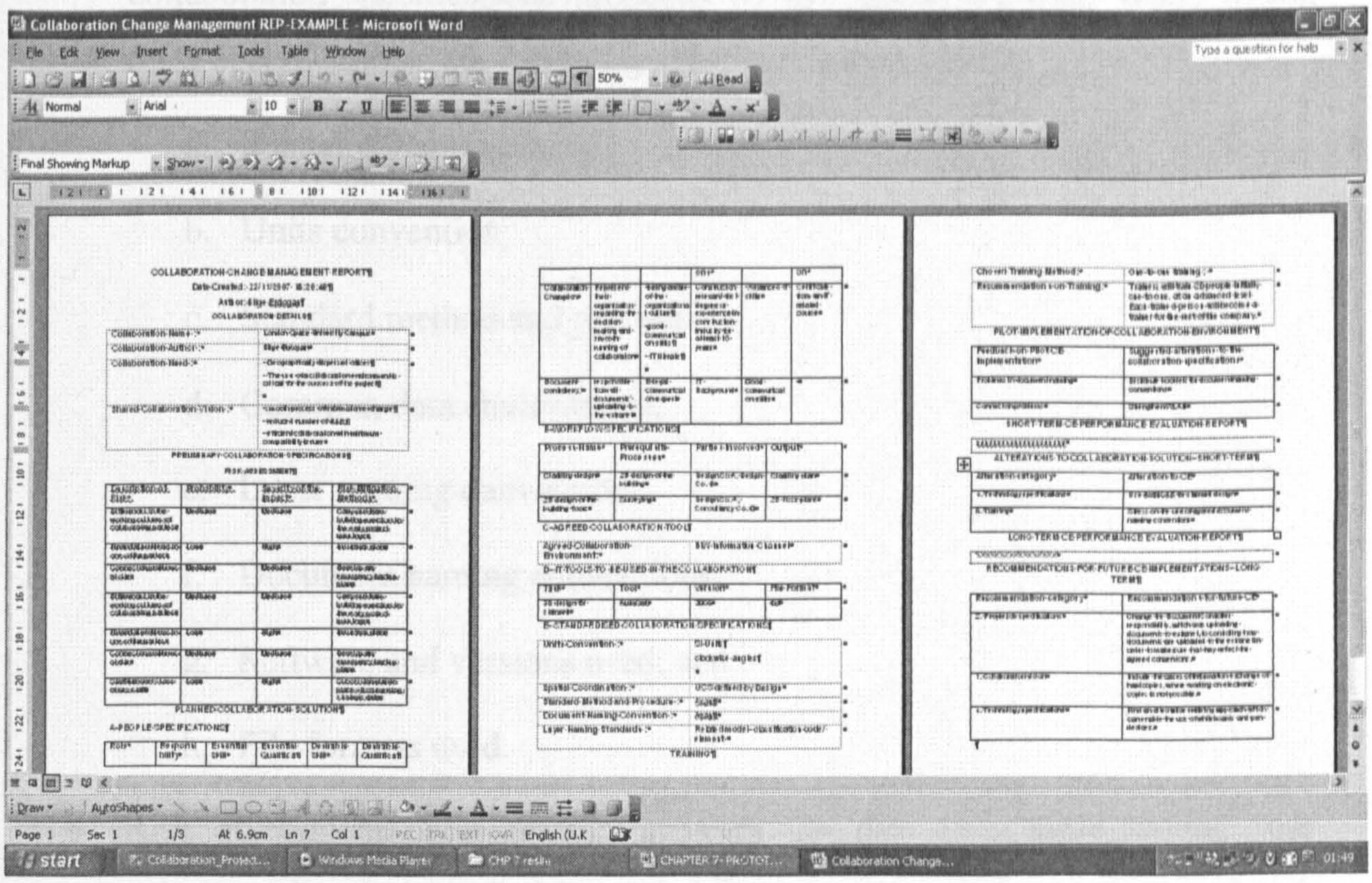

Figure 7.30 Recommendations for Future Collaboration Environment Implementations

The main sections in a collaboration change management report are listed below:

1. Heading: The heading for the document is "COLLABORATION CHANGE MANAGEMENT REPORT". The date the report is created and the name of the report author are also written at the heading section. The author's name is "Bilge Erdogan" as default since she is the developer of this prototype. However, if the prototype is used in the industry, the name of the company using the prototype should be customized as default.

2. Collaboration details: This part gives details on the collaboration. The subheadings for this section are:

   a. Collaboration name;

   b. Collaboration author;

   c. Collaboration need; and

   d. Shared collaboration vision.

3. Preliminary collaboration specifications: This part lists the preliminary collaboration specifications proposed by the project director. While listing these specifications, the following sub-headings are used:

    a. Spatial collaboration;

    b. Units convention;

    c. Standard method and procedure;

    d. Common data environment;

    e. Layer naming conventions;

    f. Document naming conventions;

    g. Software and versions used; and

    h. File formats used.

4. Risk assessment: This section presents the data in a table having four columns: description of risk, probability, severity of the impact, and risk mitigation methods.

5. Planned collaboration solution: This section presents the collaboration specifications agreed at the end of the third stage of ICE. Collaboration specifications are presented under five headings:

    a. People specifications: presents the data in a table having six columns: Role, responsibility, essential skills, essential qualifications, desirable skills, and desirable qualifications.

    b. Workflow specifications: presents the data in a table having four columns: Process name, prerequisite processes, parties involved, and output.

    c. Agreed collaboration tool.

    d. IT tools to be used in collaboration: presents the data in a table having four columns: Task, tool, version, and file format.

    e. Standardised collaboration specifications: lists the collaboration specifications agreed by the collaboration management team. These specifications will be presented under five headings: Units convention,

spatial collaboration, standard method and procedure, document naming conventions, and layer naming standards.

6. Training: This section presents the details of the training under two headings:
    a. Chosen training method;
    b. Recommendations on training.
7. Pilot implementation of collaboration environment: This section presents the results of the pilot implementation in a table having two columns: Feedback on pilot collaboration environment implementation and suggested alterations to the collaboration specifications.
8. Short term collaboration environment performance evaluation report: This section presents the report created by the collaboration management team after the short term performance evaluation.
9. Alterations to collaboration solution – short term: This section presents the alterations to the collaboration solution in a table having two columns: Alteration category and alteration to collaboration environment.
10. Long term collaboration environment performance evaluation report: This section presents the report created by the collaboration management team after the short term performance evaluation.
11. Recommendations for future collaboration environment implementations – long term: This section presents the recommendations for future implementations in a table having two columns: Recommendation category and recommendation for future collaboration environment.

Writing codes for creating a report in a word document is not difficult but it is time consuming. It is required to write codes for selecting the right data from the database, locating the selected data at the right places in the document, and formatting the document with properties such as font size, type, layout, spacing and borders. Figure 7.31 shows the code written for the risk assessment section.

```
'Define the paragraph and table
    Dim oParar As Word.Paragraph 'risk
    Dim oTabler As Word.Table
'Define the location
oParar = oDoc.Content.Paragraphs.Add(oDoc.Bookmarks.Item("\endofdoc").Range)
'Formatting the heading
     oParar.Format.SpaceBefore = 24
     oParar.Range.Font.Bold = 1
     oParar.Range.Text = "RISK ASSESSMENT"
     oParar.Alignment = Word.WdParagraphAlignment.wdAlignParagraphCenter
     oParar.Range.Font.Size = 10
     oParar.Format.SpaceAfter = 12
     oParar.Range.InsertParagraphAfter()
     oParar.Range.Font.Bold = 0
     oParar.Alignment = Word.WdParagraphAlignment.wdAlignParagraphLeft
     Dim rr As Integer, cr As Integer
'Specify Rows, then Columns. This will depend on number of people specified.
     selStr = "SELECT Count(*) FROM RiskAssessmentsSchema WHERE
FK_CollaborationID = @CollabID"
     selCmd = New OleDbCommand(selStr, DBconn)
     selCmd.Parameters.AddWithValue("@CollabID", collaborationID)
     Dim objScalarr As Integer = 0
'Open connection with the database
DBconn.Open()
     objScalarr = CInt(selCmd.ExecuteScalar)
DBconn.Close()

     Select Case objScalarr
         Case 0
         Case Else

     Dim dt As New DataTable
       selStr = "SELECT * FROM RiskAssessmentsSchema WHERE
FK_CollaborationID = @CollabID"
       selCmd = New OleDbCommand(selStr, DBconn)
       selCmd.Parameters.AddWithValue("@CollabID", collaborationID)
       Dim adp As New OleDbDataAdapter(selCmd)

DBconn.Open()
       adp.Fill(dt)
DBconn.Close()
       Dim rowCount As Integer = dt.Rows.Count
       oTabler = oDoc.Tables.Add(oDoc.Bookmarks.Item("\endofdoc").Range,
rowCount + 1, 4)
        oTabler.Range.Paragraphs.SpaceAfter = 4
'Assign the column headings
       oTabler.Cell(1, 1).Range.Text = "Description of Risk"
       oTabler.Cell(1, 2).Range.Text = "Probability"
       oTabler.Cell(1, 3).Range.Text = "Severity of the Impact"
       oTabler.Cell(1, 4).Range.Text = "Risk Mitigation Methods"
'Assign the called data to the right cells in the word table
       For rr = 0 To rowCount - 1
       For cr = 1 To 4
       oTabler.Cell(rr + 2, cr).Range.Text = dt.Rows(rr).Item(cr +
1).ToString
 Next
 Next
'Format the table- column headings=bold and borders=visible
       oTabler.Rows.Item(1).Range.Font.Bold = 1  'Make first row bold
       oTabler.Rows.Item(1).Range.Font.Size = 12
       oTabler.Columns.Borders.InsideLineStyle =
Word.WdLineStyle.wdLineStyleSingle
       oTabler.Borders.OutsideLineStyle = Word.WdLineStyle.wdLineStyleSingle
End Select 'END OF Risk Assessment!
```

