A VIRTUAL-COMMUNITY-CENTRIC MODEL FOR COORDINATION IN THE SOUTH AFRICAN PUBLIC SECTOR

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A VIRTUAL-COMMUNITY-CENTRIC MODEL FOR COORDINATION IN THE SOUTH AFRICAN PUBLIC SECTOR

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DECLARATION:

In accordance with Rule G4.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

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ABSTRACT

Organizations face challenges constantly owing to limited resources. As such, to take advantage of new opportunities and to mitigate possible risks they look for new ways to collaborate, by sharing knowledge and competencies. Coordination among partners is critical in order to achieve success. The segmented South African public sector is no different. Driven by the desire to ensure proper service delivery in this sector, various government bodies and service providers play different roles towards the attainment of common goals.

This is easier said than done, given the complexity of the distributed nature of the environment. Heterogeneity, autonomy, and the increasing need to collaborate provoke the need to develop an integrative and dynamic coordination support service system in the SA public sector. Thus, the research looks to theories/concepts and existing coordination practices to ground the process of development.

To inform the design of the proposed artefact the research employs an interdisciplinary approach championed by coordination theory to review coordination-related theories and concepts. The effort accounts for coordination constructs that characterize and transform the problem and solution spaces. Thus, requirements are explicit towards identifying coordination breakdowns and their resolution.

Furthermore, how coordination in a distributed environment is supported in practice is considered from a socio-technical perspective in an effort to account holistically for coordination support. Examining existing solutions identified shortcomings that, if addressed, can help to improve the solutions for coordination, which are often rigidly and narrowly defined. The research argues that introducing a mediating technological artefact conceived from a virtual community and service lenses can serve as a solution to the problem.

By adopting a design-science research paradigm, the research develops a model as a primary artefact to support coordination from a collaboration standpoint. The suggestions from theory and practice and the unique case requirement identified through a novel case analysis framework form the basis of the model design. The proposed model support operation calls for an architecture which employs a design pattern that divides a complex whole into smaller, simpler parts, with the aim of reducing the system complexity. Four fundamental functions of the supporting architecture are introduced and discussed as they would support the operation and activities of the proposed collaboration lifecycle model geared towards streamlining coordination in a distributed environment.

As part of the model development knowledge contributions are made in several ways. Firstly, an analytical instrument is presented that can be used by an enterprise architect or business analyst to study the coordination status quo of a collaborative activity in a distributed environment. Secondly, a lifecycle model is presented as meta-process model with activities that are geared towards streamlining the coordination of dynamic collaborative activities or projects. Thirdly, an architecture that will enable the technical virtual community-centric, context-aware environment that hosts the process-based operations is offered. Finally, the validation tool that represents the applied contribution to the research that promises possible adaptation for similar circumstances is presented. The artefacts contribute towards a design theory in IS research for the development and improvement of coordination support services in a distributed environment such as the South African public sector.

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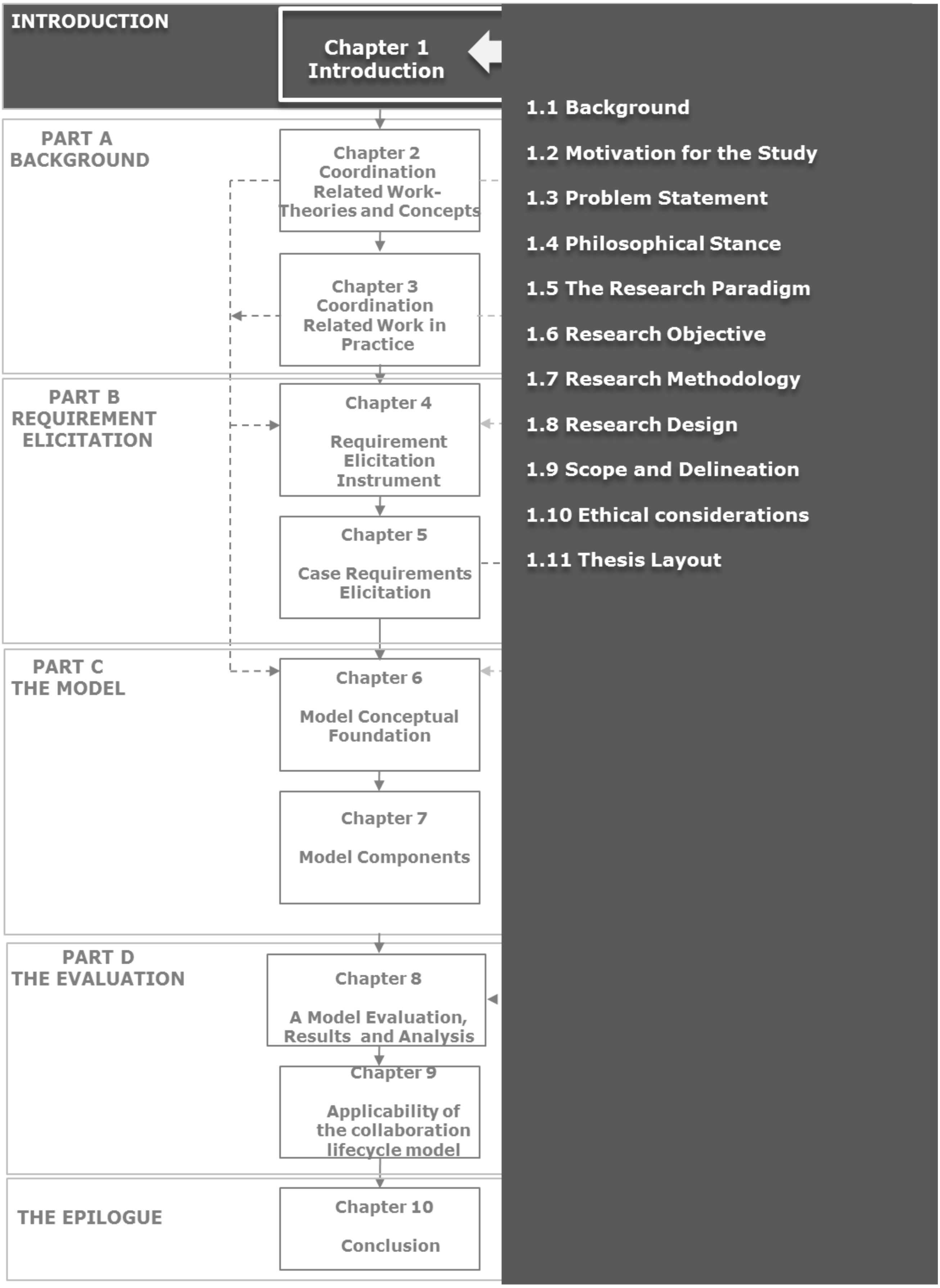
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CHAPTER 1
INTRODUCTION

This first chapter introduces the research topic briefly, beginning with the background to the research in Section 1.1. This is followed by the description of the problem and the rationale behind it in Section 1.2. Section 1.3 presents the problem statement and the thesis statement. Section 1.4 discusses the philosophical stance which motivates design science as a research paradigm in Section 1.5. The research objectives are revealed in Section 1.6. The research methodology is brought forward in Section 1.7, followed by the research design for the study in Section 1.8. The scope and delineation of the research is presented in Section 1.9. Section 1.10 covers the ethical considerations and the chapter ends with the layout of the thesis in Section 1.11.

1.1 Background

A 2010 State of the Public Service Report (SOPS) themed *Integration, Coordination and Effective Public Service Delivery* emphasised that integration and coordination are critical for effective collaboration and service delivery.

In 2001 a report on the state of the public service in South Africa acknowledged that coordination and cooperation among governmental agencies is a major challenge (PSC, 2001). Section 4.3 of the report, which highlights the *promotion of effective, economic and efficient use of resources* in terms of Section 195 (1) (b) of the Constitution, expressed concerns about coordination. Section 4.3 (p. 16) stated:

"*A key issue in this regard (Section 195(1) (b)) is the failure of different levels of government to coordinate planning and delivery. This leads in many instances to isolated and ineffective initiatives despite the provision of resources and various kinds of state-funded support"*

This need for coordination between various governmental agencies is further recognised in the strategic planning for local government. The National Capacity Building Framework (2008-2011) (NCBF) specifically introduced a programme area focused on building the capacity of individuals and institutions responsible for the coordination of municipal capacity building. The framework claims that (p. 25):

"*If municipal capacity is to continue to improve over the longer term, greater emphasis is needed on the coordination of the capacity building environment to avoid overlaps and to close gaps"*.

Avoiding overlaps brings efficiency, but requires coordination among participants. Closing gaps regarding critical resources, according to resource dependency theory, is essential to the survival of an organisation. The establishment of networks, partnerships, alliances and inter-organisational teams promises success (Mehandjiev et al., 2000; Keinänen, & Oinas-Kukkonen, 2001) but also requires coordination.

Cooperative work usually consists of many interdependent activities. For this reason, coordination among stakeholders is critical to avoid conflicting or repetitive actions. The South African public service is no different in that proper coordination among the various organisations charged with delivering public policy/services will prevent both redundancy and gaps in service delivery. This suggests that ensuring proper service delivery requires coordinated activities from cooperating organisations or stakeholders.

However, this is easier said than done. South Africa has a complex governmental structure involving a number of provinces, local governments and municipalities, each with different authority and responsibility (NCBF, 2008-2012). The three spheres of government are distinct. However, they are also interdependent as they work together towards a common governmental goal. All spheres of government therefore are required to observe the principles of cooperative government set out in Chapter Three of the Constitution, which includes coordination of activities to avoid duplication and waste (The Constitution of the Republic of South Africa, 1996).

What is required is an adhocracy: an informal structureless organizational form that is flexible, as opposed to the formal structures of bureaucracy, and can respond to change dynamically (Waterman, 1999; Mintzberg (1989, p. 198). In order to seize opportunities across bureaucratic boundaries, or to address problems it compels a sophisticated and automated technical systems to succeed (Travica, 1999), primarily owing to its many coordination needs (Waterman, 1999).

Coordination problems in adhocracies are more pronounced when participants are distributed across space and time, as is the case in the South African public sector. Technological solutions that supply a flexible platform for creating and managing dynamic collaborative structures would be constructive, optimal and valuable. Thus, this research deems that virtual communities are the logical initiation point to develop a system to coordinate work effectively within a distributed environment.

The complexity associated with the distributed nature of the environment, heterogeneity, autonomy and the increasing need to collaborate, engenders the need to develop a novel coordination support system for the South African public sector.

1.2 Motivation for the Study

Coordination in a distributed environment, as explained above, is generally a difficult endeavour (Hinds & McGrath 2006; Kiesler & Cummings 2002). The problem of coordination is formulated and synthesized from background literature and practice dealing with coordination breakdowns of a physically distributed workforce. Coordination is a multifaceted concept that consists of attributes with origins from various disciplines that range from human to machine (Baker & Millerrand, 2007; Malone & Crowston, 1994; Crowston et. al, 2006). The need for a technological support for coordination cannot be overemphasized especially if a workforce is physically dispersed as established in the previous section; thus, reflecting the need for an IS theory towards coordination support in a distributed environment.

The adoption of collaboration support technologies has been recognized as a complementary approach to coordinate work in conjunction with the explicit division of labour within a distributed environment. The support technologies as established in theory aid in facilitating the working together of teams over geographic distances, through the provision of tools that assist communication, coordination and problem solving processes. However, these tools are often limited as coordination practices are context specific and the expectations can change with rapid and continuous environmental changes and developments. Such complexity makes it difficult to have one solution that fits all. Thus, the need exists for a flexible solution capable of accommodating the dynamic coordination needs of a workforce that is distributed, but must work together to achieve a common objective. The need for such a solution is further emphasized in practice.

Drawing from the environment with specific interest in the capacity building training interventions process targeted at municipalities within the SA public sector, a coordination problem is identified. As made evident in the NCBF 2008-2012, 2013-16 reports, respectively and in the empirical findings in Appendix B, while efforts have been made to achieve problem-free coordination in the South African public sector, they have frequently fallen short of this state. The present state of multiple mechanisms, including information/knowledge sharing among role players and supporting tools for communication and processing (query, reasoning) is inadequate. The approaches are predominantly manual, with sporadic, limited and ineffective IT-based interventions.

The challenges associated with geographic dispersal of documents, their manual integration and the limited application support impact on coordination as there is limited overview regarding activities and resources. This results in conflict bookings and the overextension of staff, among other things. The challenge with the geographically dispersed documents, as well as the difficulty to aggregate and share this information impact on coordination as a lot of duplication and incoherence occurs. More so, possible opportunities to work together are hidden from various stakeholders with similar interests, among other things.

The purpose of this study is to propose a model to manage and promote sustainable coordination of collaborators in a heterogeneous and distributed environment. Tellioglu (2008) emphasized the need for a collaborative work environment that considers socio-technical factors together with a guide to support collaboration. This research argues that a virtual community perspective from a service lens can support such an endeavour.

1.3 Problem Statement

Coordination in the heterogeneously distributed South African public sector is complex. Role players within the sector are required to collaborate from time to time to take advantage of opportunities and to maximise resource utilization in a valuable way. However, the work pattern that emerges owing to the complexities associated with size, autonomy, structure, and geographical dispersal of role players provides unique coordination challenges. In essence, a lack of coordination and visibility would cause the ineffective use of resources through incoherence, fragmentation and the duplication of efforts. In addition, it makes collaboration, effective quality control and measurement of success a difficult, if not impossible task. It becomes clear that the problem cannot be managed effectively if it is done manually.

Therefore, the problem statement for this research is the fact that currently a model to support and promote sustainable coordination in the South African public sector is lacking.

The next section looks at the philosophical foundation of this research.

1.4 Philosophical Stance

A philosophical research stance refers to the perceptions, beliefs and assumptions of the researcher pertaining to the nature of reality and how knowledge regarding that reality is developed (TerreBlanche & Durrheim, 1999). The philosophical stance plays an important part in determining the course of the research, as it reflects the basic beliefs of the researcher about the world, with the research paradigms arising from these origins. Understanding the philosophies and beliefs of the researcher provides the frame for understanding the research objectives, which are highlighted in Section 1.7. It is my belief that applying a technological design to the problem can help to solve the problem and in the process to generate knowledge. Thus, I deem the approach worthy of further exploration.

Paradigms can be characterised through **ontological assumptions**, a world view; **epistemology**, knowledge and how it is acquired, and through **methodology**, how to go about finding out (Guba, 1990). Ash and Persall (2002) and Oates (2006, p. 282) define a paradigm as a set of shared assumptions, concepts, practices or ways of thinking about reality. It serves as a set of assumptions, research strategies and criteria for rigour, shared by a community of researchers (Fossey et al., 2002). Oates (2006) avers that a wide variety of philosophical paradigms exist, resulting from different ideas, views and perspectives of the world. There are three traditional research paradigms, viz. the positivist, the interpretive and the critical.

The **positivistic paradigm** underlines the 'scientific method': studying aspects of natural sciences, based on scientific observation and empirical inquiry, which deal with facts rather than with values (Gray, 2004, p. 18; Lee, 1999). Positivists normally employ a quantitative research method, which can take the form of experiments or hypothesis testing that requires the researcher to be an impartial observer, neutral and objective (Cresswell, 2003; Hoepfl, 1997; TerreBlanche & Durrheim, 2006; Vaishnavi & Kuechler, 2004).

The **interpretive** or phenomenological paradigm partly embraced in this research *"is aimed at understanding human behaviour from a participant's own subjective frame of reference"* (Collis & Hussey, 2003, p.53). Contrasting with the position of the positivists, the interpretive researcher typically interacts with research participants, aiming at better understanding the study context, (Roode, 2009; Vaishnavi & Kuechler, 2004).

Critical research, similar in some ways to the constructionist research, which assumes that reality, is socially constructed and that the construct thereof by an individual is influenced by societal norms (Creswell, 2009; TerreBlanche & Durrheim, 1999). Collis and Hussey (2003, p. 51) assert that it is difficult to separate these research paradigms completely, because, as theoretical perspectives change, one paradigm can include qualities of another. This research subscribes to one such paradigm as design science research which has become prominent in IS research (Hevner et al., 2004; Vaishnavi & Kuechler, 2004).

Design Science represents a problem-solving paradigm, which involves building and evaluating innovative artefacts in a rigorous manner to solve complex, real world problems, making research contributions that extend beyond the boundaries of what is already known, and communicating the results to appropriate audiences (Adomavicius et al., 2008; Gregor & Jones, 2007; Hevner et al., 2004; March & Smith, 1995; March & Storey, 2008; Pries-Heje & Baskerville, 2008; Vaishnavi & Kuechler, 2005; Venable, 2006). Knowledge and understanding of the problem domain is achieved through artefact construction (Hevner et al., 2004), which must have novelty and utility in the application environment (Hevner & Chatterjee, 2010; March & Storey, 2008; Simon, 1996). As behavioural science research paradigms fall short in addressing the requirement of human creativity and innovative solutions - 'wicked problems' (Hevner & Chatterjee, 2010; Peffers et al, 2007) design science comes into play as a popular and accepted paradigm within the IS field of research (Carcary, 2011).

Since the intention of the research is to resolve a problem, and extends beyond mere understanding, the approach providing the most precise philosophical description of this research is design science.

1.5 The Research Paradigm

The problem addressed in this research is a classic design science archetype: it is a real-world problem which has unstable requirements, and it consists of complex interactions between elements of the problem and solution domain (Hevner et al., 2004). Research in design science is concerned with theory for action (Gregor, 2006). It describes an approach that builds and evaluates novel artefacts in a rigorous manner to solve intricate real world problems (Carcary, 2011).

According to March and Smith (1995), design science is technology-oriented and it attempts to create things that serve varying human purposes. Hevner et al., (2004) explain this statement by saying that design science seeks a solution to a real-world problem of interest to practice. According to Simon (1996, p. 119) if an optimal solution cannot be found it should at least suffice. The design-science paradigm seeks to extend the boundaries of human and organisational capabilities by creating new and innovative artefacts (Hevner, et al., 2004). They maintain that knowledge and the understanding of a problem domain and its solution are achieved in the building and application of the designed artefact. To this end, they proposed seven guidelines to follow in design-science research. This research will adhere to these guidelines presented in an effort to meet the design-science principles. Furthermore, in an attempt to theorise and conceptualise the IT artefact this research looks to some propositions by Orlikowski and Iacono (2001) and to other supporting literature (Carlsson et al., 2011; Venable, 2006) for guidance.

As stated by Hevner et al. (2004), "research must address the problems faced and the opportunities afforded by the intersection of people, organisations, and information technology". The statement stands true for this study as cooperative systems have been defined as "a combination of people, technology and organisations that facilitates the communication and coordination necessary for a group to effectively work together in pursuit of a shared goal, and to achieve gain for all its members (Garrido et al., 2005)."

A socio-technical view focused on the interdependencies between and among people, technology, and the environment towards a self-regulating system capable of meeting environmental demands, is necessary. At the same time it must be resilient to external disturbances and responsive to change. As such, the research looks to providing an IS that is inclusive, more flexible, adaptive, and closely integrated with the needs of the cooperating organisations in a distributed environment.

As noted by Venable, (2006) in line with March and Smith (1995) the type of knowledge produced by design science is reflected in the form of constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), instantiations (implemented and prototype systems) and better theories. Therefore, the first design science guideline by Hevner et al., (2004), suggests producing a viable artefact in any or a combination of the forms listed. Furthermore, Venable notes that design science should produce guidelines or recommendations for practitioners that are clear and comprehensive enough to guide the actions of a practitioner. In addition, the knowledge created should be presented in such a way that it can be tested and enhanced by other researchers. According to Hrastinski et al. (2008), IS design science studies should develop realistic and practical design knowledge to be used in solving various IS problems. This implies theoretically developing knowledge that can be used to design and implement IS projects or initiatives.

The primary artefact to be produced by this research is a two-part model (an architectural and a collaboration lifecycle model). This is in an effort to create better theories and frameworks for coordination support in a distributed environment. The objective of this study is conveyed in the next section.

1.6 Research Objective

As mentioned above, South Africa has a fairly complex public sector when considered in terms of its size, the governmental structure and its geographic dispersal. Thus, the complexity introduces coordination challenges.

The main objective of the research is to design a model (an IT artefact) to mitigate coordination problems in the South African public sector.

The objective results in the following primary question that needs to be addressed.

What functionality should characterise the proposed IT artefact exhibit to meet the coordination requirement of the South Africa public sector?

In order to meet the main objective and to answer the primary question the next section motivates the sub-objectives that must be met.

Three main sub-objectives are emphasised to achieve the main objective and to answer the primary question. Each sub-objective consists of questions that form the basis for the chapters in their associated parts.

1. Sub-Objective 1 (Part A)

What are the known constructs that characterise and transform the problem and solution spaces?

Identify the problem and solution constructs that characterise coordination in a distributed environment.

Q1. What can be learnt from theories and concepts related to coordination?

Identify existing theories and concepts that characterise coordination in a distributed environment.

Q2. How is coordination in a distributed environment supported in practice?

Identify existing coordination solution practices and their limitations in a distributed environment.

2. Sub-Objective 2 (Part B)

What are the requirements for coordination in the South African public sector?

Determine what is required to support coordination in the South African public sector.

Q3. What are the contextual factors that must be considered to help evaluate the state of coordination?

Identify the constituents of a framework that can influence coordination in the South African public sector.

Q4. What is the status quo of coordination in the South African public service?

Identify existing coordination mechanisms and practices employed in the South African public service, and their limitations.

3. Sub-Objective 3 (Part C)

What are the IS elements/constructs that characterise the solution space and how can they be weaved together to support coordination in the South African public sector?

Construct the model artefact that can support coordination in the South African public sector.

Q5. What are the IS components necessary to support coordination and how will they function together in the solution domain?

Define model components and their function and show the interplay between the constructs of the solution.

Q6. What are the service capabilities of model components that need to be considered when addressing the problem of coordination in a distributed environment?

Define the capabilities of the model.

To account effectively for the above-mentioned sub-objectives, the next section discussion the research methodology employed.

1.7 Research Methodology

Thorough, comprehensive and useable research requires a systematic and rigorous approach to the design and implementation of the study, the collection and analysis of data, and the interpretation and reporting of findings (Fossey, 2002). Therefore, this section discusses what characterizes the overall research process employed. The process is characterized by a qualitative approach, a case study method and the design science research process followed. The research approach employed is discussed next.

1.7.1 Qualitative approach

To gain an in-depth understanding of the application domain, towards building better theories a qualitative approach is employed, using a single case study. In order to understand the complexity of coordination within the environment the researcher employs an interpretivist qualitative approach, affording a descriptive and explanatory power to understand and to analyse the problem domain. Creswell (2012) describes qualitative research as representing a means of knowledge acquisition, which investigates and understands how individuals or the community resolve the problems they encounter. The approach is frequently exploratory, with the objective of gaining insightful understanding into a complex situation through observing participants in their work environment. The researcher plays a key role in collecting data, either by utilising a collection tool or through interactions with subjects, to help understand and explain the phenomena under scrutiny. To do so the single case study is employed to gain the deep understanding that is required.

1.7.2 Case study method

To provide an in-depth understanding of why the circumstances and status quo exist, along with the causes of such occurrences in the situation under investigation, a single case study is employed. A case study, as a strategy, supports a comprehensive evaluation of real life occurrences within a specific context, which may reveal hidden evidence (Yin, 2008; Oates, 2006). The requirement for the case study research strategy results from the complexity of the phenomenon under investigation as it cannot be comprehended or viewed in isolation from its environment (Alqatawna et al., 2009). Yin (2008) considers that case studies are best suited for answering 'how' or 'why' questions about *"a contemporary set of events, over which the investigator has little or no control"*; which explains the adoption of this approach for this study. Customarily, findings from case studies are useful in generating hypotheses from which generalisations for providing solutions to similar circumstances may be inferred (Hofstee, 2006). Thus, the strategy involves choosing a representative sample of the situation under investigation. The selected case should have a significant resemblance to a particular population, family or institution to which it belongs. In this thesis the South African public sector exemplifies the distributed environment intended for examination.

In order to construct a holistic and rich picture it is the belief of this research that a single case study is an appropriate strategy for understanding the coordination problem. The research argues that the South African public sector represents a suitable archetype of a distributed environment. The selection of the SA public sector, as an example of a distributed environment, leads to the single case study with multiple analysis points.

1.7.3 The design science research process

A researcher can attempt to achieve rigour through adherence to the research process of design science (March & Storey 2008; Vaishnavi & Kuechler 2007; Peffers et al., 2007). Thus, the design science research process is employed to aid in addressing the problem of coordination in the SA public sector. The paradigm consists of two fundamental actions, namely build and evaluate. Essentially, the building constructs an artefact to address a problem and the evaluation measures how well it performs. These two activities usually follow a set process, referred to as the "general design cycle" (Vaishnavi & Kuechler Jr., 2008, p. 12) which forms the basis of the research process followed in the thesis.

A typical design science research process is initiated with an awareness of the problem which, relative to this study, is grounded in practice and supported by existing literature. After identifying the problem, the existing knowledge base of the related scientific community was reviewed to determine whether an adequate solution exists to resolve the problem; however, drawing from the knowledge discovered an idea was formed for resolving the issue. The following phase of the process involves development, where suggestions lead to the implementation of a new artefact to address the problem. To ensure scientific rigour and practical relevance, the artefact must be evaluated; this incorporates the assessment of the evolution of the artefact, where the artefact is studied and variations from expectations are explained.

The research process employed in this research consists of four primary components. Figure 1.1 depicts the manner in which the steps, as discussed, are employed in the current study. Fundamentally, the research employs a qualitative approach, utilising a single case study, and is executed in accordance with the steps demarcated in Figure 1.2 This commences with understanding the problem and solution domains; succeeded by understanding the environment to ascertain the requirements, build and evaluate the model, all communicated appropriately when warranted. The next section discusses the research design steps.

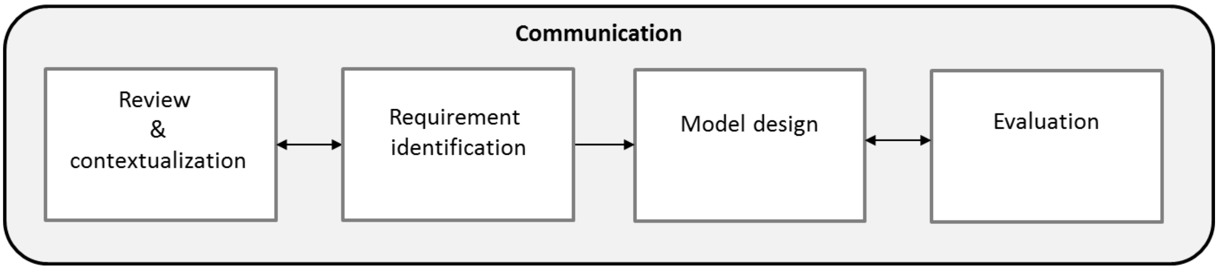


Figure 1.1: The Research Process

1.8 Research Design

Leedy and Ormrod, (2001) define a research process as a systematic process of collecting and analysing information, with the objective of increasing the understanding of the phenomenon under investigation, in order to create and implement a solution. Therefore, this section will look at the detail of the process. The research design presents a detailed overview of the research process. This research process is depicted graphically in Figure 1.3. Note that it consists of four phases, as introduced in Figure 1.2.

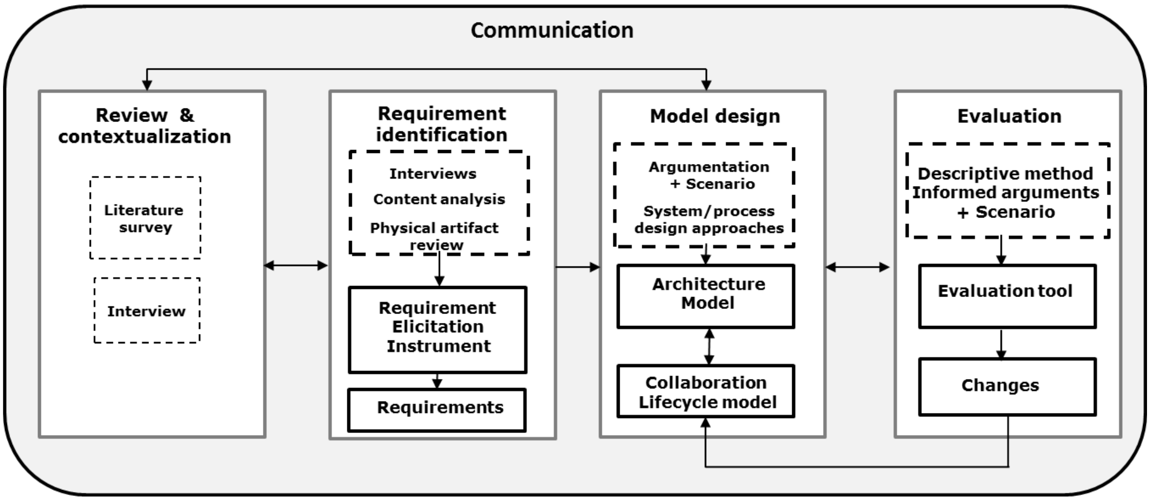


Figure 1.2: Detailed Research Process

Each of those phases consists of a number of steps that need to happen. The next sub-sections will discuss each of these steps in the context of the phase where it is to be found. It commences by discussing the review and contextualisation phase of the process.

Phase 1: Review and Contextualisation

Phase 1 initiates the review, along with the contextualisation of both the problem and solution domains. As in any research undertaking, understanding the problem is essential and the design science approach employed in this investigation is grounded in existing knowledge. To attain the most practical, complete and suitable solution there is a need for an extensive literature study.

More so, to provide further insight into the problem area and to characterize the solution requirements adequately an interview with the relevant stakeholders in the environment is conducted. As put forward by Hevner et al., (2004) business needs constitute goals, tasks, opportunities and problems as defined by people within a given environment. As such, a take on the view of the stakeholders is important for the contextualization of both problems and possible solutions.

Phase 2: Requirements Identification

The second phase, the requirements identification phase, concerns the relevance of the research, through understanding the environment. The research relevance is guided by the coordination problems experienced by the South African public service. An elicitation instrument, designed by the researcher, is utilised to deduce the requirements. Therefore, this phase concerns the production of a requirement elicitation instrument, based on lessons learnt from theory and practice, to substantiate the resolution and ideas inferred. This entails the instrument serving as the basis for identifying the requirement that a solution model must fulfil.

The outputs from this phase are the synthesized factors that may influence coordination moulded as a descriptive artefact for requirement elicitation. The factors and identified requirements serve as the foundational components that are required for the design and development of the desired artefact, the coordination support model.

The data collection methods, as depicted in Figure 1.3, include interviews, documentation, observations and the review of the physical artefact (Yin, 2009; Alqatawna et al., 2009).

Phase 3: Model Building

In Phase 3 this researcher considers and utilises the background, grounded in both relevance and rigour (theory and practice), to create a model. This activity includes determining the desired functionality of the artefact, anchored by the requirements deduced and identified in the previous phase, subsequently creating the actual artefact. Thus, the objective of Phase 3 is to contextualize the suggested requirements in order to propose a conceptual model for coordination support. This phase develops a two-part model, viz. the architecture and a lifecycle model, synthesised through argumentation. Lapakko (2009) and Walton (2009) define argumentation as an inductive process based on research strategy, which directs the construction of convincing conclusions, founded on assertions arising from reasoned discourse.

The design approach employs the classic hierarchical design and business process design methodologies (Alfaris, et al., 2010; Balaji & Murugaiyan, 2012). The hierarchical design pattern advocates multilevel abstractions and designs from which system parts can be considered through decomposition and assembly. The bottom-up and top-down approach employed, referred to as Meet-in-the-middle Methodology (Gajski et al, 2009) is guided by the set objective specifications to define the abstraction levels of the model components. Essentially, it employs the modularization principle, which advocates the separation of concerns where functions are separated into distinct parts enabling a complex whole to be divided into smaller and simpler parts, in order to help manage the complexity of a system. These self-contained parts can stand alone or can be intuitively and logically joined together to address a problem (Gittel et al., 2008). Section 2.3.7 further elaborates on the modularization principle.

The interaction between logical components is premised on causality relations, a concept that reflects cause and effect. The technique employed identifies input and output relations to create a graphical representation. More so, the design exploits and leverages both the linear-sequential and responsive process approaches as experienced in waterfall and agile process design methodologies, respectively to create a lifecycle model capable of meeting the unique environmental needs.

Phase 4: Evaluation

The developed model has to be evaluated, to assess whether the proposed artefact meets the needs of the environment. Phase 4, *evaluation,* outlines the procedures for evaluating and refining the model.

In addition to utilising argumentation arising from the knowledge base, a domain expert review was realised, through the aid of a scenario, as a validation tool to assess the applicability and usefulness of the model. The review exercise consisted of feedback from publications, the domain experts, through interviews conducted by the researcher, to demonstrate the efficacy of the artefact in addressing the problem. The experts assessed the relevance of the suggested components, as well as the utility and practicality of the solution model.

The two evaluation stages employed in this research include the formative internal assessment of the artefact, to refine the design during the iterative build process and the summative external testing of the artefact in its application environment (Hevner, 2007).

Also, an evaluation of the research should be done according to design science principles. Hevner et al., (2004) established seven requirements for design science research:

1) **Design as an artefact**: the research output should be a purposeful artefact, which addresses a significant problem.
2) **Problem relevance**: the problem should be relevant in the research community.
3) **Design evaluation**: the functionality, completeness and practicality of the research output should be demonstrated.
4) **Research contributions**: effective research must provide clear contributions in the research area.
5) **Research rigour**: rigorous methods should be applied, in both the construction and evaluation of the research output.
6) **Design as a search process**: an iterative search process should be utilised.
7) **Communication of research**: research should be presented to a wide audience.

Phase 5: Communication

Phase 5 spans all the proposed stages, encompassing the communication of every aspect of the research process by the researcher. Essentially, it explains the implications for academia, management and practice. The model is communicated to the subject domain and to academic experts, for their evaluation. Publication of ideas and results may be made at each stage of the design cycle. The current undertaking of the researcher in this discourse is the communication of the process and solution, with the end results articulated and consolidated into a thesis towards contribution to the knowledge base and application in practice. The model is presented to experts in the academic audience through publication. Furthermore, the model is revealed to subject domain experts, in order for them to determine its usefulness and applicability, through relating it to its application in real or actual situations. As stated, this phase features throughout the course of this study, with communication, at different stages, of the problem and its relevance, the artefact, its utility and novelty, the rigour of its design, and its effectiveness to researchers and practitioners. The communication is explicated in the writing of the thesis, other scholarly publications and the validation tools employed throughout the course of the research.

1.9 Scope and Delineation

This research focuses on coordination in relation to a distributed environment, specifically the South African public sector. To study the problem of coordination, towards addressing it, the study focuses on work that is of a collaborative nature involving more than one person. In other words, it takes a closer look at articulation work which represents any work that enables other work towards attaining some common objective, in this case the capacity building interventions. The research draws on empirical study of the public sector and the literature on coordination. The single case study is considered to get comprehensive knowledge and understanding of the phenomenon under study.

In addition to existing multidisciplinary coordination related theories the research also draws on the fields of CSCW, ubiquitous computing and service science. CSCW provides an overview of existing practices with technological support aimed to support collaborative activity, understand cooperative work arrangements and streamline coordination. Ubiquitous and distributed computing teaches us about context and personalization, two important concepts for the solution domain. The service science provides a lens through which the coordination problem can be further understood and managed while taking cognizance of possible influencing factors (Alter 2008, Ng & Maull, 2009; Spohrer et al; 2008; Stroulia, 2007). Thus, the two sides are considered: service in the business context to enable understanding of the problem, and service in the software-engineering context, which provides a lens towards a solution.

A pronounced practical use of the model is beyond the scope of this study, owing to time and resource limitations. The application in a live environment is time consuming, since it requires implementation of all the components of the model and corresponding architecture in order to demonstrate its applicability, and to get feedback for its maintenance. However, an attempt is employed to determine the validity and applicability of the model without actual implementation through a scenario. Thus, domain experts are presented with a scenario that mimics the use cases of the model and asked to comment on their perception of the applicability and usefulness of the models. The comments obtained from the experts are used as feedback to substantiate and refine the model.

1.10 Ethical considerations

Adding to the rigour of the research process ethical values were accounted for. These values were upheld in the dealings with research participants and stakeholders. The aims of the research were clearly communicated to the participants. The participants voluntarily consented to participate in the research. They were informed of their rights to privacy, and of the fact that their data would be presented anonymously. The participants in this study were asked to sign an informed consent form before the interviews were conducted, as shown in Appendix A1. None of the participants involved in the research belonged to any category that required special ethical considerations; therefore no ethical clearance was required for the study. The data that was collected was solely used for the purpose of the research. More so, academic integrity was observed throughout the research process in acknowledging the contributions of other people and reporting adverse findings.

1.11 Thesis Layout

This thesis consists of four parts with each, in turn, consisting of a number of chapters. Figure 1.4 provides a graphical depiction of the layout of the thesis. The current chapter, Chapter 1, provides an introduction to the research problem. **Part A** introduces the domain of discourse. In doing so, existing work in the domain of discourse is discussed. In essence, this part provides the background that is essential in understanding coordination, and the eventual formulation of the model. In **Chapter 2** the reader is introduced to coordination, relative to existing theories and concepts. In particular, the problem and solution constructs are identified and discussed. **Chapter 3** discusses coordination research relating to practice, during which favoured features for coordination support are identified

Part B is dedicated to identifying the requirements in the environment, as input towards model design. **Chapter 4** designs the requirement elicitation instrument and **Chapter 5** applies the instrument in a case study towards the requirement extraction.

Part C, which is dedicated to the development of the proposed model, commences by providing the conceptual foundation from which the model development originates. It originates with **Chapter 6,** which presents a conceptual overview of the proposed model, and the supporting architecture while briefly introducing their activities and components respectively. This is then followed by a detailed discussion of the components in **Chapter 7**, expounding on the various functions and services within the model and architecture.

Part D is dedicated to the evaluation of the proposed model and associated services. **Chapter 8** describes and reports on the result of the process followed in order to evaluate the applicability, functionality and usefulness of the proposed coordination support model. **Chapter 9** verifies the potential for practical use of the proposed model in real-life circumstances and maps the said action to the architecture components. **Chapter 10** concludes the thesis, reflecting on the research and showing the extensibility of the model. The chapter summarises the research and evaluates it to determine whether the objectives have been achieved, augmented by a discourse on ideas for further research.