Figure 7.31 The Code for the Risk Assessment Section in the Collaboration Change Management Report

7.7 Summary

This chapter has discussed how the conceptual ICE framework has been automated using VB.net as the development environment, Microsoft Access as the database, and Microsoft Word as the documentation medium. Firstly, the development environment and the reasons for its selection have been discussed. Secondly, the system architecture of the ICE prototype has been explained. These were followed by the demonstration of the prototype. The chapter also presented a copy of the report generated by the prototype and how it is generated.

CHAPTER EIGHT: EVALUATION OF THE ICEMOCHA FRAMEWORK AND THE PROTOTYPE

8.1 Introduction

This chapter presents the evaluation of the ICEMOCHA framework presented in Chapter 6 and the ICE prototype presented in Chapter 7. It starts with an explanation of the aim and objectives of the evaluation. This is followed by a description of the methodology for the evaluation. The analysis of the quantitative and qualitative data obtained during the evaluations are presented. The suggestions of the evaluators for improvement and further development of the framework and the prototype are summarised. The chapter concludes with a discussion of the results.

8.2 Evaluation Aim and Objectives

The evaluation was carried out with the aim of validating the conceptual ICEMOCHA framework and determining the appropriateness and functionality of the prototype system developed to automate the ICEMOCHA processes at the project organization level. The specific objectives of the evaluation were:

1. To assess the overall effectiveness of the conceptual ICEMOCHA framework and to check the extent to which the framework realises its objectives as stated in Section 6.2.3;
2. To assess the capability of the ICEMOCHA framework to facilitate the implementation of collaboration environments;
3. To assess the capability of the ICEMOCHA framework to help manage the organizational changes resulting from the collaboration environment

implementation;

4. To assess the usability of the prototype as a tool in the construction industry; and
5. To obtain suggestions from the industry professionals for further improvement of the framework and the prototype.

8.3 Adopted Evaluation Methodology

Evaluation research is not distinguished from other forms of social research with the research methods adopted, but with the purpose of research (Babbie, 1995). The primary purpose in evaluation research is not to discover new knowledge, but to study the effectiveness of a practical action enhanced by the existing knowledge (Clarke, 1999). According to Scriven (1996), there are two basic types of evaluation, formative evaluation and summative evaluation. Clarke (1999) compares the characteristics of formative and summative evaluation as shown in Table 8.1.

Table 8.1 Comparison of Formative and Summative Evaluation (Clarke, 1999)

	Formative	**Summative**
Target audience	Programme managers/practitioners	Policy-makers, funders, the public
Focus of data collection	Clarification of goals, nature of implementation, identifying outcomes	Implementation issues, outcome measures
Role of evaluator	Interactive	Independent
Methodology	Quantitative and qualitative with an emphasis on qualitative	Emphasis on quantitative
Frequency of data collection	Continuous monitoring	Limited
Reporting procedures	Informal via discussion groups and meetings	Formal reports
Frequency of reporting	Throughout period of observation/study	On completion of evaluation

The evaluation research carried out on the framework and prototype could not be

categorized as purely summative or purely formative. It was mainly aimed at gathering data for measuring the outcome and investigating the implementation issues of the prototype, which can be considered as a summative approach. However, the evaluation also aimed to gather feedback from the industry practitioners on how the prototype could be further improved to be more appropriate for the needs and preferences of the industry. Therefore, a methodological triangulation was performed during the evaluations following a "between-methods" approach. Between-methods approach, also referred to as across-methods approach, is the actual mixing of methods in a single research design (Denzin, 1970). The data collection was carried out arranging meetings in eight construction organizations.

The ICEMOCHA framework and the prototype had been built using the data obtained from the case studies. Whilst choosing the targets for the evaluation, it was decided to contact the same companies and preferably the same people who had participated in the case studies. This decision was based on two factors: Firstly, it was thought that since they were the ones explaining the difficulties and barriers met during the implementation of collaboration environments, and therefore, defining the need for a framework/methodology to manage the implementation process, they would be the best ones to evaluate whether the framework and the prototype are capable of addressing this need and overcoming the difficulties and barriers. Secondly, an opportunistic approach was followed. It would be easier to approach the same people for a follow up meeting than to get in touch with new people who would be hearing about the research and its objectives for the very first time. Furthermore, during the case study meetings, most of the interviewees had expressed an interest in following the progress of the research and seeing the final output when the research was complete. The companies in the case studies, previously shown in Table 5.1, had been chosen from architecture, contracting, engineering consultancy and technology-providing companies. For the evaluation of the framework and the prototype, the technology-providing companies in Case 8 and Case 9 were excluded since neither the framework nor the tool could directly be used by a technology-providing company. The contracting company in Case 5 could not be included in the evaluation since the project director interviewed left the company and it was not possible to access anyone else in the same company. Likewise, the project collaboration analyst interviewed in Case 4 was not available for the evaluation. However, a senior

design manager and a project manager, dealing with the collaboration issues in joint projects at a more senior level than the original contact, were approached and a meeting was arranged for the evaluation.

Apart from the companies that participated in the case studies, another consultancy company was approached. An evaluation meeting was arranged with a senior consultant working in this company. Two project managers from a real estate investment trust organization collaborating with this senior consultant on design management also attended the meeting and participated in the evaluation. Therefore, a total of eight construction-sector organizations participated in the evaluation. The details of these organizations and the people involved in the evaluation are given in Table 8.2.

Table 8.2 Summary of the Evaluators

Company No	Previous Case No	Company type	Participant(s)	Experience (years)
E1	Case 1	Consultancy	1. Collaboration Consultant	23
E2	Case 2	Consultancy	1. Programme Director	13
E3	Case 3	Contracting	1. Head of Quality	34
			2. Business Systems Analyst	5
E4	Case 4	Contracting	1. Senior Design Manager	25
			2. R&D Project Manager	35
E6	Case 6	Architecture	1. Associate	20
			2. Associate, Project Manager	30
E7	Case 7	Architecture	1. Information Manager	26
			2. Drawing Office Manager	10
E5	-	Consultancy	1. Senior Consultant	5
E8	-	Real Estate (Design Management)	1. Project Manager	6
			2. Project Manager	3

The designed evaluation method was piloted before being used in the evaluation. One of the post doctorate researchers working in the Department of Civil and Building Engineering at Loughborough University acted as an evaluator in the pilot. After the pilot evaluation, some of the questions in the questionnaire were reworded and some changes were made to the presentation before the actual evaluations started.

Each evaluation session was arranged to last one hour. However, during the meetings in the companies E1, E3, E4, E6, and E7, the discussions lasted for more than one hour and the meetings were extended up to two hours at their request. The agenda followed during the evaluation sessions is illustrated in Figure 8.1. The session consisted of six parts:

1. A brief summary of the research was presented to the evaluators. The aim and objectives of the research, the adopted methodology, case study findings and an overview of the ICEMOCHA framework were presented in ten minutes.
2. The project organization level processes of the ICEMOCHA framework were explained and the prototype was demonstrated. Running the prototype and explaining the ICE model were completed in ten minutes.
3. The MOCHA model was introduced to the evaluators. The organizational change management processes to be carried out in each organization due to the implementation of collaboration environments were presented using IDEF0 diagrams. This presentation was also completed in ten minutes.
4. A ten-minute period was reserved for questions and answers. However, the evaluators were given the option of interrupting the presentation and asking questions as the presentation went along. Some qualitative data was collected during this stage.
5. When the presentation was finished, an informal discussion session was held. In some cases, this was combined with the questions and answers session after the presentation. This also enabled the collection of qualitative data on the framework and the prototype.
6. The evaluation questionnaire consisted of closed and open-ended questions and was filled in by the evaluators. Most of the evaluators completed the

questionnaire in ten minutes.

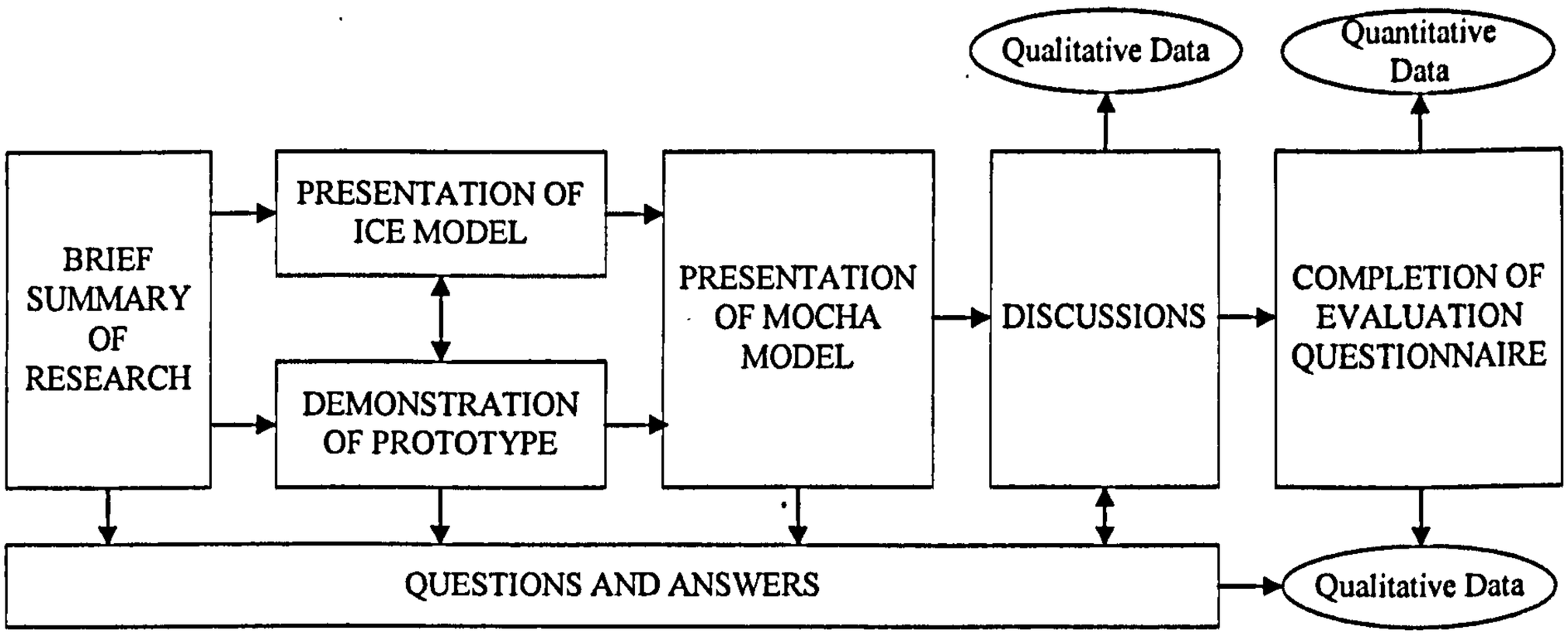

Figure 8.1 The Evaluation Meeting Agenda

A presentation had been prepared by the researcher for each evaluation session in order to give an overview of the research and to introduce the framework. Therefore, in the companies where there were several evaluators, a data projector was used for the research presentation and prototype demonstration stages. The evaluators were also given three sets of handouts:

1. An example of the collaboration change management report to enable them to follow the presentation of the ICE model and the prototype (Appendix 2);
2. A set of five IDEF0 diagrams to enable them to follow the five main stages of the MOCHA model (Figures 6.17, 6.18, 6.19, 6.20, and 6.21);
3. The evaluation questionnaire which was collected after being filled in by the evaluators at the end of the session (Appendix 3).

The design of the questionnaire was based on the aim and specific objectives of the evaluation stated in Section 8.2. The questionnaire included the sections below:

1. Background information section, which requested information about the evaluator's name, job title/position, experience in construction industry in terms of years, company name and address, and e-mail or contact number;
2. Framework – overall view section, which consisted of nine closed questions that assess the effectiveness of the overall ICEMOCHA framework;

3. Framework – project organization level section, which consisted of nine closed questions that assess the effectiveness of the project organization level processes in implementing collaboration environments in construction projects;

4. Framework – organizational level section, which consisted of eight closed questions that assess the effectiveness of the organizational level processes in managing the organizational changes resulting from the implementation of collaboration environments;

5. Framework - general comments section, which consisted of four open-ended questions on the conceptual ICEMOCHA framework asking about its main benefits, barriers to its implementation, potential improvements that can be made to the framework, and the further comments of the evaluators;

6. Prototype section, which consisted of seven closed questions on the usability of the prototype as a tool in the construction industry; and

7. Prototype – general comments section, which consisted of four open-ended questions on the prototype asking about its main benefits, barriers to its implementation, potential improvements that can be made to the prototype, and further comments of the evaluators.

8.4 Evaluation Results

This section presents the analysis of the qualitative and quantitative data obtained from the evaluation sessions.

8.4.1 Results Obtained from Quantitative Data

This section provides the quantitative analysis results obtained from the closed questions in the questionnaire. In order to keep the evaluators anonymous, the results of the background information section reported in this thesis are limited to the information provided in Table 8.2. The answers to the closed questions regarding the conceptual ICEMOCHA framework are shown in Tables 8.3, 8.4 and 8.5 whereas the answers regarding the prototype are shown in Table 8.6. These tables present the responses in terms of percentage of evaluators with regard to the assessment scale.

The assessment scale used in the questionnaire was based on a Likert scale and ranged from 1 to 5, which represent a range from poor to excellent. The tables also present the average ratings obtained for each question.

8.4.2 Results Obtained from Qualitative Data

8.4.2.1 Main benefit of the framework

The evaluators were asked about what they particularly liked about the framework and what they considered to be the main benefit of the framework. Apart from the two evaluators in the architecture company E7, all evaluators agreed that the main benefit of the framework was that it provided organizations a smooth logical process to follow for the implementation of collaboration environments. It was perceived as a well considered system by all organizations which would guide the collaborating parties to set up an effective collaboration environment.

The two evaluators in company E7 also stated that the framework was a very useful tool for the implementation of collaboration environments in construction projects, however both evaluators were of the view that the main benefit of the framework would be obtained if it was used to implement an internal collaboration tool. During the discussion period, they stated that they had always been imposed with another party's collaboration procedures and tools, and never had a chance to modify any of these imposed decisions. The other architecture company, E6, also had had to work with some procedures which did not suit their traditional working culture, but could not alter any of the decisions imposed by the client or another party. However, both contributors were of the view that the processes in the ICEMOCHA framework had the potential to manage the collaboration implementation process provided that all parties agreed to collaborate and have the desire to collaborate. Overall, the framework was seen as a useful guide to follow during the implementation of collaboration environments.