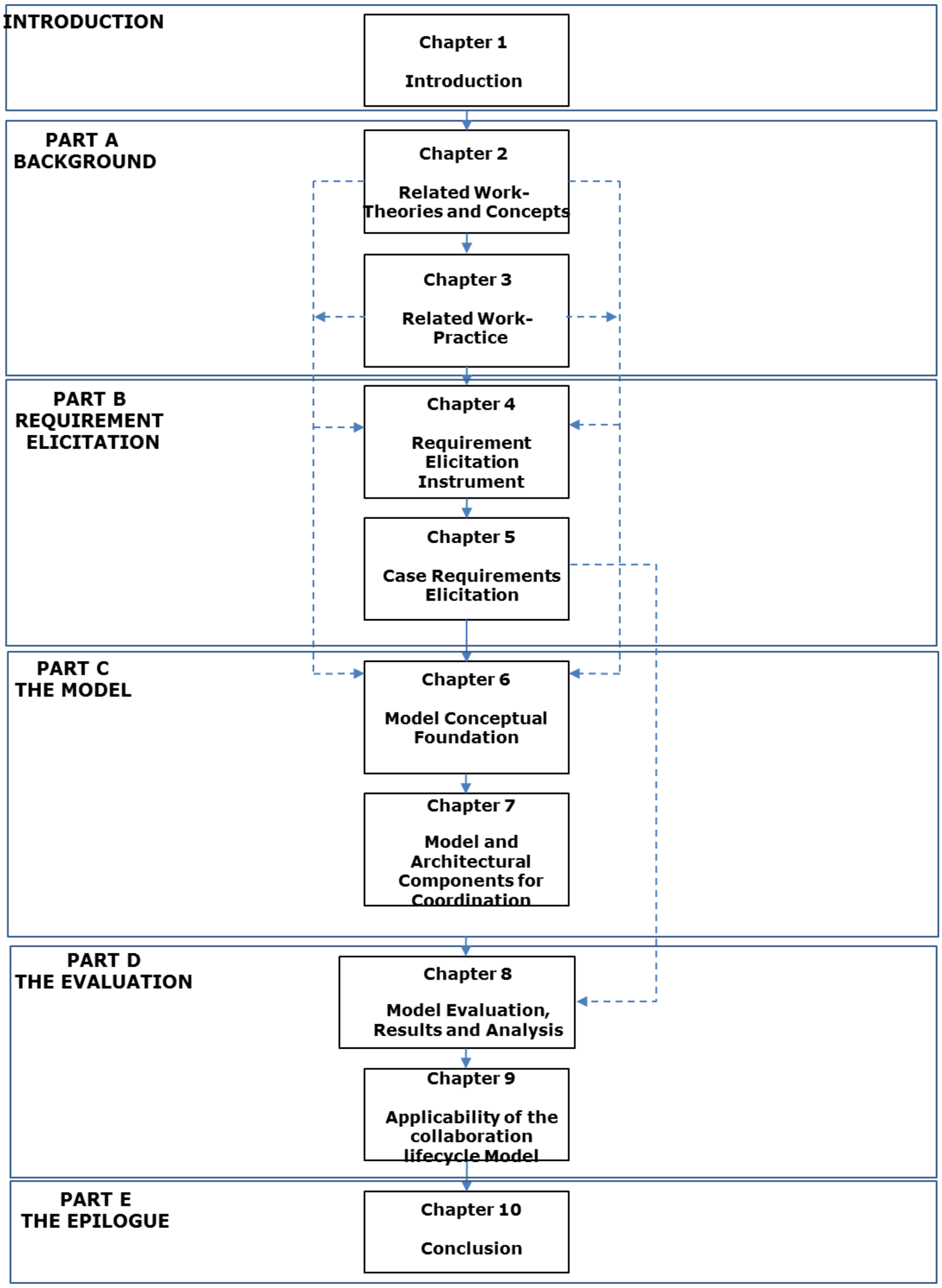
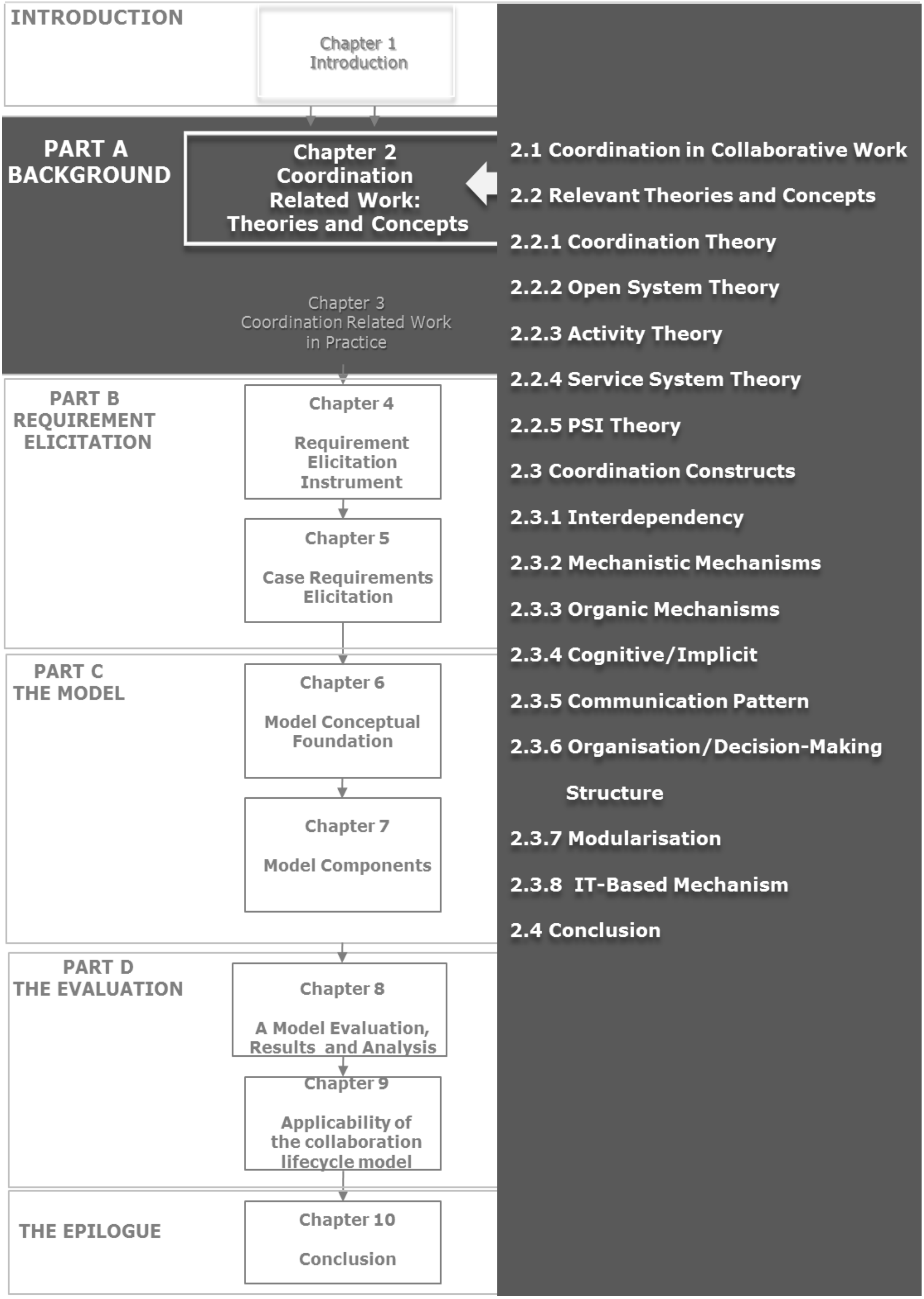


Figure 1.3: Layout of Thesis

PART A

Given that design science research should be grounded in an existing knowledge-base, Part A of this study focuses on reviewing existing knowledge that reflects the domains of both the problem and the solution. Part A contributes to the research rigour by that ensuring previous research is considered. The knowledge base suggests theory and practice in order to address the research problem. By conducting a systematic literature review Part A make sense of the body of literature that concerns coordination in a distributed environment. This provides the basis to answer the question: *What are the known coordination constructs that can characterise and transform the problem and solution spaces?*

The answer is divided into two chapters. **Chapter 2** reviews the relevant theories and concepts in terms of how they characterise coordination and how they apply in a distributed environment, while **Chapter 3** reviews the existing socio-technical practices employed to alleviate the coordination problem in the distributed environment.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CHAPTER 2
COORDINATION-RELATED WORK: THEORIES AND CONCEPTS

This chapter presents an overview of the literature relevant to realising coordination in a distributed environment. The primary question addressed in this chapter is "What can be learnt from theories and concepts about coordination in a distributed environment?" Fundamentally, the constructs relevant to understanding coordination breakdowns is identified and discussed. In order to assist in determining how coordination challenges can be addressed, the chapter discourse extracts lessons from the coordination-related literature that emphasise how organisations can manage and resolve coordination breakdowns. In addition, the organisational conditions and configurations that may limit or enhance coordination in a distributed environment are highlighted; while the role of coordination mechanisms are indicated, and cognisance is taken of the essential requirements for computer-supported coordination mechanisms.

In order to clarify, characterise and account for coordination in a distributed environment adequately, the discussion is framed in terms of coordination theory. Coordination theory presents an interdisciplinary approach to analyse coordination. The analytical literature review is consequently framed around the basic constructs presented by coordination theory. These constructs aid in defining the themes of discussion, to review the identified theories and concepts. During the course of this discussion the requirements identified for understanding coordination breakdowns and their subsequent management is made explicit

The chapter begins with a review of what coordination in collaborative work means, relative to the study. This is followed by a review of the identified theories and concepts, highlighting their capabilities and focus. Next, the lessons learnt from the theories and concepts are emphasised in terms of the identified coordination constructs. The chapter commences with an exploration of the significance and meaning of coordination in collaborative work.

2.1 Coordination in Collaborative Work

Several authors have described and defined coordination (Malone & Crowston, 1994; Weigand, Van der Poll & de Moor, 2003; 1967; Singh & Rein, 1992; Holt, 1988). These definitions reflect that within a collaborative work there are many activities working towards a common goal and interdependencies exist between these activities that must be managed. For instance, Malone and Crowston (1994) define coordination as the act of managing interdependencies between activities performed towards achieving a goal. Collaborative work therefore denotes the management of interdependencies towards attaining a specific common objective.

From a more holistic perspective, with aim to promote sustainability, the idea of coordination emphasised in this study encapsulates all aspects of articulation work as realised in CSCW. This takes cognisance of factors that can influence the coordination outcome. Articulation work is referred to as the additional effort required in obtaining the actual collaboration from the sum of individual tasks. In articulation work, certain tasks are accomplished initially, and rarely require alteration, while others are dynamic and are subject to constant re-negotiation. Coordination represents the dynamic aspect of articulation work, which constantly demands renegotiation to align actions during a collaborative effort. Other activities of articulation work include the identification of the objectives of the group work; the mapping of these objectives into tasks; the selection of participants, in conjunction with the distribution of tasks among the participants; and the eventual coordination of the execution of the tasks. By focusing on the execution of goal-oriented tasks, users with overlapping task structures are able to exploit opportunities for coordination with each other. Thus, coordination is referred to as a process of articulating work and managing interdependencies to support and sustain collaborative work. To adequately negotiate agreements over collaboration and coordination of activities, it is imperative to gain insight and awareness into the actions and accomplishments of the other participants.

Collaboration allows groups with limited resources to work together more effectively. As organisations often have limited resources and are constantly faced with a dynamic and unstable environment, collaboration allows the pursuit of shared goals and the addressing of common concerns to a mutually beneficial end. It is vital, however, to stress the need to coordinate actions towards a successful collaborative effort. This connotes that a principal aspect of collaborative work is the notion of interdependency, which has to be effectively managed.

As organisations combine to take advantage of opportunities, solve problems or produce goods and services (Dyer & Singh, 1998; Gulati et al., 2000) they create interdependency. This is generated as a result of cooperation, out of which negotiations and subsequent agreements emerge between the collaborators. Therefore, in order to attain the desired objective(s), collaborators must coordinate their tasks and actions to avoid conflicts or repetitive tasks. To align actions collaborators often depend on coordination mechanisms such as communication, information sharing, and standardisation of assets. In order to work harmoniously, individuals and their interdependent activities must be well-coordinated (Gerson & Star, 1986; Strauss, 1994). Although the coordination of interdependencies between tasks in a collaborative environment is crucial, it is not easily achievable. Usually the coordination problem is inherently distributed as there are multiple participants involved. The complexity of the situation is defined by the number of participants involved; the distance between participants (co-located or geographically distributed); and the autonomy of participants (Gerson & Star, 1986; Schmidt, 1998).

In situations of low complexity, where there are few people involved, who are, for instance, co-located, collaborative work activities may be coordinated within the regular range of day-to-day modes of social life interaction. In certain instances these modes of coordination are sufficient to manage cooperative work effectively and efficiently. Collaborative work participants in a co-located environment can implicitly monitor each other as they perform their activities, in a manner in which the awareness and understanding of the work of a co-worker is supported. This allows contributors to take each other's previous, present and future activities into account when planning and conducting their own work. Essentially, the role-players talk, write and gesture among themselves, allowing a seamless and dynamic complementary interconnecting of these modes of interaction (Schmidt, 1998).

The achievement of effective cooperation and collaboration is, however, far more difficult when multiple actors are involved; are geographically distributed and are engaged in a variety of interdependent activities. This introduces a new level of complexity wherein everyday social and communication skills become insufficient. This is exacerbated if the entire coordination process is left to the users to manage exclusively, by whatever *ad-hoc* means will work (Holt, 1985). Principally, when dealing with greater complexity, relative to coordination in a heterogeneous and distributed environment, there is a necessity for other coordination artefacts.

Raposo, et al., (2001) assert that a significant challenge in proposing coordination mechanisms to control collaborative activities is accounting for the flexibility demanded by the dynamic interactive nature of the partners. These authors contend that by clearly separating coordination activities from the coordinated work such flexibility can be achieved. This infers that by separating the actual work aimed at goal achievement and the work aimed at coordination, policies may be altered, adjusted and aligned for certain interdependencies, without affecting the core of the entire collaborative system.

In order to account for the complexities of coordination in a distributed environment the research has explored and reviewed existing theories and concepts. These diverse and varied theories and concepts arose with the aim of providing insight into the potential coordination issues which may occur at different levels of granularity. To describe the fundamental tenets and bases of organisation and to identify the requirements towards the development of suitable solutions the subsequent section, based on existing frameworks, points towards potential resolutions.

A consideration of the existing theories and concepts on coordination reveals that several perspectives on coordination, arising from various disciplines, exist, with no specific one providing a complete overview of coordination. The existing frameworks that have emerged typically focus on a limited number of defining features. As multiple authors, including Mintzberg (1998), Marlone and Cawston (1999) as well as Sposito (2000), suggest, it is necessary to observe the issue from the perspective of manifold dimensions to understand the complexity of the modern organisation fully. To assess all the requisite elements adequately, this chapter therefore reviews and examines previous work generated from an assortment of disciplines, in order to gain insight into and an understanding of possible coordination breakdowns, together with how to resolve them.

Moreover, to appraise the coordination possibilities from these diverse perspectives, Section 2.3 encompasses a discussion regarding the construct provided by coordination theory (CT). CT as an interdisciplinary model provides a structure which assists in categorising and summarising the constructs, lessons and ideas generated by the theories and concepts considered within this chapter. Coordination management constructs are discussed in the analytical literature review, making explicit the conditions and configurations which may limit or enhance coordination in a distributed environment. The following section reveals the relevant theories and concepts, with emphasis on their analytical focus.

2.2 Relevant Theories and Concepts

This section accounts for the theories and concepts pertinent to understanding and improving coordination within a distributed environment. The guiding principles for the selection of relevant theories and concepts relates to interdisciplinary coverage, their acknowledgment of dependencies, contradictions, conflict, and the unavoidable need for coordination in the functioning of any system. Consideration of the relationship between elements, subsystems and the environment, which continually strive to stay in balance, indicate a useful starting point for analysis.

The theories and concepts reviewed are considered reasonable and credible for the study of coordination, as they reveal important constructs and propositions at various levels of granularity. The review investigates and compares their analytical capabilities as they deal with coordination breakdowns, revealing their strengths and weaknesses. The evaluation examines the similarities between the theories and concepts, relative to the constructs they present and how, occasionally, they validate each other. Their differences, on the other hand, may be regarded as complementary. Furthermore, different levels of abstractions are explained, in that some are more elaborate than others, and sometimes differ slightly with regard to their representation and meaning of constructs. The theories and concepts reviewed include: Coordination Theory, Open System Theory, Activity Theory, the Service System Suites, and PSI Theory. Their focus areas are depicted in Table 2.1.

Table 2.1: Theory and Concepts Analytical Focus

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
Analytical Focus	Business process	Global environmental landscape Inter-organisational relation	Group work activity and networking + contextual factors	Holistic Work system /Inter-organisational Relation + Environmental factors	Individual transaction to Business process

Owing to the lack of a single theoretical framework that can account exclusively for coordination in a heterogonous distributed environment, it is deemed in this study that these theories and concepts can provide useful insights. The following subsection commences with an exposition of coordination theory.

2.2.1 Coordination Theory

Coordination theory provides a generalised representation which may be used to capture and re-design a wide array of processes, or business processes. Malone and Crawston (1994) introduced the term *coordination theory* as a body of principles relating to how activities can be coordinated; and provided a theoretical framework for analysing coordination in complex processes. These experts contend that the coordination problems encountered in a variety of disciplines arise from dependencies. Crowston, Rubleske and Howison (2004) assert that a central issue in the analysis of group works relates to the understanding of the dependencies between the tasks undertaken by the different participants and how they are coordinated. These authors maintain that many approaches are limited because they fail to characterise in detail the differences between dependencies; the problems that dependencies create; or how the proposed coordination processes address those problems. Without explicit representation this results in it being difficult or impossible to determine what alternative processes might be useful in a given situation.

The primary assertion of coordination theory is that dependencies and their managing mechanisms are general. This indicates that in any given dependency several mechanisms may exist to manage it which can be found in varied organisational settings. One contribution of coordination theory, therefore, is the grouping of dependencies and their corresponding coordination mechanisms, as illustrated in Table 2

(Crawston & Osborne, 1998; Crowston et al., 2003). The contentions of coordination theory suggest that alternative processes can be defined by identifying the dependencies within a given process and by considering what alternative coordination mechanisms may be employed. This denotes that a useful initiation point for process analysis and redesign is to look for dependencies and coordination mechanisms. The conceptual separation of the coordination process from production processes is considered useful, as it focuses attention on the coordination mechanisms, which are believed to be an especially variable part of a process, thereby indicating an approach to redesigning processes (Malone, et al., 1999).

Table 2.2: Taxonomy of Dependencies and Coordination Mechanisms

DEPENDENCY	EXAMPLES OF COORDINATION PROCESSES FOR MANAGING DEPENDENCY
Shared Resources	"First come/first served", priority order, budgets, managerial decision, market-like bidding
Task Assignments	(same as for "Shared resources")
Producer / Consumer Relationships	Negotiations, price
Prerequisite Constraints	Notification, sequencing, tracking
Transfer	Inventory management (e.g., "Just In Time", "Economic Order Quantity")
Usability	Standardisation, ask users, participatory design
Simultaneity Constraints	Scheduling, synchronisation
Task / Subtask	Goal selection, task decomposition

While coordination theory provides an important analytical approach to managing the problem of coordination, it is limited in focus. Additionally, it assumes that the basic components, activities and structures of a system, along with the general context are identified and understood. Furthermore, it does not account for external or environmental factors which may change rapidly and may impede the coordination processes or outcomes motivating the interdependencies that exist. Espinosa (2007) avers that *context, task, and team* variables can influence the types of dependencies that will be encountered, and as a result, the choice of coordination mechanisms that could be employed to manage the dependencies.

Although coordination theory subscribes to a process approach in order to manage dependences between activities, Malone and Crowston (1999) observe that coordination mechanisms also rely on other necessary group functions. These incorporate decision making; communications; the development of shared understandings; and collective sense-making (Britton, et. al., 2000; Crowston & Kammerer, 1998). This infers that developing a complete model of a specific process may involve the modelling of all of the aspects of, *inter-alia,* coordination, communication and decision making. To supply a wider view and to account for a number of factors that may influence coordination processes to a greater degree, the subsequent subsection discusses open system theory.

2.2.2 Open System Theory

Conceived from several perspectives, 'systems theory' accounts for complex system behaviours and the dynamic relationships between systems and their components (Cozier & Witmer, 2001; Leavit, 1974). The theory relates to the socio-technical systems[1]; of which every organisation consists. It characterises all systems as the assembly and combination of parts which are interdependent because of their relationships (Malhotra, 1993; Scott, 1987, p.77). The components constituting a mechanical standpoint are considered to be highly constrained, as opposed to a social system, where the connections between parts are deemed to be loosely coupled. This implies that the interactions between the components become more variable and complex as one moves from the extremes of the mechanical to the social systems.

Systems theory presents organisations as open systems that interact with their environment inferring that organisations are firmly influenced their surrounding (Bastedo, 2004). This allows for the provision of a structure to attempt examination and understanding of the environment. An open system receives input from the environment and releases output to the environment. The key concept stressed by the theory is that a mutual relationship exists between the environment and the components of all subsystems that operate within it; receiving and releasing output. Therefore, the overall health of organisation as a system is strongly linked to its ability to anticipate and adapt to changes in the environment. Concurring, Kuhn (1974) asserts that all systems move toward achieving a state of equilibrium, and the prerequisite for their sustainability remains in their ability to maintain a state of balance.

Communication and transaction between systems are considered the vehicles through which systems achieve equilibrium. Kowalski (1994) contends that maintaining balance in a system requires a shared pattern of exchanges between components. Kowalski (1994) and Leavit (1974), in their concept of a socio-technical system as an open system, advocate that it reveals culture; structure (social components); machines and methods (technical components), which work interdependently to produce work, thereby necessitating the need for a shared pattern of communication and exchanges. Given their function these items represent important synchronisation components that must be orchestrated to prevent a coordination breakdown. A state of equilibrium may be achieved through positive or negative feedback cycles, which serve as a control mechanism, intended to maintain order in systems. Fundamentally, information is sensed, with changes effected (or not) accordingly. In system theory a performance

[1] A socio-technical system accounts for the complex organizational work design that recognises the interaction between people and technology in workplaces.

evaluation is required relative to the input; transformation process; output; feedback effects; and the pattern of the interrelationships of the entities (Ash & McFadden, 2010).

An important consideration for open system theory is the nature of coupling (weak or strong) between elements, for instance, tasks; ideas; individuals; units; hierarchies; and organisations, which underpin the survival of a system (Orton & Weick, 1990; DiTomaso 2001; Brusoni et al., 2001). Therefore, the goal of coordination as a management function is to ensure the survival of the system. A primary characteristic of an open system is the dynamic interaction of its components. Ramstrom (1974) and Bertalanffy, (1956) assert that it is necessary to study the organising relations that result from the dynamic interactions within and between systems in order to maintain a state of balance. Meyer and Scott (1983) stress three approaches to analyse the relationship between organisations and the environment; namely: a focus on the resource needs and dependencies of an organisation (resource-dependency theory); a look at the pool of organisations that make similar demands with consideration for the limited environmental resources (organisational population model); and the relations of organisations to other organisations, within a localised geographic space (the inter-organisational field model).

Furthermore, open systems tend towards higher levels of organisation. To evaluate subsystems, three approaches are identified: a holistic approach to examine the system as an overall functioning unit; a reductionist approach, which opts for a downward examination of subsystems within a system; and the functionalist approach, which evaluates upwards from the system to examine the role it, plays in the larger system. All three approaches recognise the existence of subsystems operating within a larger system. In an attempt to actualise and aid analysis complexity, four distinct levels of socio-technical systems boundaries are suggested: the international, national, organisational and group-to-individual levels.

To account, however, for other system regulating mechanisms requires a more detailed actualisation and analysis of the systems, within both a macro and micro context. These environmental mechanisms include, *inter alia*, the mediation components responsible for the environmental scanning and feedback functions, which interprets and brings information into and out of the system; boundaries; interfacing/delineation; and the historical and on-going communicative practices (Dozier, 1990, Witmer 1997). These elements lead the study to look at other theories, in order to account for such specifity, as opposed to the more generalised, abstract view and propositions brought forth by the open system theory.

2.2.3 Activity Theory

To a certain extent activity theory actualises the claims of open system theory. It presents a theoretical framework for the analysis and understanding of human interaction through their use of tools and artefacts. It captures situations that have a considerable historical and cultural context, and where the participants, their purposes and their tools are in a process of rapid and constant fluctuation. Activity theory focuses on the developmental transformation of collective human work activity and its dynamics (Vygotskij, 1978; Korpela, 2004). Activity theory utilises the work activity as the unit of analysis. As a descriptive tool it is oriented towards practice; considers an entire work activity system beyond just one role-player; and accounts for: the environment, the history of an individual, culture, the role of the artefact, motivations, and the complexity of the actions involved.

Activity theory offers an approach which is intended to extend coordination theory looking beyond the confines of a process, to account for coordination issues and problems. In this instance the actions in the activity are seen as directly proportionate to the activities in coordination theory. Although it does not capture the global context of phenomena and elements entirely, as emphasised in the open system theory, it provides a more detailed, comprehensive representation of elements and their relationships in the localised context of a group, which is underemphasised in open system theory. It provides a holistic conceptualisation and contextualisation of multiple factors, which incorporate a collaborative activity, its functions and work processes. It is sensitive to the correlation and interconnection of agents and activities, thereby capturing the quintessence of culture as a product of experience and interaction.

Badram (1998) contends that the theory puts forward an appropriate conceptualisation suited for analysing cooperative work, ranging from its dynamic transformation to its breakdowns. Activity theory, therefore, appears to be a promising potential initiation point to understand the problems of coordination in a collaborative environment; providing a foundation to formulate key questions for systematic empirical analysis. Korpela, Mursu, and Soriyan (2002) as well as Hashim and Jones (2007) advocate that the unit of analysis must be an activity as a whole, and not any of the single constituent parts in isolation, when studying collective work.

Activity theory is characterised by a hierarchical organisation, in that an activity as a whole is defined by purpose and motive which consists of groups of actions geared towards a specific goal and operation. This accounts for the routine and cognitive/ behavioural processes of actions. Additionally, central to an activity is the interactive relationship between subject (individual or collective stakeholders) and purpose (object) mediated by some tool(s) and community. The notion of mediation involves the use of a tool as mediator and the means of work, which in turn evolves capturing the historical knowledge of how the community behaves and is organised. This is more clearly evidenced when computer-based tools are involved (Kaptelinen, 1996). Figure 1 shows the subject-object relationship, which defines the activity and is mediated by tools and community through rules (formal or informal) and division of labour.

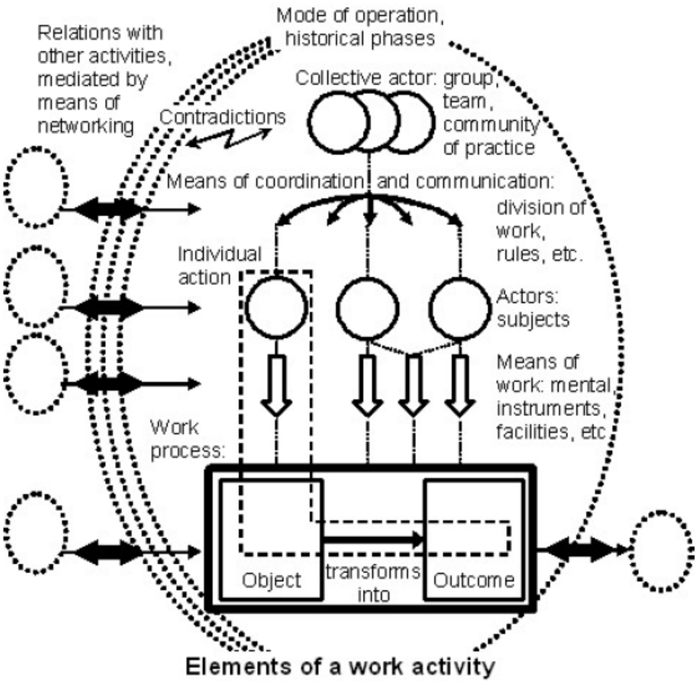


Figure 2.1: The ACTAD Framework (Korpela et al., 2004)

Derived from Engestrom's more abstract representation of an activity, Figure 2.1 presents a more elaborate representation by Korpela et al. (2000). Intended to make activity theory more practical in Information System research, they define an analytical framework called the Activity Analysis and Development (ActAD) framework. This research employs the ActAD framework, as it provides a check list for a work activity and its elements, starting with the with the work activity as an entirety (Korpela et al., 2004). As stated, activities do not stand alone when the outcome of an activity is transformed to be utilised as the object of work for another activity when a *means of networking/*data sharing *(e.g. phone, paper/electronic flow* of information) is required to mediate the relationship between the activities. The ActAD framework seems to resemble partially the service system suite highlighted in the next section. Although less elaborate than ACTAD framework, the service system suite appears to capture a slightly broader environmental context, showing, external relationships between systems and their boundaries.

2.2.4 Service System Theory

The use of the term *service* reflects the value-producing processes between a service provider and a customer, from both a business and a software engineering perspective. Vargo and Lusch (2004) describe the *service* concept as the application of specialised competencies (skills and knowledge), through some actions or processes, for the benefit of another entity or of the entity itself (self-service). This infers that it takes into consideration the organisational capacity, in terms of resources and capabilities, to create value. The resources refer to the components which serve as direct inputs for production. The ability to coordinate, control, and deploy resources refers to capability. Spohrer, et al. (2007) as well as Ng & Maull (2009) explain service systems as complex systems, consisting of dynamic configurations of resources, which include people, organisations, shared information, and technology, with at least one active participant capable of interacting and judging outcomes. Therefore, they emphasise the management of organisational value towards value creation.

Spohrer et al. (2008) designate two types of service systems (formal and informal). They note the value of the informal service system as necessary to support a formal system, which in turn influences the informal system. For example, the dynamic formation of teams to coordinate work across functional departments represents such informal services. Alter (2008) presents three frameworks providing a foundation for understanding and analysing and building service systems. This suite of frameworks is suitable for identifying problems and opportunities in service systems and includes: the work system framework for situation analysis, the service value chain framework that reflects on value co-creation (opportunities and expectations), and the work system life-cycle model that focuses on system adaptability to change.

A service system can be understood and analysed in terms of the elements of a work system framework, as shown in Figure 2.2. It provides a catalogue of components to consider, how they are organised and what they are intended to accomplish. The framework uses nine fundamental elements to provide a system-oriented view of any system that performs work within or across organisations. This makes it useful in identifying problems and opportunities (Alter, 2006; Petkov & Petkova, 2008). Figure 2.2 comprises four production elements: processes and activities, (otherwise known as work practices), participants, information, and technologies. The five other elements (products/services produce, customers, environment, infrastructure, and strategies) exist to facilitate an understanding of the situation. This allows it to provide a basic understanding of the operation, context, and significance of the work system. Pinelle, (2004) avers that these factors can influence coordination strategies thus, suggests levels of analysis that should be explored in developing groupware design techniques.

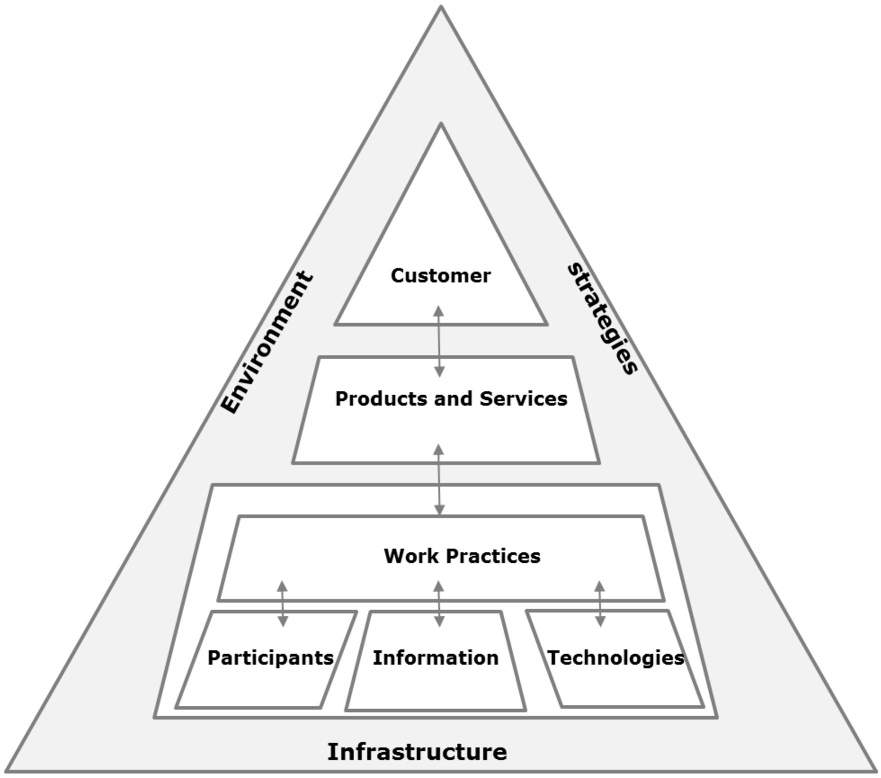


Figure 2.2: The Work System Framework (Alter, 2006)

The service system framework correlates to the Socio-technical Systems Theory, often used as a framework to design and understand organisations. As defined by socio-technical systems, every organisation is made up of three interdependent subsystems: social, technical, and environmental, which must work together and be aligned in order for organisations to function optimally. The social subsystem represents the people using the technical subsystem (tools, techniques and knowledge) to produce a product or service valued by the environmental subsystem (of which customers form a part) (Shani, Grant, Krishman & Thompson, 1992,p.-92).

Alter (2006) and Spohrer et al. (2008) maintain that, since most work systems receive and use things from other work systems, trying to understand one work system in isolation from another is insufficient. Similar to activity theory the work system must be considered in a larger context. Although it is possible to divide a work system into several subsystems, the desirability of the scope or level of division should depend on the purpose of the analysis and degree of overlap between work systems. For instance, it is meaningful to consider more than one work system when analysing issues related to coordination between separate subsystems. As such, an analysis on a larger work system is worthwhile, while considering the subsystems as single steps, in order to capture their relationships.

The work system framework, as part of the elements of the process/activities, recognises the vital significance of coordination for managing dependencies between work system activities. It acknowledges coordination, as stressed in coordination theory (Alter, 2006; 2008). However, it emphasises that simply focusing on business process to identify dependencies can lead to omissions (Alter, 2006) and advises a look at communication and decision-making patterns in organisations to account for other dependencies that may exist.

2.2.5 PSI Theory

Performance in Social Interaction (PSI) theory provides a focus on communication and transactional undertakings occurring between active human role-players within an organisation, contrary to the passive roles projected in Coordination Theory. In Psi theory, some kind of communication or information exchange is required in order to achieve coordination. In addition, such communication or exchanges benefit from an already established shared knowledge and understanding, to see that intentions are properly propagated and effectively interpreted. The theory posits that organisations consist of individuals who interact; and where during the course of communication, subjects enter into and comply with commitments towards an agreed output. Dietz (2006) contends that the carrying through of a transaction constitutes a game of entering into and complying with commitments and suggests that communication acts are responsible for establishing such commitments. Therefore, Dietz (2006) equates communicative acts to coordination acts.

A principal contribution of Psi theory is its *operation axiom* which calls for a separation between production activities and coordination activities, to facilitate analytical simplicity for production or coordination problem solving. While production acts are performed to realise the mission of an organisation, the coordination acts initiate and coordinate the execution of the production acts. The success of performing both a production act and a coordination act respectively, results in a production fact (product/service) or coordination fact (agenda). An example of a coordination act is a ‘request’, while conversely a ‘promise’ is an instance of a production act, plus its subsequent finished state and delivery. This means that by carrying out coordination acts role-players enter into, and comply with, commitments between each other regarding the execution and performance of production acts. Chopra (2005) avers that commitments provide an opportunity to assess and establish interoperability, since they propagate a notion of compliance suitable in open settings, where participants may act as they please, as long as their activities are in accordance with established commitments.

Another contribution, the *transaction axiom* accounts for the coordination acts performed as steps in universal patterns termed transactions, focused on a customer–performer interaction. As is the case with the Action Workflow Loop (Denning et al., 1995) it uses a predefined set of communicative acts that Dietz, (2003) equates to coordination acts. The pattern is said to account for actions that can be supported in an IS design. Based on Language Action Perspective (LAP) (Winograd & Flores, 1986), the transaction pattern describes how a requester and a performer interact through communicative acts to come to an agreement concerning the performance of a task (Goldkuhl, 2007). LAP as a theory of communication accentuates the process of creating shared understanding, with the objective of coordinating the actions of the participants. Although implicit, the execution of the production act serves as a multi-responsive action to several communicative acts, whether initiator or control (Goldkuhl, 2007).

Latching onto the *transaction axiom*, the *composition axiom* provides the basis for defining the notion of the business process as a collection of causally related transaction types. However, owing to its simplicity, the transaction axiom ignores other situational, external factors or acts that may influence an outcome. To account for this the *distinction axiom* stresses the need to consider the production acts at three levels of abstraction, which serve as lenses into the organisation. Fundamentally, it suggests consideration for the various actors and their roles as they perform production and coordination acts; the supporting knowledge/information processing; and the communication infrastructure supporting the business process.

2.3 Coordination Constructs

Coordination theory presents the basic constructs which can be used to characterise coordination. Two main concepts are considered: the concept of interdependency, and coordination mechanisms. Figure 2.4 shows the relationship between these concepts and further elaborates on the coordination mechanisms, in order to provide the coverage necessary to account adequately for lessons in relationships and linking to the abovementioned relevant theories and concepts.

Figure 2.3 presents a catalogue of constructs showing coordination mechanisms as comprising two aspects: structure and process, defined to manage interdependences. The coordination structure provides the necessary connection to execute the process. The coordination process may be considered to build the structure, through facilitating communication and configuring decision-making patterns. In addition, it complements modular-based structures by, for example, optimally prioritising or rearranging modules. Hence, the relationship between the mechanisms is reciprocal, as they usually co-exist in an organisational setting. Decision-making, communication patterns (Malone, 1987), and modularisation (Shen & Shaw, 2004) constitute the three elements of the structure of a coordination mechanism. Modularisation separates and groups system components in a variety of ways allowing much greater flexibility in end configurations (Schilling, 2000). Usually dependencies are very domain-specific, and the mechanisms to manage them must therefore be considered in a specific context as well. While there are a variety of coordination process mechanisms, as shown in Table 1 Section 2.5.1, they can be classified into three major groups: mechanistic coordination; organic coordination; and cognitive coordination.

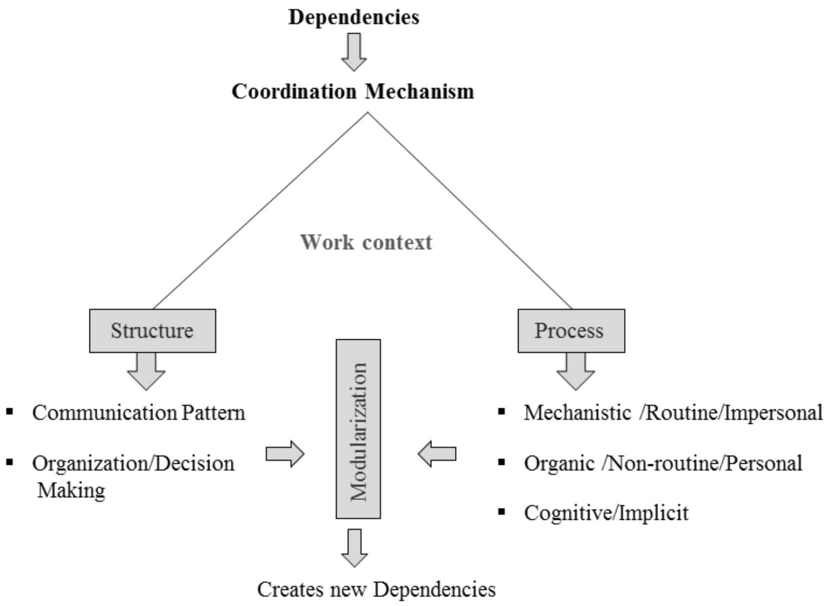


Figure 2.3: Catalogue of Coordination Constructs

Structures like hierarchies in organisations, serve as the pillars of coordination. Individuals coordinate their work through interconnecting role-definitions, which delineate how they interact and exchange information, facilitated through the use of shared artefacts and information-systems. To attain a state of governance, organisations examine how they should put into place various structures, processes and mechanisms to ensure effectiveness. This appraisal and perspective usually examines who should be making decisions; which roles should be defined and which processes and mechanisms should be in place to ensure successful operation in the organisation (Espinosa, 2009; Ross et al., 2006). By focusing on the mechanistic and structural aspects of management governance this encourages desirable behaviour. However, additional coordination mechanisms which require the standardisation of work practices and mutual adjustment are often required. Decision-making and communication feature in all instances of coordination (Malone & Crowston 1990; Gittel, 2002). The subsequent section clarifies and elaborates on the nature of dependencies.

2.3.1 Interdependency

The notion of interdependency is a principal aspect of collaborative work. Coordination strategies in collaborative work are linked to the concept of interdependence between relevant stakeholders. Malone and Crowston (1993) encapsulate the broad description of coordination implying interdependency with the statement "*working together harmoniously".* Interdependency can be described as level coupling between elements in terms of their strengths, and consistency of interactions. Pinelle and Gutwin, (2004), concurring with Scott (1987), refer to interdependence as the extent to which the items or elements of a work process are interrelated, in that changes in the state of one element affect the state of others. Malone and Crowston (1994) describe the interdependence seen between activities as playing a vital role in shaping coordination mechanisms seen in groups and organisations. This is consistent with the simple insight that, if there is no interdependence, there is nothing to coordinate.

When multiple individuals, sub-tasks and resources are required to interact in a synchronised fashion in order to accomplish a joint task, it gives rise to dependencies among them (Espinosa, 2002). Coordination theory emphasises identifying dependencies among individual parts (activities, unit or functions). Then the strategies to manage the identified dependencies or interactions will follow. Although implicit, all theories employed in this study have the common tenet that in order to achieve an objective, the nature of interdependences between participating elements must be managed. For instance, with activity theory, the relationship between the work activities of role players is subject to a division of work, usually regulated by explicit rules and norms, which maintains that an activity cannot be achieved in isolation. Neto, Gomez and Castro, (2005) contend that real life situations consist of an entwined and connected web of activities, usually specified using an activity diagram. Furthermore, when studying collective work, the unit of analysis must be an activity as a system, a whole, not any of its constituent parts in isolation (Korpela, Mursu, & Soriyan, 2002; Hashim & Jones, 2007).

Correspondingly, the work system framework stipulates that in order to provide a service a business process is required performed by human participants using information technology and other resources. The perception of the theories and concepts relative to interdependency is depicted in Table 2.3. The work system framework, as part of the elements of the process/elements, recognises the importance of coordination as vital for managing dependencies between work system activities. This is augmented by the associative service value chain framework that emphasises the customer/producer relationship, where services are usually co-produced. This allows service providers to interact with partners, employees and customers in order to co-create value. Similarly, Psi theory focuses on the social elements (individuals) and their ability to enter into and comply with commitments relative to the outputs generated in collaboration.

Table 2.3: Interdependencies of Theories and Concepts Constructs

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
COORDINATION CONSTRUCTS					
Interdependency	Primary: Activity to activity Activity-Resource (Actors, Units, functions departments in organisation)	Cooperative organisation relations and degree of coupling between the systems and their components	Activity networking Sub activity action relations Actor-Actor Actor-tool Actor-activity	Producer/ consumer Service systems Activity-tool Actor-tool	Actor to actor Implied Actor to activity relation

Open systems theory is characterised by an assembly of parts whose relations or interactions make them interdependent. Additionally, the system elements can differ in size and complexity without any constraints (Scott, 1987). The theory provides flexibility in representing the nature of couplings between elements, which incorporate tasks; ideas; intentions and actions; along with individuals; units; hierarchies; and organisations (Orton and Weick, 1990; DiTomaso 2001; Brusoni et al., 2001). However, whether interdependency is presented as weak or strong between elements or modules, it nonetheless constitutes dependency and it should be managed (Gittel, et al., 2008; Pinelle & Gutwin, 2003).