Table 8.3 The Evaluation Responses – Framework – Overall View

NO	Evaluation Questions	Rating					
		1 Poor	2 Fair	3 Satisfactory	4 Good	5 Excellent	Mean Rate
1	How useful do you consider the overall ICEMOCHA framework?	-	-	15%	62%	23%	**4.08**
2	How easy is it to follow the IDEF0 process models in ICEMOCHA?	-	-	46%	38%	15%	**3.69**
3	To what extent can following the ICEMOCHA framework help parties in the construction project to implement collaboration environments?	-	-	15%	77%	8%	**3.92**
4	How effectively can ICEMOCHA improve the overall success of collaboration across the construction project?	-	-	31%	54%	15%	**3.85**
5	To what extent can ICEMOCHA improve the benefits obtained from the collaboration tools and technologies?	-	-	8%	92%	-	**3.92**
6	How effectively does the framework focus attention on the people and organizational issues in the planning and implementation of collaboration technologies?	-	-	46%	46%	8%	**3.62**
7	How useful is it to have both a project organization level and an organizational level approach in ICEMOCHA?	-	-	8%	31%	62%	**4.54**
8	How well does ICEMOCHA establish the link between project organization level with organizational level?	-	-	62%	31%	8%	**3.46**
9	To what extent does ICEMOCHA have the potential to offer tangible benefits (such as time and cost reduction) to construction projects?	-	-	23%	77%	-	**3.77**

Table 8.4 The Evaluation Responses – Framework – Project Organization Level

NO	Evaluation Questions	Rating					
		1 Poor	2 Fair	3 Satisfactory	4 Good	5 Excellent	Mean Rate
1	How useful is ICEMOCHA in enabling an agreement between project parties on "one common way of doing things" ?	-	8%	15%	54%	23%	**3.92**
2	How useful is ICEMOCHA in planning for the people aspect of the collaboration solution?	-	15%	23%	46%	15%	**3.62**
3	How useful is ICEMOCHA in planning for the data/workflow aspect of collaboration solution ?	-	8%	38%	46%	8%	**3.54**
4	How useful is ICEMOCHA in identifying the IT and collaboration tools to be used in the project?	-	8%	31%	38%	23%	**3.77**
5	How useful is ICEMOCHA in defining collaboration standards and procedures/ agreeing on common formats, types and conventions for information exchange?	-	-	38%	46%	15%	**3.77**
6	To what extent can ICEMOCHA contribute to establishing trust between the parties?	-	31%	46%	23%	-	**2.92**
7	To what extent can ICEMOCHA enable buy-in by all parties to the collaboration decisions?	8%	8%	15%	69%	-	**3.46**
8	How convinced are you that ICEMOCHA should be used at the project organizational level?	-	-	31%	54%	15%	**3.85**
9	How would you rate the usefulness of ICEMOCHA in planning the implementation of collaboration environments?	-	8%	15%	54%	23%	**3.92**

Table 8.5 The Evaluation Responses – Framework – Organizational level

NO	Evaluation Questions	Rating					
		1 Poor	2 Fair	3 Satisfactory	4 Good	5 Excellent	Mean Rate
1	To what extent do you believe that building a CCMT (collaboration change management team) is helpful in managing the organizational change?	-	-	23%	46%	31%	**4.08**
2	To what extent can ICEMOCHA ensure top level commitment to organizational changes?	8%	-	31%	54%	8%	**3.54**
3	To what extent can the high level of user involvement in ICEMOCHA be ensured in construction projects?	-	15%	54%	31%	-	**3.15**
4	How useful is ICEMOCHA in managing the employee resistance to change?	8%	-	69%	23%	-	**3.08**
5	How well does ICEMOCHA encourage increased user involvement in change management?	-	-	31%	62%	8%	**3.77**
6	How well can ICEMOCHA capture employee requirements and wishes?	-	8%	38%	46%	8%	**3.54**
7	How convinced are you that ICEMOCHA should be used at the organizational level for change management?	-	8%	23%	46%	23%	**3.85**
8	How would you rate the usefulness of ICEMOCHA in managing organizational changes?	-	8%	31%	54%	8%	**3.62**

Table 8.6 The Evaluation Responses – Prototype Section

NO	Evaluation Questions	Rating					
		1 Poor	2 Fair	3 Satisfactory	4 Good	5 Excellent	Mean Rate
1	How well does the prototype help to facilitate the implementation of ICEMOCHA?	-	-	23%	62%	15%	**3.92**
2	How effective is the graphical user interface of the system?	-	-	46%	38%	15%	**3.69**
3	How easy is it to navigate between different stages of the system?	-	-	15%	46%	38%	**4.23**
4	How well does the prototype support decision making?	-	15%	38%	38%	8%	**3.38**
5	How useful is the prototype in documenting implementation processes and changes?	-	-	8%	54%	38%	**4.31**
6	How effective is the reporting facility?	-	-	15%	46%	38%	**4.23**
7	How convinced are you that the prototype should be used in construction projects?	-	8%	31%	38%	23%	**3.77**

8.4.2.2Main benefit of the prototype

The evaluators were asked about what they particularly liked about the prototype and what they considered to be the main benefit of the prototype. The benefits mentioned by the evaluators were mainly on the capability of the prototype to capture all decisions required for the implementation of collaboration environments, and to document all the decisions and their outcomes as a report. It was perceived by all evaluators as an effective tool to guide the collaborating parties in coming up with the most appropriate collaboration solution for them. The Associate that evaluated the prototype in company E6 liked the prototype since the interface was simple but highly effective.

8.4.2.3 Barriers to the use of framework

The following list provides the barriers identified by the evaluators for the implementation of ICEMOCHA in construction projects:

- There is the potential that the users will think that adopting this methodology or using the prototype for the framework will be enough for success and they might underestimate the actual contribution and effort required from people to make the collaboration work;
- People may think they follow these processes already - even if they do not;
- Senior managers might not believe the time spent on planning for the collaboration will pay off;
- The pilot implementation might be considered too costly by some organizations;
- The ICEMOCHA processes can also be considered as a change; thus there might be a resistance to implementing the ICEMOCHA approach;
- The framework processes might be perceived as too rigid; and
- The structure of collaboration systems are often fixed and there is little opportunity to request changes.

The possible hesitation that the time spent will not payoff in monetary terms when the collaboration is implemented was shared by 3 out of 13 evaluators. That the

framework might be perceived as too rigid was stated by two evaluators who are working in the same company, E4. All the other barriers were stated by one evaluator only.

8.4.2.4 Barriers to the use of the prototype

A number of barriers were defined by the evaluators to the use of the prototype in construction projects. These barriers were found to be related to each other and to some of the barriers defined for the framework. These barriers are listed below:

- Relying too much on the tool and underestimating the amount of work required as a team to maintain a good level of collaboration;
- Difficulty in getting people in a workshop to sit down and fit it in;
- Managers wanting to start the job with a minimum amount of time and money spent on planning / business pressure;
- Lack of trust between project parties especially in traditional contracts;
- Possible perception of the prototype as another set of tasks that people have to undertake and resisting the change; and
- Lack of organizational demand/desire to collaborate.

Among these barriers listed, 5 out of 13 evaluators agreed that the biggest barrier is the managers in construction organizations want to start the job with minimum time, money and effort spent on planning.

8.4.2.5 Recommended improvements and suggestions for ICEMOCHA framework

The evaluators made some recommendations for improving the ICEMOCHA framework. Since all recommendations were related to the project organization level processes, these were also suggestions for the prototype. These suggestions are listed below:

- The evaluators in the contracting company E3 suggested adding some specific test scripts for the pilot implementation to guide how that pilot implementation should be carried out. They also suggested that defining a format for the feedback to be

provided during the pilot stage would be helpful.

- For the risk assessment stage, the Head of Quality in company E3 suggested that defining a risk owner might be necessary for some risks.

- The research and development project manager in the contracting company E4 suggested that the framework might be improved by linking some of the ICEMOCHA processes to the standard methods or procedures of related processes. Embedding the information exchange requirements of Avanti into the definition of collaboration standards sub-process was given as an example.

- The architecture company E6 stated that the framework relies on the desire to collaborate and suggested introducing a mechanism making the commitment of all parties to the collaboration planning a "must".

8.4.2.6 Recommended improvements and suggestions for the prototype

The evaluators were asked for their suggestions for the improvement of the prototype. The suggestions were more specific for the prototype than for the conceptual framework and were more focussed on the improvements required to further develop the prototype into a collaboration planning software/tool used in the construction industry. These suggestions are as follows:

- During the collaboration planning stage, ICE/A3, some of the free text boxes might be replaced by combo boxes or checkboxes where some standard or best practice data are shown. Having some options for the key roles, data flows, standard method and procedures will guide the users in the planning, therefore it will not be necessary to rely on an expert.

- The prototype could be linked to some standard method and procedures accepted for different areas and for different regions. For example, the specifications to be considered in the United Kingdom might be Avanti or RIBA procedures whereas it will be AIA procedures for USA.