According to Raposo, et al. (2001), interdependencies can be divided into temporal and resource management forms. The temporal form establishes the execution order of task, with the resource management dependencies seen as complementary and may be used in parallel. This research concurs with the tenet in that all possible relationships between elements engaged in a collaborative activity may be defined within these types. The separation between temporal and resource management dependencies is in alignment with the coordination model proposed by Ellis and Wainer (1994). Therefore, coordination in a collaborative environment can fundamentally occur at two basic levels: the activity in terms of sequencing and the resource object level.

The idea of creating a set of task interdependencies and respective coordination mechanisms was proposed in the coordination theory of Malone and Crowston (1990; 1999). They defined three types of elementary resource-based dependencies (flow, fit and sharing) and posited that all other dependencies could be defined as combinations or specialisations of these basic types. A *flow* dependency occurs when a task produces resource(s) that will be used by another task. A *fit* dependency arises when two or more tasks collectively produce the same resource. A *sharing* dependency occurs when two or more tasks use the same resource. These dependencies are consistent with the pooled, sequential, and reciprocal interdependencies of Thompson (1967) concerned with achieving organisational coordination; subsequently modified and extended by Malone and Crowston (1994). Table 1 presents a summary representation of the set of task interdependencies and respective coordination mechanisms of Malone and Crowston (1994).

2.3.2 Mechanistic Mechanisms

Mechanistic coordination is an explicit form of coordination achieved through some form of structured activity tasks, in conjunction with some predefined execution protocol (Espinosa & Boh, 2009). These mechanisms are more suitable for well-defined and routine tasks. They instruct individuals as to how to behave and to contribute to an overall project goal, without need for further communication. Examples include the division of labour; scheduling; interface specifications; plans; manuals; procedure; and workflow systems. These formal mechanisms, used for administrative coordination (Faraj & Sproull, 2000), are deemed impersonal (VanDeVen et al., 1976) as they remove direct human interaction from the task. The management of routine tasks can be programmed since they reflect mechanical tasks with predictable dependencies (March & Simon, 1958; Crawston, 2003). As such, the coordination process establishes standardised procedures and utilises formal reporting structures and work manuals to control output.

Standardisation is employed to minimise cross communication between agents. As proposed by Schmidt and Simone (1996), cooperative work settings characterised by complex task interdependencies require specialised artefacts (conventions and procedures) to articulate the distributed activities. These authors advise that these artefacts are instrumental in reducing the complexity of articulation work, thereby alleviating the need for ad hoc deliberation and negotiation. The coordination theory of Crowston and Malone (1994) stresses the usefulness of such mechanisms in the management of the usability, simultaneity and prerequisite constraints, which subscribe to standardisation, scheduling and sequencing among others. Table 2.4 provides a summary of how the theories and concepts perceive the mechanistic mechanisms.

Although not made explicit, the work system models are in alignment, given that they subscribe to coordination theory for coordination management, especially the business process. Open system theory advocates maintaining a level of equilibrium between systems or elements in an environment through agreed upon or standardised protocols in order to aid communication and mutual understanding. Psi theory is based on the intention of a production act, which often results in a coordination fact (e.g. an agenda or schedule), where two participants agree on the conditions of satisfaction, a clear statement of intent relating to what is to be accomplished and by when.

Table 2.4: Perceptions of Mechanistic Mechanisms

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
COORDINATION CONSTRUCTS					
PROCESS-BASED MECHANISMS					
Mechanistic Mechanisms	Predictable task programming Standardisation: outputs, norms and skills.	Socio-cultural norms and conventions	Explicit rules, norms, Reference frameworks, instructions manuals scripts	Socio-cultural norms and conventions Standardisation: of work processes, outputs, norms and skills	Convention, agenda, schedule

Activity theory posits mediated interaction of human activity through coordination artefacts (physical and psychological), incorporating language; scripts; heuristics; operating procedures; and individual and/or collective experiences (Bardram, 1998). An example is evidenced where the relationship between the work activities of the role players is subject to a division of work, which is usually regulated by explicit rules and norms. Ricci et al., (2002) aver that these coordination mechanisms provide effective means for coordination and cooperation across different levels of abstraction/operation. Bardram (1998) designates these levels of abstraction as the three hierarchical levels for analysing a collaborative activity. They provide for the analytical distinction of a collaborative activity and are identified as co-construction, cooperation and coordination (Badram, 1998; Engestrom, et al., 1997).

The coordination aspect, which is focused on routinised work, captures the normal and routine flow of interaction. The coordination mechanisms at this juncture are referred to as the objective or prescriptive coordination mechanisms, as shown in Figure 2.4. At this level the participating individuals follow their scripted roles (plans, written instructions, schedule or norms). Members focus on the successful performance of their individually assigned actions. The scripts responsible for coordinating the actions of the participant are not usually questioned or discussed, known or understood in all their complexity. Essentially, at this phase the contributions of the role players are passive (Kuutti, 1991) and coordination ensures that an activity is working in accord with surrounding activities.

Harding (2000) and Manolopoulos (2007) identify the common characteristic of mechanistic coordination instruments as such that they pre-specify the expected behaviour of individuals. Schmidt and Simone (1996) advance that a mechanistic coordinative protocol may be expressed as having weak or strong stipulations, and may be determined by the case or situation context. The rigidity of the protocol is expressed in the programming of the interdependencies as represented by the modus operandi. As such, the imprinted coordination artefact, including plans, conventions or procedures, may play different roles in cooperative work. They may play the 'weak' role of a guide map, which provides a codified set of functional requirements, serving as a general heuristic framework for decision making. Conversely, they may play the 'strong' role, such as a 'script' that offers a rigid 'pre-computation' of interdependencies among activities, providing step-by-step instructions to participants of the following possible or required measures.

However, whether weak or strong, coordination protocols involve an unavoidable aspect of situational interpretation and improvisation. Fundamentally, they should be adjustable, able to manage, meet or handle the condition or situation of an object in context. They may inevitably encounter situations where this is beyond their objective limits (less predictable aspects of work) and may need to initiate a more subjective approach.

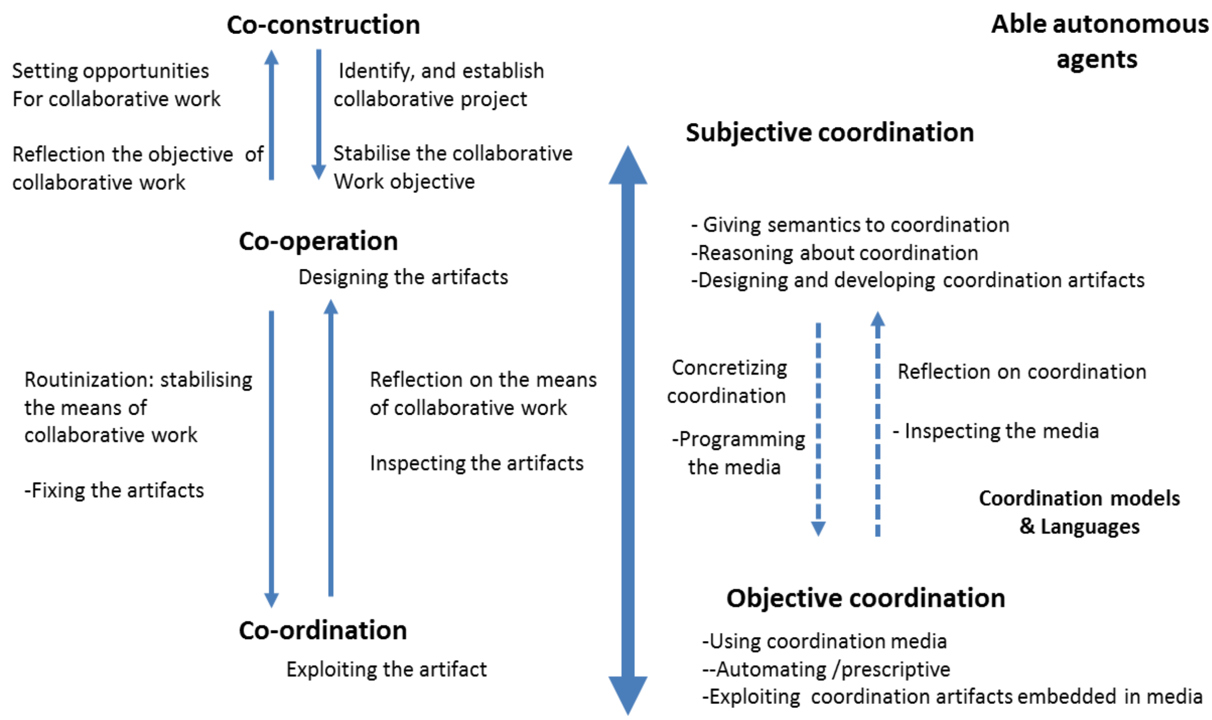


Figure 2.4: Dynamics of Cooperative Work

(adapted from Bardram, 1998 and Ricci, et al, 2003)

Correspondingly, Symon et al., (1996) advocates that any investigation of work coordination should look beyond formal procedures to consider contextual factors. These may give rise to informal practices, while simultaneously taking into account the use and influence of formal procedures. Figure 2.4 shows the dynamic transitions between subjective and objective coordination.

2.3.3 Organic Mechanisms

Organic coordination is synchronisation utilising mutual adjustment through communication, and feedback (Thompson 1967; VanDeVen et al., 1976, Espinosa, 2009). This form of coordination is engaged in situations of uncertainty, with less predictable and non-routine tasks that cannot be coordinated mechanistically. This more spontaneous form of coordination, regarded as relational coordination (Gittel, 2002), is effective owing to its fundamental flexibility and adaptability. Mintzberg (1979) identifies a number of structural elements used to facilitate mutual adjustment within and between units. These include: liaison/mediating devices with formal or informal authority, task force, and standing committees, among others. How the theories and concept perceive organic mechanism is shown in Table 2. 5.

Table 2.5: Perceptions of Organic Mechanisms

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
COORDINATION CONSTRUCTS					
PROCESS-BASED MECHANISMS					
Organic mechanisms	Mutual adjustment Relational spontaneous coordination Developing standards for communication	Feedback loop for adaptive response to external environment	Externalisation/ internalisation of knowledge to transform mediation artefact	Producer/ consumer service adjustment	Communicative acts to facilitate transaction patterns Exchanges to establish commitment

Organic coordination achieves coordination through a process of informal or formal communication, which can be spontaneous or planned (Kraut & Streeter, 1995; Espinosa & Boh, 2009). For instance, groups or teams can coordinate by communicating formally via meetings and documents, but may also achieve coordination via more informal communication, where team members may encounter each other spontaneously, and communicate face-to-face (Kraut & Streeter 1995). As established in the previous section, not every cooperative work arrangement can be coordinated mechanistically. Sometimes individuals require more frequent interactive communication to coordinate less predictable aspects of work. In this regard organic coordination supplements standardisation and hierarchy.

The interactive nature of mutual adjustment speaks to a more subjective coordination extreme, as reflected in Figure 2.4, where a mutually agreeable result is often negotiated. This is similar to the tenet of establishing commitment as prescribed in Psi theory. Both subjective and objective coordination means must complement each other, as current situations will prescribe the coordination mechanism employed, whether be it rules, hierarchy, or mutual adjustment. The importance of this is reflected in Figure 2, where the transition between the more objective and the subjective form of coordination means provides great advantage.

The symbiotic relationship between subjective and objective mechanisms is reiterated in literature, as coordination mechanisms in organisations often reflect both approaches. For instance, Thompson (1967, pp.54-55) hypothesises three explicit coordination mechanisms - (standardisation, plan and mutual adjustment) to be utilised in response to three different patterns of dependencies (pooled, sequential or reciprocal). Mintzberg (1979) describes a similar set of coordination mechanisms in organisation theory (mutual adjustment and direct supervision) in conjunction with four kinds of standardisation (work processes, outputs, norms and skills), while Gittell (2002) posits three formal organisational coordination mechanisms (routines, boundary spanners, and team meetings for mutual adjustment).

Denning and Malone (2006) reveal that the fundamental building block of coordination is the action loop. Similar to the transaction axiom and Conversation for Action in Winograd (1986), the loop expresses a universal pattern of human coordination; the model of interactions between two entities as they coordinate to accomplish a task. This coordination implies some sort of feedback, to ensure that the active individuals can tell whether their actions are effective, and allows them to correct when necessary. Figure 2.5 shows the similarities between approaches and the negotiations that result in commitments and lead to an eventual production plan.

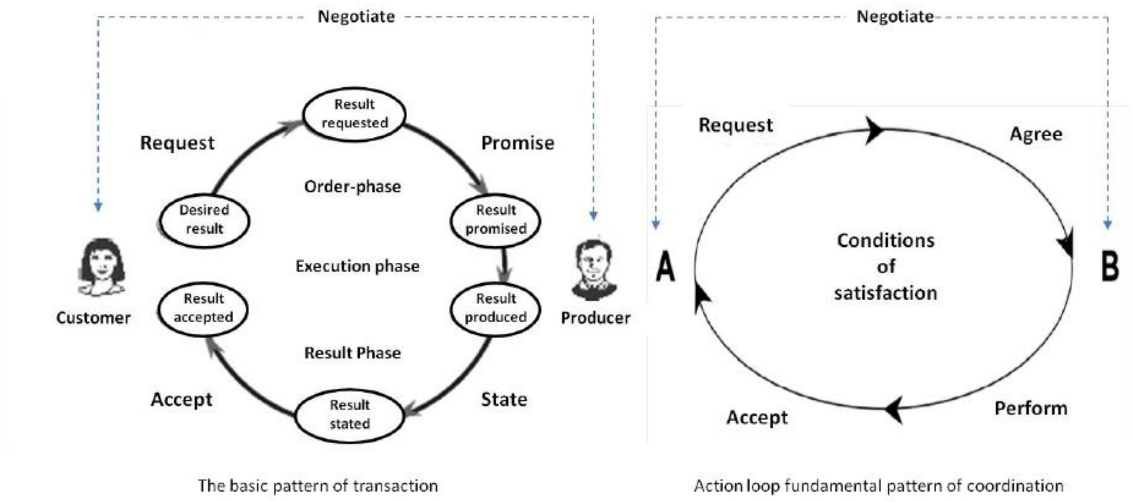


Figure 2.5: Transaction Pattern and Action Loop Constructs Similarity
(Dietz, 2006; Denning & Malone, 2006).

The structure is defined by the language acts through which people coordinate. During any phase or at any stage it is common for additional actions, such as further negotiation or clarifications about conditions, to make changes of commitments by the participants required.

Open system theory refers to such feedback loops as control information that guides subsequent system operations or behaviour. Thus, the output generated influences the system operations. The service value chain framework stresses the importance of feedback in managing the relationship between a service provider and a consumer. The work system life-cycle reflects the dynamic transition between the subjective and objective coordination extremes as portrayed in Figure 2.4, which depicts a dynamic view of how coordination services change over time. Figure 2.4 illustrates activity theory, which recognises that through interaction with mediation, artefact knowledge is gained and used to transform or improve the artefact(s) given the need context. Given the three levels of collaborative activity, in Figure 2.4 subjective approaches to coordination can be considered fundamental for both the co-construction and the cooperation level. Mediating mechanisms employed at this stage will usually include negotiation, through some high-level, semantically driven interaction protocol. The outputs of the cooperation level will often tend to the more objective forms of coordination, which are also subject to automation and perhaps to subsequent optimisation.

2.3.4 Cognitive/Implicit

Cognitive driven coordination reflects the establishing of shared mental models that may allow team members to coordinate their actions and communicate better subject to situational demands. Through the development of a shared understanding members can coordinate their actions by anticipating and predicting the needs of each other , enabling them to adapt to task demands more easily (Gasson, 2011; Sycara & Sukthankar, 2006). This form of coordination is implicit in nature, grounded in knowledge or mental representations or schemas that individuals possess about each other and their tasks (Espinosa & Boh, 2009). This innate knowledge aids in anticipating and interpreting what other individuals are doing, or will do, which can serve as a useful information base to plan an the activities of an individual . This form of organised knowledge may be referred to as ‘shared mental models’ and can incorporate goals; strategies; tasks; possible actions and each other, (Cannon-Bowers et al., 1993; Klimoski & Mohammed, 1994). To summarise, this individualised context-based information assists in collaborators becoming coordinated; having implicit knowledge about each other and the tasks of each other. Collaborators can plan their own activities.

Cognitive coordination although based on the knowledge that individuals have about tasks and about each other, can be described and designated in diverse ways. These include: knowledge about shared tasks; the expertise of team members; and their common ground. For instance, when viewed in relation to organic/mechanistic coordination through communication and interaction via shared understanding, awareness among collaborators can be established (Cannon-Bowers & Salas, 2001). Therefore, when collaborating members share knowledge about tasks and about each other, they communicate more effectively, augmented by their already established mutual knowledge. This, in turn, helps to cultivate a common ground and shared vocabulary (Cramton, 2001). Having a shared mental model can help collaborators to achieve mutual understanding about the established mechanistic coordination practices (. standards, specifications, shared models). How the theories and concepts perceive cognitive/implicit mechanisms is depicted in Table 2.6.

Table 2.6 Perceptions of Cognitive/Implicit Mechanisms

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
COORDINATION CONSTRUCTS					
PROCESS-BASED MECHANISMS					
Cognitive/ Implicit	Implied in the distribution of mechanistic mechanisms Synchronisation	Implied towards achieving a state of system balance through environmental awareness	Mental knowledge for producing work /mediation through contextual awareness for adaptation (Feedback and learning)	Knowledge and skill of work and awareness of the role of actors Shared awareness of commitments	Shared knowledge to assist shared understanding and decision-making

The literature pertaining to team cognition suggests that as group members interact over time they develop organised knowledge about the task and about each other. This aids team members to coordinate implicitly as they can anticipate the moves that others are likely make, and can, therefore, achieve a more effective interaction (Espinoza et al., 2005; Kraiger & Wenzel, 1997). Consequently, it can be suggested that both explicit and implicit coordination mechanisms complement and interact with each other. As noted by Weigand, van der Poll and Aldo de Moor, (2003) the communication process will be more efficient in mutual adjustment when accompanied by a shared background of behavioural patterns or shared knowledge of a given situation. Ideally, a shared understanding of the task and members has the potential to balance communication deficiencies and help collaborators to coordinate, even if the strength of their communication is reduced by geographic distance. By providing an understanding of what other users are doing; where and how the environment is changing, this awareness provides users with the context for their own activities (Dourish and Belotti hold, 1992:107). This information is considered functional and useful for many of the activities of collaboration, including: coordinating actions; managing dependencies; communication about the task; anticipating the actions of others; and finding opportunities to assist one another.

When people collaborate, it is essential that they perceive and understand things that are happening or have occurred in the context of their group, relevant for the accomplishment of their activities (Veira et al., 2005). Team awareness has been defined simply as *"an understanding of the activities of others, which provides a context for one's own activity"* by Dourish & Bellotti (1992). Knowledge of an upcoming deliverable deadline and consciousness of the progress status of a particular project are examples of team awareness. When working collaboratively, individuals not only need individual situational awareness to carry out their respective tasks, but they also need team awareness to synchronise their actions with other team members (Espinoza et al., 2005) As such, context information needs to be standardised so that its meaning is understood by users.

Abowd and Mynatt (2000) specifically propose that the definition of context should include the 'five Ws': **W**ho, which not only stands for the role of a person in context, but for the identity of a person and other people in their environment; **W**hat, refers to the recent activity of a person; **W**here, is the present location of a person and **W**hen, reflects the influence of time on the activity taking place, along with the duration. Finally, **W**hy, defines the reasons for the actions of a person. Although not part of the 'five Ws', **H**ow represents the way the interaction between persons, artefacts and activities is carried out (Gutwin & Greenberg, 2000). These factors support the assumption of this research that, equipped with such information, coordination can be simplified. The benefits and use of context models has been emphasised in numerous computing and groupware research domains (Strang & Linnhof-Poppien, 2004; Gu, Wang, Pung & Zhang, 2004).

The transaction axiom, of Psi theory aligned with communication theory, accentuates the need for interaction and shared knowledge to facilitate and aid acute decision-making purposes. The service framework, in agreement with the transaction pattern in Psi theory (initiator/executor concepts), stipulates that the responsibilities of a service provider include creating the awareness of service and negotiating a commitment with the customer, whose responsibility is to become aware of the need and negotiated commitment with the provider. Additionally, it is advocated that the need should be monitored (followed-up) from both the provider and the customer perspective to capture value. The concept is viewed in a narrow sense in coordination theory, relative to synchronisation between producer /customer activities. Activity theory emphasises the need to perceive and make sense of the environment, as the constituents of activity are not fixed, but can fluctuate dynamically as conditions change. Similarly, open system theory emphasises awareness of the environment, in order to maintain the balance of element in a system.

2.3.5 Communication Pattern

It has been established that mechanistic coordination mechanisms are often preferred when communication opportunities are limited and multiple people are involved (Kotlarsky, et al., 2006). However, knowledge about these mechanisms needs to be communicated, ensuring that communication is considered a critical device in managing dependencies in organisations, as it influences practically all coordination processes (Malone & Crawston, 1994). It is intended to provide answers to the questions of what is conveyed, to whom, how and when. Communication therefore appears to form an interactive pattern. It is embedded in both vertical and horizontal organisation (Weigand, van der Poll & de Moor, 2003). Communication patterns reflect the direction by which a communication link travels from one role-player to another, along a vertical or horizontal path (Monge & Contractor, 2003; Shen & Shaw, 2004). In addition, the mode of interaction (synchronous or asynchronous) employed at a given point in time influences the pattern. This indicates that the communication pattern is considered in terms of the communication flow and the process employed.

Relative to communication links, the vertical and horizontal represent two directions of communication flow within an organisation (Richmond, McCroskey & McCroskey, 2005). Vertically it is concerned with a down- or upward communication between participants at various hierarchical tiers within an organisation. Horizontally, it is concerned with lateral communication between peers or active individuals on an equal or nearly equal level in an organisation. Although influenced by contextual factors, the synchronous or asynchronous mode of interaction may be used in either direction, regardless of whether or not technology is involved.

Malone (1993) postulates that one way to generate a new coordination processes is though consideration of alternative forms of communication (synchronous vs. asynchronous, paper vs. electronic) which can be situated in any of the places along a process where information needs to be transferred. By engaging in communication and establishing some form of agreement, a pattern may emerge that can advise participants regarding what actions to expect from each other in given situations. For instance, a monthly face-to-face project team meeting will often subject members to a synchronous form of communication. Thereafter, agreements for follow-ups on the state of various project activities at intervals can be done asynchronously. Also, by defining or specifying the roles and responsibilities of actors, which influence the direction of communication, a pattern can be derived. This established pattern forms a mental model of communication paths and a schedule that can be followed and transformed into practice (Orlikowski, 1992; Kotlarsky et al., 2008). A communication pattern establishes a shared awareness model of a given situation that role-players can rely upon to anticipate and coordinate future actions. These communication actions are responsible for establishing a shared understanding and need to be supported as they reflect a mode for adaptive coordination.

A communicative action is essential for establishing a commitment that supports the future actions of collaborating participants (Searle, 1969). These commitments, according to Chopra (2005; 2008), represent the business semantics of business processes. The commitments provide a base for reasoning relative to interoperability. This concerns the ability of participants to enter into agreements and to comply with agreement terms, in an endeavour to maintain well-aligned commitments to each other. It defines the conditions for satisfaction. Clark (1996) asserts that participants will often revisit their shared agreement or common knowledge, when trying to solve coordination problem. Clark (1996) highlights the importance of establishing a shared knowledge base. Weigand et al. (2003) theorise that the larger the shared background (shared knowledge of a situation or, behavioural patterns), the more efficient communication processes will be. How the theories and concepts perceive communication patterns is depicted in Table 2.7.

Table 2.7: Perceptions of Communication Pattern

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
STRUCTURE-BASED MECHANISM					
Communication pattern	Horizontal communication and implied vertical communication	Horizontal inter-system model interaction Feedback loop process control mechanism (roles and responsibility) Vertical hierarchical subsystem interaction	Workflow process Actor to actor interaction	Explicit horizontal communication Synchronous and asynchronous exchanges for establishing agreements and eventual follow-ups between actors Implied vertical communication	Explicit Horizontal communication Implied vertical communication on transaction

While coordination theory and activity theory acknowledge the importance of communication as a relevant coordination device, there is no emphasis on how communication works and how it is to be supported. However, one contribution, the *transaction axiom,* courtesy of Psi theory, accounts for some possible communication actions, which may be supported in an IS design, as shown in Figure 2.4 The *transaction axiom* states that coordination acts are performed as steps in universal patterns, called transactions. It describes how a requester and a performer interact in order to come to an agreement concerning the performance of a task. The *transaction axiom* focuses on how the production and coordination acts relate to each other. It describes the pattern in which they occur, revealing the universal pattern of coordination with communication acts valid for all organisations. Of course, other communication acts also need to be considered, aside from the request that may serve as a control or input, influencing the production act in Figure 2.4 in some way.

It is suggested in open system theory that communication and transaction are the only inter-system modes of interactions. Likewise, the *service system suite'* specifically the *value chain model* reflects on the exchange between the service provider and the customer, stressing the management of commitment between parties and the follow-up that ensues. It acknowledges that service delivery involves a negotiated commitment (like service-level agreements) that guides future delivery and therefore considers the before, during and after communication. Of course, these acts are more difficult when players are spread across geographic distances, as opposed to the case of co-located teams. Both the transaction axiom and the service system value model reflect on communication subtleties like reminder, feedback, tracking and notification services which can be supported with ICT.

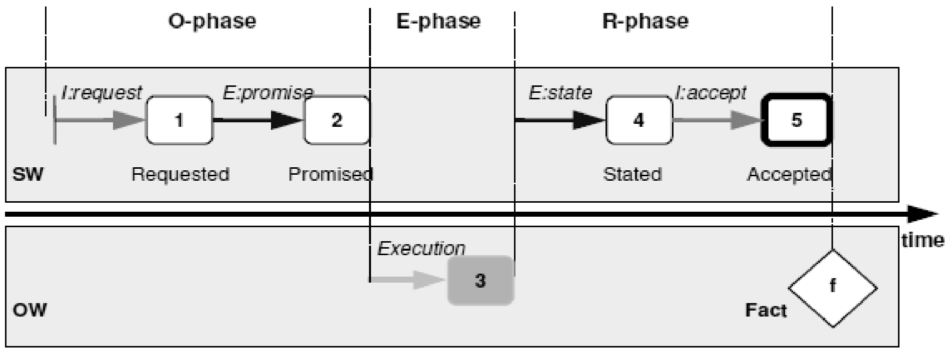


Figure 2.4: Standard Transaction Pattern

2.3.6 Organisation/Decision-Making Structure

Organisational design mechanisms include formal or informal structures, such as: hierarchies, linking pins, teams, and direct contacts (Hinds & McGrath, 2006; Kotlarsky et al., 2006). These mechanisms provide structures for managing knowledge flows that constitute organisational learning and value creation by defining the roles and establishing the patterns of dependence and cooperation (Kang, Morris, & Snell, 2007). For instance, whether formal or informal, a hierarchy increases efficiency by controlling the flow of information within an organisation; reducing redundancy; and ensuring that workers have the information they need as they need it (Hinds & McGrath, 2006).

A predominant process underlying coordination mechanisms is decision-making. For instance, a decision on how to segment tasks in managing task/subtask dependencies or how to allocate resources reflects the decision-making procedure. An alternative method of decision-making often results in an alternative coordination mechanism. For example, decision-making can be made by authority (the decision of the manager), by consensus, or by voting, which originates from negotiation. Decision-making is subject to influences from the mix between centralised and decentralised governance strategies (Ahuja & Carley, 1999). Generally, the decision-making pattern can be characterised across centralised or decentralised extremes (Malone & Crowston, 1994). From one perspective, centralised authority facilitates coordination by mitigating the chance of resource allocation conflict, as active individuals perform their varied functions aligned with the overall organisational goals. For this a continuous provision of decision-relevant information is necessary as the problem situation evolves. Alternatively, decentralised decision-making facilitates coordination in a more flexible and responsive manner. It allows local level individuals to capitalise on knowledge and information, permitting the making of snap, on-the-spot decisions when a localised problem arises. However, it creates the need to monitor the overall performance of a team with checks and balances. How theories and concepts perceive organisation/decision making structure is depicted in Table 2.8.

Table 2.8: Perceptions of Organisation/Decision Making Structure

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
STRUCTURE-BASED MECHANISM					
Organisation/ Decision-making structure	Hierarchical resource/task allocation decision Implied Centralised liaison/ mediating devices Formal authority /informal control , task force or standing committee (teams voting)	Specialisations and decentralisation in network structural coupling and distribution Responsive/ Adaptive decision-making Hierarchical distinction	Division of labour /decision-making power Activity hierarchical distinctions Centralised or decentralised	Actor to actor negotiation Role specification	Actor to actor transaction and negotiation on commitment

Espinosa and Boh (2009) assert that governance structures, as defined by an organisation, provide a base that influences the complexity and extensiveness of coordination that must be undertaken by various roles, ranging from the definition of objectives, to planning and implementation. The definition of roles and the structure of decision-making in the organisation, whether centralised within or decentralised, represents the governance structure. As such, a key aspect of governance is therefore, to specify and create roles that provide specific individuals with the authority and responsibility to lead and carry out various coordination tasks or projects (Sauer & Willcocks, 2002). Governance defines a behavioural and communication structure guide, which reduces uncertainty and promotes greater accountability and trust (Malone, 1997). The correlation between roles is managed by coordination mechanisms which can be identified across mechanistic or mutual adjustment extremes. The types of coordination processes adopted will depend on the task activities.

Coordination efforts are also influenced by the extent of centralisation versus decentralisation, which, according to Mehandjiev, Karageorgos & Tsang (2003), as well as Espinosa (2002), is influenced by contextual factors, including distance and time separation. For instance, geographic barriers make it more difficult to coordinate personally, making it more important for a team to implement effective mechanistic coordination processes (Hinds & Weisband, 2003). Geographic distance eliminates most of the benefits of co-presence (which thrives on organic mechanism) and collaborators will communicate less frequently (Gittel, 2001). In addition, alternative communication occurs through electronic media, which often lacks the shared contextual cues (Cramton, 2001).

Furthermore, schedule variability affects the timeliness of communication (Espinosa & Pickering; 2006), in that as time separation increases the window for real-time interaction diminishes. This means that geographic distance and time separation have a negative effect on coordination. However, this may be mitigated by having shared knowledge of tasks, team and situational awareness (Espinosa et al., 2008). The use of these shared entities would be an example of mechanistic coordination, as they would ensure some consistency among segments.

As is the case with communication, coordination theory recognises the importance of decision-making, and the development of shared understandings. However, it says little about how they work and how they should be supported. Coordination theory subscribes to the hierarchical resource allocation methods of organisational theorists, where managers at each level decide how the resources they control will be allocated among the people who report to them. Activity theory, through its division of labour mechanism accentuates tasks and decision-making powers. PSI theory underlines the organised means by which actors respond in adaptive ways. Like PSI theory, open system theory emphasises the way organised systems (human or non-human) respond adaptively to cope with significant changes in their external environments, which often involves decision-making in an effort to maintain a state of equilibrium.

2.3.7 Modularisation

Modularisation reflects a structural principle that can be used to manage complexity in a system. It can, for instance, allow problems to be solved locally without propagation through a larger social space. Modularity can be described as the decomposition of complex work into self-contained clusters of tasks/subassemblies/modules, which can stand alone or be joined together to form a product or service (Gittel et al., 2008).Thus, modularity emphasises the separation of concerns where functions are separated into distinct parts. Perrow (1984) portrays modular systems as an effective response to complexity, in that a problematic part of a system can be isolated from the other functional portions of the system. Also, each component of the organisation may adapt to its own environment, thereby reducing the cost of coordination, interdependency, information processing and administrative overhead between modules. How theories and concepts percieve modularastion is depicted in Table 2.9.

Table 2.9: Perception of Modularisation

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
STRUCTURE-BASED MECHANISM					
Modularisation	Activity composition in business process Goal decomposition (task/subtask) to respond to complexity	Modular activity design and composition for flexibility and efficiency Modular separation of functions into distinct parts Level and reasons of coupling between parts (loosely or tightly coupled) Integration mechanism to manage coupling	Activity work process definition (Modular actions) Division of labour to manage complexity	Composition of sub-service towards a larger service output	Purposeful separation of transaction actions Compositions of transactions toward a defining a process

Coordination theory reflects modularisation in its recommendation of goal decomposition as a coordination process that manages task/subtask relationships in response to complexity. Likewise, activity theory features the division of labour to mediate between object and community; however, recognising the need to mediate further between participants with mechanistic or organic mechanisms to keep aligned with the objective(s). The service system suite responds to modularisation in that the nature of the service to be provided may be composed of sub-service systems to provide value to customers. The service system supports modularisation from both the business and software perspectives, as it emphasises the composition of modular services to perform larger functions of services to another entity. The Psi theory composition axiom is indicative of modularisation, in that every transaction can be seen as the part of some larger transaction, where involved participants may turn to other secondary parties to fulfil certain subtasks.

Simon (1973) advocates that there are advantages that result from decomposing work and argues that for complex systems to survive they should be designed using a modular based approach. The extent to which these modules are required to work together will determine the nature of coupling, with two forms of coupling: tight and loose, arising. Figure 2.5 provides an illustration of the differences.

Grinter et al. (1999) theorise that tightly coupled work is more interrelated, and requires more communication and coordination, while loosely coupled work is carried out relatively independently of other work, requiring a reduced level of communication.

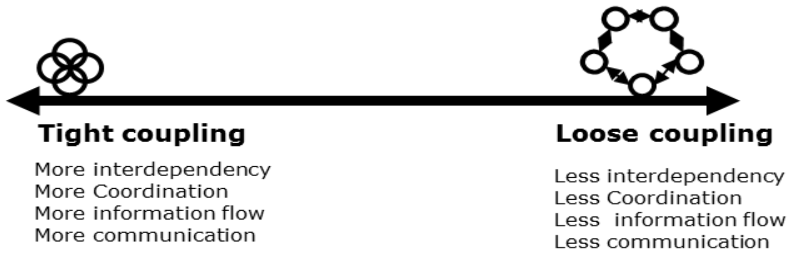


Figure 2.5: Levels of Coupling

Orton and Weick (1990), describe modularity as a form of loose coupling that offers particular advantages in complex environments. From a system perspective, Hagel (2003) describes loose coupling as an approach to designing interfaces across modules, to reduce the interdependencies across modules or components, thereby reducing the risk that changes within one module will create unanticipated changes within another. This approach specifically seeks to increase flexibility when adding modules, replacing modules or changing operations within individual modules. Grinter et al. (1999) define loose coupling as the relationship that allows autonomy with reduced coordination and communication demands, providing great benefits.

Conversely, Sabel & Zeitlin, (2004) argue that modularisation undermines the ability to coordinate, innovate and learn. They contend that an increasing complexity of work should rather call for tight coupling among elements. Although that may be the optimal route, it is not easily accomplished, as situations arise that warrant or force shifts to a loosely coupled relationship among elements or organisations. In loose couplings the work is primarily autonomous, and communication and coordination occur less, comparative to tight coupling. Pinelle and Gutwin (2003) assert that the extent to which modules, people, units or agents relate or work together will determine the specific style of coupling. Certain work situations may require a particular coupling style or may move back and forth between the tightly coupled and loosely coupled styles. By remaining alert and cognisant of the activities of others in an environment, workers can identify when tighter coupling is needed (Baker et al., 2002).

Multiple authors (Perrow, 1999; Brusoni & Prencipe, 2001; Staber & Sydow, 2002; Pinelle & Gutwin 2005) supply reasons for loose coupling, comprising: uncertainty in the work setting requiring rapid adaptation, non-routine and unpredictable tasks that are difficult to plan, manage, monitor and evaluate, highly specialised expert employees, in consort with other aspects including: physical environmental constraints, organisation/group size and complexity, physical distribution, schedule variability, and mobility, that provide limited opportunities for interaction or collaboration. Pinelle and Gutwin (2005) assert that the adoption of loose coupling affects the patterns of work and collaboration. Some outcomes that result from loose coupling incorporate autonomy and behavioural discretion among a workforce, without the need to consult others when making decisions. Hasenfeld (1983) avers that adopting loose couplings will result in weakly connected and coordinated tasks or activities. In addition, this can result in a weak system of administrative control or authority over activities and information buffering, where members of the workforce maintain their own local information repositories. Fundamentally, loose-coupling promotes a behaviour allowing elements or constituents to operate dynamically in isolation, masking the detail of each other, but can connect via the inputs and outputs required to provide a service. The input /output interface should be agreed upon or standardised.

Since interdependence in loose coupling is considered as weak, Pinelle (2004) and Gutwin (2005) contend that it is likely that well-founded communication channels may not exist. Additionally, significant effort will be required when collaboration is needed, and may possibly result in adjustment without negotiation, utilising illogical assumptions (Gamoran et al., 2000), which may be detrimental. Furthermore, owing to the autonomic nature of the workers, they may initiate interactions at their discretion, and owing to the associated weak interdependence they will most likely utilise low-cost, slow collaboration mechanisms (memos, post mail, email), since the work is not usually organised to facilitate regular interactions (Staber & Sydow, 2002; Pinelle & Gutwin, 2003). This results in voluntary rather than directed coordination.

While it is recognised that modularisation presents few and weak interdependencies between modules, it is dependency nonetheless and it should be managed (Gittel, et al., 2008; Pinelle & Gutwin, 2003). As such the concept of integration becomes important to weave together distinct modules into a coherent process (Sosa et al., 2003). Modularity is described as consisting of weak ties between modules, but with a system integrator which coordinates between modules without distracting participants from their areas of focus (Baldwin & Clark, 2000). According to Sosa et al, (2003) a well-designed system integrator role can enable a work process to be modularised without the loss of coordination.

2.3.8 IT-Based Mechanism

Transaction cost theory has been used to support the idea that information and communication technology (ICT) can reduce coordination cost. Malone, Yates, & Benjamin (1987), maintain that information technology can significantly reduce the costs of certain kinds of coordination. This reduced cost can facilitate the adoption of desirable coordination mechanisms or structures, which were previously too expensive. However, traditional approaches to coordination are often limited and are usually optimised for a particular type of situation, as is the rigid IT support, which loses value as situation changes. As traditional coordination mechanisms continue to prove inadequate, especially as collaborating members are not always co-located, distributed workers resort to technology to provide them with the information and interactions necessary for decision-making and work coordination. Thus, as distance increases between core workers they rely on computer-mediated support to communicate and coordinate their actions, as discussed in Chapter 3. Considering the need for flexible and adjustable structures, Mintzberg (1979) notes that information technology can facilitate adhocracies: flexible organisations, which consist of many dynamic project teams and decentralised networks of communication, among relatively autonomous groups. While adhocracies often require unplanned communication and coordination, technologies such as email and tele-conferencing help to reduce the costs of communication. This can further be enhanced with information sharing tools (Malone, et al., 1987) including *Dropbox.* Furthermore, it is established that depending on its usage, IT can lead to either centralisation or decentralisation (Gurbaxani & Whang, 1991). Where IT reduces decision information costs, it leads to centralisation, as the reduction in agency costs denotes decentralisation.

The use of technology as an alternative to other coordination mechanisms or simply to enhance the existing mechanisms is valuable. How the theories and concepts perceive IT is shown in summarised form in Table 2.10. Weigand et al. (2003) state that *"The solution for modern organisations must be sought in flexible standardisation."* This can be attributed to the emergent nature of organisations where they must adapt to shifting environments (Jones et al., 2003). It has been clearly established that ICT can play an enabling role, whether from the support of rigidly defined procedures or for flexibility, relative to quick adaptability and extensibility, as unveiled with widespread web service technology (Yang & Papazoglou, 2002; Jones et al., 2003). The service system from the software engineering perspective highlights service activities as facilitated by software systems, which are used to formalise, codify and push the execution of business processes (Stroulia, 2007). Additionally, it emphasises the modular abstraction of services and the standardisation of their interfaces to achieve interoperability.

The uses and functions of information technologies complement other coordination mechanisms. For instance, plans/specifications as work based mechanisms can be made available in a project repository and be web accessible (Kotlarsky et al., 2008). The information processing capabilities influence the choice of coordination mechanism, which in turn is influenced by contextual factors or uncertainty (Espinosa et al., 2010).

Table 2.10: Perception of IT Based Mechanisms

	COORDINATION THEORY	OPEN SYSTEM THEORY	ACTIVITY THEORY	SERVICE SYSTEM SUITE	PSI THEORY
STRUCTURE-BASED MECHANISM					
IT based mechanism	Support information processing to reduce coordination cost	Support for process efficiency Intersystem interaction Support for modular service abstraction and integration System sustainability and adaptive evolution	Means of work , mediation (communication &coordination) and networking Facilitates adaptive operational evolution	Support for process activities and service/self-service interaction Modular abstractions of services /interfaces standardisation for business process flexibility and interoperability Sustainability and adaptive evolution	Support for communication acts. Information process and knowledge management for process support.