- The prototype could be converted into a Web-based program so that the user requirements can be collected internally from the users.

- The prototype can be made Web-enabled so that the external project partners, such

as subcontractors, can also access the program.

- Testing the prototype on a real project will help to understand what to improve.
- It would be nice to convert it into a live document.
- It can be customized for different contract styles such as traditional contracts and collaborative style contracts.
- An alternative to the pilot implementation could be developed since most organizations will not want to spend time and money on the pilot.
- If it is going to be further developed for the use of industry, it might be a good idea to use the term "meeting" rather than "workshop meeting" due to the negative perception of workshops by construction organizations which are known to prioritise carrying out the actual work than spending some time at the beginning to plan them.
- The prototype can be customised to serve projects with different levels of complexity.

8.5 Discussion of Results

When the overall results obtained from the qualitative and the quantitative data obtained through the evaluation meetings are analysed, it is seen that both the conceptual framework and the prototype were found successful by the evaluators based on the aim and objectives stated in Section 8.2.

When the results obtained from the closed questions in the questionnaire are investigated, it is seen that the responses of the evaluators to the framework and the prototype were positive. Having a two-level approach in the ICEMOCHA framework was highly appreciated by the evaluators and the mean of the evaluators' ratings was 4.54 out of 5. The usefulness of the overall ICEMOCHA framework was rated as 4.08. When the evaluators were asked how convinced they were that ICEMOCHA should be used at the project organization level and at the organizational level, the average rating for both levels was 3.85.

When the results for the overall view of the ICEMOCHA framework, shown in Table

8.3, are investigated, it is seen that the mean ratings were higher than 3.5 for 8 out of 9 questions in this section, which can be restated as the mean rating for 89% of the questions in this section were higher than 3.5. When the results for the project organization level of the ICEMOCHA framework, shown in Table 8.4, are investigated, it is seen that the mean ratings were higher than 3.5 for 7 out of 9 questions in this section, which can be restated as the mean ratings for 78% of the questions in this section were higher than 3.5. When the same analysis is carried out for the data shown in Table 8.5 and 8.6, it is seen that for 75% of the questions regarding the organizational level of ICEMOCHA framework, and for 86% of the questions regarding the prototype, the mean ratings were higher than 3.5.

The lowest calculated mean rating was for the question on the extent to which ICEMOCHA can contribute to establishing trust between the parties and was equal to 2.92. This was the only question rated below 3.0. Although it was rated just below satisfactory, it was not a very surprising result since building trust between collaborating parties depends on many factors, and the ICEMOCHA framework cannot engender trust on its own.

From the open-ended questions in the questionnaire and from the discussions with the evaluators some qualitative data was obtained. This data mainly focused on the main benefits and barriers to the implementation of the ICEMOCHA framework and the prototype. The logical process proposed in the ICEMOCHA framework to follow for the implementation of collaboration environments was considered as the main benefit of the framework. What was liked the most regarding the prototype was that it covered all aspects of the collaboration solution planning and had a very good documentation system and reporting facility.

The barriers to the implementation of framework and the prototype identified by the evaluators were mainly down to cost and time issues. The common approach in the construction industry was observed to be spending the minimum amount of time and money on the planning and starting doing the actual work immediately. However, most of the time the time and money spent on correcting the mistakes resulting due to insufficient planning cost more than what planning would have cost if carried out at the beginning of the work.

The architecture companies complained about companies trying to impose their own working procedures on all parties without questioning whether it would suit the rest of the collaborating parties. They were of the view that the companies following this approach would not like to have a methodology like ICEMOCHA since it suggests the comments of all collaborating parties should be considered whilst developing a collaboration environment.

All the evaluators made valuable suggestions for further improvement of the framework and the prototype with a focus on what would they have liked to see if this prototype was further developed into a software to be used commercially in the construction industry. Linking the prototype with standard methods and procedures and creating some combo boxes or check boxes instead of free textboxes based on these procedures will be recommended by the researcher as future research.

During the quantitative data analysis, one of the evaluators was noticed to rate the questions significantly lower than the other evaluators. The evaluator was from the contracting company, E4, and was working as a design manager in the research and development (RD) department. In most questions, there were contradictions with the evaluator's colleague from the same company. For example, questions 2, 3 and 4 at the project organization level ICEMOCHA framework were marked as 2 by the evaluator whereas the other evaluator rated the same issues as 4. The reason for this difference between two evaluators from the same company was understood later in the analysis of the qualitative data. This evaluator was of the view that the standard methods and procedures or proposed methodologies and frameworks were no solution to the collaboration planning process in the construction industry. According to the evaluator, each methodology introduced to solve the current problems would also be considered as "a new set of tasks" and the employees would resist the new set of tasks and would not contribute. Stating that their company already had some standard method and procedures for collaboration which were not accepted by the employees, the evaluator suggested that the ICEMOCHA methodology would not be seen any differently. On the other hand, the other evaluator was of the view that the standard method prescribed for the company was not accepted since it was imposed on the employees with no user involvement during the planning process. The company introduced the standards with the aim to standardise the working procedures

within the company and to get all their partners in the construction project to work in the same way they do, therefore, to shape the collaboration in the construction project according to their own standards. This approach completely contradicts with the foundations of the ICEMOCHA framework. ICEMOCHA was developed due to the need for collaboration environments designed according to the requirements and expectations of all parties and users collaborating. Although it is accepted that it will not be possible to fully please everyone at the same time, ICEMOCHA supports the idea that any solution defined by the consensus of collaborating parties would work better than a standard method and procedure of one company imposed on other parties. Besides, it would not be considered as a new set of tasks since it does not prescribe any solution but guides the collaborating parties to find their own solution.

Using a triangulation of quantitative and qualitative research methods during the evaluation helped the researcher in many ways. Carrying out a quantitative data collection, the researcher bias was avoided which could be more difficult to avoid in qualitative data collection. Using the qualitative data collection, the researcher had a chance to understand the quantitative data better and to capture other dimensions which might not have been captured in the questionnaire. The evaluators cannot be expected to provide purely objective data during the qualitative or quantitative data collection. This is not considered a weakness of the research methodology by the researcher. In fact, it is believed by the researcher that the subjective data obtained from the evaluators increased the richness of the data and provided guidance for further research.

8.6 Summary

This chapter has presented the evaluation of the ICEMOCHA framework and the developed prototype. The evaluation was based on the qualitative and quantitative data obtained though discussions and the completed questionnaire in the evaluation sessions carried out with participants from eight construction organizations. The evaluation findings showed that the framework and the prototype have managed to achieve their aims and objectives, although there are still some steps to be completed to make the prototype suitable for the use of industry professionals. The next chapter makes recommendations for further work and concludes the research project.

CHAPTER NINE: CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

This chapter summarises the research, and evaluates it against the original objectives. The conclusions drawn from the research are presented and the limitations are discussed. The last section of the chapter covers the recommendations for further research.

9.2 Summary

The aim of this research was to find how to introduce collaboration environments to construction organizations and how to manage the changes required in order to obtain the full benefits of their implementation. This aim was achieved through several specific research objectives including:

1. To review the theoretical concepts and previous work on collaboration environment implementation in construction and on change management with a focus on organizational change management;
2. To investigate the current collaborative working approaches in construction organizations and how collaboration environments are implemented;
3. To develop an organizational change management framework for the implementation of collaboration environments;
4. To automate the framework in the form of a computer based prototype system; and
5. To evaluate the framework and the prototype.

The specific tasks of this research and the key findings are summarised below with respect to the original research objectives:

Objective 1: To review the theoretical concepts and previous work on collaboration environment implementation in construction and on change management with a focus on organizational change management.

The literature review on collaboration environment implementations, presented in Chapter 2, revealed that collaboration environments generally did not achieve the full benefits expected and the reason for this failure was not technical but related to organizational and people issues. A number of barriers to IT implementation and to collaboration environments were determined. The review also determined the key issues to focus on during the collaboration environment implementation to overcome these barriers and to enhance successful collaboration. These key issues were: user requirements capture, user involvement, user resistance to change, proper planning/ project management, strategic IT implementation, buy-in, and trust. The main finding from this review was that the success of collaboration environments did not only depend on "what is introduced to the organization" but was also related to "how it is introduced". Some of the strategic IT implementation frameworks and the socio-technical design concept proposed in the literature were reviewed in order to establish their potential to be used in construction for introducing collaboration environments. However, it was realised that none of these tools or methodologies have an established use in the construction industry and more importantly that they mainly focused on the design of the IS/IT systems but fail in providing guidance on how these systems should be introduced to organizations. The need for an organizational change management approach whilst implementing collaboration environments was justified using previous research and the Contingency Theory.