Weigand et al., (2003) posit that ICT can reduce uncertainty by creating the opportunity for shorter time spans to supply definite feedback and by increasing the clarity of information. Moreover, aside from enabling both synchronous and asynchronous communication, ICT can reduce the degree of information asymmetry, by disclosing relevant information on time, to the pertinent actors. The IT based mechanisms can support coordination by capturing, processing, storing, and exchanging information through services, comprising: electronic calendaring/scheduling; shared databases; and groupware (Kotlarsky, et al., 2008; Haynes, Purao & Skattebo, 2004). Coordination can be achieved by IS components that operate and interact with their environment, so that resource conflicts such as version problems or the use of shared resources are resolved.

Given the evolutionary nature of organisations, and the coordination mechanisms employed, organisations should be enabled by information and communications technology (ICT) systems (Markus & Benjamin 1997). ICT from a coordination theory perspective is recognised as a facilitator of coordination mechanisms. Conceived from an activity theory perspective, ICT can assume the role of a mediating device between a subject and an object. The service system suites recognise technology as an important tool to support the work process. Like the service suite framework, open system theory acknowledges the possible role of technology in supporting the transformation of input resources during throughput to produce a type of output, along with its role as a catalyst for change. The organisation theorem that stems from the four axioms of Psi theory emphasises the integration of the three organisational aspects of an organisation through technological means. For instance, the technological support apps for each aspect can be as follows: document (spread sheet, text processors); information (information/knowledge management systems) and process management system for the business level. The lower levels provide support services to the higher levels.

2.4 Conclusion

Understanding the problems of coordination, especially in a distributed environment may be complex, as it is influenced by many factors. In order to understand the problem, one must consider the broader context in which an activity or business process exists. This is because there are factors which may influence coordination. A few theories and concepts were reviewed to assist in the study of coordination breakdown and its possible resolution in a distributed environment. The review revealed that, in certain instances, the theories and concepts share similarities, validating each other. In other cases they complement each other, relative to their differences.

In order to account holistically for the problem of coordination they provide valuable insight. All the theories and concepts considered advocate the separation of concerns to aid in the analysis of problem solving. It is established that while many mechanisms exist to solve coordination problem, mixtures are often appropriated. Thus they should be carefully considered. The review also indicates that usually both subjective and objective mechanisms interact and are often required together to manage the interdependencies in a collaborative environment.

As established in this chapter, almost every situation provides its unique coordination complexities and, as such, it is clear that the analytical coverage of existing approaches and frameworks is often limited, as there is not an all-encompassing, suitable fit for every circumstance. Each is individual and requires a specific solution. Dependencies are very domain-specific, and the mechanisms to manage them must therefore be considered in a specific context as well. There is no single blueprint or model for achieving coordination that would be adequate for all problem contexts. More likely, the coordination mechanisms or combination thereof will have to fit the type of the problem, to work within the constraints and opportunities offered by the existing organisational landscape/capacity, taking the local political and social, economic and cultural contexts into consideration, finally adapting and innovating within these parameters. Resources and capabilities need to be coordinated in adaptive ways to lead to a desired outcome, hence fostering a sustainable action of coordination.

It has been established that environmental, work-context and human factors all affect coordination at various levels of granularity. To succeed in a rapidly changing environment, organisations have to be able to react quickly and to optimise resource usage. In order to account adequately for a suitable coordination support solution in a distributed environment, the following chapter reviews existing coordination practices, as well as tools and technologies, in order to extract baseline requirements and ideas to guide the design.

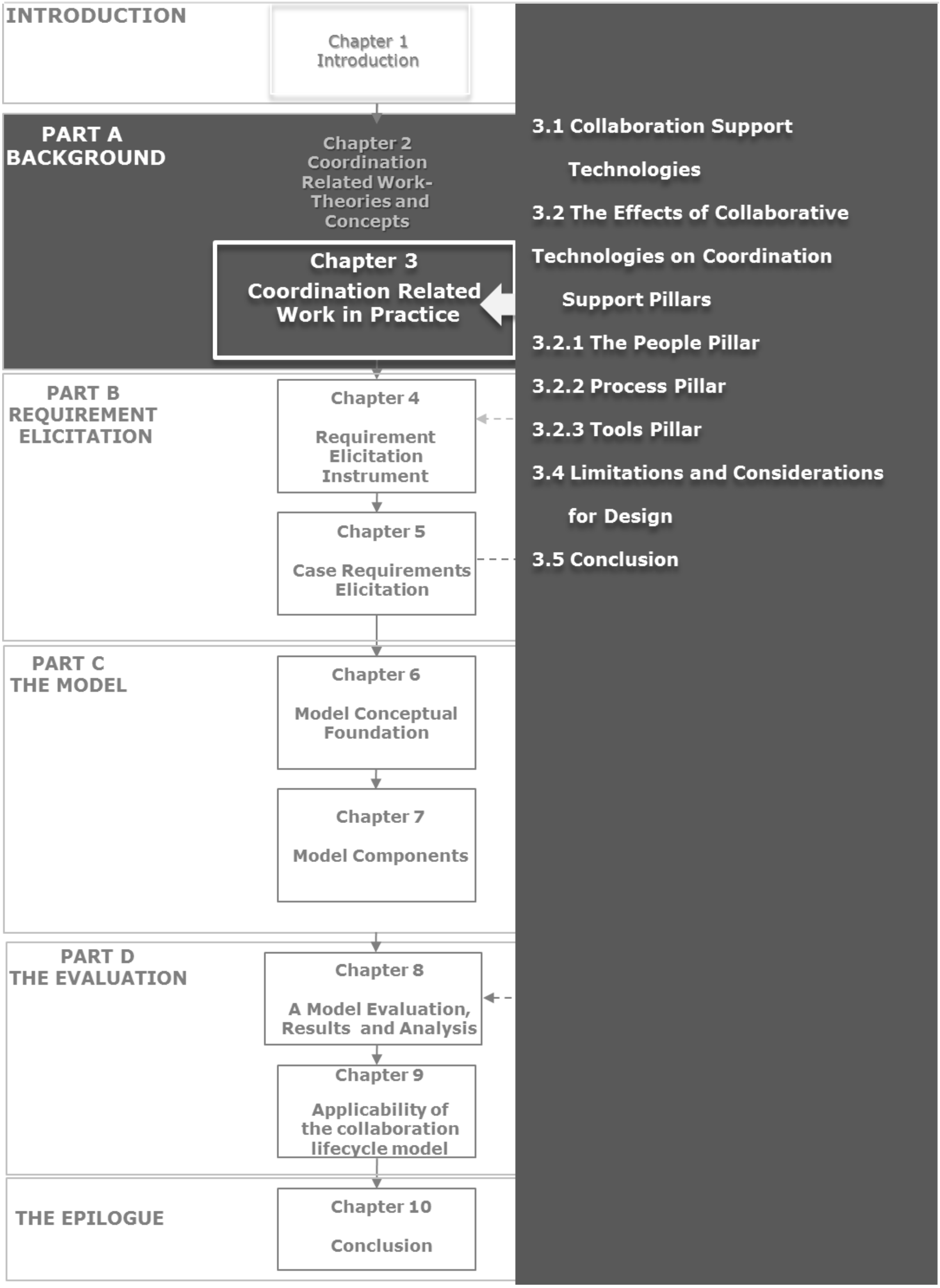
Table 2.11 below provides a summary of constructs and lessons towards understanding and managing coordination breakdowns, as suggested by the reviewed theories and concepts. It is divided into two major sections. The first looks at the analytical focus of the employed theories and concepts.

The second section presents the coordination constructs which have been identified. These are divided into three sections: process and structure base mechanisms as well their general IT support mechanism. Alongside are the interpretations of how the theories and concept perceive the constructs at the various levels where they operate. Although the constructs are theoretically separated they interact and often function together in practice. Thus the separation does not constitute a clear- cut situation.

Table 2.11: Summary of Lessons Learnt

<table>
<tr><th colspan="6">*LESSON LEARNT denoted as "L*"</th></tr>
<tr><th></th><th>COORDINATION THEORY</th><th>OPEN SYSTEM THEORY</th><th>ACTIVITY THEORY</th><th>SERVICE SYSTEM SUITE</th><th>PSI THEORY</th></tr>
<tr><td>1. Analytical Focus</td><td>Business process</td><td>Global environmental landscape Inter-organisational relation</td><td>Group work activity and networking + contextual factors</td><td>Holistic Work system /Inter-organisational Relation + Environmental factors</td><td>Individual transaction to Business process</td></tr>
<tr><td colspan="6">L1 *In this thesis the analytical focus encapsulates the micro- and macro-context which accounts for a collaborative activity that captures a cooperative business process and its host environment which consists of influencing factors that can affect coordination.</td></tr>
<tr><td colspan="6">COORDINATION CONSTRUCTS</td></tr>
<tr><td>2. Interdependency</td><td>Primary: Activity to activity Activity-Resource (Actors, Units, functions departments in organisation)</td><td>Cooperative organisation relations and degree of coupling between the systems and their components</td><td>Activity networking Sub activity action relations Actor-Actor Actor-tool Actor-activity</td><td>Producer/ consumer Service systems Activity-tool Actor-tool</td><td>Actor to actor Implied Actor to activity relation</td></tr>
<tr><td colspan="6">L2 *This thesis describes Interdependency as the nature and degree of coupling between interdependent organisations and their constituents engaged in collaborative acts which can determine the suitability of the coordination mechanisms employed.</td></tr>
<tr><td colspan="6">PROCESS-BASED MECHANISMS</td></tr>
<tr><td>3. Mechanistic Mechanisms</td><td>Predictable task programming Standardisation: outputs, norms and skills.</td><td>Socio-cultural norms and conventions</td><td>Explicit rules, norms, Reference frameworks, instructions manuals Scripts</td><td>Socio-cultural norms and conventions Standardisation: of work processes, outputs, norms and skills</td><td>Convention, agenda, schedule</td></tr>
<tr><td colspan="6">L3*Ensuring and instituting an agreed set of protocols and standards can facilitate interoperability, common understanding and guide the actions and behaviours of multiple role players towards achieving a common objective with minimal overheads</td></tr>
<tr><td>4. Organic mechanisms</td><td>Mutual adjustment
Relational spontaneous coordination
Developing standards for communication</td><td>Feedback loop for adaptive response to external environment</td><td>Externalisation/ internalisation of knowledge to transform mediation artefact</td><td>Producer/ consumer service adjustment</td><td>Communicative acts to facilitate transaction patterns
Exchanges to establish commitment</td></tr>
<tr><td colspan="6">L4*In this study it reflects a mechanism that facilitates the adaptive synchronisation of action between collaborating entities from the initiation of projects to their conclusion especially in situations of uncertainty, while taking account of changes that may occur, in order to adapt accordingly and stay on track.</td></tr>
<tr><td>5. Cognitive/ implicit</td><td>Implied in the distribution of mechanistic mechanisms synchronisation</td><td>Implied towards achieving a state of system balance through environmental awareness</td><td>Mental knowledge for producing work /mediation through contextual</td><td>Knowledge and skill of work and awareness of the role of actors Shared awareness of commitments</td><td>Shared knowledge to assist shared understanding and decision-making</td></tr>
</table>

LESSON LEARNT denoted as "L"					
	COORDINATION THEORY	**OPEN SYSTEM THEORY**	**ACTIVITY THEORY**	**SERVICE SYSTEM SUITE**	**PSI THEORY**
			awareness for adaptation (Feedback and learning)		
L5* Having a shared insight, founded on common understanding, can enable collaborating members to gauge member circumstances, anticipate the actions of collaborating members and act or react appropriately towards accomplishing a cooperative work objective, in a non-intrusive way, while accounting for and accommodating changes in the dynamic environment.					
STRUCTURE-BASED MECHANISM					
6. Communication pattern	Horizontal communication and implied vertical communication	Horizontal inter-system model interaction Feedback loop process control mechanism (roles and responsibility) Vertical hierarchical subsystem interaction	Workflow process Actor to actor interaction	Explicit horizontal communication Synchronous and asynchronous exchanges for establishing agreements and eventual follow-ups between actors Implied vertical communication	Explicit Horizontal communication Implied vertical communication on transaction
L6*The communication pattern represents the collaborators' shared communication model that results over a period of time, which may employ both formal and informal communication approaches to manage and facilitate timeous information diffusion and reactions to suit the dynamics of a specific context.					
7. Organisation / Decision-making structure	Hierarchical resource/task allocation decision Implied Centralised liaison/ mediating devices Formal authority /informal control , task force or standing committee (teams voting)	Specialisations and decentralisation in network structural coupling and distribution Responsive/ Adaptive decision-making Hierarchical distinction	Division of labour /decision-making power Activity hierarchical distinctions Centralised or decentralised	Actor to actor negotiation Role specification	Actor to actor transaction and negotiation on commitment
L7* Reflects the characterisation of the management process and governance structures employed by collaborating organisations to manage their relationships and achieve a sense of coherence, increasing efficiency by controlling the flow of information, while ensuring accountability.					
8. Modularisation	Activity composition in business process Goal decomposition (task/subtask) to respond to complexity	Modular activity design and composition for flexibility and efficiency Modular separation of functions into distinct parts Level and reasons of coupling between parts (loosely or tightly coupled) Integration mechanism to manage coupling	Activity work process definition (Modular actions) Division of labour to manage complexity	Composition of sub-service towards a larger service output	Purposeful separation of transaction actions Compositions of transactions toward a defining a process
L8*Describes the division of complex task into manageable parts or concerns to be addressed or function separately, but can be dynamically assembled to work together as a whole to achieve uniquely defined objectives.					
9. IT based mechanism	Support information processing to reduce coordination cost	Support for process efficiency Intersystem interaction Support for modular service abstraction and integration System sustainability and adaptive evolution	Means of work , mediation (communication &coordination) and networking Facilitates adaptive operational evolution	Support for process activities and service/self-service interaction Modular abstractions of services /interfaces standardisation for business process flexibility and interoperability Sustainability and adaptive evolution	Support for communication acts. Information process and knowledge management for process support.
L9* Reflects the dynamic integration of ICT functionality that facilitates adhocracies by creating and managing dynamic collaborative processes and structures in an agile and adaptive environment that transcends distance and space.					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CHAPTER 3

COORDINATION RELATED WORK IN PRACTICE

The previous chapter answered the question: *"What is possible in principle, as far as coordination in a distributed environment is concerned?"* This chapter is intended to expand on and extend the discussions from the previous chapter, through answering the question: *"How is coordination in a distributed environment supported in practice?"* In this chapter existing coordination practices, tools and technologies are reviewed, determining the extent and limitations of their support. This consideration is aimed at extracting baseline requirements and ideas from practice, in order to guide the design of an IT artefact that can holistically account for coordination support in a distributed environment.

Coordination practices are considered from a socio-technical perspective, taking into account the people who collaborate and the processes through which they collaborate, in conjunction with the tools and technologies that support their efforts. This approach concerns interdependent social, technical, and environmental subsystems, in consort with how they align and work together, towards the optimal, effective and efficient functioning of the organisation.

The initial portion of this chapter introduces the collaborative technologies that will serve as the basis of the review. Thereafter, the chapter presents and discusses the socio-technical organisational pillars of people, processes and tools. Lessons drawn from the literature and theories surrounding collaborative technologies are presented, especially in regard to strengths and weaknesses in practice. This is followed by a brief review and exploration into certain design challenges and considerations, with a final chapter summary and conclusion ensuing. The subsequent chapter section highlights the underlying collaborative support technologies that are critical for the analysis.

3.1 Collaboration Support Technologies

The adoption of collaboration support technologies forms a complementary coordinating technique or approach to coordinating work through the explicit division of labour within a distributed environment. The support technologies aid in facilitating the working together of teams over geographic distances, through the provision of tools that assist communication, coordination and problem solving processes. The 'support' for such cooperative work has been the subject and theoretical construct of the multidisciplinary research field of Computer Supported Cooperative Work (CSCW). This investigatory field examines the potential, possibilities and effects of technological support for individuals involved in collaborative work, advancing the concept that collaborative work can be supported by software tools.

The propagation of personal computers and their corresponding networks, has made the electronic support of geographically distributed groups feasible, cost-effective and realistic. Computerised support for collaboration is recognised as necessary when the collaborating users are physically distributed. This scenario has become more common, with the advances in networking technologies and the increasing popularity of the Internet and the World Wide Web (Israel et al., 2008). Holt (1988) advocates that coordination technologies should express tasks, their diverse relationships and connexions to each other and the people responsible for them, in a flexible and well-integrated manner, while accounting for unpredictability. Distributed teams often turn to software systems, which incorporate groupware, project management, business process modelling tools, and Workflow Management Systems (WFMS), in an endeavour to fulfil their requirements and to satisfy their coordination needs. These coordination support technologies range from the customarily strictly defined and asynchronously executed business processes, as with most WFMS, extending to those that provide communication and cooperation support for groups dealing with more fluid and ill-structured processes, as in most groupware (e-mail, shared workspaces) or combinations thereof.

While there is no consensus on classification schemes relative to these technologies, the degree of human participation in the coordination process and the level of task automation are currently utilised. The scope of support spans from fully automated coordination decision support systems, to those which simply facilitate human interaction through communication, in order that coordination is realised. To provide a foundation for the development of an artefact which can support coordination effectively in distributed environments, this chapter explores certain technological fields: cooperative groupware, workflow management, and virtual communities. Figure 3.1 portrays the collaborative tools, relative to their level of support for task-automation and process-structure, on a grid adapted from Dustdar and Gall (2002). Their focus, with an overview, is explored further in Section 3.

In many organisations where there is reliance upon groups to execute and accomplish tasks well-structured, individually performed procedures usually coexist with ill-structured undertakings requiring cooperative work processes. This results in both types of processes requiring concurrent support.

Although, these technologies may mutually co-exist, for the purposes of this discussion they are considered separate, to assist in effectively accounting for and comprehensively reviewing their usefulness and limitations in the analysis.

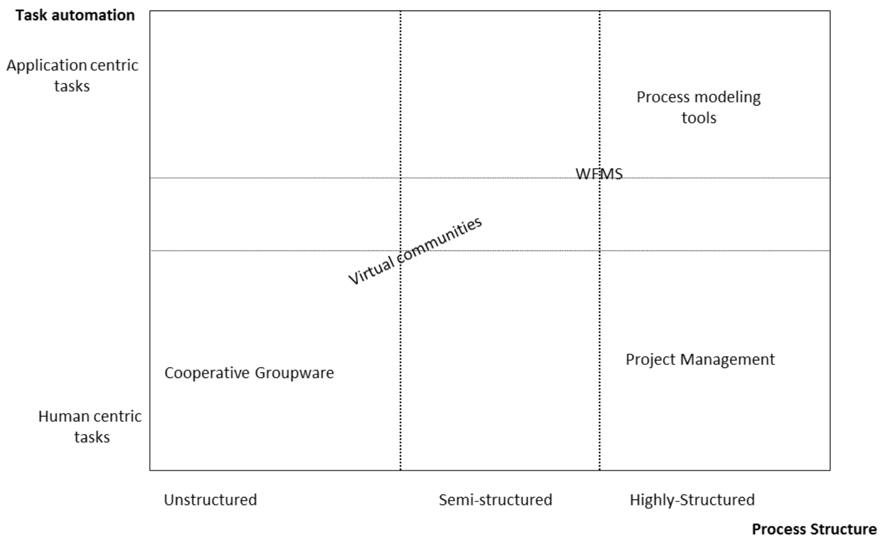

Figure 3.1: The Collaborative Tools Grid

Customarily, support for business processes focuses either on supporting coordination aspects of generally asynchronously based individually executed business processes (WFMS) or on providing communication and cooperation support for groups dealing with more fluid, unstructured or ill-defined processes (e-mail, shared workspaces). Table 3.1 presents a summary of the properties of collaboration tools, reflecting their similarities and differences. While cooperative groupware tends to support more unpredictable and ad-hoc interaction groups, workflow extends automatic strategies and provides predefined procedures to guide individualised tasks. Virtual communities are often caught in the middle and closer to extremes in some cases, with the capability of leveraging both worlds as the situation presents itself, while accounting for a large number of people. Despite this, their overall objective remains constant and consistent: to increase the combined effectiveness of groups or teams engaged in the achievement of a shared goal.

Cooperative Groupware technologies focus on group-level unstructured task management. Unstructured tasks cannot be standardised owing to their innate characteristics, which include their being not easily predictable, and therefore, having no obvious structure. For these tasks no abstract work models describing the steps necessary for performing a task exist, as shown in Figure 3.1. Instead, the groupware system must offer as much flexibility as conceivable to teams, in order for them to execute the actions they deem correct or necessary to achieve a particular goal. Groupware provides a shared environment for people engaged in a common task. Ellis et al. (1991) classify groupware as a computer-based system, which provides an interface to a shared environment, in order to support groups of people engaged in accomplishing a common task or goal. This often requires a high degree of group awareness, with co-workers and role-players being cognisant of past and present actions within a shared environment. Groupware provides mechanisms for synchronising cooperative behaviour.

Table 3.1: Summary of Collaborative Tools Properties

	PROCESS	MEMBER AWARENESS LEVEL	INTERACTION	DOCUMENTATION/ TRACKING
COOPERATIVE GROUPWARE (Formal teams/group formation of known members)	Unstructured/unpredicta ble assumes dynamically shifting goals	Group awareness of past/present co-workers	Synchronous/ asynchronous ad-hoc Formal/informal communication/shar ed work space	No- obvious structure Difficult to keep track of activities + interactions
WFMS Individual functions in departments – Organisational	Mostly Predictable (highly structured-semi-structured formal model) Assumes well-defined business goals	Individual activity awareness Organisation process model specific	Formal (work list) Asynchronous communication	Easy documentation and tracking made
VC Dynamic teams/groups formation in larger community of known/unknown members	Dynamic degrees of semi-structured to unstructured Somewhat-defined +dynamically shifting goals	Ad-hoc /informal community/group/ individual activity level and real-time action running commentary and presence	Social protocols Synchronous/ asynchronous ad-hoc formal/informal communication Shared work space	Fairly balanced easy documentation/ tracking

Groupware does not typically control the activities of the user, unlike WFMS, and notably neglects support for automatic execution and monitoring of processes. This form of coordination control frequently does not incorporate facilities for process definition and constraint configuration. Rather, the category predominantly provides synchronous and/or asynchronous communication capabilities to facilitate human to human interaction as a means to coordinate collaborative work. Ordinarily, knowledge and information sharing within a work group, rather than the ordering of their tasks, characterises these applications. This denotes that they customarily deal with ad-hoc work-processes within an organisation. As such, any enabling technology, where predominantly human interaction or decision-making is facilitated in order to promote coordination between geographically distributed users, supporting ill-structured processes, is classified as groupware.

Workflow management systems relate to more structured processes than groupware, with the tasks involved frequently formalised by a detailed model, clearly describing and specifying the steps requisite for completing the task. Typically, each task is assigned a role corresponding to an active individual or group, who actually executes the task.

The workflow management approach often involves fully automated, computer driven coordination as shown in Figure 1. Despite the possibility of several people being involved in attaining a common objective, each acts individually in an assigned, precise stage of the work process. Table 3.1 presents a summary of the properties and focus of WFMS. Workflow management systems are being increasingly applied to handle the coordination of structured tasks, as well as the execution of the individual steps associated with these tasks. Workflow is generally associated with the concept of business processes, through representation of it in a machine readable format. The business process is considered to be a set of procedures or directly related activities that collectively contribute to the realisation of a business objective (Mueller, 2001). The Workflow Management Coalition (WFMC) defines workflow as the whole or partial automation of a business process, in which documents, information or tasks are sent from one participant to another to influence their actions, in accordance with a set of established rules. As such, the issues which concern automatic scheduling and the ordering of tasks that require little or no human intervention to manage formalised or structured processes at runtime are considered workflow technology-oriented. This kind of coordination is most suitable for routine and highly repetitive business processes, whereas a process model can be fully defined in advance (Marjanovic, 2005). Therefore, as opposed to groupware, the workflow automated systems reduce the need to communicate.

The strength of WFMS lies in the system-driven process definition and its controlled enactment or execution, which enables various features, incorporating: status and history tracking as well as automatic scheduling. However, most WFMS have problems supporting non-structured or incomplete processes. Thus, complementary synergy with groupware is often explored, and will be discussed in further detail later in this treatise. Also, WFMS mostly focuses on coordinating and controlling the activities of an individual user in pursuit of efficient scheduling of the actions of the user in a particular situation, rather than providing cooperative support for groups of users in defining and executing dynamic collaborative business processes. The need to pursue approaches that allow collaborative systems to evolve over time has been suggested. It has also been established that no representation of workflow in any organisation can be wholly complete (Bannon & Schmidt, 1996; Marty, 2005). This underscores the need to develop collaborative systems that are capable of co-evolving to meet requirements that cannot be predicted in advance and this issue is explored with virtual communities.

Virtual communities influence tele-cooperation, a construct that describes the cooperation among spatially distributed partners, supported by computer driven telecommunication systems. Virtual communities can provide support for the three areas of collaborative business processes which comprise communication, coordination and cooperation. As shown in Figure3.1, virtual communities maintain a hybrid state, with the possibility of a mixed composition of both groupware and workflow properties, as described in Table 3.1. Virtual communities can account for a larger scale of collaborating partners, contrary to groupware, in which coordination functions and relationships become cumbersome when situations involve a larger number of users, or workflow where coordination is often focused on individually driven activities. De Moor and Weigand (2006) deem that in an increasingly networked society, with a need for global and flexible ways of professional or social interaction, virtual communities are the natural candidates to fill collaborative gaps in traditional, hierarchical organisations.

Virtual communities exhibit dynamic properties, which include: flexibility, adaptability, scalability, and robustness. To support collaboration and to optimise the effective use of limited resources, organisations adopt new organisational structures, which facilitate flexible and decentralised work management. This has led to flatter, coordination-centred organisational forms, such as networked organisations (Malone & Crawston, 1994) and virtual organisations (Mowshowitz, 1997) to account for the business processes that extend across organisational boundaries (Mehandjiev, et al., 2003). This leads to virtual communities being capable of representing flexible networks consisting of independent, globally distributed entities (individuals or institutions) that share knowledge and resources and work towards a common goal. They can form, disband, and re-form to meet fluctuating, spontaneous and emerging situations. In addition, they transcend geographic locations and time constraints, thereby enabling anywhere, anytime access.

Virtual communities such as social networks, like Facebook, focus on bringing unknown people with similar interests together, mediated by technology to facilitate social interaction through contact initiation and knowledge sharing; and they are dependent on social protocols or norms for coordination (Chiu, Hsu, & Wang 2006; Porter, 2004). From a business oriented view it is conceived of as virtual cooperation, which represents collaboration or alliances formed to achieve a common objective, through the extensive use of ICT to enable vertical integration and collaboration (Leimeister et al., 2006). For example, the Dell supply chain is leveraged for 'just in time' production or ecommerce web sales. Transactions are satisfied by other work organisations that find, package and ship the products.

Aside from the unique characteristic of bringing widely distributed people or businesses with shared interests together dynamically, virtual communities can be leveraged to account for groupware and workflow functions, commonly at different levels of granularity. Similar to the way that workflow and groupware technologies can benefit from each other by embracing the human-to-human interaction paradigms and adding explicit and consistent process definition and enactment respectively, virtual communities can subsume both functions towards collaborative business process support. The collaboration process, in this instance, extends beyond a single department, organisation or enterprise, often supported by existing workflow technologies. This enables a virtual community to facilitate the cooperation and execution of inter-organisational processes. Moreover, it can be leveraged to bring people or institutions with shared pursuits or concerns together; provide them with opportunities to collaborate and exchange ideas; and can extend beyond the use of simple social protocols, as the need arises to coordinate activities across organisational boundaries. This is done by utilising the Internet platform. Gupta and Kim (2004) stress the significance of virtual communities in their capacity to build trust, relations and commitment over the Internet.

To understand the lessons in practice, the subsequent section introduces the socio-technical components influenced by these collaborative technologies, to account effectively for their functionalities and limitations.

3.2 The Effects of Collaborative Technologies on Coordination Support Pillars

Cooperative systems have been defined as a combination of technology, people and organisations, which facilitate the communication and coordination necessary for a group to work together effectively in the quest of a shared objective, to achieve benefits and advantages for all its members (Ramage, 1999). The definition is synonymous with the Computer Supported Cooperative Work discipline (Greenberg, 1991; Garrido et al., 2005) which studies and analyses coordination mechanisms and their supporting systems for collaborative support. CSCW describes software systems designed to support collaborative work as inherently *socio-technical*. Per se, the co-evolution of collaborative systems and the social practices they are designed to support must be in balance (Ackerman, 2000) to be effective. Marty (2005) contends that the inability to address any balance disparities can result in inefficient work practices. The socio-technical components that must be in equilibrium are the people who collaborate, their supporting processes, and the tools responsible for the transformation of an organisation, subsequently described as the pillars of that organisation. Grenville (2005) asserts that organisational design improvements may be defined by these socio-technical pillars; therefore this section employs them to serve as the framework for the discussion. The influence of the collaborative tools discussed in the preceding division affects these pillars from various perspectives. The first of the three pillars, 'People' is described in the following subsection.

3.2.1 The People Pillar

People are the core assets of an organisation. They possess the capabilities and skills, which include: the capacity for creativity, learning and decision making. Their aptitudes and ability to reason makes them a valuable asset to the organisation. They are enabled by processes and tools to produce goods or services. People can create, compose and configure other socio-technical components towards a value-driven purpose. An important aspect of people is governance, which is often responsible for the policies, roles, responsibilities, processes and structures established to guide, direct, and control how an organisation accomplishes its business goals and its reason for existence (Espinosa & Kim 2007). Important perspectives that support coordination include working relationships, social cognition and inter-personal communication activities (Kotlarsky et al., 2008). Allen (1997) and Olson (2000) aver that dense social networks, intense communication networks, and loosely-coupled work structures can aid distributed teams in coordinating their work. The 'people' pillar associated perspective must be examined for experiences and examples to help provide support for coordination in a distributed environment. The subsequent sub-section reveals the shared social cognition perspective on coordination.

3.2.1.1 Shared Social Cognition

Shared social cognition involves resources that provide shared representation, interpretations and systems of meaning among parties (Nahapiet & Ghoshal, 1998). These cognitive properties are frequently expressed as shared vision and language, along with other factors. Essentially, shared social cognition reflects the frames of reference and/or mental models that people share because of their similar or related personal experiences or training (Kotlarsky et al., 2008). Virtual communities present a medium that supports contact initiation with unknown or known collaborators, who share similar interests and preferences, denoting that the basic unit of collaboration is shared interest. Cooperative groupware frequently assumes the knowledge possessed by collaborators, in that it provides a medium to contact and interact with known cooperative partners, who aim to achieve a common goal.

Schilter (1998) theorises that awareness is an essential precondition for making contact with other members of a community. Information regarding who is in the same virtual place, in conjunction with their interests, facilitates the initiation of contact. Furthermore, it encourages informal spontaneous communication between community members and contributes to their ability to make informed decisions. The idea of increasing social awareness in virtual communities expedites social interaction grounded in the physical world. To support the awareness of shared interests and experiences in communities, knowledge awareness is emphasised (Sumy & Mase, 2000).

Table 3.2 presents some examples of how social cognition is influenced by the various aspects of collaborative tools. One prominent benefit of more sophisticated virtual communities, for instance Facebook and Ecommerce, and communities like Amazon, is the community awareness service. The service leverages shared cognition by taking partial advantage of the preferences and certain contextual information provided by individual members. As members provide their personal information and preferences, they highlight location information and interest, which is used to provide friend recommendations on social networking sites, like Facebook, and object (e.g. books) suggestions on transaction sites, such as EBay and Amazon, accounting either for synchronous or asynchronous awareness notification instances, online or offline. However, there are associated challenges, as the asynchronous updates are often sporadic at best, with inadequate user controlled notification filters, exacerbated by other issues.

Being part of a community may make it easier to identify members who possess a required skill or competencies, and are willing to collaborate and exchange information towards the appropriate execution of an individual or group task. Stated differently, it may be relatively simple to identify an individual in a select, like-minded group, who has similar interests or who possesses the requisite characteristics for a specified task or the accomplishment of an objective, and who is willing to exchange knowledge and/or enter into a joint effort towards a common end. This underscores the primary aspect of community support being to facilitate the identification and selection of potential collaboration partners.

Overall, virtual communities predominantly focus on finding people with similar interests, while, contrastingly, groupware often focuses on the collaboration process which synchronises and exchanges information in the context of a specific task team. Cooperative groupware supports human interaction within or between groups and establishes conventions on a shared artefact. Awareness information is considered vital to the success of cooperative work (Schilit et al., 1994) as it aids in establishing a common ground for individual and cooperative actions (Kirsch-Pinheiro et al., 2004). Product examples of groupware include Lotus Notes and Microsoft Exchange, both of which facilitate calendar sharing, e-mail handling, and the replication of files across a distributed system, allowing all users to view the same information. Electronic 'face-to-face' meetings are facilitated by CU-SeeMe and Microsoft NetMeeting. Awareness information can help to define activities and the expectation of users; however, to prevent possible awareness information overload, the concept of personalised context-ware content delivery is often prescribed (Kirsch-Pinheiro et al. 2004).

Furthermore, the inherently distributed nature of cooperative work denotes that interoperability must be accounted for (Simone & Schmidt, 1998). The type of interoperability considered in this instance, is semantic interoperability at the cooperative level, extending beyond the technical infrastructure or between loosely-coupled applications. The interoperability of systems to support cooperative work concerns the means, methods and practices adopted by users to coordinate their cooperative activities. The groupware 'Reconciler' is an example of a system whose main objective is to manage the interoperability between groups at the semantic level, reconciling their visions through the treatment of terminology and unity conflicts, along with other factors (Raposo et al., 2001). With workflow systems the extent of shared cognition is tacitly related to the underlying organisational model, which connects roles and responsibilities to the actual, active work performers. Frequently, the focus of user cognition workflow is limited to the task list, as presented by the workflow management system.

Table 3.2: Examples of Collaborative Tools Influence on Shared Cognition

PEOPLE	COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Social Cognition frames and mental models: language, culture, beliefs and norms	Ad-hoc human interaction Support for intra and intergroup cooperation with predefined conventions on a shared artefact **Reconciler:** known collaborators Semantic interoperability to Reconcile contrasting conventions/perspective on shared objects for mutual awareness in tight cooperative work.	Implicitly captured in process definition, thus limited view by users.	Member shared interest, Social interaction/social context aware contact facilitation, information and knowledge sharing **Facebook :** Friends recommendation, Social Interaction **Online Dating (zooks)** sites location based recommendations **Amazon** Shared interest/semantic collaborative filtering based object (book) suggestion)

3.2.1.2 Knowledge of Working Relationship

Working relationships enhance the accuracy of expectations and predictions relating to the thoughts, activities, and awareness of another person, and plays a major role in groups or communities. Many patterns deal with the process of developing and maintaining interpersonal relationship. Dourish and Belotti (1992) advocate that awareness information is always required to coordinate group activities, whatever the task domain. Coleman (1988) avers that social relationships between people, serving as productive resources, are the core of social capital [2] theory. Nahapiet and Ghoshal (1998) define social capital in terms of structural, relational and cognitive dimensions. The structural dimension (as social-interaction ties) accounts for the overall connection patterns between role-players; the relational facets (trust, identification and norms of mutual benefit) refers to the type of personal relationships that have resulted throughout the history of interaction between people; and the cognitive components focus on shared

2

Social capital can be defined as the total resources existing across a social network (Cronk , 2011) representations, meanings and interpretations lending support to coordination, as revealed and discussed in the previous section.

Virtual communities demonstrate the importance of social ties: in a strong community social connexions facilitate knowledge exchanges, and through close social interactions the depth and efficiency of mutual knowledge exchange is increased (Chiu et al., 2006; Lane & Lubatkin 1998). Virtual communities are characterised as groups of people sharing social interactions, social ties and a common 'space' (Kosinets, 1999), in consort with of a set of relationships that provide sociability support, information, and a sense of belonging (Wellman, 2001). The primary elements rooted in such societal, cybernetic networks of relationships include: shared norms, identity and trust. Coordination roles or referrals in virtual communities may serve as structural components to influence trust formation positively within the community (Akram, Allan & Rana, 2005). Table 3.2 presents some examples of how knowledge of working relationships is influenced by aspects of collaborative tools.

Table 3.2: Examples of Collaborative Tools Influence on Knowledge of Working Relationships

PEOPLE	COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Knowledge of Working relationship Stakeholders involved: Who and what they are doing.	Group awareness configuration **Lotus Notes** Synchronous collaboration **Intermezzo:** use of roles and policies to access control support flexible object-level coordination and shared workspace awareness	Assumed roles in process definition Machine formal controlled relationship **SAP :** document approval transfer **Toxic farm** workflow /to do list	Roles definition Community/group awareness **Online Multiplayer gaming (Heracles)** **DELL Virtual organisation** business partners to fulfil parts of their supply chains. **Glasscubes project-based** community members/roles

Research in CSCW accentuates awareness-oriented collaboration systems, where users coordinate their work utilising knowledge of what the collaborating group members are doing or have done. The identity of a collaborator and awareness of their activities is required to determine the type of awareness information necessary in a team. Group awareness constitutes the understanding of the activities of other members, thus providing a context for one's own activity (Schilter, 1998; Dourish & Blloti, 1995). Zhang and Weiss (2003) describe awareness as the ability to preserve, and continuously to sense and update the social and physical context of a user. An increase of awareness within a collaborating group encourages informal spontaneous communication, such as Chat, video conferences and phone calls. Status and presence awareness information in groupware, like Skype; mail systems (Gmail and yahoo); along with social networking sites (Facebook), supply tools to support synchronous communication. Schilter (1998) theorises that people are more apt to contact others directly if they perceive the individual to be contacted is free and at leisure, and able to be interrupted with nominal interference of the on-going work of that individual. Awareness is imperative to keep group members updated on important events contributing to their ability to make sensible decisions.

Identity in groupware is deemed by Williams (2003) as a kind of awareness. Through identity the processes of workspace awareness and feed-through (running commentary of the actions of other users) are possible. Identity is useful for role restrictions, which determine the actions a user can or cannot undertake (Dourish & Belotti, 1992). Fundamentally, the uncertainty about the actions a user might take is reduced; while providing awareness among participants about the probable activities of others. Role restriction is also useful as a means of access control (Bushbach, et al., 1997).

Workflow tasks are defined for known roles. The most common function provided by workflows is assigning tasks to staff, thus the relationships are machine controlled. The only flexibility allowed is to assign different users to the same role, thereby granting them permission to perform their allocated tasks. However, all roles have to be specified in advance and stored in a workflow repository, along with their corresponding tasks. During process execution, the workflow engine will use the repository to allocate tasks to the appropriate roles (via individual or shared to-do lists). Other less-automatic tools, such as the regular project management tools; simply take cognisance of the formal relationship between the different roles and the corresponding milestones. Conversely, in emergent processes, although not all users and their roles are always known in advance, relationships are supported. Groupware supporting functionalities include*: e-mail*, news, discussion, and document repositories.

3.2.1.3 Communication

Communication is the simple ability to exchange information between parties involved in a collaboration process, usually in different forms. Communication patterns may emerge as a set of definitions describing desired or acceptable interaction patterns within a community. Patterns for various forms of interaction in groupware are often provided as templates (for instance, shared news databases or simple discussions,) in systems, such as lotus notes. However, both formal and informal communication structures are useful for adaptive coordination support within organisations (Atkin et al., 1994). Formal communication represents channels which incorporate: agenda-based meetings, formal correspondences/interviews; flow within the chain of command or task responsibility, as defined by the organisation (Daft, 2000). Informal communication embodies conduits such as tea room chats or forums, and is not usually bound to strict rules and conventions. Such channels exist outside the formally authorised channels, with no regard for an organisational hierarchy of authority (Daft, 2000). Table 3.3 presents some examples of how communication is influenced by aspects of collaborative tools.

Table 3.3: Examples of Collaborative Tools Influence on Communication

PEOPLE	COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Communication Sporadic face to face Telecommunication Voice/fax technology	Messaging /voice Synchronous/asynchronous **Skype:** messaging/video conferencing, **Gmail/Yahoo:** instant messaging/e-mail **Instant conference** **Basic Support for Cooperative Work** (BSCW) shared workspace +awareness	Automated asynchronous event-driven notification **Web-based Toxic Farm** Work List/mail notification	Web-based messaging /voice Synchronous/asynchronous **Google+, Facebook** instant messaging/ e-mail and forums **Second Life** Avatar online formal/informal meetings Tea rooms/water cooler

Both formal and informal communication channels between collaborators are useful and aid in avoiding misunderstandings or mismatching. In situations of uncertainty, workforces communicate to establish a shared understanding or to resolve issues. Generally speaking, groupware tools enable communications between collaborators working on a mutual task and usually include using different communication technologies, from simple plain-text chat, to advanced video-conferencing (Martín, et al., 2003). Text-based communication via e-mail and chat programs, for instance, have been complemented by multimedia e-mails, Internet telephony and video conferences, among others. WFMS clearly does not deal very well with communication and is often focused on one-way notification systems at best.

In collaborative communities, effective and efficient communication is essential to perform and coordinate work, in conjunction with defining, calibrating, and evolving community governance structures and processes. This is because communities are not declared, but develop over time (De Moor & Weigand, 2006). These communications help to create a sense of community and belonging for members, allowing them to influence others, and to relish a state of flow (Kohl & Kim, 2004; Blanchard, 2004). Communication processes are critical for virtual communities to succeed, be productive, focused, sustained, and to evolve. A variety of tools are employed by collaborative communities in an endeavour towards achieving a common purpose (De Moor & Aakhus, 2006). A multilateral communication type is supported and evidenced, for instance, by bulletin boards and list servers.

Support for direct communication among a distributed team may be realised through standard synchronous and asynchronous methods of computer- and network-based communication: telephone calls, video and audio conferences, text talk, e-mail/news. Other direct communication approaches utilise avatars in 3D virtual spaces, for instance, as in Second Life, which also integrates the communication and conferencing capabilities of Skype. Studies indicate that the emergence of an appropriate communication structure may lead to more productive teams (Hinds & McGrath, 2006; Cramton, 2001) Members of distributed teams depend considerably on communication technologies to facilitate their interactions. Situations arise that only benefit from tightly-coupled modes of work, which require more communication overheads. This underscores the requirements for technological support to facilitate such necessary communication. Liechti (2000) holds that an indication of whether users are present in a shared workspace encourages real-time interaction in a virtual space. This accentuates the substantial role and significance of the element of contextual awareness as a facilitator.

Groupware, comprising mechanisms such as e-mail, desktop and video conferencing tools, are transforming personal and business communications (Poltrock & Grudin, 1995). While each, individually, offers unique benefits, newer technologies are able to gain advantages and market share through the integration, amalgamation and incorporation of these e-mail and conferencing features. For instance, Skype, an integrative groupware, allows users to communicate with peers through a microphone for voice input, a webcam for video interface, along with instant messaging and image sharing over the Internet. Additionally, this technology is being further integrated, extended and advanced. For instance, the Outlook.com e-mail service of Microsoft is assimilating Skype to webmail, thereby adding video and audio calls to its interface (Lancet, 2013).

Organisations often use e-mail to hasten the flow of information and to cut coordination costs (Sproull & Kiesler, 1991). There are negative elements associated, however, aside from the issues relating to spam and virus contaminations. An additional threat results from administrative overheads, which manifest from the sheer volume of e-mail an individual is expected to manage and acknowledge (Symantec survey, 2010). This has become a common, frequently recognised problem in groupware or virtual communities. The complexities associated with e-mail content control and archiving has resulted in the overwhelming interest in intuitive e-mail management applications, such as 'Mailbox'. Certain mail providers, for instance Google, have modified their mail system (priority inbox), to assist the user to sort and categorise mails in accordance with specified urgencies, significances and priorities, thereby aiming at reducing the management burden on the users.

Kiesler (2002) contends, however, that while technologies may provide communication links, people tend to communicate less and engage less in unplanned, spontaneous interactions with their co-workers (Hinds & Mortensen, 2005), with a significant drop in face-to-face exchanges. Workflow technologies, as previously stated, are examples of IT applications that reduce the need for communication and coordination, as they automatically route work-related documents, information rules and activities to the active, participating individuals (Alavi & Leidner, 2001). Essentially, workflow technologies communicate by passing information, documents and tasks from one employee or machine within a business to another. A workflow process can be designed to generate notifications about the progress of a specific record or activity, especially where the reports include e-mail notification. These notification or alerts can be specifically allocated with purposely designated roles or groups as recipients. Workflow systems can locate and communicate with a client for whom the execution is carried out.

In a state of dynamic, fluctuating and context-dependent situations, effective communication and exchange of distributed data or services is crucial in collaborative networks (Bianchini & Antonellis, 2006). A primary benefit of group awareness tools is to facilitate coordination among people, and to provide cues helpful to initiate communication and collaboration. This is clearly evident in a virtual community collaborative environment, through certain elements, including news feeds and presence. This is so in existing mail systems which define the availability of using a communication channel, whether text or voice.

3.2.1.4 Information and Knowledge Sharing

Successful coordination concerns both information and knowledge sharing (Kotlarsky et al., 2008; Jortad et al., 2005). Therefore, relative to collaboration, it is critical to share knowledge. Groupware systems support cooperation by enabling interaction, frequently through a shared document, in order to enhance closer group inter-workings. Groupware often facilitates object level (documents) coordination and shared workspace awareness, thereby managing sequential and simultaneous access by multiple participants to the same set of objects (Orozco et al.,2004). Protective mechanisms, for instance the locking mechanism in database systems, are regularly employed to control use. Examples include document management systems, which help teams to collaborate by providing access and version control, document search, and status tracking (*Poltrock &* Grudin, 1995). Intermezzo provides coordination support and is based on user access control rights on shared objects. GroupKit focuses on data structures, events, user interface widgets and monitoring to support coordination.

Virtual communities facilitate the rapid exchange of information and knowledge, utilising electronic media to communicate within a shared semantic space (Schubert & Ginsburg, 2000). Differences in knowledge can encourage people to communicate, with Sumi and Mase (2000) positing that knowledge-sharing may facilitate the formation of a virtual community. Essentially, information sharing denotes an awareness of that knowledge. Certain organisations, which include Dell and Microsoft, are providing customer support and service through building virtual communities of users and practitioners, where knowledge is exchanged and transferred on an, on-going basis (Ayman & Abuhamdieh, 2006). Virtual communities practise, share and accumulate knowledge relative to: a topic of interest, colleagues, level of expertise, perspectives, community organisation, relationships, interest, competencies, community organisation, relationships, and knowledge that other members possess (Díaz, & Canals, 2007).

Table 3.4: Examples of Collaborative Tools Influence on Information and Knowledge Sharing

PEOPLE	COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Information and knowledge Physical social interaction Post mail/travel, localised information/knowledge management systems	Shared workspace with mutual awareness functionalities **Groove/Microsoft's SharePoint Team Services** integrated workspace (**Google docs, Intermezzo group kit)** synchronous and distributed collaborative applications **Toxic farm** asynchronous data sharing services + awareness: Events on data and data states notifications Asynchronous Document sharing and archiving (place a document in the workspace) **Dropbox , Sugar sync, Basic Support for Cooperative Work** (BSCW) shared workspace +awareness **Glasscubes**-document/file sharing **Reconciler** Semantic interoperability & personalised notification Formal team formation Organise information according to specific relations Grouping or classification schemes are, of course, used in **knowledge management/decision support tools (Lotus Notes groupware)**	Automated tasks list distribution/notification **Lotus notes/FlOWer system** workflow information routing View next steps, monitor what has been done, as well as current progress Information flow pattern **Lotus notes, SAP. IBM** primary organising structure is the "routing" of information objects among users **Process model** directed work list to specified roles in organisation Goal decomposition	Shared workspace Personalised recommendation/notification Archiving & shared information spaces **Facebook**, newsfeeds; forums , shared photos **Wikipedia, peer-peer wikis** **Virtual Tearoom-** social interaction **Glasscubes** – shared online collaboration workspaces for known collaborators +water cooler socialising **Avatar based Second Life** Virtual meeting Water-cooler socialisation **Social text:** knowledge base **Tweeter** social awareness Ad hoc/dynamic team formation Centralised to distributed Governance structures Goal-based activity selection & composition Modular classification and grouping of people in **Facebook, and Amazon interest group like auction** **Wikipedia, Dell, EBay. Linux** governance model

Awareness, as previously highlighted, is critical in facilitating collaborative work, as it supplies individuals with knowledge regarding activities and progress (Wenger, McDermott & Snyder, 2002; Dourish & Belloti, 1992; Gutwin & Greenberg, 1999). Awareness provides data about the existence of new concerns, problems, comments, conclusions, discussions, or even any news about the community structure - the inclusion of new members or groups, etc. Table 3.4 presents some examples of how information and knowledge sharing is influenced by aspects of collaborative tools.

Although awareness, as a source of knowledge has defining categories, they are not mutually exclusive, and are often combined by systems (Liechti, 2000). The types of awareness information commonly considered includes: group, workspace, contextual, and peripheral awareness (Liechti, 2000; Wenger et al., 2002; Kawash, 2007).

Group awareness, as previously emphasised, conveys information about the activities and the status of people in a team; thereby generating context for interpreting statements and anticipating the actions of others, while decreasing the effort required to coordinate tasks and resources. Calendar systems, such as 'Augur' (Tullio et al., 2002) and 'Activity Stream Desktop Tool' (Zhang, 2010), collect and provide details about the personal scheduling information of an individual. The Activity-Stream desktop tool or public display evinces the amalgamated, aggregate calendar information of an individual (Google-calendar, Outlook, iCal), displaying the activities of a user to project and maintain a high level situational awareness. This provides all role-players with knowledge and data relative to the activities and schedules of an individual and how these affect the group.

Workspace awareness stresses the tools used to support collaboration, synchronously or asynchronously. This applies to both the short- and/or long-term. **Synchronous awareness** is consistent with using a shared editor, for example 'Google docs', which makes remote, synchronous collaboration easier. Additionally, Groove provides subscriptions for user presence and activity awareness. **Asynchronous awareness** refers to shared workspaces, which are continuous, supportive collaborative tasks, possibly occurring over a long period, with the workforce having access to artefacts emerging as a result of the collaboration. Examples of such information comprise, along with other facts, current artefact use or state, and prior usage. Document management systems, inclusive of Lotus Notes and intranets, are frequently used to share information within an organisation. Further tools include electronic bulletin boards and other sharing apparatuses, and are often used to support non-real-time conversations. Certain groupware, however, for instance Tearooms and virtual communities, like Facebook, support both synchronous and asynchronous activities in their virtual situations. **Peripheral awareness** relates to the presentation of information to users without necessarily requiring the full attention of that user. An outstanding example is the presence indicators in Google-chat. **Contextual awareness** is regularly associated with ubiquitous computing, where applications are capable of adapting their behaviour given a specified situation. It is repeatedly described as the behavioural adaptation of systems, relative to situational state changes, alterations or fluctuations.

Groupware systems and virtual communities often implement some construct of contextual awareness in its most basic form. Instances of this are: knowing how and who to contact when certain activities occur, or receiving dating match information based on location and profile preference settings. Workflows project partial awareness of the organisational context supplied in the generic process model at build time. They are deemed partial, as they frequently neglect certain significant factors, such as the 'why' or the greater context of the work. WFMS are typically 'organisationally aware' because they contain an explicit representation of organisational processes (process model) (Dustdar &Gall, 2002). The need to study the correlations and connexions between process-driven and awareness-based coordination is imperative, in order to provide process awareness (Charoy, et al., 2005).

Awareness information is considered crucial for the success of cooperative work (Kirsch-Pinheiro et al., 2006). It is vital, however, to consider what information users should be made aware of and how they should be made aware of it (Leitch, 2000). This denotes, to prevent excess distribution of data, it is critical only to notify users regarding events deemed relevant, as aligned with the notification means. This results in the principal requirement in dealing with unusual information overload, which may generate requirements for extra effort or mask important information. There is a vital need to personalise recommendations or feedback.

A class of systems which facilitates personalised context-driven responses is called **recommender systems** which incorporate Amazon and EBay. Here people rate information items they come across, for instance books. These ratings are used to filter incoming information, relative to the specified interest level. Recommender systems are considered efficient tools for overcoming the information overload problem by providing users with the most relevant content, data or ideas, habitually generated through the selected preferences, partialities and stated predilections of individuals and the ratings supplied to choices made by them (Breese, Heckerman, & Kadie, 1998; Abbar et al., 2009). In an effort to provide users with personalised content, applications employ various techniques, which comprise: content recommendation, content filtering, and preference-driven queries. These techniques exploit different items of knowledge, organised into profiles and contexts (Abbar, et al., 2008).

Considering that **Personalisation** relates to tailoring products and services to better fit the needs of a user, employing various factors inclusive of their preferences, interests, expertise, workloads and tasks, a scalable and dynamic information service delivery system is required (Linda, 2006). This type of information service publishes and subscribes systems, connects information providers and consumers through delivering events from several sources to interested users (Huang & Garcia-Molina, 2004). Where large distributed networks are concerned, a publish/subscribe paradigm is often suggested for information dissemination from the publishers (data/event producers) to the subscribers (data/event consumers) (Shen, 2010). These publish/subscribe systems have been employed in a variety of applications, ranging from personalised information dissemination to large-scale and critical monitoring. Linda (2006) advocates that by introducing a publish/subscribe system information access can be made more efficient, as the paradigm ensures that information is forwarded to the users according to their preferences.

3.2.1.5 Organisational Design

Organisation design mechanisms encompass formal structures, comprising: hierarchies, linking pins, teams, and direct contacts. These structures provide a pillar for coordination support, as they form operational mental models. Organisation design mechanisms define roles for knowledge workers as well as patterns of dependence and cooperation. These provide structures for managing knowledge flows, which facilitate organisational learning and value creation (Kang et al., 2007). Organisational design contributes to concerted, unified actions by making explicit who is responsible for what; who is supposed to know what; and how individuals are supposed to collaborate. This assists in aligning and synchronising their actions. WFMS attempts to achieve such alignment by developing an underlying organisational model (process model), which relates roles and responsibilities to those who actually perform the work.

To cope with the coordination challenges of a distributed workforce organisations adopt various forms of flexible and decentralised work patterns (Mehandjiev et al., 2000). Coordination in a distributed environment often subscribes to a decentralised and network mode of governance, as indicated by the case of the South African public sector. Network structures, which are based on social interaction and informal control, provide coherence and direction to stakeholders in specified circumstances (Robins, Pattison & Bates, 2011; Powell, 1990; Sagers, Dickey & Wasko, 2004). Acha and Cusmano (2005) cite loose-coupling as a form of governance which extends across organisational boundaries and can assist distributed teams. Brusoni et al. (2001), commenting on governance in a networked system, emphasise the critical role of system integrators within loosely coupled organisations.

Furthermore, relative to the work-structure Hinds and McGrath (2006) assert that distributed teams will experience fewer coordination problems if there is less interdependence between members at distant sites. Responding to the challenges associated with and faced by distributed teams, certain scholars advocate for the loose-coupling of work between distant team members (Kiesler & Cummings, 2002). Olson and Olson (2000) note that, for example, distributed teams who modularise their work by site are able to function more smoothly and consistently. There are multiple risks, however, which include isolation, incoherence and the duplication of efforts, generating the need to maintain an awareness of team efforts.

Cramton (2001) and Borman (2010) posit that having the right governance structure to manage interdependencies can ease the coordination burden. Employing an informal hierarchical structure may ensure the flow of information to the correct people as it is needed, thereby making the flow of work more efficient and effective (Galbraith, 1973). A technological solution that presents such a flexible platform for creating and managing dynamic collaborative structures would be valuable. Members of virtual communities could form a specific functional or business unit or group, within the larger community, to provide support services, for instance. This would subscribe to a modular structure design to attain specific goals. Commonly, this would occur with a continuous flow of information, enabling decision-making and management, increasing the functionalities of the corporation.

Virtual communities as socio-technical entities also require control and steering to maintain the common interest of the community (Akram, et al., 2005). To ensure this they subscribe to certain codes of practice. Although virtual communities support decentralised and autonomic decision-making, there is a need to monitor structures, and control communication and information flow among members, in accordance with the operation principles of the community. To define the rules and to coordinate the actions of a community different governance models exist. A virtual game communal group has, conceptually, one large community made up of all the game players. For effective management the entire community comprises smaller, modular groupings. The primary community is composed of smaller communities or sub- communities, accounting for the different types of games and the varying skill levels of players, with community leaders controlling access and maintaining the reputation of the community (Zhan & Weiss, 2003). Furthermore, social networking sites, such as Facebook, make it possible for a number of organisations to generate several project groups, whether social or business in nature. For instance, this facilitates the organisation’s having interactive spaces to engage with their customers, Table 3.5 presents some examples of how organisation design is influenced by aspects of collaborative tools.

Rosenkranz and Feddersen, (2010) underscore the role of management teams (centralised or decentralised) and their importance to the successful running of virtual communities. They define a virtual community management team as one which organises all administrative tasks in the community, providing a technical and organisational framework for interaction and communication. The specified framework is controlled by the management team and focuses on supporting the virtual community and its members. Chiu et al. (2006) add that there is a need to reinforce the mechanisms of mutual trust, interaction and reciprocity among individuals. This can be achieved with the right structure(s) in place.

Table 3.5: Examples of the Influence of Collaborative Tools on Organisational Design

PEOPLE	COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Organisational structure Direct contacts/supervision, committee, hierarchy/liaison devices Highly structured 'heads-down' paper processing	Formal team formation Organise information according to specific relations Grouping or classification schemes are, of course, used in **knowledge management/decision support tools (Lotus Notes groupware)**	Information flow pattern **Lotus Notes, SAP. IBM** primary organising structure is the "routing" of information objects among users **Process model** directed Work list to specified roles in organisation Goal decomposition	Ad hoc/dynamic team formation Centralised to distributed governance structures Goal-based activity selection & composition Modular classification and grouping of people in **Facebook,** and **Amazon interest group** like auction **Wikipedia, Dell, EBay, Linux** governance model

Various virtual communities have adopted single types or combinations of governance. The appropriateness of the selection of a governance structure or combination thereof, is dependent on the context of the existence of the community or group. Ahuja and Carley (1999) allow that, although virtual communities may be non-hierarchical and decentralised from the standpoint of authority, they may still be hierarchical and somewhat centralised from the standpoint of communication. In a continuum of two extreme modes of centralised and decentralised governance structures, as shown in Figure 2, with case examples, four basic modes of governance can be identified.

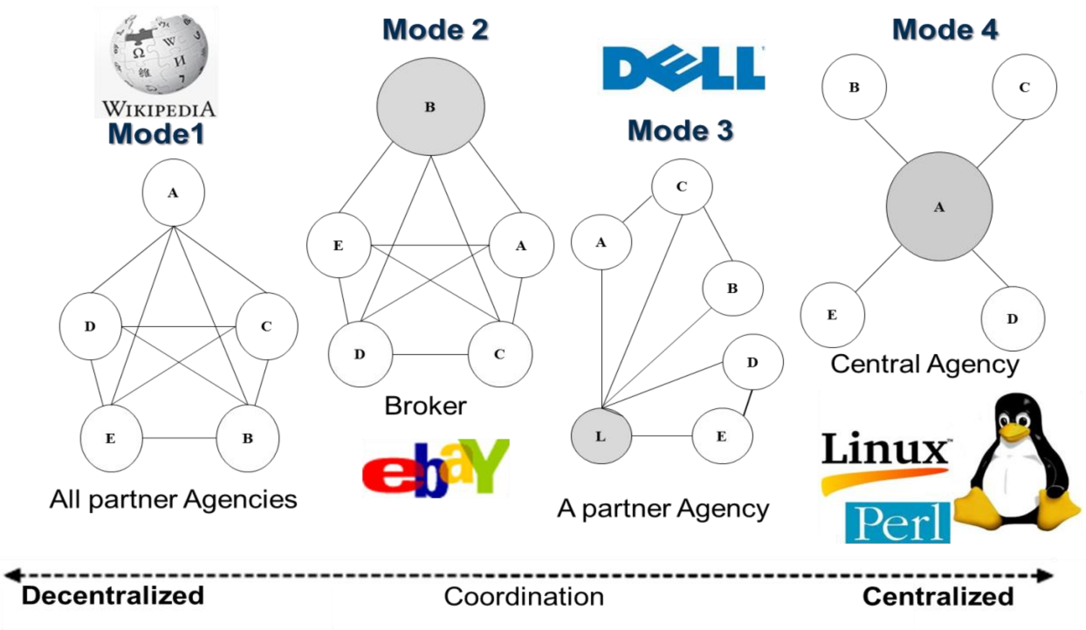

Figure 3.2: The Different Modes of Governance

(Adapted from Lattermann et al., 2007)

Virtual communities facilitate modular design structures, including: functional groups, the offering of a specific service support, or a task force. The virtual community governance concept helps to formalise management under constant change, dynamically matching requirements to tangible satisfiers (Mehandjiev et al., 2003; Mowshowitz, 1994). Moor and Weigand (2007) affirm that the advancement of web applications makes virtual communities natural candidates to fill collaborative gaps in traditional, hierarchical organisations.

At a more technical level, knowledge management represents a form of organisation and reflects how efficiently information is organised and accessed to support day-to-day business operations and decision making (Chowdhury, 2000). The process includes: capturing, organising, refining, and disseminating information, relevant to the activities and interests of people within an organisation. Techniques associated with knowledge organisation include: cataloguing and indexing, ranking, and filtering. Whether utilised to support object-level or activity-level coordination, information access efficiency depends largely on the proper organisation of information, which can be available in a variety forms and formats.

3.3 Process Pillar

While people form a critical part of every project owing to their unique characteristics, including intellect and creativity, individually they are not sufficient to provide the necessary support. Frequently, to account for human error and imprecision, opportunities are realised to mitigate their shortcomings in terms of processes and tools. This section considers the process pillar which enables the people pillar to be efficient and consistent in executing tasks and activities. Process-centred coordination may be described under the broad umbrella of business process management (BPM). Prominent BPM solutions, such as the IBM Flow Mark, the Fujitsu I-flow, as well as the SAP Net Weaver, support the integration and/or alignment of people, information and business processes, across the boundaries of business and technology (Ngeow et al., 2007).

Documentation is usually required, so different groups or functions can work effectively to assure that the needs of the organisation as a whole are being met. These are often manifested in the form of routines or in some form of protocol (e.g. plans, specifications, procedures and standards). A workforce can acquaint itself easily and rapidly with the rules and work patterns, in conjunction with gaining insight and knowledge regarding what is expected of them. Process models, for instance, can serve as a resource for action, in that the process serves as a guide for users to build their own situation-specific plan. Using a process modelling tool, e.g. an inter-organisational business process, activities can be represented and can be shared by participating originations responsible for executing components of the public process. Fundamentally, typical coordination support processes do not have to constrain users to a predefined order of activities that must be enforced, but rather provide guidance towards reaching a goal.

Business processes have long been a focus for the development of computers. The inherent collaborative nature of business processes, carried out by organisations composed of people reflects the need for effective management. Different types of processes or workflows have been distinguished, with workflow or groupware usually focused on supporting a special process type, while insufficiently supporting others (Wainer et al., 1996; Hollingsworth, 2010). The coordination requirements of business process vary based on the fluidity of its structure. A business process can be unstructured, semi-structured, or highly structured, reliant on the need context (Hagen et al. 2005; Heravizadeh & Edmond, 2008). It can reflect the creative, subjective and objective coordination extremes, aimed to support collaboration, as highlighted in Chapter2. Table 3.6 presents some examples of how processes are influenced by aspects of collaborative tools.

One extreme represents a strictly defined process that is captured in a fixed process definition (low fluidity), while the other extreme represents a more complex, intellectually demanding process, which is situation dependent (high fluidity that cannot be completely captured in a fixed process definition beforehand). The usefulness of the various processes varies based on the circumstances presented. Their characteristics and usage circumstances are examined in the next subsection.

3.2.2.1 The Types and Characteristic of Coordination Support Processes

Relative to the dynamics and variation of processes in a situation, different requirements for task coordination, within and between activities, come to the fore. Processes need to be supported seamlessly and to incorporate administrative processes (highly structured); production workflows (semi-structured workflows); and ad-hoc workflows (unstructured process).

A collaborative project commencement may exhibit patterns of unstructured process forms, evolving to semi-structured forms and then into structured forms. In situations where disruption occurs, what was previously a structured or semi-structured pattern may require replacement by unstructured patterns and then re-evolve. Therefore, a coordination process representation ranges between highly structured and unstructured extremes, as well as factoring in the level of automation involved. Processes that are strictly defined, where no process instance can stray from the process model, are highly structured and are usually managed and coordinated by a BPMS or workflow system. **Structured processes** are usually represented as workflows, which can only be enacted as designed, and if exceptions occur, a remodelling of the process by a workflow administrator is required before execution is continued (Dustdar & Gall, 2002). This ensures that they are frequently predictable, pre-defined and easily subject to automation.

Table 3.6: Process Examples and Supporting Collaborative Tools

PROCESS		COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Work-practice mechanisms	**UNSTRUCTURED**	**Group awareness** **Toxic farm** availability/presence awareness of members +document state changes reporting **Google calendar**: Entry/Scheduling **Google site;** Document transfer **Sugar sync** –Doc sharing Support for **Data level integration** Enterprise Resource Planning and SAP, PeopleSoft		Groupware-based synchronous/asynchronous communication and workspace cooperative tools
Plans, specifications, standards, manuals, instructions Paper based transactions Highly structured "heads-down" paper processing Highly structured "heads-down" paper processing	**HIGHLY STRUCTURED**	**Project/task management** Ad hoc Project management tools **MS project;** project management (Tasks are defined but not enacted). **5PM *Web*-based** project and task management software for teams Online Project management of task (**Glasscubes, liquid planner)**	Process modelling & enactment IBM Flow mark fully specified control-flow, resource and data **SAP** Status and Action Management (object state specific). Open WFE, Business Process Modeling Notation (BPMN)+ workflow systems Workflow interoperability support: **OZ**, (point to point) a multisite collaborative WFMS (interoperate heterogeneous and autonomous processes) **Process modelling** can present useful view of "big picture" inter-organisational process.	**Action-Metro technologies** Business process composition
	SEMI-STRUCTURED	Lotus Notes or Microsoft's Exchange that provides some basic (script-based) workflow functionality. **SourceForge Toxic farm,** workflow support/process awareness based on to-do lists (Create/assign new task, + consult list of tasks and their states). Basic Support for Cooperative Work (BSCW) shared work space	Syspro Workflow solutions, CSE/Workflow system Personalised activities work-list Process model-focused awareness	Dynamic global business process formation **Collaborative semi-structured business process support** Service Process integration (Ecommerce community like **transaction based workflow in Amazon/eBay** The integration of the functional flow processing btw the applications. **SemanticGov** one stop portal for live event **artful process support context drive citizen** Self-service Service-oriented approach units of work, composition to an end-to-end process

The strengths of traditional WFMS, such as Flowmark, Status and Action Management (SAP), reside with the highly structured processes, which limits their usability when continuous adaptation to new situations is necessary. With highly structured workflow, once data is entered, usually no additional input from a human is required. Many workflow products appear to utilise the logic of stored process models relatively, which defines task dependencies and execution control flows to support coordination (WFMC, 2001). However, these are usually only effective in the case of routine, highly repetitive processes, where process models and coordination rules can be fully specified in advance. The information required to perform a workflow instance is typically wholly directed by the workflow management system. Some aspects of business-oriented virtual communities, like the Amazon transaction-related service, subscribe to this model, where some patterns are pre-defined in code This triggers the execution of a structured process, for instance, to perform payment verification to provide services to users. Internet-based process management solutions, for example Action-Metro, address the needs of organisations that wish to automate their business processes across a virtual enterprise.

Additionally, although groupware systems, such as project or task management applications, do not support enactment of the tasks, they are highly structured. They manually capture, order and deconstitute tasks to guide project execution. This usually utilised to support the classic project management (Allen, 2005) processes which include, project initiating, planning, executing, monitoring/controlling and closing (PMBOK guide, 2013; Mauk, 2009). This is utilised by project managers, who are commonly the only ones with an overview or insight into the overall complexities. Contrasting to WFMS, these applications do not provide a machine- processable process definition capability as a basis for workflow automation. Workflow automated systems are examples of applications that reduce the need to communicate and to coordinate, while enabling the efficient use of organisational routines through automatic and timely routing of work-related information rules, documents and activities.

Contrary to the highly structured workflow, the **unstructured** process (ad-hoc workflows) frequently requires some form of human intervention. As such, human inputs play a significant and sometimes dominant role in the process, usually directed by a framework or guideline, but only as a recommendation. Each instance of an unstructured process may distinctly vary from another, based on the circumstances, situation, content and skills of the people involved (Goesman, 2000). Highly dynamic situations often depend on informal discussions or negotiations when utilising groupware. These groupware tools are employed for the planning and definition of informal processes, such as a shared work plan document or a shared calendar tool, using apparatuses, for instance Lotus Notes or Microsoft Exchange. As predominantly human-to-human interaction is required, coordination is often characterised by tacit or explicit contextual and general knowledge (Markus et al., 2002). As such, groupware, similar to certain virtual communities, supports emergent business processes, with no exclusively ideal structure or sequence.

While a lot of solutions may exist to support dynamic, evolving, knowledge-intensive business processes, Markus et al. (2002) contend that the effective integration of these technologies, both with the work processes and with other tools, is the primary requirement. Skaf-Molli et al. (2007) assert that the problem lies in finding the appropriate balance of the right tools and their integration. These authors further advocate that the combination of solutions from different domains should complement each other seamlessly. Furthermore, in regard to the often dynamic state of business activities, the need to support both structured and unstructured processes and the uniform, unbroken transition between them has been emphasised.

Semi-structured processes represent a composite of highly structured as well as unstructured processes. Similar to the case with unstructured processes, human input plays a role. Essentially, the semi- structured process presents a circumstance where some activities of the process are structured and others are not. In situations where exceptions occur or the model does not hold, unstructured processes are invoked. Coordination can shift from the model specification in workflow technologies, to tenets of groupware and other knowledge management systems (Hill et al., 2006). Frequently, a focus on effective data integration to support, for instance, human decision-making, is employed to support emergent business processes. Thus, interoperability of distributed support systems is suggested, in order to facilitate information sharing, enabling coordination (Gouws, 2000). Relative to dynamic emergent processes, with highly unpredictable potential users, work contexts and information requirements, it is necessary to have collaborative groupware support.

To realise collaborative business processes successfully different types of procedures, with various levels of structuring, must be executable. One requirement toward flexible business processes is supporting existing social models in the organisation, through additional informal communication or cooperative means (Marjanovic, 2005; Siebert, 1999). Haake and Wang (1999); Hollingsworth (2010); Marjanovic (2005); and Siebert (1999) contend that, since business processes vary with respect to their fluidity, a system needs to provide, in addition to other factors, support for different types of processes. This must happen in consort with appropriate provision for integration and the execution of these processes, along with backing for the explicit formation of goals to guide the processes. Moreover, concepts of communication, coordination and cooperation must be supported together, to ensure collaborative success.

3.2.2.2 Dynamic Integration in Collaborative Process and Challenges

Several efforts have been made to support the dynamic transition between process types, in order to accommodate different coordination requirements. In the most basic form workflow functionality has been added to groupware platforms, like Lotus Notes, to achieve ad-hoc routing. Unstructured task support has also been added to workflow systems, utilising cooperative groupware activities (Siebert et al., 1999). For instance, the Syspro Workflow solution and CSE/Workflow system integrate predefined workflow with ad-hoc workflow, by enforcing the predefined parts in the process definition, and by enlisting the administrator or end user at run-time, whenever a non-predefined series of steps is instigated. Concerning groupware process level integration, systems such as Lotus Notes or Exchange from Microsoft, which support replication and asynchronous editing of shared documents, and provide some basic (script-based) workflow functionality, are significant. Demonstrating a more advanced form of the value of automated processes in virtual communities, is the automated supply chain process scenario from Dell for just in time production. This indicates business process interoperability, where it is possible to enact business procedures and transactions, automatically initiating other organisations to implement those parts of the process which lie within their domain of responsibility. The complete supply chain business logic is expressed in a manner which can be flawlessly automated across diverse business entities.

Although approaches exist that appear to support flexible and adaptive processes, levels of integration are limited, in that there is no single approach that provides exclusive, extensive support for multiple, diverse process types. Usually, the tools focus on a single process with insufficient support for the others. Furthermore, the integration of coordination support for gradually evolving process structures, from un-structured to structured collaborating groups remains a challenge.

WFMS often assumes the homogeneity of products and additionally focuses on coordination of individual users, rather than providing cooperation support for groups of users defining and executing collaborative business processes. WFMS, similar to Oz, is a multisite collaborative WFMS which supports interoperability among heterogeneous and autonomous processes, is limited in its support for only structured processes. Since its means of integration is point–to-point it is subject to the weaknesses of a mesh topology. Additionally, synchronisation between parallel execution and support for dynamic shared-state data between processes is challenged. This stresses the need for process awareness, and although most Workflow systems integrate with process definition and modelling tools in order that a proposed system can be fully specified and simulated prior to introduction, the need for automatic process definition inference is required.

Despite workflow technology being considered a leading integration technology, it is often tightly coupled and limited chiefly to applications and tasks, rather than being applicable between heterogeneous processes (WFMC, 2001). Solutions which combine tools include: Lotus Notes; BSCW; SourceForge; and toxic farm. However, none provides an all-inclusive collaboration solution. In addition, they are proprietary, with deployment and maintenance difficulties, often requiring solid programming skills. For example, SAP workflow integration with Lotus Notes or Outlook requires an Advanced Business Application Programming expert. The need to develop solutions that are integrated, scalable, easy to deploy, and general enough to address a large range of applications, beyond temporal and spatial limitations, has been emphasised (Skaf-Molli et al., 2007; Alfaro et al., 2009). In order to cope with the dynamic collaboration needs of distributed teams, as well as to adapt to different, but necessary processes, this necessitates flexibility in supporting systems (Camarinha-Matos, 2003). A loosely coupled integration approach is emphasised to achieve coordination in a heterogeneous distributed environment. There is, additionally, the crucial need to identify and reveal hidden collaboration opportunities, to achieve seamless, loosely coupled integration.

While efforts have been made to support geographically distributed teams, the level of support provided is insufficient. This is evidenced in web-based platforms that aim to provide some or most of the functionality of existing standalone collaboration tools within a single integrated collaborative environment. For instance, Toxic farm supports both object- and activity-level coordination for formal projects and known collaborators. The activity-level support is mainly based on a ‘to do list’. Ecommerce communities, such as EBay and Amazon, offer streamlined workflow processes between partner organisations, where the functionality of key tasks is integrated, synchronised and synthesised. Although there is no support process modelling, they reflect semi-structured online interactive transaction processing.

Lukicic, Sruk, and Budin (2006) advocate the use of portal technology, to enable the integration and interoperability of function or application in virtual communities. The European one-stop portal provides for this, as it offers service integration of distributed government services for citizens, termed life-event portals. These life-event portals are basically understood as portals that provide public services, organised and integrated according to ‘real-life’ situations, such as ‘getting married’ or ‘establishing a business’, at which stage citizens or businesses require relevant public services in order to comply with legislation (Momotko, 2007). The use of ontology-drive integration at a process and semantic level to achieve a common and shared understanding of a domain(s) is also emphasised (Obrst, 2003).

As part of the egovernment initiative, for instance, a one-stop portal; a European project SemanticGov, provides integrated public services to citizens using semantic web technologies. Life events are composed automatically on the basis of public service descriptions, supplied in Web service modelling language (WSML) and concepts from the web service modelling ontology. They integrate and share information across traditional government boundaries, which involve complex interactions among a variety of participants, all utilising complicated technical and organisational processes. Virtual communities can access and effect the personalised user integration of tools. For instance, Facebook, a social networking service, allows ad-hoc integration of tools to support specific user needs. Essentially it should be simple and easy for users to design their own orchestration of services, as well as to configure their own service front-end web access to services, by means of self-servicing. A balanced integration of tools can result in flexibility and dynamic views of relationships (artefacts and people), as well as process awareness.

3.3.1 Tools Pillar

Tools make people and their coordination processes more efficient. As established in previous sections various solutions that deal with coordination challenges often function by sharing messages or documents, or employ tightly coupled workflow designs. The support for business processes, as mentioned above, typically focuses on supporting the coordination aspects of generally asynchronously executed business processes by individuals (WFMS); or on providing communication and cooperative support for groups dealing with more fluid, unstructured processes (e-mail, shared workspaces); or on a combination thereof, within more advanced virtual communities. This section therefore considers the optimisation efforts of collaborative tools, as with the supporting infrastructures, to account for their various limitations towards achieving effective coordination, at people and process levels, respectively. Table 3.7 presents some examples of some of the optimisation efforts considered.

3.2.3.1 People Level Tools Optimisation

Groupware, as previously stated, refers to a broad range of technologies designed to help people collaborate. It includes a wide range of application technologies that support tasks executed by people in groups, varying in size and composition. Groupware mechanisms support coordination through information system services, which enable knowledge/information management (capturing, processing, storage, and its exchange) through: electronic calendaring and scheduling, along with shared databases. They can function separately, but may also be combined to fit a purpose.

Table 3.7: Collaboration Tools Optimisation Efforts

TOOLS	COOPERATIVE GROUPWARE	WORKFLOW MANAGEMENT	VIRTUAL COMMUNITIES
Paper based artefact, Post-it note, letter, telephone	Composite synchronous/asynchronous communication tools **Awareness tools** (Integration focus) E-mail notification alert system **Group calendar** integration to allow coordination by defining meetings accessible to specified members Intranet, extranet **Lotus notes**: knowledge sharing origin for collaborative environments + scripted language for workflow functionality **GroupKit** offers seamless coordination support within environment and **allows third-party** extensions through the "open protocols" **Toxic Farm** suggest dynamic integration through web services	Workflow management system Application integration **Lotus notes , BSCW** **Toxic-farm** traditional workflow engine + process awareness **Oz**, distributed heterogeneous point to point integration	Online virtual communities Online synchronous /asynchronous collaborative tools +shared workspace awareness Context + Recommender systems (**Amazon object based**) social networking **Technical interoperability** Permit third party tools extension through open protocol; application integration **EGovernment Portal integration (multiple portlets)** **OneStopGOV** Active live event Portals**. (frontend integration)** **Backend integration**: process + data integration. Ontology driven integration

More sophisticated communities, e.g. Facebook, account for both synchronous and asynchronous collaboration tools, and are often employed to varying degrees in virtual communities. Asynchronous collaboration tools include: document sharing software, group calendaring, and newsgroups. Synchronous tools incorporate virtual meeting rooms (group support systems), shared whiteboards, application sharing, and video/audio conferencing. However, the combination of support tools must be directed by need contexts. William (2003) advocates that the ideal mix of groupware types should be defined by a given situation.

The rapid growth of virtual teams cooperating over the Internet has increased the complexity of the corresponding cooperative applications, with several tools having been constructed to support such cooperation models. However, most of these tools are specialised, only concerned with one facet of cooperation, either communication or the ordering and structuring of tasks. The Internet and www provide a platform for the implementation of CSCW systems where protocols HTTP and HTML have been leveraged to support distributed workgroups (Leitch, 2000). According to Kalpic and Bernus (2006), intranets, extranets, web portals and the Internet at large have created a networking potential that drives corporations to work faster, create and manage more interdependencies, and operate on global scale.

Web 2.0 describes the increasingly popular tools that promote two-way communications on the Internet. These social tools include: ambient communication tools, e.g. tweeter, that support both synchronous and asynchronous messaging; blogs, wikis, social bookmarks, comment, shared workspaces, and polling (Bebensee et al., 2010). These tools differ from traditional publishing as they put the knowledge sharing facility into the hands of the users themselves (Gurteen, 2012). Cronk (2011) indicates that these web 2.0 tools *"facilitate the development of social capital through knowledge sharing, which in turn increases the potential to create intellectual capital thus, have been the basis for online communities."*

Collaboration solutions exist that are integrated, scalable and general enough to address a large range of applications for distributed teams. For instance, a collaboration support tool, such as Glasscubes, brings together a collection of online collaboration tools to facilitate better teamwork and improved communication. Among the support tools are secure workspaces with control over invites, sharing of any type of file or document, calendars to organises multiple happenings within corporate meetings, events and conference calls, Dashboards, to make announcements, as well as to view the latest activity in a snapshot, and online project management, which allows one to create, assign and track task execution. However, similar to many others, Glasscubes is proprietary and not open for extension, with tasks being designed but not enacted.

To facilitate flexibility, extensibility and agility in catering for more dynamic processes, a loosely coupled approach is advocated. Also, significantly, there is a need for semantic interoperability at the computer and process levels (Papazoglou & Ribbers, 2006). Commonly lacking from most existing solutions is the ability to exchange meaningful and context-driven data or messages between distributed autonomous systems. This underscores the requirements for shared meaning, tailorability and adaptability as important success factors for collaborative support, in view of the varied and dynamic nature of cooperative work requirements. The following subsection elaborates on the significance of support at the process level.

3.2.3.2 Process Level Tools Optimisation

Workflow application has continued to evolve to accommodate the continuously fluctuating, dynamic needs of work groups. While traditional workflow often requires a strictly defined protocol to function, users continue to ask for more adaptive workflow products and models, which have the facility to provide the robustness and security of the predefined scripts, in consort with the flexibility of ad-hoc applications (Lucinéia et al., 2003). Optimisation efforts of structured workflows extend beyond simply engaging human intervention during the course of execution, when exceptions occur. While concepts like role resolution at runtime, to determine an appropriate active role-player or control flow, depending on predefined conditions are inherent to most existing WFMS, some integrate rule-based approaches, such as Event-Condition-Action rules, to adapt the execution of processes when exceptions occur. Exception handling approaches permit users to change the process definitions of a running process.

Workflow systems, however, do not provide adequate support for exception handling, as designers cannot predict every unusual circumstance that may occur during process execution. Usually, exceptional conditions are not easily predicted until they occur. This is exacerbated by the limited level of dynamic support, as structured approaches assume that business process activities are always implemented in similar fashions, with few exceptions.

The integration of different application tools to support individual tasks is often tightly coupled with WFMS, as well as usually proprietary (Bergemann, Hausotter, & Koschel, 2009), making extensibility a difficult and demanding task. To manage more emergent situations or cooperative processes, where human interventions are predominantly required, WFMS subscribes to ad-hoc collaborative groupware to coordinate work and to manage such situations.