Another review was carried on change management in construction both at organizational level and project level, with a focus on the organizational change management. This review was presented in Chapter 3 of this thesis. The classifications of the changes and the nature of changes were reviewed, and the enablers and barriers for managing the changes at each level were discussed. The theories which have contributed to the evolution of organizational change

management through highlighting of different perspectives were reviewed. These theories were Taylorism, the human relations movement, the contingency theory and the systems theory. The previous models developed to manage organizational change were reviewed. It was found that the construction industry was trying to introduce organizational change using tools such as business process reengineering, total quality management and maturity model, which were criticised for their deficiencies in managing organizational changes. Leading the change, resistance to change and communicating change were discussed as they were considered as key concepts in organizational change management.

The literature review concluded that there has been little research in construction on organizational change management related to the implementation of information technologies or collaboration environments, this was then chosen as the research focus. The specific aim and objectives of the research were determined combining this gap in organizational change management area the principle that the key issues in collaboration environment implementation could be achieved through an organizational change management approach.

Objective 2: To investigate the current collaborative working approaches in construction organizations and how collaboration environments are implemented.

Chapter 5 presented the nine case studies conducted in order to map the current practice of the collaboration environment implementations and their success level in the UK construction organizations. All case study companies were found to be failing in achieving the full benefits of collaboration environment implementations because of the under-estimation of people and organizational issues. The case studies revealed a number of factors affecting the success of collaboration environment implementations. These factors were categorized into two groups as factors affecting the collaboration at the organization level, and factors affecting the collaboration at the project organization level.

Using a systems thinking approach, the causal relations between these factors were defined and it was shown that there was a need for a framework to control all these factors simultaneously.

Objective 3: To develop a conceptual organizational change management framework to implement collaboration environments.

From the literature review and case studies, it was revealed that there is a need for a structured procedure for collaboration implementation and management, together with a detailed organizational change management approach to control all the factors affecting the success of collaboration environments. The ICEMOCHA framework, described in details in Chapter 6, was developed to address this need.

ICEMOCHA consisted of two interlinked process models: Implementation of Collaboration Environments (ICE), at project organization level, and Management of Organizational Changes (MOCHA), at organizational level. The ICE model provided a methodology to guide the collaborating organizations in the planning and implementation of collaboration environments whereas MOCHA provided a methodology to enable each organization to come up with an organization specific organizational change management approach. Both models followed a scientific problem solving approach following five stages: initiation (problem definition), vision development, solution planning, implementation, and evaluation. Each of these stages were further broken down into their sub-processes according to the level they were targeting. These stages and the sub-processes were represented using the IDEF0 modelling approach.

Objective 4: To automate the framework in the form of a computer based prototype system.

The project organization level processes of the ICEMOCHA framework were automated and resulted in a tool for the collaboration management team members which will guide them in the planning and implementation of a collaboration solution to be adopted by all parties in the project.

The prototype consisted of three main elements. The first one was the user interface developed in VB.net environment. The second one was the database where all data entered using the interface were stored. This database was developed using Microsoft Office Access. The third element was the report created as the output of the prototype. The medium chosen for the report creation was Microsoft Word. The links

between these three elements were established by the codes written in VB.net. The prototype development was explained and the prototype was demonstrated in Chapter 7 of this thesis.

Objective 5: To evaluate the framework and the prototype.

The conceptual ICEMOCHA framework and the prototype system were evaluated using a survey. Evaluation meetings were arranged with thirteen senior managers in eight companies. The data collection was carried out by triangulation of unstructured interview and questionnaire techniques. The evaluation results confirmed that the participants were generally satisfied with the effectiveness and usability of the framework and the prototype. The participants also made comments on possible ways to improve the framework and the prototype. Chapter 8 of this thesis presented the evaluation process and discussed the results obtained.

9.3 Conclusions

This research investigated the implementation of effective collaboration environments in construction projects and the management of the required organizational changes in each organization collaborating on the project. The conclusions drawn from the research are listed below:

- Most of the organizations do not realise that they need to introduce some organizational changes in order to implement collaboration environments successfully.

- The success of collaboration environments does not only depend on "what is introduced to the organization" but is also related to "how it is introduced". Therefore, the change management required for the implementation should be considered carefully.

- The issues affecting the success of collaboration environment implementations, established from the analysis and interpretation of the case studies, are listed below:

    - Criticality of the collaboration environment implementation for the project success;

- Binding clauses in the contract regarding the use of a collaboration environment;
- Agreement between parties on the use of a collaboration environment;
- Trust between the organizations and trust in the system;
- Security of organizational data;
- Top level commitment;
- User resistance to change;
- Early user involvement;
- User friendly interface;
- Training;
- Consistency of data format, types and standards used;
- Use of common conventions;
- Efficiency of the collaboration environment.

- The case studies also showed that the issues listed above are interrelated and should be approached as a system.

- The efforts to manage the changes resulting due to collaboration environment implementations should focus on both project organization and organizational levels.

- Specifications for the people to work on the project, the workflow of the project, and the details for the technology solution, collaboration standards and procedures should be agreed before the collaboration environment is set up.

- At the project organization level, the ICEMOCHA framework provides a smooth and logical methodology to guide the collaboration parties to set up an effective collaboration environment for the construction project considering both organizational and project organizational factors.

- At the organizational level, the ICEMOCHA framework provides a methodology guided by organizational change management principles in order to manage how

collaboration environments are introduced into the organization.

- The 'collaboration change management team', introduced by the ICEMOCHA framework at the organizational level, has the potential to manage the resistance of employees to change by enhancing user involvement, user requirements capture and change communication, therefore creating a sense of ownership of change among the employees.

- The prototype system developed provides a practical tool which will enable the parties collaborating on a construction project to capture and integrate the needs and expectations of all collaborating parties.

- The prototype system captured the decisions required for the implementation of collaboration environments and documented all decisions and their outcomes as a collaboration change management report. This documentation can be used as a guide for future collaboration implementations.

- Both the framework and the prototype were evaluated by participants from the construction industry and were accepted as an effective guide and an effective tool for the successful implementation of collaboration environments and change management.

9.4 Limitations of the Research

All studies have limitations and this study was no exception. Due to time and practical limitations, the framework and the prototype could not be implemented on a real construction project. A real project would have provided more feedback than the evaluation and both the framework and the prototype could have been better improved. However, there was limited accessibility to the real projects due to confidentiality reasons and it would have required the permission of all parties participating on a project. Furthermore, the limited time for the PhD would not have allowed the development and automation of the framework and the implementation of it on a real project.

9.5 Recommendations for Further Study

This study has explored how to implement collaboration environments in construction projects and how to carry out the required organizational changes in each organization due to the introduction of a new collaboration environment. During the study, some areas were identified for further research. These are listed below:

- The ICEMOCHA framework and the prototype system should be implemented on a real project and be further improved according to the findings in the study.

- The free textboxes of the prototype for the key roles, data flows, standard method and procedures should be are converted into combo boxes.

- The prototype should be converted to a Web-enabled system. A new interface can be added to capture some of the requirements or feedback from users located in different organizations and feed into the prototype.

- The ICEMOCHA processes related to planning of the people, technology, workflow, and collaboration standards and procedures dimensions of collaboration solution should be linked to the standard methods or procedures of related processes such as Avanti procedures.

- The MOCHA framework should be modified for different types of organizational changes altering collaboration environment related processes and be tested following a longitudinal case study or an action research.

- Many factors affecting the success of collaboration environments and the causal relations between these factors were determined using case studies. Although the ICEMOCHA framework addresses all of these factors considering the causal relations, building the trust between collaborating parties cannot be achieved through the use of ICEMOCHA only. Further research should be carried out on finding solutions to build trust between the collaborating parties in a construction project through a collaboration environment.

- Further research should be carried out on managing employee resistance to change during collaboration environment implementations focusing on the end user

perspective. These should be used to detail the current ICEMOCHA processes adding sub-processes to the current processes.