Typically, to support and avoid difficult manual adaptations, specific organisational procedures (delegation/hold-files), predefined adaptations (decision points/ad-hoc refinement) and knowledge of history are offered. In order to contend with situations of uncertainties adequately, and to enhance exception handling capabilities, while mitigating exception occurrences, service-oriented, flexible, adaptive, and context-aware workflow management is advocated (Heravizadeh & Edmond, 2008; Ngeow et al., 2007; Rosemann et al., 2006; Ranganathan & Campbell, 2003). According to Heravizadeh and Edmond (2008) context-aware workflows present a route towards overcoming the shortcomings of workflow management systems. Context-aware enabled workflows can support knowledge-intensive tasks, where the people performing such tasks are subject to a fair degree of uncertainty. This denotes that people not only deal with support-predictable and easily automated decision-making, as with current workflow technologies, but also support situations that require the application of human factors, including experience, training, expertise and judgment. Furthermore, to support the seamless integration of process types and organisational or process knowledge, Abramowicz et al., (2009); Marjanovic (2005); Dutsdar & Hall (2002) stress the need for context driven, loosely-coupled integration (both frontend and backend interfaces) and process awareness.

Virtual communities increasingly make use of web services to support dynamic and loosely coupled integration and will continue to do so towards support of their collaborative activities (de Moor, & van den Heuvel, 2004*).* For instance, The Open Grid Service Architecture (OGSA) adopts web-services to enable integration of services and resources across heterogonous distributed, dynamic environments and communities

(Talia, 2002). Taking lessons from Grid computing, Thomas and Botha (2009) illustrated the feasibility of data integration across the SA public service using web services.

Abramowicz et al. (2009) highlight the magnitude of employing a service computing approach to detect, invoke and orchestrate services seamlessly with semantic rich inference rules and context information. This emphasises the need to define context ontologies to support smooth and effective collaboration. For instance, by integrating a variety of user interface service types, the seamless and dynamic selection of the most appropriate mode of interaction becomes possible. Efforts towards seamless coordination can benefit from approaches that support contextualised, proactive and personalised access to services and their offerings. For example, most online virtual communities strive towards maximising member involvement, by offering optimal degrees of interactivity and personalised services, based on various factors, including user preferences, interests and locations. To facilitate the collaborative effort of existing groups with shared goals, while leveraging opportunities for potential collaborators, without initial or previous ties, requires both group and community level awareness, guided by context information.

In common with most web-based cooperative groupware, virtual communities can support the collaborative work of previously-organised people with shared objectives. Additionally, they account for ad-hoc knowledge processes that support diverse and unstructured groups of people sharing interests and preferences, with no obvious goals. In essence, virtual communities can employ the capabilities of ad-hoc process tools to coordinate in their communities. Some virtual communities leverage context (user preference information) to trigger spontaneous collaboration by identifying opportunities, aside from awareness information that synchronises groups relative to the state of on-going tasks. Communities utilise electronic tools, comprising forums, chat rooms, e-mail lists, message boards, and other interactive Internet mechanisms, synthesised and tailored to the particular requirements of the community.

3.4 Limitations and Considerations for Design

With an emphasis on human-to-human interaction CSCW researchers and developers have put together design strategies for groupware. These design strategies aim to account for organisational, social and collaborative issues. The claim is that for a groupware application to be accepted and used, the social and organisational characteristics of a group must be considered. Failure to do so can result in the rejection of the design by the users. Work groups operate in larger organisational contexts and the structure and culture of an organisation influence the way a groupware system should be designed and will be used (Orlikowski, 1992). When computer systems are designed without consideration for these factors, it is likely that the system will be used sub-optimally or will be discarded (Preece et al., 1994).

It has been established that many solutions are developed without a clear understanding of user needs. Grudin (1994) asserts that it is hard to capture the requirements for a collaborative system design. One reason for this is that so many groups and aspects need to be considered, comprising elements which are often not intuitive to software architects. Additionally, the requirements are frequently not clearly known to any participant, which necessitates conversation or interaction analysis. The requirements or boundary conditions also fluctuate and change over time, as well as through the introduction of a system. These components motivate the requirement for a systematic analysis framework with the capacity to account for the social, organisational and environmental context to guide design. Gross and Koch (2006) contend that designing a CSCW system involves not only designing the technical system, but also shaping the social system. Owing to designing applications for groups and organisations being considerably more difficult than designing for single users, Pinelle (2004) asserts that designers must consider complex social and organisational issues, in addition to issues that are traditionally considered 'single user', such as visual perception and human factors.

Koch and Gross (2006) identify the problem with existing collaboration support tools as being that they possess different functionalities, which are provided as separate applications. Groupware systems are often targeted to a specific task domain. Unfortunately, this is aggravated by increasingly financial interest. For example, the IBM Lotus collaboration solution is divided and sold as categories of software products. Thus, solutions are often proprietary and standalone. Furthermore, existing solutions are often rigidly defined and do not sufficiently cater for certain alternative factors, including the frequent changes regarding process participants, or the ad-hoc formation of collaborating groups (Dustdar & Gall, 2003). Although some systems attempt to promote flexibility through integration, their approaches may be inadequate to meet needs, and/or may be complex, requiring major technical skills.

In order to afford effective support to the coordination of distributed teams, dynamic and emergent process must be supported. Fundamentally, process models have to be more flexible than traditional workflow control-flow oriented models, and process awareness must be pursued. Knowledge, including instructions, experience, and reasons for decisions or problems and solutions, is often is needed by workflow participants to implement activities during process execution (Goesman, 2000) and thus, must be supported. Understanding the current process content (previous tasks, the task that needs to performed, available resources) and context (components that influence process execution) is deemed crucial.

Importantly, the need for identifying similar past experiences or process models or components and case-based reasoning techniques could be further explored to develop tools and techniques to help users to determine comparable process cases and re-use in new models, is suggested. To account for process flexibility and adaptability, a loosely coupled approach towards process design is underscored and advocated. Majanovic (2005) suggests that a user-friendly modelling language, to enable users to y design new process models dynamically, to modify the existing ones and to analyse past experiences with coordination mechanism, is potentially useful in a collaborative environment. This suggests that artful processes must be supported. Tellioglu (2008) contends that achieving sustainable collaboration requires a methodological framework embedded in a collaborative system to guide initiations, formation operation and decomposition, emphasising a collaboration life-cycle to help form and operate a collaborative environment. This is based on the assumption that a coordinated environment is in place. Thus, Tellioglu (2008) emphasises the need to setup a coordinated work environment that is configurable, offering users interfaces to integrate with other tools to support collaboration. This research argues that engaging a virtual community perspective from a service lens, while leveraging context awareness can aid toward that end.

Awareness, as an implicit form of coordination support is critical to achieving distributed collaborative work. Support for distributed teams often requires a relatively high degree of awareness to achieve collaborative work. Therefore, to coordinate effectively, support systems must account for awareness in groups, processes and communities or in the external environment. Knowledge centred on the multiple relationships between the artefacts, relative to 'who, what, when' and the context in which they were created, shared, and distributed is important for coordination. Shared workspaces (shared or web-based folders), for instance, should provide information on the relationships between artefacts (document) and the associated activity of a business process (review). Community group or process awareness should enable participants to join virtual project teams, share process artefacts in and across teams, and to utilise different means of communication (asynchronous or synchronous) to collaborate on particular business processes. The services should be provided in a user-friendly and personalised way.

3.5 Conclusion

While many coordination solutions exist in practice, they are often isolated and narrowly focused. However, the coordination of virtual teams often requires the integration of several services that complement each other. A primary problem has been the integration and finding of the correct balances. In order to support coordination in a dynamic distributed environment system, flexibility is emphasised and a loosely- coupled approach to integration is suggested. Additionally, support for dynamic adaptation of work coordination processes to adapt to situational factors as encountered is crucial. As highlighted, a seamless integration of group and community awareness is necessary to provide opportunities for collaboration and to support coordination. By knowing *who*, in conjunction with their interests, a collaboration opportunity is identified; where after, knowledge of *what* is occurring with team members is necessary to accomplish a goal. To manage awareness information and its distribution effectively, context-ware and personalised notification service systems are advocated.

Although virtual communities have been dominated by leisure activities, often coordinated by basic 'social protocols', they can be leveraged to account for the more sophisticated coordination mechanisms necessary in distributed cooperative work. However, both the social and technical support systems must complement and shape each other. Moreover, given that there is no 'one size fits all' solution, finding the right mix of mechanisms should be dependent on the need context. However, relative to the possibility of uncertainties, solutions should be flexible enough to accommodate changes. To account for the organisational, social and environmental context, the subsequent chapter examines the provision of a holistic analytical framework to identify systematically the unique requirements that characterise the problem context towards building a solution. Table 3.8 provides a summary of lessons learnt.

Table 3.8 Summary of lessons from collaborative technologies

CATEGORY	**COLLABORATIVE SUPPORT TECHNOLOGIES**		
	COOPERATIVE GROUPWARE	**WORKFLOW MANAGEMENT**	**VIRTUAL COMMUNITIES**
1. PEOPLE			
1.1 Social Cognition frames and mental models: language, culture, beliefs and norms	Ad-hoc human interaction Support for intra and intergroup cooperation with predefined conventions on a shared artefact **Reconciler:** known collaborators Semantic interoperability to Reconcile contrasting conventions/perspective on shared objects for mutual awareness in tight cooperative work.	Implicitly captured in process definition, thus limited view by users.	Member shared interest, Social interaction/social context aware contact facilitation, information and knowledge sharing **Facebook :** Friends recommendation, Social Interaction **Online Dating (zooks)** sites location based recommendations **Amazon** Shared interest/semantic collaborative filtering based object (book) suggestion)
L10*Shared social cognition means availing social and working context awareness to members of a collaborative community with similar interests, shared language and beliefs to leverage hidden opportunities.			

CATEGORY	COLLABORATIVE SUPPORT TECHNOLOGIES		
	COOPERATIVE GROUPWARE	**WORKFLOW MANAGEMENT**	**VIRTUAL COMMUNITIES**
1.2 Knowledge of Working relationship Stakeholders involved: Who and what they are doing.	Group awareness configuration **Lotus Notes** Synchronous collaboration **Intermezzo:** use of roles and policies to access control support flexible object-level coordination and shared workspace awareness	Assumed roles in process definition Machine formal controlled relationship **SAP :** document approval transfer **Toxic farm** workflow /to do list	Roles definition Community/group awareness **Online Multiplayer gaming (Heracles)** **DELL Virtual organisation** business partners to fulfil parts of their supply chains. **Glasscubes project-based** community members/roles
L11*Working relationships accounts for knowledge that helps manage expectations and predict actions of role players automatically to support implicit coordination.			
1.3 Communication Sporadic face to face Telecommunication Voice/fax technology	Messaging /voice Synchronous/asynchronous **Skype:** messaging/video conferencing, **Gmail/Yahoo:** instant messaging/e-mail **Instant conference** **Basic Support for Cooperative Work** (BSCW) shared workspace +awareness	Automated asynchronous event-driven notification **Web-based Toxic Farm** Work List/mail notification	Web-based messaging /voice Synchronous/asynchronous **Google+, Facebook** instant messaging/ e-mail and forums **Second Life** Avatar online formal/informal meetings Tea rooms/water cooler
L12*Represents support for varied communication channels that can adapt to the need context of users, helping to avoid misunderstandings and mismatches between collaborators.			
1.4 Information and knowledge Physical social interaction Post mail/travel, localised information/knowledge management systems	Shared workspace with mutual awareness functionalities **Groove/Microsoft's SharePoint Team Services** integrated workspace (**Google docs, Intermezzo group kit)** synchronous and distributed collaborative applications **Toxic farm** asynchronous data sharing services + awareness: Events on data and data states notifications Asynchronous Document sharing and archiving (place a document in the workspace) **Dropbox , Sugar sync, Basic Support for Cooperative Work** (BSCW) shared workspace +awareness **Glasscubes**-document/file sharing **Reconciler** Semantic interoperability & personalised notification Formal team formation Organise information according to specific relations Grouping or classification schemes are, of course, used in **knowledge management/decision**	Automated tasks list distribution/notification **Lotus notes/FlOWer system** workflow information routing View next steps, monitor what has been done, as well as current progress Information flow pattern **Lotus notes, SAP. IBM** primary organising structure is the "routing" of information objects among users **Process model** directed work list to specified roles in organisation Goal decomposition	Shared workspace Personalised recommendation/notification Archiving & shared information spaces **Facebook**, newsfeeds; forums , shared photos **Wikipedia, peer-peer wikis** **Virtual Tearoom-** social interaction **Glasscubes** – shared online collaboration workspaces for known collaborators +water cooler socialising **Avatar based Second Life** Virtual meeting Water-cooler socialisation **Social text:** knowledge base **Tweeter** social awareness Ad hoc/dynamic team formation Centralised to distributed Governance structures Goal-based activity selection & composition Modular classification and grouping of people in **Facebook, and Amazon interest group like auction** **Wikipedia, Dell, EBay. Linux** governance model

CATEGORY		**COLLABORATIVE SUPPORT TECHNOLOGIES**		
		COOPERATIVE GROUPWARE	**WORKFLOW MANAGEMENT**	**VIRTUAL COMMUNITIES**
		support tools (Lotus Notes groupware)		
L13*Information and knowledge awareness constitutes taking advantage of context information and communication channels to effectively distribute relevant information and knowledge to members, in order to facilitate collaboration and coordination of their actions				
1.4 Organisational structure Direct contacts/supervision, committee, hierarchy/liaison devices Highly structured 'heads-down' paper processing		Formal team formation Organise information according to specific relations Grouping or classification schemes are, of course, used in **knowledge management/decision support tools (Lotus Notes groupware)**	Information flow pattern **Lotus Notes, SAP. IBM** primary organising structure is the "routing" of information objects among users **Process model** directed Work list to specified roles in organisation Goal decomposition	Ad hoc/dynamic team formation Centralised to distributed governance structures Goal-based activity selection & composition Modular classification and grouping of people in **Facebook,** and **Amazon interest group** like auction **Wikipedia, Dell, EBay, Linux** governance model
L14*An organisational structure defines support for ad hoc and dynamic team formation, whether employing centralised or decentralised forms of management to supubort dynamic collaborative efforts.				
2. PROCESS				
Work-practice mechanisms Plans, specifications, standards, manuals, instructions Paper based transactions Highly structured "heads-down" paper processing Highly structured "heads-down" paper processing	**UNSTRUCTURED**	**Group awareness Toxic farm** availability/presence awareness of members +document state changes reporting **Google calendar**: Entry/Scheduling **Google site;** Document transfer **Sugar sync** –Doc sharing Support for **Data level integration** Enterprise Resource Planning and SAP, PeopleSoft		Groupware-based synchronous/asynchronous communication and workspace cooperative tools
	HIGHLY STRUCTURED	**Project/task management** Ad hoc Project management tools **MS project;** project management (Tasks are defined but not enacted). **5PM *Web*-based** project and task management software for teams Online Project management of task (**Glasscubes, liquid planner)**	Process modelling & enactment IBM Flow mark fully specified control-flow, resource and data **SAP** Status and Action Management (object state specific). Open WFE, Business Process Modeling Notation (BPMN)+ workflow systems Workflow interoperability support: **OZ**, (point to point) a multisite collaborative WFMS (interoperate heterogeneous and autonomous processes)	**Action-Metro technologies** Business process composition

CATEGORY		COLLABORATIVE SUPPORT TECHNOLOGIES		
		COOPERATIVE GROUPWARE	**WORKFLOW MANAGEMENT**	**VIRTUAL COMMUNITIES**
			Process modelling can present useful view of "big picture" inter-organisational process.	
	SEMI-STRUCTURED	Lotus Notes or Microsoft's Exchange that provides some basic (script-based) workflow functionality. **SourceForge Toxic farm,** workflow support/process awareness based on to-do lists (Create/assign new task, + consult list of tasks and their states). Basic Support for Cooperative Work (BSCW) shared work space	Syspro Workflow solutions, CSE/Workflow system Personalised activities work-list Process model-focused awareness	Dynamic global business process formation **Collaborative semi-structured business process support** Service Process integration (Ecommerce community like **transaction based workflow in Amazon/eBay** The integration of the functional flow processing btw the applications. **SemanticGov** one stop portal for live event **artful process support context drive citizen** Self-service Service-oriented approach units of work, composition to an end-to-end process
L15*This means in this research support for the seamless transition between process types to account for varying engagement scenarios from automation across processes to support for dynamic human intervention through the use of dynamic templates and tools as required by the collaboration context from its initiation to completion.				
3. TOOLS				
Paper based artefact, Post-it note, letter, telephone		Composite synchronous/asynchronous communication tools **Awareness tools** (Integration focus) E-mail notification alert system **Group calendar** integration to allow coordination by defining meetings accessible to specified members Intranet, extranet **Lotus notes**: knowledge sharing origin for collaborative environments + scripted language for workflow functionality **GroupKit** offers seamless coordination support within environment and **allows third-party** extensions through the "open protocols" **Toxic Farm** suggest dynamic integration through web services	Workflow management system Application integration **Lotus notes , BSCW** **Toxic-farm** traditional workflow engine + process awareness **Oz**, distributed heterogeneous point to point integration	Online virtual communities Online synchronous /asynchronous collaborative tools +shared workspace awareness Context + Recommender systems (**Amazon object based**) social networking **Technical interoperability** Permit third party tools extension through open protocol; application integration **EGovernment Portal integration (multiple portlets)** **OneStopGOV** Active live event Portals**. (frontend integration) Backend integration**: process + data integration. Ontology driven integration
L16* In this thesis, this reflects the use of approaches that allows dynamic, seamless and loosely coupled integration of the functionalities of varying tools to support collaborative processes that can span across organisational boundaries. .				

PART B

Business needs drive the design of artefacts when conducting design science research. ‘Part B’ sets out to provide an understanding environment in which this research takes place. It addresses the question: *What are the coordination support requirements in the distributed environment?* Given the limitations of the existing frameworks, as explicated in Part A, to account adequately for the coordination status quo in such an environment, triggers the need for the development of an instrument of analysis to help examine the state of coordination holistically. The solution to the inquiry is divided into two chapters, 4 and 5. **Chapter 4** concerns the design of a holistic investigative instrument that can encompass the resolution of all possible situational coordination problems. The instrument is developed by traversing between an extensive literature study and empirical evidence. The application of the instrument is carried out in **Chapter 5,** to reflect comprehensively on the South African public service capacity building efforts towards requirement identification. The first contribution of the study comprises the output of Part B, in the form of a two-part instrument for the analysis, which provides a list of requirements towards the development of a suitable support solution.

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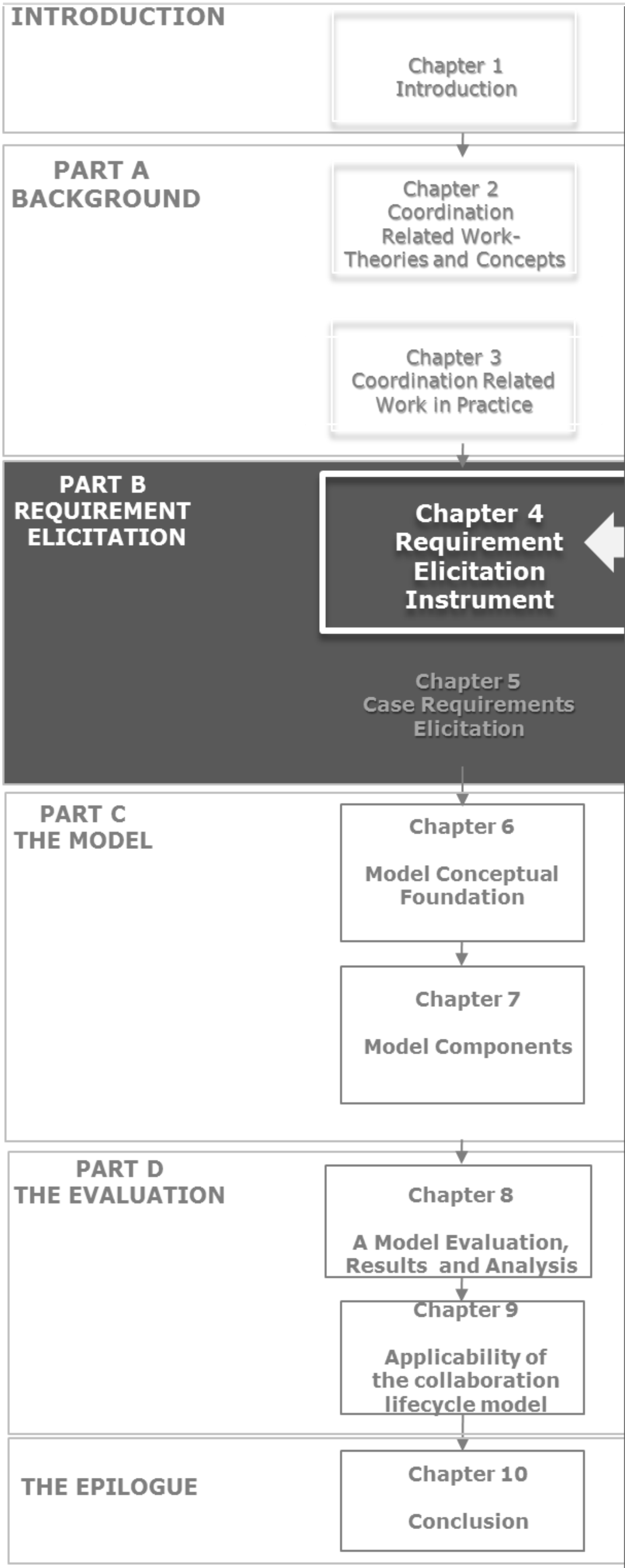


4.1 Instrument Design Method

4.2 Existing Analytic Variables

4.3 Context

4.3.1 Dependencies

4.3.2 Actors

4.3.3 Tools

4.3.4 Activities

4.3.5 Resources

4.4 The Proposed Instrument Analytic Variables

4.5 The Instrument as an Exploratory Tool

4.5.1 The High-Level Overview

4.5.2 The Low-Level Extension

4.6 Conclusion

CHAPTER 4

A REQUIREMENT ELICITATION INSTRUMENT FOR COORDINATION SUPPORT IN A DISTRIBUTED ENVIRONMENT

Part A established that effective coordination must be driven by the unique requirements which a problem context presents in order to be effective. Putting the mechanism together without regard to the need context often results in failure. However, the question: *How can such requirements be determined?* needs to be addressed. This motivates and necessitates the need for a systematic approach to the inquiry. This chapter endeavours to establish an approach to account adequately for coordination requirements that characterise geographically distributed collaborators, in the form of a requirement elicitation instrument. It explores both the literature and empirical evidence to account for coordination influencing factors, including: human components, the work context, and the environment, which are usually only partially covered or even excluded in existing frameworks. This chapter is intended to answer the question: *What are the constituents of an instrument, which could be applied to evaluate the state of coordination in a distributed environment efficiently?*

This chapter refers to the coordination-related theories and practices discussed in Part A, in conjunction with the patterns emerging from empirical evidence, as the basis for the instrument design. Thus, the chapter employs a socio-technical and service perspective on the matter, from both a micro and macro context, to account for factors that may affect coordination in a distributed environment. The socio-technical perspective presents an abstract overview of elements and constructs to provide a high-level 'As-is' model. The two-part instrument, in its most basic form, should reveal the distinct and obvious threats (or its absence thereof) to coordination. Additionally, to account for the less evident risk factors, an extension is suggested at the lower level to expose the implicit threats to coordination. This results in stressing a more in-depth degree of probing, through a set of categorised propositions motivated from a service lens.

The chapter commences by identifying the elements and constructs to be considered. Subsequently, the composition of the elements and their relationship are made explicit in the discourse, followed by the introduction of the service perspective and the thematic propositions that have been formulated. Thereafter, the instrument, as a useful exploratory tool is emphasised, with a summarising conclusion.

4.1 Instrument Design Method

In order to provide effective coordination support in a distributed environment a holistic analytical instrument is proposed. The development of the instrument is built on a foundation based on relevance and rigour. The relevance of the instrument is driven by the limitations of existing analytical frameworks and practices, as discussed in Chapters 2 and 3. While existing solutions offer best practices and guidance in several ways, they do not address the scope of a full analysis. This results in coordination assessment in a distributed environment remaining a significant problem. This chapter contends that an effective coordination assessment mechanism should take into account a number of factors, which are inadequately encompassed by existing approaches and which may impede coordination processes. The objective of the chapter is to provide an approach to support the assessment of coordination efforts in a distributed environment to intervene effectively. Thus, it forms the basis for identifying coordination requirements in an application environment.

In order to account realistically and holistically for the complex web of connexions between factors, which may influence the ability of collaborators to coordinate, a sociotechnical approach to the matter is employed. The proposed instrument draws from existing frameworks and concepts in an attempt to establish a compromise amid the varying perspectives explored, with the objective of providing the best analytical tool for this study. The design method employed is shown in Figure 4.1. The framework design follows the iterative build/evaluate strategy.

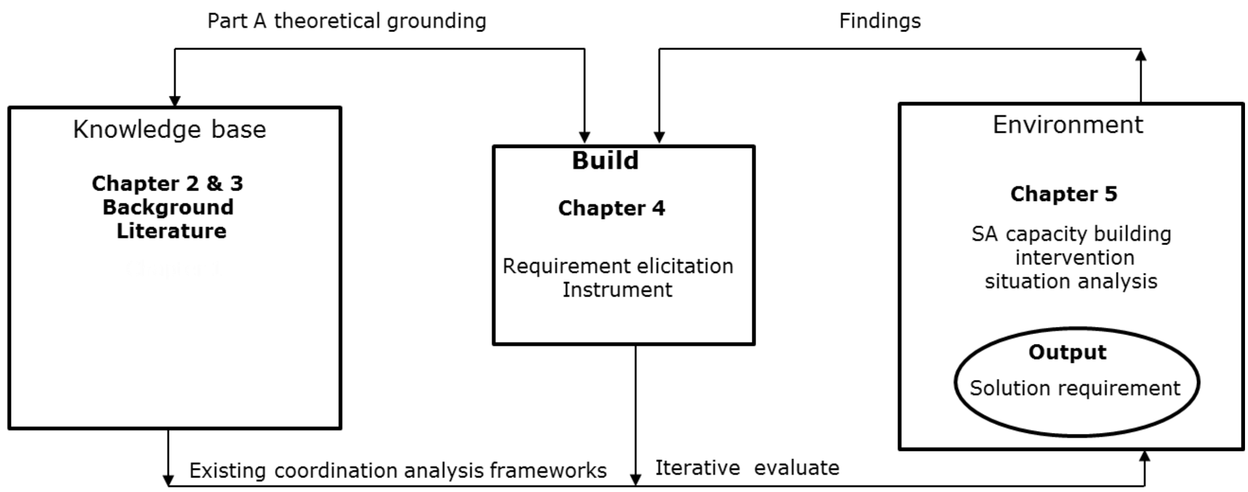


Figure 4.1: Instrument Design Method

The instrument has been evolved and improved through feedback provided from case evaluation activities initiated by using the existing analytical approaches in the knowledge base. The evaluation for the framework includes the use of the informed argument method and field application of the artefact. While the starting point of analysis employed an approach (coordination theory) that was underpinned by many disciplines, the feedback from the case application identified certain limitations. The findings show that when a coordination mechanism related support system (attributes) is ignored it impedes coordination efforts. Therefore, a multi-dimensional instrument is proposed as the basis for identifying the requirements for coordination support in a distributed environment.

The transition between theoretical and empirical perspectives reveals hidden dimensions. The case provides practical significance in the development process as time is spent in building and understanding the work context and practices of end-users. Several techniques, comprising: interviews, observations, and analysis of documents used in the work practice, are utilised to understand the user domain. The identification of the socio-technical factors that impact on coordination is based on existing evaluation method variables outlined and discussed in the following section.

4.2 Existing Analytic Variables

Several authors have proposed evaluation frameworks targeted at capturing the essential nature of organisations and identifying the requirements for successful coordination in distributed environments. However, the particular characteristics presented by existing coordination models do not embrace a holistic approach for solving coordination problems, as they often concentrate on a limited number of defining features. These features are often considered at various levels of focus, observation and emphasis, which can result in the overlooking, neglecting or dismissal of relevant dimensions of interest. Nonetheless, they present an important initiation point to identifying the varying, diverse and hidden socio-technical dimensions that may influence coordination in a distributed environment. Although conceived at different levels of granularity, the frameworks considered showed a certain degree of convergence on a set of concepts, as shown in Chapter 2.

This section considers the constructs and function of the coordination-related literature, discussed in Chapters 2 and 3, towards proposing an analysis instrument based on the strengths and similarities of the approaches emphasised. Figure 1 presents the composite origin of the existing approaches considered. The variations in focus of the analytical approaches show coordination as a multi-dimensional discipline, with complex and intertwined aspects, which are affected by many factors, including the users involved, goals, tools, and context. This is reflective of the socio-technical subsystems of people (social subsystem) using tools, knowledge and techniques (technical subsystem) to produce goods/services for a customer or partners (environmental subsystem), as mentioned in Chapter 2. An extract from socio-technical elements considered in existing frameworks follows. Table 4.1 presents an extract from Chapter 2 inspired by lesson 1 and 2 in the summary Table 2.11 in Chapter 2, which reflects the elements considered vital to evaluating coordination needs effectively.

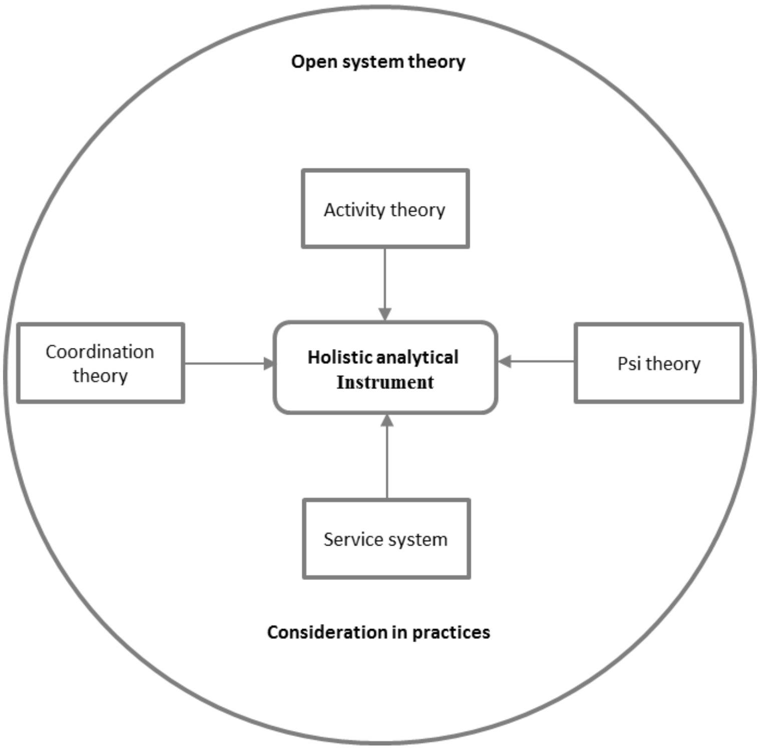


Figure 4.1: The Framework Origin

Table 4.1: Constructs of Different Models

MODELS	ACTIVITY	ACTOR	RESOURCE	TOOL	INTERDEPENDENCE	CONTEXT
Coordination theory	Activity	Actor (passive resource)	Resource	-	Activity-activity, activity -resource	Process
Activity theory	Activity/action	Community of participants, subject	Object	Tool	Activity-activity, actor-actor, actor-object, actor-tool, object-tool	Micro collective activity
Work system framework	Activity/sub activity	Participants, customers	Information	Technology	Activity-activity, activity –resource Environment- activity Actor-tool	Macro
Psi theory	Action	Actor: (active) performer, addressee	Information document	Technology	Actor-Actor Actor – tool	Transaction

4.3 Context

The context refers to the surrounding environment where collaboration takes place. Context comprises the collaborative objective(s), the social, technical and environmental subsystems that influence coordination needs. The analytical focus category in Table 2.11 emphasises the importance of monitoring the environment, regarding activities, goals and the nature of dependencies in determining the coordination mechanisms to be employed. This denotes that an organisation cannot be studied in isolation from its environment. The geographical area, where the proximity of actors plays a role, along with other factors, which include the rules, social and technical components, can constrain coordination. How an organisation works may be influenced by factors from outside the organisation. As the level of uncertainty in the environment increases, an organisation may be subject to additional risks. By reflecting on the collaborative activity context, which also considers the immediate surrounding environment context can be considered at macro and micro levels as shown in Table 4.1. CSCW design recommendations in Chapter 3 stress the need to understand the cooperative context, in order to define coordination mechanisms effectively, in consort with the requisites for considering dependencies, as discussed in the subsequent section.

4.3.1 Dependencies

As Table 4.1 illustrates, different types of dependencies should be considered to account adequately for coordination. The nature of dependencies includes those between actors, and between activities. By employing a process view the dependencies between activities is made explicit to aid in the selection of an appropriate coordination mechanism. The management of interdependencies between activities performed should be tied towards achieving an objective, while explicitly showing the relation between the participant and the process. The relationships between elements in a collaborative activity must strive continuously to be in balance and synchronised by monitoring contradictions that may arise. By taking cognisance of working relationships, the communication and decision-making of the role-players in practice dependencies can be revealed. The importance of knowing the level of coupling (tight or weak) in order to determine the nature of the mechanisms and their support is also highlighted in Table 2.11.

4.3.2 Actors

Actors are entities responsible for initiating or performing an activity, often referred to as subjects, role-players, participants, and performers or addresses, along with the community, which represents an entity responsible for performing an activity. Humans or autonomous agents, whether individual or collective, can fill the role of an actor. The function of actors as active or passive participants needs to be determined, in conjunction with their relationship to each other, their means of communication, information and knowledge sharing, as well as networking. Different kinds of actors are represented in Table 2.11, which are classified here as playing a passive role, considered as a resource to be allocated to activities or active roles for that communicates with the capability to make decisions and negotiate. The communication reflects a coordination device between participants, thereby providing patterns with regard to how collaboration may be achieved.

4.3.3 Tools

The means of work, coordination or communication, usually achieved with distinct, assorted types of tools, which may be physical, intellectual or abstract, should be considered in context. The capacity in which a tool is defined is relative. From the research standpoint the computer is simply another tool, which aids in mediating the interaction of humans and their environment. Tools can take many forms, from mental models to physical artefacts. Although not all theories and concepts in Table 2.11 consider tools explicitly in a mediating capacity, they recognise coordination as an information processing activity, which may be facilitated with information technology. Lessons in Table 2.11 indicate that a tool can be employed by actors to perform actions that can transform a resource. Furthermore, a community through its participants, can operate on an object, mediated by a tool, to perform a determined action. In practice, mediation tools are manifested in different forms, in a given a need context which needs to be considered to determine their effectiveness.

4.3.4 Activities

An activity reflects the actions performed in the real world. Typically, an activity may be decomposed into smaller parts, termed sub-activities, subtasks, or actions, and can be related to other activities. In this research context a sub-activity is the most basic unit, which can be combined with others to form a more complex component, in a process toward achieving a goal. BPM practices provide techniques for representing relations between activities in processes, including flow charts and goal-based models. Prominent are process-based models, which make explicit the dependencies (relations) between activities by specifying their control flow. As the distinction between the action and sub-activity presented in Table 2.11 is unclear, in this research capacity they are equally described as sub-activities.

4.3.5 Resources

Resources, for instance information, a document or an object, may be defined as something that is exploited, manufactured or transformed by an activity. An information resource can exist or be made available, in an electronic form containing, for instance, what to do. It serves as the input or output of an activity, to help define the flow of work. Object- or artefact-based coordination forms the basis for defining the connexion between activities. As shown in Table 4.1 what is considered resource depends on context, from human actors as passive resources, to reducing environmental interdependence and uncertainty, a view that sees collaborating partners as resources to each other.

The existing variables offer special advantages, relative to the similarities and differences they project, which are leveraged to propose the requirement elicitation analytic variables reviewed in the next section.

4.4 The Proposed Instrument Analytic Variables

The proposed composition embodies the sociotechnical subsystems, viz. the social, technical, and environment subsystems. The supporting technology, in this circumstance, is seen as an integral part of the collaborative work system, working with other elements to provide a required service impact. The analysis of IT support is done within the context of the work-system that uses it, rather than in isolation, which fails to account for the multitude of factors that may influence its use. The elements that constitute the proposed instrument considered are sourced from the literature and from empirical studies, framed in the service capacity lens, detailed in Appendix B1. The proposed composition leverages the similarities and differences of existing analytic metric variables and findings from the empirical study to populate the instrument. The instrument aims to cover all possible aspects of inquiry which could possibly influence the choice of coordination mechanism. Central to the proposed framework is the collaborative activity, as the basic unit of analysis, with a few extensions. Given the lessons in Table 2.11 lesson categories 1 and 2, it takes into account the contradictions or imbalances that may occur between various socio-technical elements in a given collaborative activity. Figure 4.2 presents an overview of the composition, as motivated by existing analytical frameworks. The collaborative activity, at the core, subsumes the process and transaction capabilities, as discussed in Section 2.2.1 and 2.2.4 respectively. It leverages these views to account for both the horizontal and vertical collaboration patterns, which may exist in a system, by taking advantage of the activity structure and direct feedback-loops. This approach endeavours to account for both the structured and the unstructured processes that may exist, as discussed in Chapter 3 Section 3.2.2. At this level, the composition reflects the micro level context.

The micro context represents the dynamic collaborative activity context. This is somewhat consistent with the properties of organisations which have purpose, structure and processes that use and combine resources to achieve objectives. In addition, they can work with other organisations in a cooperative capacity to meet certain objectives. Thus, the collaborative activity context considers the relationships between all the elements that must work together to accomplish the collaborative goal. The collaborative activity, therefore, consists of actors performing work, using information, technology, knowledge and other resources, towards achieving a common objective. To account for the coordination practices in the micro context, a multi-perspective review approach is considered. The business process, communication, decision-making, information and knowledge-sharing patterns are contemplated. The cooperative work process in question brings about a process view to reveal the dependencies between the activities and the corresponding coordination mechanisms that manage them. The process-based approach makes explicit existing activities, their relations, viewed as a set of steps, and the accountability roles of actors. Although the roles of actors can be considered in a passive capacity, the composition acknowledges the possible active state of actors, in that they are capable of decision-making and negotiation, as clarified in Chapter 2. The producer/consumer relationship is explored in this circumstance. This relationship can also determine sequencing of work activities. It is clearly apparent that other factors influence the process, viz. the goals, the means of work available, and the rules involved.

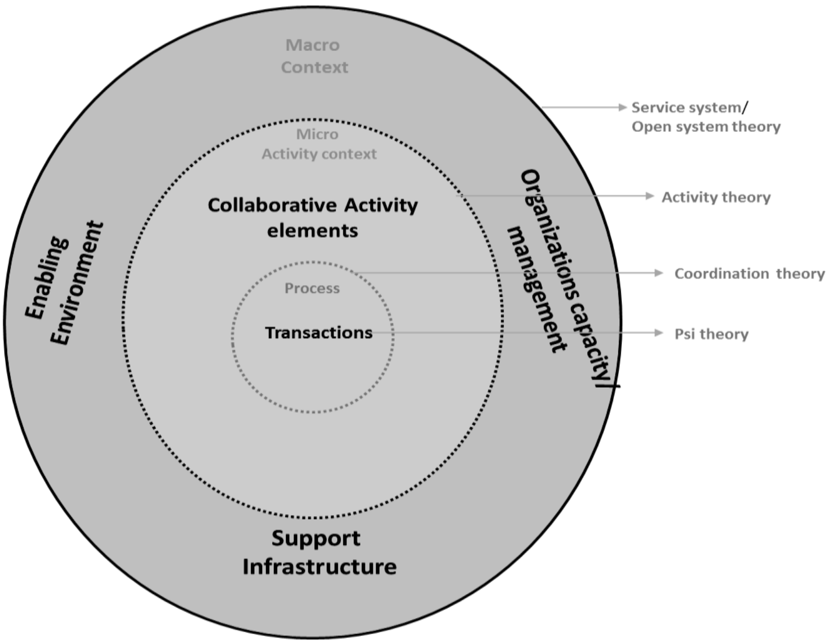


Figure 4.2: The Holistic Analytic Composition

Additionally, as more actors become involved in the collaborative activity, analysing their communication, information and knowledge sharing patterns, in consort with their effects and completion, becomes critical. This allows missing paths to be restored and duplications to be eliminated.

To account for outside influences that may impede or facilitate the coordination of activity in the larger context, as highlighted in Section 2.1, the proposed composition takes cognisance of the surrounding factors, as made explicit in Category 1 of Table 2.11 in Chapter 2. These surrounding external factors fall under the enabling environment, the organisational capacities/strategy and existing supporting infrastructure, which can affect the operation of a collaborative activity. The success of a collaborative activity is dependent on its fit with the surrounding environment, organisational strategies and its use of the available infrastructure. These external factors characterise the **macro context**. The macro context denotes the **environment factors**, for instance, the geographical distribution, cultural-historical setting, and regulations that can influence the collaborative activity. Additionally, it comprises the constraining **organisational factors**, that can affect the daily running of an institution inclusive of corporate culture, design; and strategy, as well as the **infrastructure elements**, including shared human, technical, and information system resources, that the activity relies on to operate, even though the resources are managed outside of the collaborative activity. Examples include: the internet, telecommunication, and (a) shared training provider/service centres. Relative to the instrument, elements considered to be technology are viewed as those internal tools that are directly engaged to support the goals of a given collaborative activity and the external technical support infrastructure that supports the operations of the collaborative activity.

Details of the variables considered are shown in Figure 4.3, accompanied by sample questions and discussed in further detail in Section 4.4. The figure provides a catalogue of the elements which can be included in a basic understanding of the scope and operation of a collaborative activity. It outlines and describes the system under study, to help with the identification of the problems and prospects for change, in consort with how the transformation may affect other elements. As shown in Figure 4.3, it is also important to identify the aspects of the surrounding environment that have significant impact on the situation. For example, an organisational culture that includes strong expectations of cooperation and knowledge sharing will most likely support initiatives that make it easier to realise such expectations.

The convergence of existing framework properties and elements results in a collaborative activity context that is composed of a cooperative work-process (process/activities), actors (participants), means of work, mediation (information and technology artefacts), the object of work (goal), and the desired outcome (expected service). It is deemed that within the composition the relationship between activities constitutes one where information services are provided predominantly for consumption by each other. The macro context level composition encapsulates the shared service infrastructure, organisational capacity/management and the enabling environment, to aid in defining the broader analytical context, as advocated by the service system framework and open system theory. The representation of the cooperative process in the micro context takes cognisance of the interplay between structured and unstructured process tasks. These results from the cooperative processes, potentially being composed of highly-structured processes, where tasks are patently understood and straightforward, with clear and simple flow decisions and control, or relatively unstructured processes, require discretion and judgement.

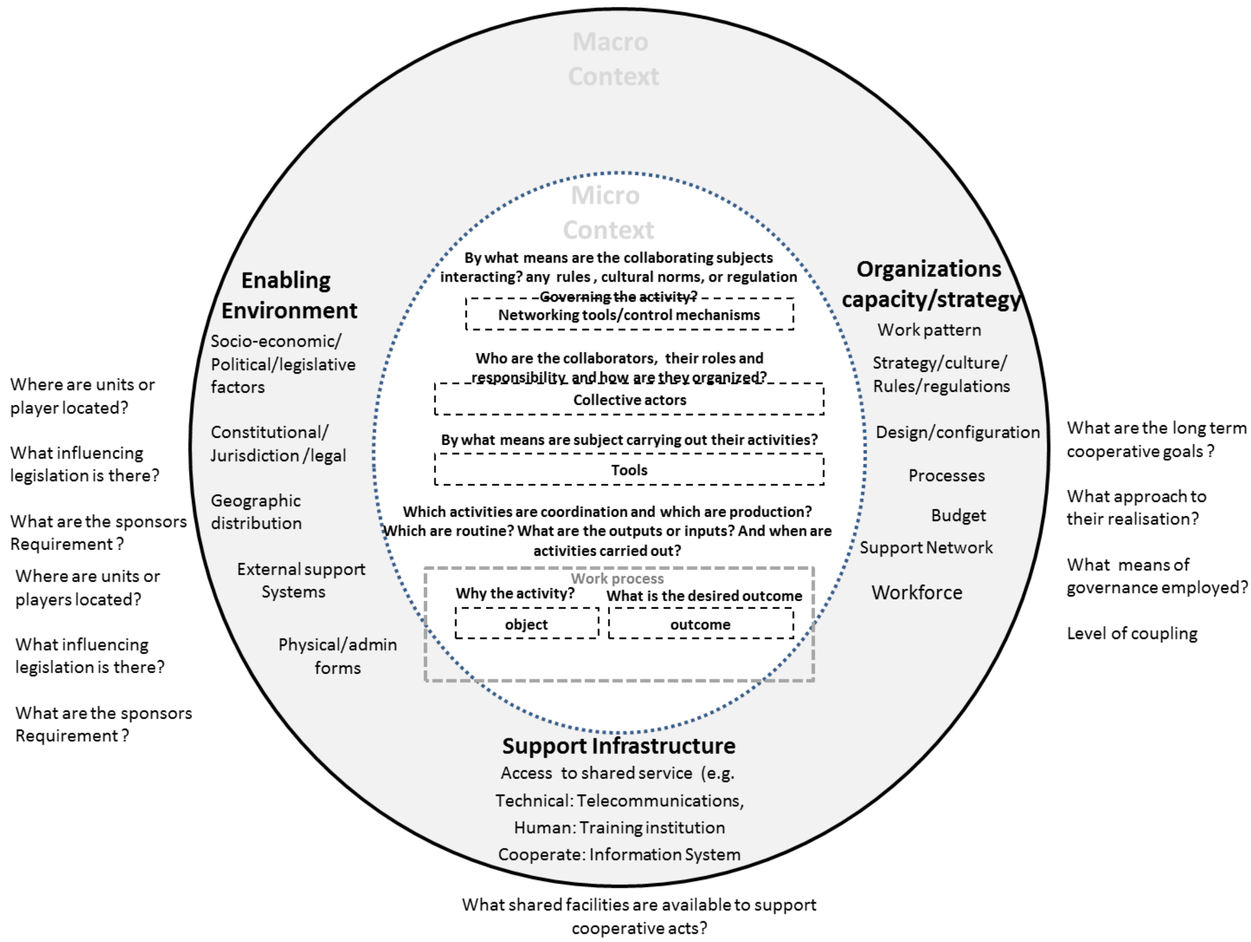


Figure 4.3: Synopsis of Macro and Micro Inquiry Contexts

In order to account effectively for the coordination mechanism in place, activities are represented in process model forms for the most structured, and in workflow action loops for the ill-structured. The actors that are part of the collaborative activity may be considered as internal customers or producers, providing services within the collaborative activity, as reflected in Figure 4.4. The relationship between the actors, or activities, subscribes to the transaction pattern of interaction as the basic building block for coordination. The workflow loop conditions for satisfaction or commitment are managed between actors, or activities, depending on the level of abstraction.

To account for the well-structured and ill-structured work processes that coexist in the cooperative work process, the framework respectively employs process-based modelling (activity or document driven), while exploring the relationship between the activities and the actors from the workflow action loop perspective to capture the ad-hoc pattern of work. To capture the unstructured process the interactions between actors and their activities are considered. Essentially, the information and knowledge-sharing perspective are contemplated, relative to the communication acts presented by the actions workflow loop. This entails consideration of what is requested, the conditions put in place, and the response that comes from the connecting actor, or activity, along with how it was delivered.

Figure 4.4 illustrates the perspectives emphasised. The understanding of existing workflow provides a baseline for the redesign of systems or the development of better processes. Chapter 1 includes an instance of View (a) to represent the document flow in a capacity-building intervention process. The remainder of the views are employed in the subsequent chapter in an attempt to identify solution design requirements.

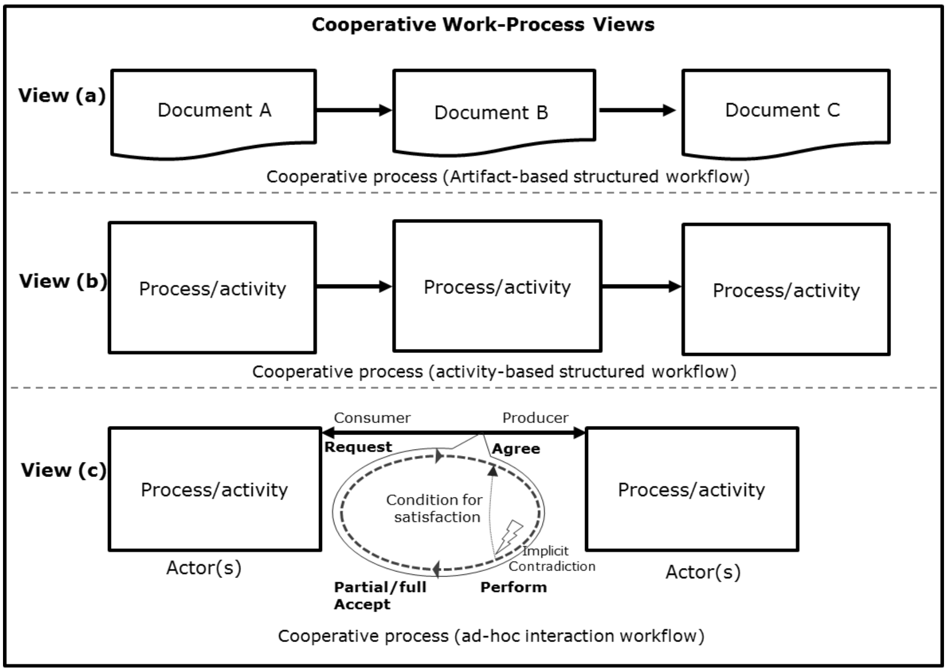


Figure 4.4: Cooperative Work-Process Views

The information passing between activities is considered as a service achieved by means of networking, serving as the input or output of the varying related sub-activities to each other. The process view is intended to show the control flow or structure, along with the information flow overview and the application or workflow data between activities. While View (b) may be used to represent the flow of activities or processes at different levels of abstraction, to serve as a guide for situated action[3], it masks other dependencies and other coordination concerns that may exist.

To account effectively for the coordination requirement, a more in-depth, detailed lower level view may be necessary. Figure 4.4, View (c), is mindful of the fact that during the

[3] Situated action represents a concrete instance of an abstracted public or global process representation to locate and guide the activities of others.

course of an activity performance, issues may arise that could impede successful outcomes, as other implicit dependencies are often involved. These issues are considered in part of the low-level analysis.

The resulting instrument can be viewed in two parts, viz. **high level** or **low level**, which penetrates into the specifics of the hidden dependencies or attributes of the sociotechnical components that indirectly influence coordination efforts. As emphasised in Section 2.2.4, a holistic evaluative approach to a system, a reductionist and functionalist approach, supportive of the downward and upward examination of subsystems, with reference to the roles of the components in the larger system, is valuable.

4.5 The Instrument as an Exploratory Tool

The two-level evaluation approaches towards the state of coordination in a distributed environment are described in this section. The high-level approach presents an overview of both the micro and macro contexts, which reflects a more superficial analysis. The low-level approach reveals a more in-depth look at the high-level components, which especially extends the micro context and is reflective of the often implicit support system of the coordination mechanism that propels or impedes their effectiveness. The components and the dimensions identified provide guidelines for the identification of possible coordination problems in the form of propositions. Details pertaining to elements that should be considered are reflected in the following subsections.

4.5.1 The High-Level Overview

The high-level evaluation serves the function of the preliminary or meta-level analysis. At a glance, the preliminary analysis of the instrument should reveal the existence, or non-existence of an actor, the dependencies that exist, and the mediator devices or coordination mechanisms. It presents an overview of the 'As-is' model of a specific situation. Figure 4.4 portrays the macro and micro inquiry context that will reflect the 'As-is' model. The context summarises the collaborative system virtually as a snapshot of the current situation, which can be utilised to discuss changes when inconsistences are identified. It provides a shared visual on the scope of and purpose of the system. Essentially it identifies the participants, the services they require, the activities in the process, and the tools required.

The **micro context** in the instrument represents the dynamic collaborative activity, composed of the goal-oriented and coordination activities. The collaborative activity work-process procedure is composed of a set of activities; actors (whether in active or passive capacity) initiating or carrying out the activities; a set of dependencies between activities, including shared resources and ordering; and the objective needing to be achieved. Fundamentally, each collaborative activity reflects a unique objective based on a problem or opportunity being explored. The characteristics of the micro context embody the motivation for collaboration. In order to understand the problem of coordination all levels are examined, since the tiers interact and influence each other. A representation of the collaborating actors, in consort with the activities and transactions they partake in, reveals, as part of the collaborative activity, the work-processes, communication and information flows, and the network of activities. It serves a functional initiation point for remaining on target, together with identifying any deviations that may occur.

Therefore, the micro-level meta-analysis reflects on the arrangement of activities (cause/effect relationship) selected towards a common collaborative goal, the presence of the coordination mechanism, the nature of the tools involved, and the transaction agreement, relative to input and output between participants. The network of transaction or workflow loops that makes up the collaborative work process connects a specific overall piece of work or task, which is required to be accomplished. The tool component accounts for the knowledge base, the technology required to acquire inputs, transform them to outputs or services, and then provided to customers of the organisation. Artefacts and mental constructs that assist activities, as well as the rules, norms and division of labour are considered. The dynamic nature of the collaborative activity influences the interaction structure of actors and the interdependencies of activities. The exchange of messages requires a communication channel to be present. This may represent an audio channel (telephone line, a videoconferencing channel), an electronic mail tool, or even live media, in which the actors are co-located in the same room.

Furthermore, the collaborative activities, as work-systems, interact with their environment, receiving for example, rules and objects from other activity work-systems, for instance, ‘management’, while producing outcomes for others. This denotes that the control structure and the influencing external work systems must be identified or their absence noted, resulting in how rules, instructions or defined practices are disseminated as being significant. Other factors that may affect coordination processes are made explicit in terms of the **macro contexts**. The collaborative activity operates within an environment that affects its operation.

Factors from the environment, the organisational culture/design/strategy employed or reasons for existence and the available infrastructure can affect the optimisation of the coordination process, frequently representing the control mechanisms. Consideration at the macro context takes into account the external collaborative activity landscape. The considerations include policies and legislation, as well as the national strategies. For instance, national laws, organisational culture, and rules or restrictions can have an effect on the work, and hence, can only be detected by examining the broader context. Moreover, the reasons why functions exist in a given work process can be viewed in a broader context. For instance, a lack of information accessibility owing to contradictions in a collaborative work-process, spanning across an organisation in the collaborative activity level, may be due to issues at the organisational, legislative or national tiers. This type of contradiction in an organisational setting, affecting the coordination support system, is only revealed when the broader context is considered. For example, advocating for the economies of scale without providing access to the information that will facilitate such behaviour. Issues like agency rivalries or the fact that knowledge may exist and an environment may promise a culture of sharing, however, does not mean that an entity will be inclined to share or will be willing to cooperate. Furthermore, it may be enabled by the level of autonomy they possess, sanctioned by legislation. Table 4.2 presents a summary of the high-level analytic dimensions and items that will help focus a problem area towards requirement for a solution.

Relative to the Micro and Macro context analysis, the following **inquiry questions** result: Who are the **actors**? What kind of information do they require? From which sources and by what means is the information obtained? What is the primary or sub-**object, goal and outcome** (from both the collective viewpoint and individual sub-activity perspective)? What are the **means of work**, the (physical or mental) instruments which facilitate work between activities? Which **professions** and **authorities** are present and what are their roles? Where do they come from (sponsors)? What are the **means of organising work** and **communication**? What kinds of rules or best practices are involved? Where and how are the rules created? What kinds of channels are employed in communication and how are they utilised? From where do they arise? Is ICT used, and if yes, what is its role? What are the **means of networking**? How are the activities of one individual related with the other activities within the network? Where are the **organisational boundaries** and how do they affect the **service chain**? What **kind of groups or teams** are there and what are their functions? How are these teams formed and **supported**? Essentially, the metaphor of tools utilised to mediate between the elements will result in exploratory questions, for instance*:* How are the **norms or standards** that affect an activity transmitted within the community? What tools are used by subjects to communicate their experiences within the activity with one another? How do the subjects organise the division of labour and to what extent is this affected by decisions of the community to which they belong, in consort with the norms of behaviour as they affect this activity?

Answers to the proposed questions will serve to reveal, for instance, the history of a certain innovation within the organisation, and previous attempts to implement technological change.

Table 4.2 High Level Analytic Dimensions and Items

HIGH LEVEL				
MACRO CONTEXT				
DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**REQUIREMENT (Functional/Non-functional)**
Enabling environment	1.1	Socio-economic		
	1.2	Size and structure		
	1.3	Legislation		
	1.4	Constitution /		
	1.5	Political /administration		
	1.6	Geography		
	1.7	External support influence		
Organisation/institutional capacity	2.1	Work pattern		
	2.2	Cooperate strategy		
	2.3	Organisational culture		
	2.4	Organisational structure		
	2.5	External operational/ procurement process		
	2.6	Support network		
	2.7	Workforce		
	2.8	Finance		
Support infrastructure	3.1	Shared infrastructure		
MICRO CONTEXT				
	4.1	Desired outcome/goal		
	4.2	Determine participants		
	4.3	Define communication/ decision-making pattern		
	4.4	Organise activities and schedule tasks		
	4.5	Determine tools		
	4.6	Identify required information		

The cultural context exposes the tensions in the organisation that may prevent success and the extent to which the end users of the system are committed to the innovation; the rules and conditions under which the technology is to be applied (where legislation guides all activity); the informal norms of behaviour in the affected work team(s) and how this might affect the innovation; the motivation for the innovation (for example, systems may be introduced to reduce paper work and to manage resource allocation);and how the total activity system affects other activity systems within the organisation. In summary, a key or crucial element is assessing how the elements between the collaborative activity and the environment strive to stay in balance.

However, while the high-level framework may obviously highlight an area of weakness, in other instances this may not be as clearly apparent, as the aspects requiring consideration are implicit. For example, the presence of a manager does not automatically mean good management. Other aspects, such as lack of skill, and the availability of other supporting mechanisms, might result in mismanagement, which must be identified. This denotes that, while it is possible to witness the presence of coordination mechanisms, the effectiveness of such mechanisms is not guaranteed. The correct coordination mechanism needs to be in place, and must satisfy its often hidden dependencies to function effectively; otherwise it results in coordination failure. Therefore, aside from the obvious issues encountered at the high level, an assessment of what other possible issues or problem points are extant needs to be considered, in conjunction with how the instrument accounts for such circumstances. The low-level extension probes deeper, through a service capacity lens, relative to the capabilities and resources that enable the coordination mechanism to perform its function. Multiple issues, inclusive of, but not limited to, levels of integration, incompatibility of tools, the unwillingness, insecurities and fears of participants, lack of authority, built-in delays to many inspection points, and a lack of common understanding, come to the fore. The justification for a deeper level of analysis is presented in the following division.

4.5.2 The Low-Level Extension

In this section the low-level extension defines additional dimensions and items that extend the micro context for the analysis of coordination problems in a distributed environment through a service lens. The low-level analytic propositions help to identify issues that could be important for the analysis, but might otherwise be omitted. Regarding this, coordination is viewed as a service provided to production activities, requiring its own support system. Appendix B1 supplies greater detail on the service perspective. The fundamental tenet is that, aside from the existence of a coordination mechanism, its attributes are considered as well. For example, a secretary in office of a director must have the necessary support system to perform his/her functions successfully; or it may impact on the work of the director. This necessitates the evaluation of the service support capacity of a coordination mechanism. Although, at a high-level, the instrument is useful in enabling preliminary understanding of the case activity overview, it ignores other significant elements owing to the level of abstraction considered. At first observation, the preliminary analysis of the framework appeared to reveal the existence of mediating devices or coordination mechanisms or the lack thereof in the 'As-is' model of the situation. However, probing deeper into issues relating to the efficiency and effectiveness of the identified mechanisms revealed some contradiction, resulting in the emergence of new concerns.

The empirical investigation revealed certain interesting facts not explicit in the high-level representation. For instance, the high-level evaluation often assumes that implicit dependencies of elements have been satisfied. However, an interview with the stakeholders revealed hidden facts that required individual attention. An instance of this could be that the presence of a human coordinator does not necessarily guarantee successful coordination. His efficacy may extensively be dependent on knowledge shared understanding of the work; the use of the correct tools and, frequently, on management support, as well as on other factors. This results in certain questions arising, for instance: Does the user have the necessary access to information to execute an action or make the desired decision? Also: What about the commitment of the other parties?

For instance, consequence, at the lower level, must be given towards the abilities of an individual to effect his or her action as required by a plan, relative to the supporting capabilities and the resources at the disposal of the mechanism. This enforces the necessity of a deeper level of analysis. In this section, for situations where issues appear to be inconclusive at a higher level, guidelines are provided as a proposal to steer such deeper analysis needs.

As suggested in Chapter 2, Section 2.2, to understand a problem situation fully, extension from other perspectives are welcomed and sometimes necessary. To make the inquiry truly holistic, the following sub-division endeavours to expand the model by viewing it from the service capacity perspective, which presents a frame for other dimensions that may be considered. Arising from the nature of contradiction revealed, it is deemed that the extended, more detailed analytic propositions reviewed in the following sections will reveal hidden facts, as well as potentially exposing additional loose ends, as a form of a critical assessment. How the research goes about exploiting the service perspective is discussed in the subsequent section of the discourse.

4.4.2.1 The Service Lens Assessment Specifications

To expose latent factors and hidden dimensions within the environment effectively some inquiry guidelines were defined. In order to classify and categorise the empirical data collected involved the employment of a systematic technique, which allocated the identified issues to an appropriate service capacity component. The initial step involved making a decision as to whether an issue related to a resource issue or capability problem. If the answer to the question: *Does this point to something that could be acquired?* was positive, it was deemed indicative of a resource problem. It was otherwise allocated to the category of a capability problem if the component or concern involved proficiency, experience, knowledge of execution or know-how of doing something. If the question related to an issue of ***who*** is responsible or accountable for accomplishing a certain activity, it was regarded as a people problem.

Relating to resource problems, if it was indicated that the allocation or availability of funds was too low or too small, it was portrayed as a finance component. However, if the issue was not exclusively attributable to financial components, and rather concerned the question: *Is additional base facility required?* Then it was coded as an infrastructure component.

An issue was coded as an application component if it involved limited decision support and task enabling tools. If the concern related to the question: *Are there sufficient facts?* Then it was deemed information constituent.

Regarding the capability problem, if an administrative difficulty was indicated it was coded as a management element. If the issue did not solely relate to management, however, but was linked to the question: *Is appropriate configuration in place?* it was coded as an organisation component.

An issue was judged to be a process component if it related to the question *Is there a proper course of action or transformation?* If the suggestion of any form of awareness difficulty was uncovered, it was coded as a knowledge component. Furthermore, if the issue did not relate purely to knowledge, but involved the question: *Is there requisite skill or competency?* it was coded as a people component, as were resource problem issues relating to the question: *Is there sufficient human resource capacity?*

The rationale for the Meta and sub categorisation of themes, which defines the dimensions and propositions, is motivated by inductive and deductive reasoning from the empirical data and existing literature. Appendix B1 presents an in-depth discourse relating to the thematic analysis approach employed. The following section presents a synopsis of the service-based components, in conjunction with the dimension propositions they explore. The dimensions considered are by no means exhaustive, comprehensive or all-embracing, and are not necessarily relevant in every case. The unique, individual nature, circumstances and characteristics of the case determines what will be considered and is not rigid, remains changeable, and therefore, open to extension. Detailed foundations and bases of the dimensions examined are presented in Appendix B1.

4.4.2.2 The Service Lens Analytic Propositions

Elements which are classified as capability components comprise management, organisation, people, and knowledge, used to transform resources. Fundamentally, capability components constitute the factors providing the requisite competence to produce value. This denotes that capability is the organisational capacity to deploy resources for a desired end result, as perceived and determined by a customer. They are typically experience-driven, knowledge-intensive, information-based, and firmly embedded within the people of an organisation, its systems, processes and technologies. Resource component types include finances, infrastructure, applications, information, and people. While it is convenient to separate the asset types, it is frequently impractical, as in reality they are correlated, over-lapping, forming a mixture or composite, and although the degree of intermingling may vary, they can affect the performance or functioning of one another.

Management is a capability asset responsible for the growth and survival of an organisation concerning direction and control. Management entails creating an environment conducive to the task being performed efficiently and effectively with the aim of maximising efforts. It prompts the organisational methods to work efficiently towards the achievement of the organisational purposes and *reasons for existence*. Decisions made at this level become the basis of action for other assets. Deemed central to management are people who nurture, coordinate and control the other assets types to aid and direct efforts towards a defined, specific purpose. A management system involves leadership, administration, policies, performance measures, and incentives. Management systems formulate rules or regulations in consort with directing group efforts to achieve pre-determined goals. The following dimensions and corresponding propositions are associated with management:

- ***Strategy***
  An issue was categorised as a strategic component if it hinted towards an issue of clearly defining what to achieve (clear collaborative objectives, goals or plans). for whom, and the intended means by which to accomplish the achievement (e.g. policies, synergy, partnership, adaptation strategies).
- ***Control***
  Concerns were deemed control issues if they related to problems connected to not clearly defining the level of authority (in terms of constraints for performing or avoiding action), boundaries, or roles and responsiblities.
- ***Monitoring***
  If the issues hinted at eliciting performances and how well resources are utilised efficiently and effectively, it was categorised as a monitoring issue.
- ***Communication***
  If the issue hinted at a problem involving the lack of interaction, understanding and commitment of role players towards achieving clear objectives it was categorised as a communication issue.

The **organisational asset** is the basis for order and structure within the organisation, concerning design and administration. The organisational asset involves active configuration and the manner by which the pattern assets are deployed, either by design or by self-adaptive processes, with the objective of maximising the creation of value for stakeholders. Fundamentally, the organisational asset unites or appropriates asset types, developing productive relationships between them for the achievement of organisational goals. An example involves decomposing and delegating tasks to the correct personnel or group, accompanied by the appropriate supporting capacity and authority to maximise value creation. Essentially, the organisational asset focuses on the structure and systems that enable the efficient utilisation of resources to realise developmental goals. The succeeding dimensions and corresponding propositions are associated with the organisation:

- ***Design***
  If the issue involves difficulties in identifying the general work or reporting patterns, and/or ascertaining collaborators, administration boundaries, grouping, and the participation of role players in applicable activities, then it is judged a design problem.
- ***Configuration***
  A configuration problem relates to issues which contend with difficulties in orchestrating the components (resources), the cross-functional team formation and the communication pattern to satisfy a collaborative goal requirement, within given constraints.

Central to the survival of an organisation are the **process assets.** These assets exist at different levels of granularity, from generic management processes to low level processes at an application level. Process assets define how a service is provided, thereby signifying action and transformation towards attaining a desired outcome or objective. They consist of algorithms, methods, procedures and routines that direct the execution and control of activities and interactions in the business environment, and are executed by processes, people and application assets. Knowledge and information assets enrich and augment them, in consort with applications and infrastructure assets enabling and facilitating them. The process asset dimensions and associated corresponding propositions follow:

- ***Process Definition and Support***
  If the issues involve an unclear structure of activities and their dependencies, lacking technological support, then it is classified as a process definition and support problem.
- ***Process Measurement***
  Process measurement problems comprise issues encompassing a lack of analytical visibility relating to immediate results or the impact of a particular process action towards optimisation.
- ***Operational/Stewardship Problem***
  If the issue deals with the assignment of undefined roles and expectations regarding specific aspects of the process, as well as logistic stewardships, and/or determining the degree to which tasks are routine and pre-specified or subject to external decisions, it is viewed as an operational problem.
- ***Process Integration***
  An issue is coded as a process integration problem when it concerns difficulties in the sharing of information and services between cross-functional or organisational processes.

The **knowledge asset** describes the contextualised or action-based accumulation of experience, awareness, information, insight, and intellectual property. It is predictive and can be used to guide action, and is inclusive of Policies, plans, design process definition configurations, and architectures. The possession of the correct knowledge, in consort with the systematic sharing of knowledge facilitates effective coordination. Knowledge assets can be expressed explicitly into, and embedded in, applications od process and infrastructure assets; the management, organisation, process and applications assets utilise and store knowledge. The following dimensions and corresponding propositions are associated with the knowledge asset:

- ***Utilisation***
  If the issue relates to the inability to measure and exploit the value of the information available, it is regarded as a knowledge utilisation problem.

- ***Acquisition***
  Therefore, if the issue concerns the incapability of acquiring and exploring valuable existing information to its fullest extent it is considered a knowledge acquisition problem.
- ***Codification***
  A knowledge externalisation or codification problem arises if the issue is associated with incapacities in transforming relevant knowledge into interpretable forms of information, in order to communicate and share.
- ***Awareness***
  If the issue relates to the lack of insight or shared understanding of situational or contextual information (relationships, artefacts, resources, processes) relating to work activities, at any point in time, relative to the possible synchronisations of actions, it is judged an awareness concern.

An **information asset** can be described as the contextualised collection/abstraction of data, forming the basis of knowledge creation. Information assets exist in many forms, comprising, but not all-inclusive of: documents, records, messages, and graphs. Frequently organisations use standardised documents to ensure that complete, uniform and consistent information is gathered. In the functioning of an organisation, information is exchanged orally, electronically or in written form between stakeholders. The information asset is used for communication, coordination, and the control of business activities and hence must be trustworthy. A communication link between stakeholders needs to be maintained for the effective functioning of an organisation. Furthermore, relevant information is commonly consumed by the other assets towards attaining an anticipated, chosen outcome or objective. The information asset dimensions and corresponding propositions ensue:

- ***Accessibility/Integration***
  If the issue related to the unavailability or isolation of important information, it was categorised as an information accessibility problem.
- ***Completeness***
  An information completeness problem arises when the issue involves the inadequacy (partially captured) or inaccuracy (error during capture/ transfer) of information supplied and/or utilised or decision making.
- ***Presentation***
  Issues concerning the poor dissemination of relevant information in a manner that is not understandable and/or is not within acceptable time frame, to provide collaborative opportunities and to enable role-players to execute their tasks efficiently are classified as information presentation/delivery problems.

Application assets derive their value from other assets. They exist to serve different, diverse and varied purposes (general, multi- to context-specific). An example of applications includes the groupware systems, designed to support collaborative activities and their coordination as seen in CSCW. To monitor what is being done, by whom, to whom or what, when, and how, organisations typically require a wide range of reports, (e.g. financial, status, and project statements) which can be supported by several, diverse and assorted application types. Application assets enable, enhance, facilitate, automate, codify, maintain and/or imitate the properties, functions and activities of the other asset types. Applications can enhance the performance of processes, along with the personal productivity of the people asset. Furthermore, they can consume, produce and maintain knowledge and information assets, and are supported by assets such as infrastructure, people and processes. The following dimensions and corresponding propositions are associated with the application asset:

- ***Applicability/Usability Problem***
  If the issue relates to the relevance or the limitation of functionality to simplify and enhance the performance of processes and personal productivity, then it is categorised as an applicability or usability problem.
- ***Tools/Features Limitation***
  A problem entailing the lack of tools or features arises if the issue concerns limitations relative to information analysis or knowledge of support tools, in conjunction the way knowledge is disseminated and applied.
- ***Integration***
  An issue is deemed an integration problem when it involves the inability to exchange and reconcile information automatically with varying tools.

The **infrastructure assets** provide support at various levels to the other asset types. Infrastructure ranges from traditional facilities such as buildings and electricity, to shared Information Communication Technologies (ICT) -based assets, comprising software, network devices, and telecommunication equipment. ICT has revolutionised the methods, routes and interactions through which people and businesses work, connect and communicate together. Fundamentally, the infrastructure asset provides the base for the functioning/operation of all other asset types. The infrastructure asset dimensions and corresponding propositions are:

- ***Interoperability***
  If the issue revolves around a problem of unifying distributed and heterogonous IT components it is considered an interoperability problem.
- ***Shared ICT Facility***
  An ICT facility problem (or lack of ICT facility problem) is extant when the issue deals with the lack of shared IT facilities, relative to enabling integration or interoperation between distributed heterogeneous tools and the facilitation of communication.

Once the organisation has established the requisite goals in consort with the strategies associated in achieving the objective, funds are set aside for the resources and labour to be utilised in attaining the goals and executing the tasks. The **financial asset** is thus required to support the ownership or use of other asset types, and is therefore a useful resource for service provision. Without the correct application and utilisation of the financial asset the full potential of the other asset types cannot be wholly realised. It measures the economic value and performance of all other asset types. This highlights its significance, and indicates that its adequacy is of concern to all organisations. The application assets help to monitor how the financial component was disbursed, spent and what it obtained. Essentially, a review of financial statements assists in determining the progress of programs and plans. By considering the problem of coordination from a capability perspective, we also consider the mapping of the resources.

- ***Fund Limitation***

  If the issue is related to inadequate monetary resources or the unavailability of funds or resources to accomplish a required task it is regarded as a funds limitation problem.

- ***Funds Misappropriation***

  If the issue dealt with investment that does not facilitate or support the collaboration process then it was deemed a funds misappropriation problem.

People are the central assets of an organisation, possessing the capacities for creativity, learning, and decision-making, in consort with numerous other capabilities, expertise and proficiencies, including knowledge, experience and skills, with other components enabling them. In addition, they have the capacity to adapt, and their capability to reason assists them in tolerating ambiguities and uncertainties. People serve the functions of both capability and resource. Regarding a capability perspective, they create, compose and configure the other component types towards a value-driven purpose. Relative to a resource perspective, they assume a passive role and serve in a production capacity. The people asset involves the following dimensions and corresponding propositions:

- ***Individual Capacity***
  An issue relating to the requisite for the employment or utilisation of people with the right skills, knowledge, capabilities, competencies and abilities to fill in the structure and to execute required tasks effectively, or the lack or absence thereof is categorised as a lack of individual capacity problem.

- ***Accountability***
  An accountability problem arises when the issue concerns the responsibility or commitment for the outcome of a certain process.

- ***Staff Turnover***

  When employees leave the issue is deemed a staff turnover problem.

- ***Interaction***
  Issues relating to limited face-to-face contact between role players are judged interaction problems.

- ***Role Definition***
  If the issue relates to the over-extension of staff and the duplication of responsibilities then it is a role definition problem.

These nine meta-components and their associated dimensions describe the complex environment, requiring in-depth consideration, when dealing with coordination support in a distributed environment. The analysis, which considers, explores and contemplates these dimensions, will focus and attempt to eliminate, areas of concern. Table 4.3 presents a summary of dimensions and items to be considered at the low level.

Thus, the table will reveal the problem indicators and its subsequent requirement. The requirement should reveal both functional and non-functional necessities that must be accounted for to streamline coordination in a distributed environment. The application of the instrument is covered in the following chapter.

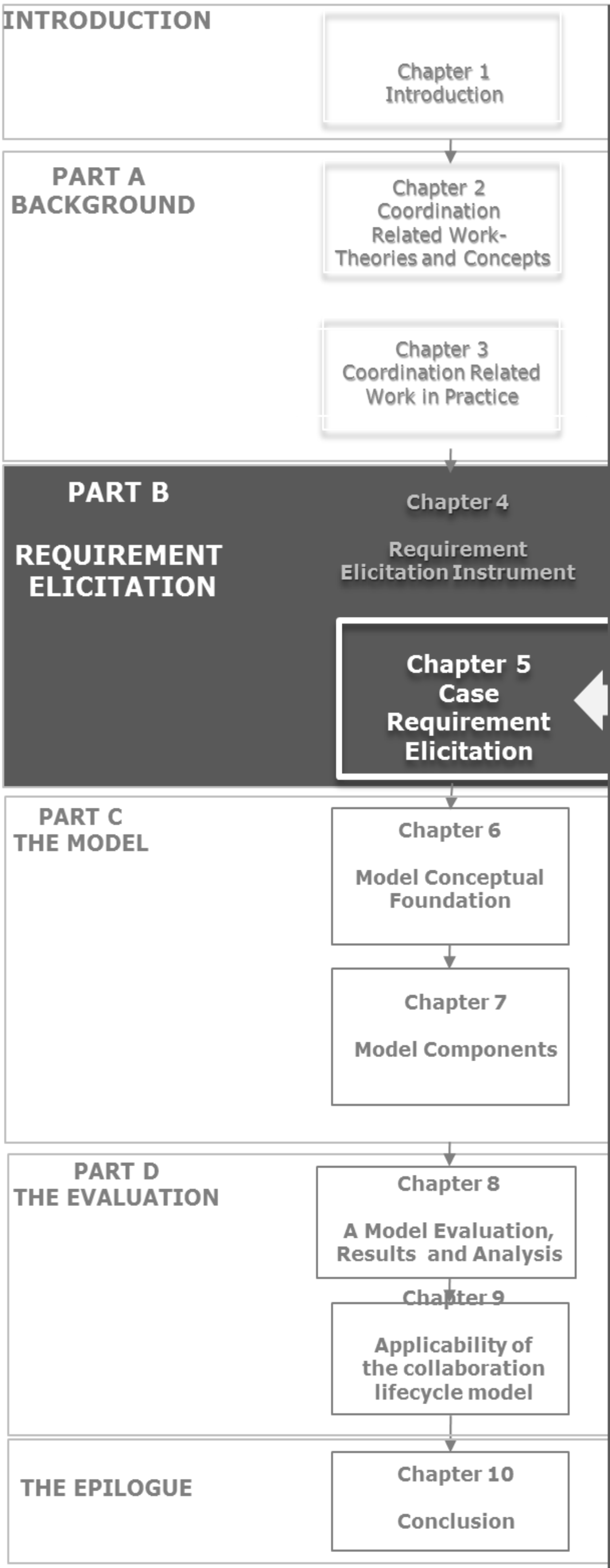
Table 4.3: Low-Level Analytic Dimensions and Items

LOW LEVEL				
DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**REQUIREMENT (Functional/Non-functional)**
Management	1.1	Strategy		
	1.2	Control		
	1.3	Monitoring		
	1.4	Communication		
Organisation	2.1	Design		
	2.2	Configuration		
Process	3.1	Process definition & support		
	3.2	Process measurement		
	3.3	Operation/stewardship		
	3.4	Process integration		
Knowledge	4.1	Utilisation		
	4.2	Acquisition		
	4.3	Codification		
	4.4	Awareness		
Information	5.1	Accessibility		
	5.2	Completeness/asymmetry		
	5.3	Presentation/ language		
Application	6.1	Applicability & usability		
	6.2	Tools and features		
	6.3	Data Integration		
Infrastructure	7.1	Interoperability		
	7.2	ICT facility integration		
Funds	8.1	Funds limitation		
	8.2	Funds misappropriation		
People	9.1	Capacity		
	9.3	Staff turnover		
	9.2	Accountability		
	9.4	Interaction		
	9.5	Role Definition		

4.6 Conclusion

In this chapter a holistic multi-dimensional instrument is presented, as a base towards a systematic assessment of a business case, in order to identify the requirements for coordination support in a distributed environment. Substantiated by both theory and practice, the instrument endeavours to identify the state of coordination in a distributed environment, where coordination mechanisms are adopted, based on the problem area identified. The study instrument takes into account several factors from a sociotechnical perspective, to aid in contextualising coordination support for collaborative work. Essentially it accounts for, and makes explicit, dimensions which previous works have often left implicit. The multi-dimensional concept thereby developed, is deemed a useful analysis frame to elucidate the strategies employed, in consort with their realisation and impact.

Evaluating, explicating and appraising the characteristics, attributes and concepts of existing approaches in the knowledge base allows, through application in theory and practice, their gaps to be identified and addressed by the proposed framework, benefiting it and gaining advantage through a complementary synthesis. The proposed framework differs from those currently extant, in that it adopts a holistic approach, in conjunction with providing guidelines to contextualise coordination support, taking into consideration several factors, including environmental components and work context. By extending the assessment instrument from a service capacity perspective, the more implicit attributes are accounted for and presented as constructs, motivated by both theory and case study. The subsequent chapter is focused on the application of the framework, relative to the circumstance of the South African public service, towards identifying the requirements which should characterise the coordination support model in a distributed environment.



5.1 Analysis Method

5.2 Characterising the South African Public Sector

5.3 The Capacity Building Process

5.4 The Requirement Elicitation Instrument Application

5.4.1 The High Level Case Study Analysis

5.4.2 Low-Level Analysis

5.5 Abstracted Summary Requirements for a Coordination Support System in a Distributed Collaborative Community

5.6 Conclusion

CHAPTER 5

A CASE STUDY BASED REQUIREMENT ELICITATION FOR COORDINATION SUPPORT IN A DISTRIBUTED ENVIRONMENT

Considering the limitations of existing coordination analytic frameworks to manage, control and account holistically for coordination requirements in a distributed environment the previous chapter proposed a multidimensional instrument towards that end. Thus, the primary question that arises is: *What requirements characterise effective coordination in a distributed environment*? This chapter presents a case study as an initiation point for identifying the requirements needed to answer that question. With guidance from the instrument, the case study will assist in highlighting the requirements necessary to support coordination in distributed environments effectively. Using the proposed instrument as a foundation, this chapter is intended to explicate collaboration patterns, aiding in a comprehensive understanding of the factors that facilitate or impede coordination in a distributed environment, as revealed in the case studied. This will clarify and contribute elements to aid in the design of a model to support coordination in a distributed environment.

The chapter begins by introducing the analysis method, through which the case studied is introduced. This is succeeded by the high level assessment, followed by the low level analysis. Thereafter, the requirements and the motivations therefor, are explicated, with a subsequent conclusion, which highlights potential routes forward. The next division outlines the method for the case study to illustrate the application of that framework.

5.1 Analysis Method

A single case study is explored, based on a series of dimensions relative to the requirement elicitation instrument proposed in Chapter 4. The intent of exploring the case study is to identify the requirements necessary to support coordination in distributed environments effectively, aiding in the design specifications and elements of a model constructed for that purpose. The single case is not intended to be definitive, but is utilised in an exploratory capacity, intended to illustrate the application of the instrument and to identify requirements. The rationale of employing a case study is to provide an in-depth, comprehensive examination or understanding of the environment. Future appraisals of additional case studies will be required to determine if the findings are universal and generally applicable. As discussed in Chapter 1, the South African public sector presents a suitable case for analysis. The research approach utilised for this case study draws predominantly on interpretivist methods.