- During the case studies, it was found that the companies did not have any defined criterion to measure the success of the collaboration environment implementations and mostly carried out a perceptual analysis of whether their employees worked better than previously and whether they were more efficient or more useful than previously. Further research should be carried out aiming to define success criteria to measure the performance of a collaboration environment and performance of an organization in a collaboration environment, and to determine the benefits gained by the construction project as a whole and by each participating organization individually due to the implementation of a collaboration environment.

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APPENDICES

Appendix 1 The Interview Questions for the Case Study

Appendix 2 Collaboration Change Management Report

Appendix 3 Evaluation Questionnaire

Appendix 4 List of Publications Arising from the Research

APPENDIX 1

Interviewer's Name Organisation... Date Contact Info

THE INTERVIEW QUESTIONS

This survey aims at gathering information on:

1) Collaboration environment implementation procedures in the construction industry;
2) Barriers and difficulties of the implementations;
3) Whether collaboration environment implementations undertaken so far have been successful;
4) Collaborative working; and
5) The thoughts and experiences of industry professionals regarding the transformation of the organization during a new collaboration environment implementation.

There are two parts in this interview. The first part investigates the generic issues mentioned above. The second part asks specific questions on collaboration environment implementation experiences. The questions in the second part are mostly open-ended and may be slightly adapted during the interviews depending on earlier responses. These questions are intended for senior level managers (i.e. IT managers and project managers).

APPENDIX 1

Interviewer's Name Organisation... Date Contact Info

PART 1

IMPLEMENTATION OF COLLABORATION TOOLS

Q1. How many years of experience do you have in implementing CE systems in your organization? ----------years

Please answer the following questions according to your experience and knowledge of the organization

Q2. What percentage of CE implementation initiatives have failed?
a) 0-30 % b) 30-50% c) 50-70% d) 70-90% e) 90-100 %

Q3. What percentage of CE implementation projects would not have been found financially viable if the actual success levels could have been foreseen?
a) 0-30 % b) 30-50% c) 50-70% d) 70-90% e) 90-100 %

Q4. What are the success criteria in your organisation for IT implementations, or specifically for collaboration systems implementation?

Q5. How do you check/measure the level to which CE implementations satisfy the success criteria?

Q6. To what extent have CE implementation initiatives met the expectations of the users?
a) Fully b) Partially c) Marginally d) very little e) not at all

Q7. a. How are users' needs captured and by whom?

Q7.b. Are there any specified methodologies for this?

Interviewer's Name Organisation... Date Contact Info

Q8. When a new CE implementation or a new way of working (i.e. e-business) is introduced to the company, could you please indicate who is/are actively involved in the following processes.

	Stakeholders	CEO	Senior managers	IT Manager	Construction Project manager	External IT specialists	End users	External Change Agent/ Consultant
Recognizing the need for a new system								
Feasibility Analysis								
User requirements capture								
Design of the technical system								
Planning the adaptation process								
Choosing the optimum among the adaptation								
Testing and evaluation								
Implementation								
Fine tuning								

Q9. What are the criteria for choosing the users that participate in the user requirements capture?

Q10. To what extent have the CE implementation initiatives successfully included consideration of the following issues during development and implementation?
Please rank between 0-5, (0=Not at all, 5=Fully)

	Rank (0-5) 0- Not at all 5- Fully
Their contribution to business goals and needs	
Their impact on organisation structures and processes	
Their impact on work organisation and job design	
Their usability (user friendliness)	
Their impact on health and safety	
Their ergonomic aspects (i.e physical layout)	
Their impact on training and skills	

Interviewer's Name Organisation... Date Contact Info

Q11. The possible reasons mentioned in the literature for failing to obtain the full benefits of a CE implementation are given below. Can you please evaluate how severely the success of the collaborative system is affected by these.

Reasons	Rank (0-5) 0- Not at all 5- Very High
Technical constraints	
Unfriendly user interfaces	
Failure to meet the user needs	
Employee resistance to change	
Organisation not being ready for change	
Misfit of the technical structure to the organisational structure	
Misfit of the technical structure to the cultural values and assumptions held and shared by organization members	
Employees find the realization of teamwork difficult	
Some employees' failure to see the benefits of the new IT implementation	
Varying levels of computer literacy among employees	
Insufficient/inefficient training of users	
Lack of or insufficient feedback for the users in the implementation process	

COLLABORATIVE WORKING

Q12. A number of barriers are said to prevent effective collaboration. To what extent do you think it is the case for each barrier?

Reasons	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Lack of clearly defined vision and goals for the collaboration					
People who do not want to work differently					
Different organisational cultures					
Participants using a variety of different methods of communication					
The poor delegation of tasks					
Imbalance of the time spent on collaboration					
Imbalance of the cost and investment put forward					
Staff turnover/ continuity of participants					
Technological incompatibilities					
A lack of understanding of participants expertise, knowledge&					
Confidentiality, intellectual property & other legal issues					
Other- please specify					

APPENDIX 1

Interviewer's Name Organisation... Date Contact Info

PART 2

SPECIFIC IMPLEMENTATIONS

Q1.a. Is there a **specific section/department** in which regular failures or implementation problems occur?

Q1.b.What is the reason for the regular failures in that department/division/section?

Q2. Can you please name the collaboration technologies implemented in the last 5 years.

Q3. What was the most successful collaboration environment implementation among all undertaken by your organization in the last 5 years?

Q3.a. Can you give some details on this implementation?

Q3.b.. What was the purpose?

Q3.c. Which technologies were used to create the collaboration environment?

Q3.d. What factor caused it to be more successful than the others? What was different in this project?

Q3.e. Who delivered the tool? Was it commissioned from a company and designed with the contribution of the construction company or was it a standard system bought off the shelf?

Q3.f. Can you please give me any specific examples of the difficulties met during the design and implementation stages?

Q4. What was the least successful collaboration environment implementation among all undertaken by your organization in the last 5 years?

Q4.a. Can you give some details on this implementation?

Q4.b What was the purpose?

Q4.c Which technologies were used to create the collaboration environment?

Q4.d. What factor caused it to be less successful than the others?/ What caused the difference?

Q4.e. Who delivered the tool? Was it commissioned from a company and designed with the contribution of the construction company or was it a standard system bought off the shelf?

Q4.f. Can you please give me any specific examples of the difficulties met during the design and implementation stages?

Q5. Do the difficulties met in the implementation of collaboration environments change from one implementation to another, or were they common?

Q6. Have you ever observed any employee resistance? How did you cope with it?

Q7. How do you manage change when you introduce a new CE system to the organization?

Q8. How do you relate the new collaboration environment with:

Q8.a. the previous/current tools?

Q8.b. the previous/current organization structure?

Q8.c. the previous/current work tasks?

Q8.d. the users?

Q8.e. the existing construction projects the company is still working on?

APPENDIX 2

COLLABORATION CHANGE MANAGEMENT REPORT

Date Created: 22/11/2007 18:20:40

Author: Bilge Erdogan

COLLABORATION DETAILS

Collaboration Name : London Space University Campus

Collaboration Author : Bilge Erdogan

Collaboration Need :
- Geographically dispersed offices
- The use of a collaboration environment is critical for the success of the project

Shared Collaboration Vision :
-smooth process of information exchange
- reduced number of RFI's
- efficient collaboration with minimum compatibility issues

PRELIMINARY COLLABORATION SPECIFICATIONS

RISK ASSESSMENT

Description of Risk	Probability	Severity of the Impact	Risk Mitigation Methods
Differences in the working cultures of collaborating parties	Medium	Medium	Carry out team building exercises in the early project meetings
Financial problems in one of the parties	Low	High	Insurance plan
Connection problems at site	Medium	Medium	Develop an emergency backup plan
Differences in the working cultures of collaborating parties	Medium	Medium	Carry out team building exercises in the early project meetings
Financial problems in one of the parties	Low	High	Insurance plan
Connection problems at site	Medium	Medium	Develop an emergency backup plan
Staff turnover / Loss of key staff	Low	High	Succession plan in place / Documenting strategic data

APPENDIX 2

PLANNED COLLABORATION SOLUTION

A-PEOPLE SPECIFICATIONS

Role	Responsibility	Essential Skill	Essential Qualifications	Desirable Skill	Desirable Qualification
Collaboration Champion	Represent their organization regarding the decision making and smooth running of collaboration	-being aware of the organizational culture -good communication skills - IT literate	Construction relevant first degree or experience in construction industry for at least 10 years	-Advanced IT skills	Certificate from an IT related course
Document controller(s)	responsible from all documents' uploading to the extranet	E-legal communication expert	IT Background	Good communication skills	-

B-WORKFLOW SPECIFICATIONS

Process Name	Prerequisite Processes	Parties Involved	Output
Cladding design	2D design of the building	Design Co A, Design Co. B	Cladding plan
2D design of the building floors	Surveying	Design Co. A, Consultancy Co. G	2D Floor plans

C-AGREED COLLABORATION TOOL

Agreed Collaboration Environment: BIW Information Channel

D- IT TOOLS TO BE USED IN THE COLLABORATION

Task	Tool	Version	File Format
3D design for stairwell	AutoCad	2006	dxf

E- STANDARDISED COLLABORATION SPECIFICATIONS

Units Convention : SI Units

clockwise angles

Spatial Coordination : UCS defined by Design

Standard Method and Procedure : Avanti

Document Naming Convention : Avanti

Layer Naming Standards : Related model- classification code/ element

TRAINING

Chosen Training Method: One-to-one training ;

Recommendations on Training: Trainers will train 20 people initially one-to one. at an advanced level Each trained person will become a trainer for the rest of the company.

PILOT IMPLEMENTATION OF COLLABORATION ENVIRONMENT

Feedback on Pilot CE Implementation	Suggested alterations to the collaboration specifications
Problems in document naming	Distribute booklets for document naming conventions
Connection problems	Strengthen WLAN

SHORT TERM CE PERFORMANCE EVALUATION REPORT

XXXXXXXXXXXXXXXXXXX

ALTERATIONS TO COLLABORATION SOLUTION- SHORT TERM

Alteration category	Alteration to CE
4. Technology specifications	Use ArchiCAD for stairwell design
6. Training	Stress on the use of agreed document naming conventions

LONG TERM CE PERFORMANCE EVALUATION REPORT

XXXXXXXXXXXXXXXX

RECOMMENDATIONS FOR FUTURE CE IMPLEMENTATIONS- LONG TERM

Recommendation category	Recommendations for future CE
2. People/job specifications	Change the Document Controller responsibility, which was uploading documents to extranet, to controlling how documents are uploaded to the extranet in order to make sure that they reflect the agreed conventions.
1. Collaboration vision	Include the cases of information exchange of hardcopies, where working on electronic copies is not possible.
4. Technology specifications	Find an alternative redlining approach which can enable the use of whiteboards and pen devices.

Loughborough University

ICEMOCHA

Implementation of Collaboration Environments and Management of Organizational Changes (ICEMOCHA)

Evaluation Questionnaire for the Model and Prototype

BACKGROUND INFORMATION

Name:	
Job Title/Position:	
Experience in construction industry (years)	
Company Name& Address	
E-mail / Contact No:	

Please tick the box that best indicates your opinion to a question according to the rating system from 1 to 5. Larger score reflect more positive response.

RESPONSE RATING SYSTEM

1: Poor 2: Fair 3: Satisfactory 4: Good 5: Excellent

FRAMEWORK – OVERALL VIEW

1	How useful do you consider the overall ICEMOCHA framework?	① ② ③ ④ ⑤
2	How easy is it to follow the IDEF0 process models in ICEMOCHA?	① ② ③ ④ ⑤
3	To what extent can following the ICEMOCHA framework help parties in the construction project to implement collaboration environments?	① ② ③ ④ ⑤
4	How effectively can ICEMOCHA improve the overall success of collaboration across the construction project?	① ② ③ ④ ⑤
5	To what extent can ICEMOCHA improve the benefits obtained from the collaboration tools and technologies?	① ② ③ ④ ⑤
6	How effectively does the framework focus attention on the people and organizational issues in the planning and implementation of collaboration technologies?	① ② ③ ④ ⑤
7	How useful is it to have both a project organization level and an organizational level approach in ICEMOCHA?	① ② ③ ④ ⑤
8	How well does ICEMOCHA establish the link between project organization level with organizational level?	① ② ③ ④ ⑤
9	To what extent does ICEMOCHA have the potential to offer tangible benefits (such as time and cost reduction) to construction projects?	① ② ③ ④ ⑤

FRAMEWORK - PROJECT ORGANIZATION LEVEL

1	How useful is ICEMOCHA in enabling an agreement between project parties on "one common way of doing things" ?	① ② ③ ④ ⑤
2	How useful is ICEMOCHA in planning for the people aspect of the collaboration solution?	① ② ③ ④ ⑤
3	How useful is ICEMOCHA in planning for the data/workflow aspect of collaboration solution ?	① ② ③ ④ ⑤
4	How useful is ICEMOCHA in identifying the IT and collaboration tools to be used in the project?	① ② ③ ④ ⑤
5	How useful is ICEMOCHA in defining collaboration standards and procedures/ agreeing on common formats, types and conventions for information exchange?	① ② ③ ④ ⑤
6	To what extent can ICEMOCHA contribute to establishing trust between the parties?	① ② ③ ④ ⑤
7	To what extent can ICEMOCHA enable buy-in by all parties to the collaboration decisions?	① ② ③ ④ ⑤
8	How convinced are you that ICEMOCHA should be used at the project organizational level?	① ② ③ ④ ⑤
9	How would you rate the usefulness of ICEMOCHA in planning the implementation of collaboration environments?	① ② ③ ④ ⑤

FRAMEWORK - ORGANIZATIONAL LEVEL

1	To what extent do you believe that building a CCMT (collaboration change management team) is helpful in managing the organizational change?	① ② ③ ④ ⑤
2	To what extent can ICEMOCHA ensure top level commitment to organizational changes?	① ② ③ ④ ⑤
3	To what extent can the high level of user involvement in ICEMOCHA be ensured in construction projects?	① ② ③ ④ ⑤
4	How useful is ICEMOCHA in managing the employee resistance to change?	① ② ③ ④ ⑤
5	How well does ICEMOCHA encourage increased user involvement in change management?	① ② ③ ④ ⑤
6	How well can ICEMOCHA capture employee requirements and wishes?	① ② ③ ④ ⑤
7	How convinced are you that ICEMOCHA should be used at the organizational level for change management?	① ② ③ ④ ⑤
8	How would you rate the usefulness of ICEMOCHA in managing organizational changes?	① ② ③ ④ ⑤

FRAMEWORK- GENERAL COMMENTS

What do you consider the main benefits of ICEMOCHA?/ What do you particularly like about the framework?

What improvements can be made to the ICEMOCHA framework?

What are the barriers to the use of ICEMOCHA framework in construction projects?

Further comments

PROTOTYPE

1	How well does the prototype help to facilitate the implementation of ICEMOCHA?	① ② ③ ④ ⑤
2	How effective is the graphical user interface of the system?	① ② ③ ④ ⑤
3	How easy is it to navigate between different stages of the system?	① ② ③ ④ ⑤
4	How well does the prototype support decision making?	① ② ③ ④ ⑤
5	How useful is the prototype in documenting implementation processes and changes?	① ② ③ ④ ⑤
6	How effective is the reporting facility?	① ② ③ ④ ⑤
7	How convinced are you that the prototype should be used in construction projects?	① ② ③ ④ ⑤

What do you consider the main benefits of the prototype? / What do you particularly like about the prototype?

What improvements can be made to the prototype?

What are the barriers to the use of prototype in construction projects?

Further comments (if any)

APPENDIX 4

LIST OF PUBLICATIONS

- Erdogan, B., Anumba, C.J., Bouchlaghem, D., Nielsen, Y., (Accepted), 'Collaboration Environments for Construction: Implementation Case Studies', *ASCE Journal of Management in Engineering.*

- Erdogan, B., Anumba, C.J., Bouchlaghem, N.M., Nielsen, Y., (2006). 'Organizational Change Management for Collaborative Construction Environments', *In: Proceedings of Joint International Conference on Computing and Decision Making in Civil and Building Engineering*, 14-16 June 2006, Montreal, Canada, pp. 3186-3197.

- Erdogan, B., Anumba, C.J., Bouchlaghem, N.M., Nielsen, Y., (2005). 'Change Management in Construction: The Current Context', *In: Proceedings of the 21st Annual Conference of ARCOM*, 7-9 September 2005, London, UK, Volume 2, pp. 1085-1095.

- Shelbourn, M.A., Bouchlaghem, N.M., Koseoglu, O.O, Erdogan, B., (2005). 'Collaborative working and its effects on the AEC organisation', *In: CD, International conference on Computing in Civil Engineering*, 12-15 July 2005, Cancun, Mexico.