In order to understand the structural aspects and operations of the case in question, the research engages the relevant role players, while considering the general reports or documentations, as well as an analysis of workflow processes. Multiple data collection methods, including observation, focus group, semi-structured interviews, and artefact and content analysis, were used to understand the case operations. Figure 5.1 presents an overview of the case research elements. A focus group of four senior managers at the national level was conducted in 2008, succeeded by a single interview of an individual senior manager. In October 2009 a senior municipal manager interview was performed, leading to a subsequent interview in August 2010, with the Skills Development facilitator (SDF), the liaison between the municipality and the LGSETA responsible for capacity building initiative. The average length of each interview ranged from between 60 to 90 minutes.

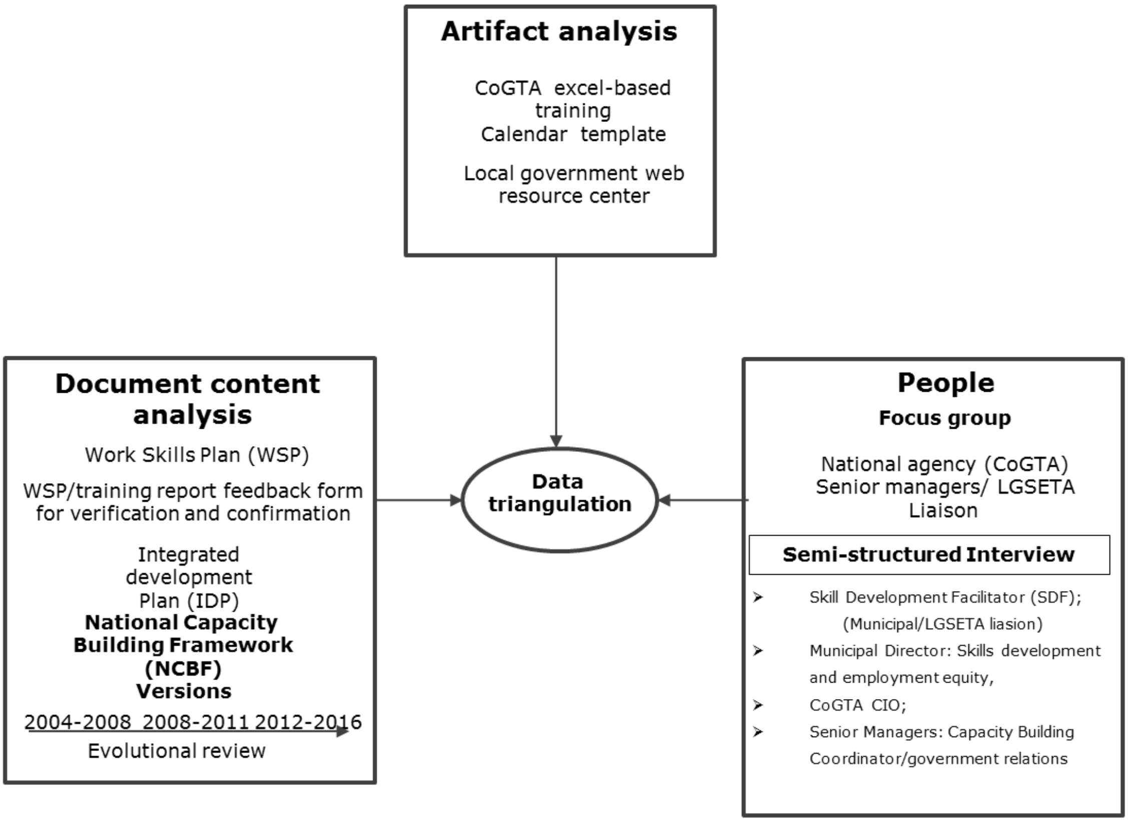


Figure 5.1: Data Triangulation

While conducting the interviews, the opinions of various stakeholders were collected, to avoid data distortion by the informants. All interviews were recorded and transcribed. The interview transcripts were analysed using the qualitative content analysis method.

Where necessary, to clarify an element or to conduct more detailed or additional enquiries, a follow up to the interviews was done via email.

To ensure research reliability, interviews were supplemented by a review of documentation, both publicly available and interviewee supplied, which facilitated an enhanced ability to triangulate the data and corroborate the perspectives provided (Yin, 2003). The collected documents primarily pertained to the capacity building intervention process. A prominent and predominant element is the National Capacity Building Framework (NCBF), an overarching framework designed to coordinate capacity building and training efforts. The analysis followed the historical evolution of the framework, as portrayed in Figure 5.1, to substantiate the claims made.

Regarding analysis, data were coded a priori in terms of their relationship to the dimensions identified, Yin (1981, p.60; Stemler, 2001). Descriptive codes were used and interview transcripts were colour coded in sentence or multi-sentence combinations, in accordance with the recommendations of Miles and Huberman (1994). The coding process was also applied to the documents, especially to the NCBF document.

5.2 Characterising the South African Public Sector

The Republic of South Africa is divided into nine provinces, currently with 226 local municipalities. The municipalities employ approximately 230 000 personnel, distributed across 2 798 kilometres. The distributed staff participated in capacity building and training initiatives provided by various national, provincial, municipal departments and associated institutions, undertaken in an effort to ensure proper service delivery in the sector.

Increasingly, attention has been placed on transforming and improving service delivery, relative to the South African public sector. The necessity to ensure that the South African workforce, particularly in this sector, is equipped with the requisite capacities, skills and competence necessary for efficient and effective service delivery, has been widely recognised and proclaimed. The recognition of this requirement is so great that laws have been enacted to give meaning to the local government capacity building system. Legislation pertaining to management practices and systems mandate components required of municipalities when addressing municipal assessments through specific approaches or initiatives. The principal statutes are the Skills Development Act (1998) and Skills Development Levies Act (1999). The Skills Development Act decrees and creates the structures and framework for the National Skills Development Strategy. Several remedial interventions are being sanctioned across all three spheres of government, viz. national, provincial and local.

Furthermore, these legislated interventions incorporate several role players, as depicted in Figure 5.2, which include external donors with specific interests. Made explicit in Figure 5.2 are the information and document exchanges between stakeholders, characterising interdependences and, in certain instances, the coordination mechanisms shared by participating members. This clearly illustrates the nature and degree of complexity involved. As mandated by the Constitution, all spheres of government in consort with all entities within each sphere, must support each other to provide for a transparent, accountable and coherent government for the nation as a whole. The Constitutional decree charges the national, provincial and district municipalities with the responsibility of building capacity in local government. This extends with elements of the framework strategies requiring the national and provincial government, along with district municipalities, to fulfil a coordination and capacity support role. Wherever possible, a collaborative approach to capacity building should be taken, to avoid duplication and to ensure the maximum utilisation of resources.

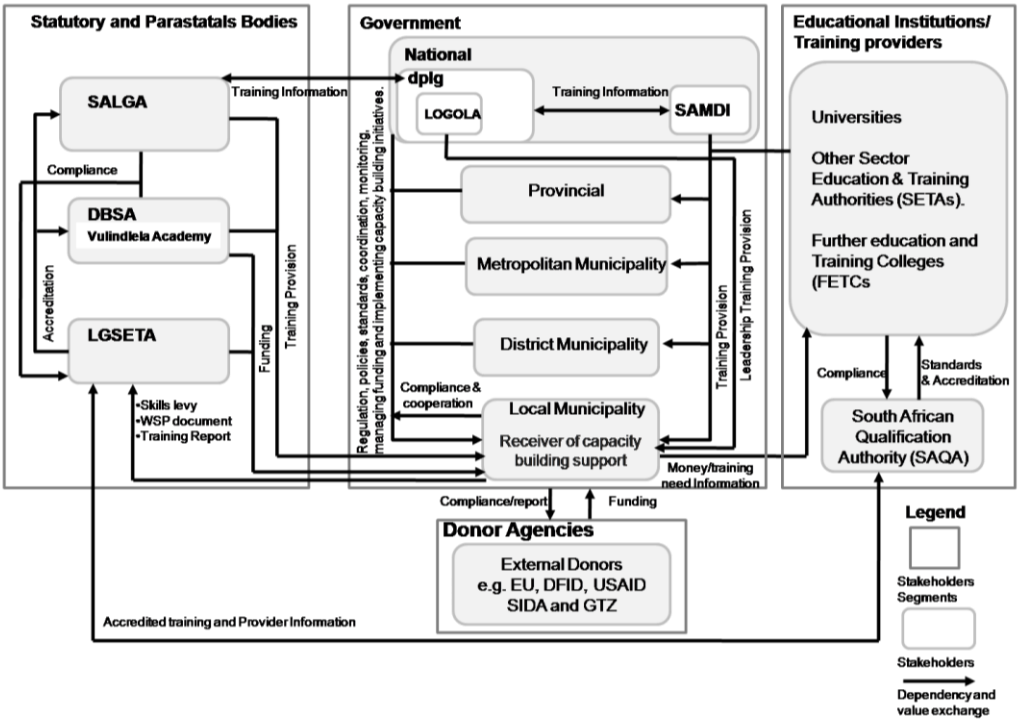


Figure 5.2: Capacity Building Stakeholders and their Value Dependency Model

However, exiting strategies and approaches have not adequately responded to capacity building needs (Layman, 2003; NCBF, 2008-2016; 3rd tier, 2009). Various problems exist in relation to skills development in South Africa, which ultimately impact on the levels of service delivery in the public service. One of the principal issues is coordination. The assessment of available programmes establishes that, while there are many capacity building programmes offered by various role players, including international donors, these programmes frequently illustrate misalignment with competency requirements and contain inappropriate content, duplication and fragmentation of efforts. These challenges illustrate the need for visibility and coordination of the various intervention efforts in the capacity building process, as reviewed and highlighted in the subsequent section.

5.3 The Capacity Building Process

The capacity building process consists of four main stages, as shown in Figure 5.3, viz. Analysis, Review, Implementation and Evaluation. Initially, municipalities perform a skills-gap audit and prepare strategies at the Analysis Phase. They establish the needs, in consort with the priorities or objectives of the Integrated Support Plan (ISP). This is followed by the identification of LGSETA accredited training service providers, who provide the tuition. Thereafter, the reports of previous training and current needs or plans are the sent to LGSETA for review and funds approval[4]. If successful, this is succeeded by training implementation conducted by the LGSETA accredited providers.

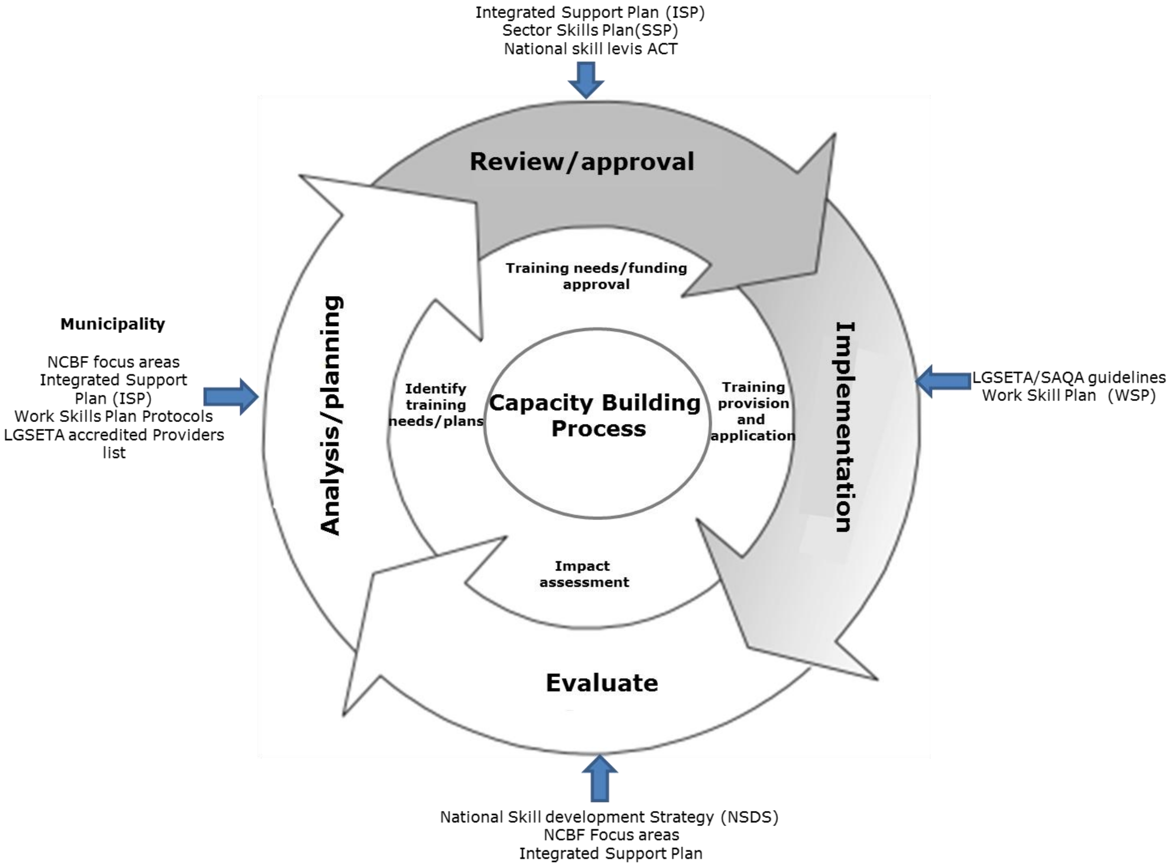


Figure 5.3: Capacity Building Process

Finally, the progress and impact are compared against the goals of the Integrated Support Plan and the National Capacity Building Framework (NCBF) focus areas, by the National Municipal Capacity Coordination and Monitoring Committee (NMCCMC) and their

[4] Prosperous municipalities may go ahead and provide training at this stage, applying for a refund later.

various working groups. The NMCCMC is a heterogeneous committee, inclusive of various representatives, including CoGTA, LGSETA and certain municipalities distributed across the various working groups. The Workplace Skills Plan (WSP), is a key strategic planning document relating to municipalities, and is the result of the skills audit. The Workplace Skills Plan must align to the key municipal ISP objectives, and to the priority training areas identified in the sector skills plan (SSP) or NCBF.

The ISP is a principal, strategic planning instrument, which guides and informs all planning, budgeting, management and decision-making within a municipality for a 5 year period. As the ISP is a legislative requirement, it has a legal status and supersedes all alternative strategies that guide development at local government level. The establishment and/or management of the ISP is an extremely interactive and participatory process, requiring the involvement of a number of stakeholders. The ISP is reviewed annually, resulting in the amendment of the plan. Owing to the critical nature of the ISP a special task team from the CoGTA, in collaboration with other stakeholders (e.g. SALGA and local government), developed the ISP Guide Pack.

The ISP Guide Pack provides a tested planning and implementation management approach, founded on lessons learnt from the previous ISP processes. The primary aim is to assist role players, including Skills Development Facilitators (SDFs), in understanding and participating in the ISP Process, which has been flawed owing to, *inter alia,* a lack of capacities and a dearth of comprehensive and systematic training programmes. The ISP consists of specified steps, requiring the municipality to identify its priority problems, which determine its vision, objectives and strategies, followed by the identification of projects to address the issues. Additionally, the ISP/IDP links this planning to the municipal budget (i.e. allocation of internal or external funding to the identified projects).

Essentially, the ISP/IDP conveys what goal(s) the municipality has to achieve and the WSP reveals who needs training, in what, in order to achieve those goals. It is imperative that Skills Development Facilitators play a meaningful role in the ISP process, in conjunction with ensuring that the WSP is informed by the service delivery and developmental goals of the ISP. Furthermore, relative to the Skills Development Act, a SETA is obligated to research and develop a Sector Skills Plan (SSP), along with other mandated actions. Compiled every 5 years and updated annually, the Sector Skills Plan is an analysis of the labour market within the local government sector and is submitted to the Department of Labour (DoL). The Sector Skills Plan forms the key strategic analysis guiding the implementation of training and skills development within the sector.

The Skills Development Levies Act proclaims that employers, including municipalities, are obliged to register with the SA Revenue Services, submitting 1 % of the monthly pay roll as a skills levy. Upon submission and approval of the Workplace Skills Plan and the Annual Training/Implementation Report, by the municipality to the LGSETA (annually, prior to June 30th), the municipality becomes eligible for both the mandatory and the discretionary training grants from the LGSETA.

The LGSETA receives and evaluates Workplace Skills Plans and Annual Training or Implementation Reports from employers. This entity, additionally, identifies and develops strategic projects arising from skills needs within the sector, funded by discretionary grants and registers, trains and supports Skills Development Facilitators (SDF). The purpose of the SSP is to ensure that the LGSETA has relevant, contemporaneous information and analysis, to allow it to perform its strategic skills planning function for the sector. This is to maximise participation by employers in the National Skills Development Strategy, through the efficient use of resources available for training within the sector.

Funds, including the discretionary grants, may be applied for by compliant municipalities to engage in training to fulfil strategic sectorial objectives, e.g. ABET learnerships and certain skills programmes. Employers employing more than 50 people are obligated to establish a training committee, comprising representatives from the employer, management and organised labour. The training committee is a workplace consultative forum, which needs to be consulted relative to the compilation of the WSP, involved in the monitoring of training and conferred with on the presentation of the implementation report. Municipalities, based on their own skills plans, can apply to the LGSETA for funding for their training priorities.

Relating to formal liaison and the representation of municipalities, an organisation may select any person in the company to act as SDF for the organisation. However, according to SETA rules and regulations the person appointed as SDF for the organisation must be qualified and accredited by SETA as an SDF. If the individual is not qualified, then the selected person may act as an assistant to a qualified External SDF. The SDF is required to facilitate the skills development processes in the selected workplace(s), as prescribed by legislation. SALGA recommends that an SDF in the Municipality should be a senior staff member, to influence decisions and planning in skills development. The SDF must, *inter alia* facilitate the formation and running of training committees, to ensure a cohesive, team-driven WSP, along with devising and adhering to a realistic training and development time table, referring to LGSETA for support and guidelines.

The LGSETA is required to establish a number of cooperative agreements with other SETAs, which may in the future organise training relevant to local authorities. For example, water services training may not fall under the LGSETA, but rather under the auspices of a Water SETA. The Water SETA enters into a cooperative agreement with the

LGSETA for training, since water provision is one of the functions of local government. In addition, the LGSETA, as an Education and Training Quality Authority, in agreement with SAQA, regulates the training providers, to whom municipalities assign their training needs. Appropriate resources are identified through advertising or requesting bids, with the selection based on the tenders submitted by the interested parties. The government based training providers, for instance SALGA, have the overall responsibility for councillor training nationally relative to certain issues, inclusive of, *inter alia*, the ISP process, finance and budgeting, and local economic development.

With the vast array of stakeholders involved, each with a critical role to play in the skills development process, the question arises as to how they coordinate their efforts effectively. The predominant elements through which coordination in the process can be seen to occur includes, although is not limited to, plans (e.g. ISP, WSP), roles and responsibilities, routines, boundary spanners/liaison devices (e.g. teams meetings, SDFs), and certain best practices. It appears that the capacity building process is equipped with mechanisms to support cooperation between role players; however, coordination remains a major challenge throughout the sector, as a result of the extant, implicit contradiction. For instance, while it is suggested that existing managers assume the role of a skills facilitator, consideration must be paid to how this added responsibility will affect both the coordination or primary workplace activities. If personnel are over-extended, a negative impact results. Furthermore, an assessment of whether the supporting technology covers the requirements of this function adequately is requisite. This denotes that there is a need for a holistic overview, which employs a socio-technical approach, to gain insight into the factors that may impede coordination efforts.

Essentially, the lack of a holistic view pertaining to the intervention process, results in the ineffective use of resources, through the duplication of efforts, conflicting schedules and over-extension of staff. Additionally, it makes collaboration, effective quality control and measurement of the intervention success a difficult, if not impossible task. The complexities associated with the government structure and magnitude, in consort with the associated ad-hoc and unreliable structures and processes, impede coordination endeavours. To account for the complex socio-technical issues, which may impede coordination, the subsequent section employs the multidimensional instrument proposed in Chapter 4, as a holistic lens with which to analyse the case being studied.

5.4 The Requirement Elicitation Instrument Application

This section of the discourse engages the instrument proposed in Chapter 4 as an analytical lens, with which to understand the case study. The primary objective of this section is to capture the essence of organisations and, in doing so, to reveal and identify the requirements for the effective design of a collaborative support system. Two perspectives are employed, viz. the high level, which considers both the macro and micro context dimensions, and the low level, which aims to make explicit latent attributes associated with existing mechanisms. The following subsection presents the high level overview.

5.4.1 The High Level Case Study Analysis

The high level overview highlights the features that influence coordination in the SA public sector, through both the macro and micro contexts. To assist in understanding the collaborative system, this portion of the study explicates the overall system, relative to the working rationales by which it operates, in conjunction with how it functions.

5.4.1.1 The Macro Context

The macro context considers the milieu in which the collaborative activity exists and on which it depends. South Africa possesses a complex governmental structure, involving a diverse number of provinces, local governments and municipalities, with different authorities and responsibilities. Although distinct and discrete, they are also interdependent, as they work together towards a common governmental goal. This makes the principles of cooperative government relevant, as elucidated in Chapter Three of the Constitution, calling for, *inter alia*, a clear division of roles and responsibilities; a collective approach to policy; coordination of activities to avoid duplication and waste, and to ensure effective use of resources. To account for commonalties, the sector employs a strategy that is intended to take advantage of economies of scale. Moreover, to deal with scarce resources, organisations perform activities that are dependent on the activities of other entities or that enact undertakings on which other organisations are dependent. However, since the stakeholders are widely dispersed and autonomous, discretional collaboration has become the norm. Factors influencing collaboration in multiple ways are represented in Figure 5.4.

The **enabling environment** of the sector, taking into account the size of the public sector, the number of role players and their physical distribution, facilitates a loosely coupled work pattern. This shapes the workforce activities, collaboration and configurations patterns. The loosely-coupled mode of operation is intended to minimise coordination overheads, as well as to mitigate the costs associated with tightly-coupled interdependences, as these constantly require possibly expensive, consistent back-and-forth communication. Through subscribing to a loosely coupled work pattern, the decision making authority is primarily decentralised, which allows the **organisational entities** to function in an autonomous fashion. The coordination strategy in the sector employs a decentralised form of governance, which affords flexibility towards managing the unpredictability of the work-setting, commonly without necessitating consultation with others. Therefore, this strategy is beneficial, since the entities operate in an unpredictable work environment, which requires the frequent revision of work plans to manage local circumstances.

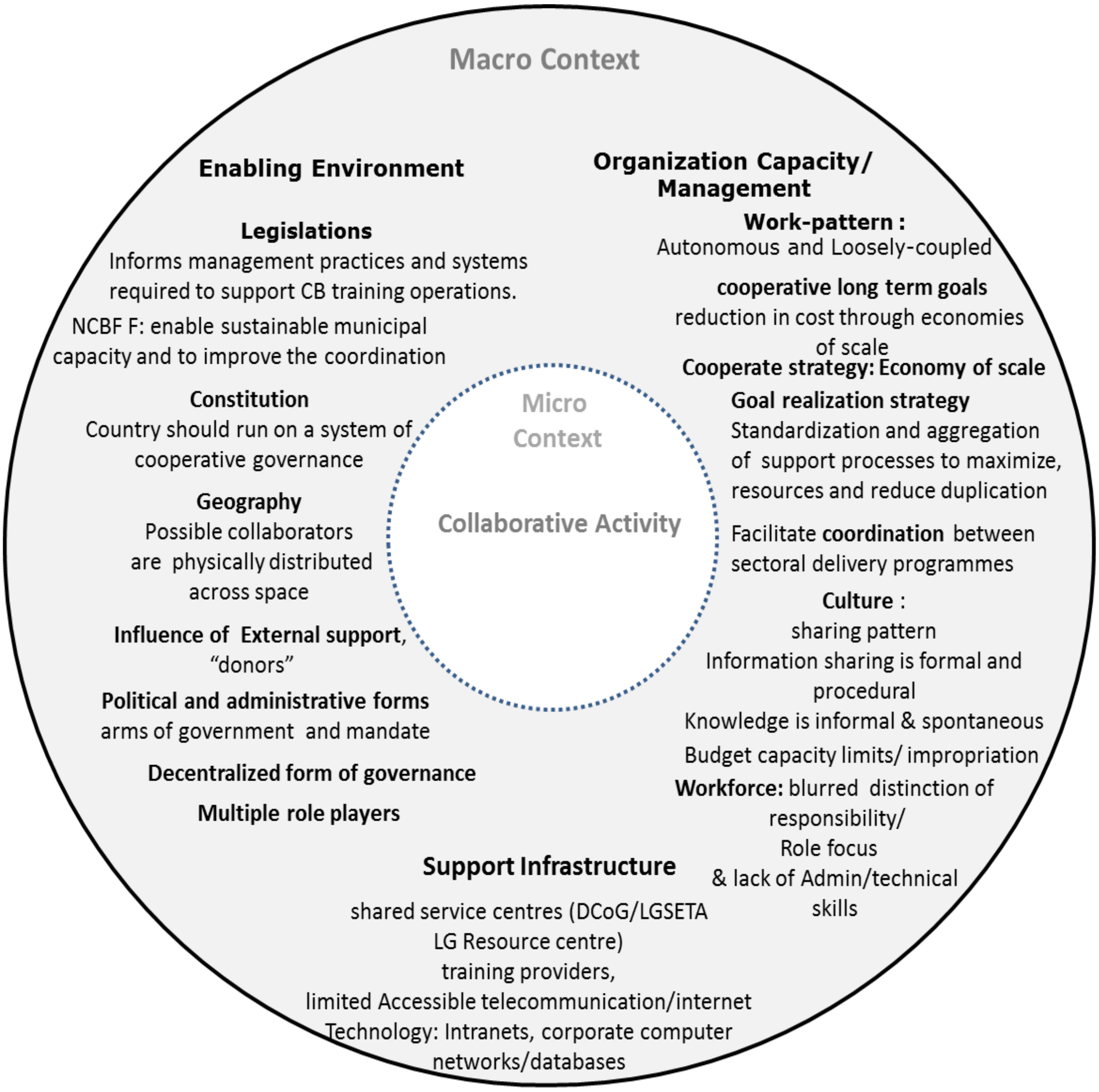


Figure 5.4: Macro Context Elements that Influence Collaboration

The partitioning enables continuous changes, transformations and flexibility in the organisations, as each can tailor its actions and internal structure to meet altering demands facilitated through the reduced interdependencies between entities, with infrequent and occasional interaction.

Despite the benefits of the loosely coupled design, challenges occur when certain dependencies arise. Though it offers adaptability, flexibility and semi-autonomous entities, loose coupling introduces some collaborative communication and information sharing difficulties. As autonomous entities, municipalities determine their level of participation in collaborative activities, establish their own schedules and plans, and carry out the majority of their work activities themselves, typically from a general framework, previously provided. Schedules are not shared among stakeholders and they do not have regularly arranged team meetings, so face-to-face meetings rarely occur. Frequently, it is problematic to maintain awareness of the statuses of other role-players, as well as their schedules and availability, potentially resulting in collaboration being difficult or complicated, with only infrequent communication between workers, often only when absolutely necessary and when the benefits outweigh the effort required to communicate.

In order to overcome the collaborative difficulties, as governmental spheres and other agencies must work together, the coordination strategy subscribes to organisational design mechanisms, which incorporate informal administrative hierarchies, linking pins, workgroups/committees, and periodic direct contacts, in an endeavour to achieve some form of integration. Coordination is also achieved via standard processes, management practices, architectures, and frameworks, among others. These choices are adopted to reduce overheads, where real-time communication is expensive. The work-based mechanisms employed to complement the organisational design involve the specific structuring of tasks to be accomplished. Activities and relationships are defined and linked by the roles to which people and units are assigned.

Furthermore, owing to the complex and dynamic nature of the environment, reform strategies engage **shared service infrastructures** to leverage the economies of scale. Shared service centres, for instance National Agencies like LGSETA and CoGTA, exist to provide capacity building services to municipalities, in order to ensure alignment with shared national objectives. They maintain control over, *inter alia*, national strategic decisions, the setting of key performance indicators or the allocation of resources. These agencies are tasked with integrating the objectives of the decentralised autonomic structures of the public service. To gain comprehensive coverage of the various activities and committees, working groups comprising members from several factions, are frequently constituted to perform the coordination functions for several initiatives. In addition, they are enabled by some term of reference. This implies that coordination may require the functioning of more than one mechanism in order to be effective.

For example, the coordination mechanisms for general support, capacity building and training aimed at local government include: (a) the National Municipal Capacity Coordination and Monitoring Committee (NMCCMC) and (b) Terms of Reference, to guide the actions of the NMCCMC and their working groups, which contain, but are not limited to, their roles, responsibilities and functions.

These structures represent the human organisational structures intended to support coordination in the public sector; in addition to the standardisation of work practices and mutual adjustment, where the communicative action, aimed at mutual understanding, serves as an integration and coordination mechanism achieved through boundary spanning liaison roles or committees, joint decision-making and, in some instances, socialisation. They do so by providing frameworks and documents comprising several protocols to guide the actions of the municipalities towards achieving a common objective. However, these require a great deal of effort, as the majority of the processes advocated are done manually, and the information sharing infrastructures are limited or non-existent in some instances. This results in the introduction of lags, delays and errors, among others.

In most instances, the supporting technical infrastructures constitute from intranets, access controlled extranets (LG resource centre), and static websites. Although the government understands the need to involve relevant roles in overarching committees, what is lacking is the support for information and knowledge sharing. While coordinating activities implies that there is an exchange pertaining to what different agencies are doing, this exchange is limited owing to the prevalent autonomy, costs of telecommunication, and the inadequate planning and availability of ICT infrastructure.

As the public service advocates a culture of cooperation and knowledge sharing, its integration strategy endeavours to support initiatives that will fulfil such expectations. Considering the decentralised nature of the government, they subscribe to a somewhat informal, but legitimate hierarchical structure, which serves as the backbone of coordination. However, efforts towards information integration remain manual relative to capacity building. While the human infrastructure to maintain the work environment is extant to extent degree, there is an absence of a well-integrated technical and information infrastructure, which could adequately support the distributed collaborative work. This emphasises the necessity for an ICT based mechanism to support the efforts of adaptation committees, set up to ensure coherence and to reduce the duplication of efforts within the public service.

The findings suggest several design implications to support coordination in a loosely coupled environment. Fundamentally, the design solution must facilitate collaboration, while preserving strategic flexibility. Consideration must be given to how fragmented information stores can be merged to improve information access and awareness; how physical spaces, shared asynchronously, can be augmented to further promote awareness and explicit communication; towards support for lightweight coordination mechanisms, for instance schedules and plans to enable mutual adjustments to the activities of others without the need for negotiation, with an outcome that requires significant awareness of the activities of others; and towards support team or group formation, adhering to certain plans or schedules. As most of the natural channels for social communication are eliminated, and distributed teams, by their nature, are denied the informal information gathered from a physical workspace, a need exists for a smart socio-technical artefact to mediate awareness in the distributed environment. Table 1.1 presents a summary of requirement, as it pertains to the high level dimensions and problem indicators.

Since the requirement is considered from a socio-technical perspective, the requirements that reflect a more People-oriented intervention is tagged as P, more Technical intervention as T and a balanced combination of both as P/T. FR stands for Functional Requirement and NFR for Non-Functional Requirement.

The requirements emphasised reflect the socio-technical subsystems of people (social subsystem) utilising tools, knowledge and techniques (technical subsystem) to produce good/services for a customer or partners (environmental subsystem). The functional requirements essentially specify behaviours or functions that outline what a system should do or provide to the user. While the functional requirement describes the behaviour of a system, in relation to functionality; the non-functional requirement explicates the performance characteristic of a system, which describes how well, or to what standard, a function should be provided. The non-functional requirements describe how a system is supposed to transpire, describing the quality attributes of the envisioned system. The non-functional requirement reflects the management and operational requirement, ensuring that whatever functions are provided are usable. This, *inter alia*, deals with availability, capacity, security, and continuity. It can be used to judge the operation of a system, rather than specific behaviours thereof. The characterisation of the requirement is amalgamated from both the business and technical standpoint.

Table 5.1: High-Level Requirements

HIGH-LEVEL DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**FUNCTIONAL REQUIREMENTS**	**NON-FUNCTIONAL REQUIREMENTS**
Enabling Environment	1.1	Socio-economic	Resource-constrained	FR1: Facilitate resource finding (T/P) FR2: Facilitate resource sharing (T/P)	NFR1: Monitor and provide reliable, secure connectivity and collaboration with customers and business partners (T)
	1.2	Size and structure	Large and complex		NFR2: Loosely interrelate modular “separation of concerns” (T)
	1.3	Legislation	Informs and constrains practices		NFR3: Facilitate awareness/compliance (T)
	1.4	Constitution	Account for cooperative governance lags in	FR:3 Facilitate administration management	NFR4: Facilitate economy of scale strategies (T/P)

HIGH-LEVEL DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**FUNCTIONAL REQUIREMENTS**	**NON-FUNCTIONAL REQUIREMENTS**
			practice	processes while maintaining autonomy (T)	
	1.5	Political /administration	Decentralised form of governance	FR4: Facilitate participation and integration (T/P)	
	1.6	Geography	Physical distribution of workforce	FR:5 Facilitate contact initiation (T/P)	NFR5: Facilitate loose-coupling (T)
	1.7	External support	Ad-hoc intervention	FR:6 Monitor/report interventions (T)	
Organisation /institutional capacity	2.1	Work pattern	Autonomous and loosely coupled		NFR6: Preserve autonomy guaranteed by constitution (T)
	2.2	Cooperate strategy/goal	Divisional autonomy Non-clear articulated goal/strategy	FR:6 Facilitate Identification and capture synergy by clearly defining end goals (T)	
	2.3	Organisational culture	Non-common ground, shared values and meaning, and misunderstanding Lack of a shared culture, in practice	FR7: Foster a unified culture of sharing (P) FR:8 Align culture to strategy (P) FR9: A clear, basic assumption about how to behave (P)	
	2.4	Organisational structure	Fit for purpose structures, unclearly defined roles, accountabilities, and relationship	FR10: Facilitate organisational modelling (T/P)	NFR7: Document roles, relationship and purpose (T)
	2.5	External operational/procurement process	Many manual processes and approval points No clear process owners Government standards, and procurement processes	FR:11 Properly specify and automate to extent possible (T) FR:12 Inform necessary processes, and expedite approval processes (T) FR13: Explicate ownership (P)	NFR8: Deliver visibility and control over shared business processes (T)
	2.6	Support network	Implicit	FR14: Provide real-time insight into operations(T)	
	2.7	Workforce	Blurred distinction of responsibilities/role focus Non-support	FR15: Facilitate role administration and foster accountability (T/P) FR16: Facilitate executive support through value showing (T/P)	
	2.8	Finance	Funds limitation and misalignment to needs	FR17: Knowledge support and analytics for budgeting (T/P)	
Support infrastructure	3.1	Shared infrastructure	Limited shared technical infrastructure		NFR 9: Avail flexible and adaptive shared infrastructure (T)
MICRO CONTEXT					
	4.1	Desired outcome/goal	Ambiguous/unclearly articulated	FR18: Define clearly articulated objectives (P)	NFR10: Document streamlined expectations (T)

HIGH-LEVEL DIMENSION	ITEM		INDICATION OF PROBLEM	FUNCTIONAL REQUIREMENTS	NON-FUNCTIONAL REQUIREMENTS
	4.2	Determine participants	Autonomous entities and distributed	FR19: Model/document roles and responsibilities (T/P)	
	4.3	Define communication/ decision-making pattern	Undocumented	FR20: Modeling decision-making structure (T/P)	NFR 11: Document/Visualise reporting /decision making structure (T)
	4.4	Organise activities and schedule task	Uniquely defined and isolated	FR21: Support scheduling an planning (T/P)	NFR12: Tailor actions to fit purpose (T/P)
	4.5	Determine tools	Several disjoint tools with limited functionalities	FR22: Seamless integration of tools (T)	
	4.6	Identify required information	Align, document and secure	FR:23 Facilitate information governance (T/P)	

5.4.1.2 The Micro Context

The micro context examines the collaborative activity patterns that exist relative to capacity building interventions. The micro context analysis exposes the collaborative activity patterns, which examine the current situation through focusing on the objective, which, in turn, provides a sense of purpose and steers the actors and their activities in a work process towards the anticipated outcome. Activities in the skills development process include, *inter-alia*, identifying the need for training; reporting the requirements; developing a training plan; and eventually, the training provision to relevant employees, with a subsequent evaluation. The goal of this process is to ensure that the local government is provided with the necessary skills and capacities to ensure effective service delivery in the sector. Essentially, collaborative activities can be identified and distinguished by their objective or purpose. A collaborative activity inherits the loosely coupled pattern behaviour as it is influenced by the macro context, with participating collaborators distributed and autonomous. The current collaborative circumstance is reflected in terms of the constructs in Figure 5.5, which are intended to illustrate the collaborative activity operations. The approach is intended to reveal structural aspects, for instance communication and decision making patterns, standardisation, and dependencies among activities and resources.

(a) Object of the activity

In order to capture the essence of the collaborative activity requiring support, the analysis starts off by identifying the object of the activity which motivates the existence of the activity; the collective actors work towards the common objective of coordinating capacity building interventions in the public sector.

(b) The Desired Outcome of this activity is the ability to ensure coherence in the allocation of resources, goals and responsibilities, across and among actors at the local, national, regional and international levels, thereby eliminating duplication and advancing targeted, coordinated and cost-effective responses. More so, in order to capture the behavioural and informational aspects, which reflect both control flow and the use of workflow data between activities, process modelling approaches to document how the process operates or should operate, are employed.

To account for the tacit views and information exchanges effectively multiple perspectives are considered, towards developing a more complete understanding of workflow and processes. Figure 1.1 employs the artefact-based or document-centric workflow approach to capture the flow of documents in the capacity building process.

The modelling perspectives are intended to account for both the well-structured and ill-structured work processes, which co-exist in cooperative work procedures, as represented in Figure 4.4, in Chapter 4. The approach takes cognisance of the fact that the relationship between activities and actors is mediated by some shared knowledge or a condition of agreement, which can be negotiated. The development activities are connected through information flow, with each activity defined by tasks, needed resources and related processes, as will be elaborated on in the next section.

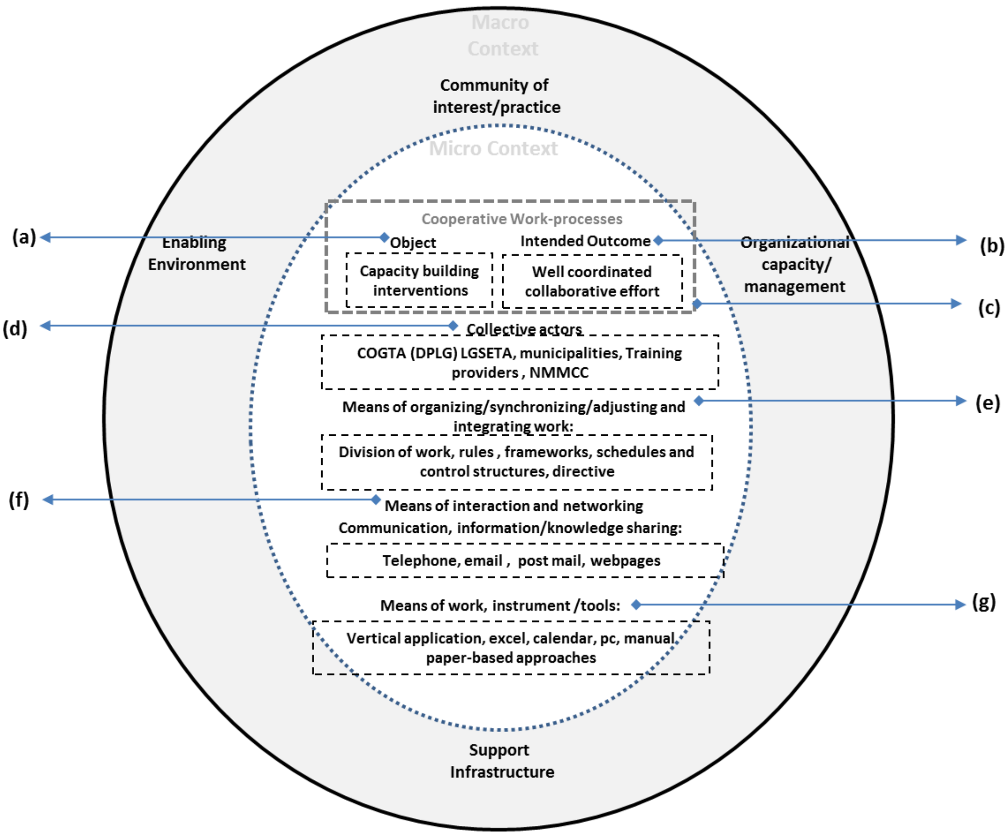


Figure 5.5: Micro Context Elements

(c) The Cooperative Process/Workflow Perspective:

In order to try to understand the problem of coordination in a collaborative activity, the relationship between the sub-activities that produce and consume resources are considered. The process model is intended to reflect the organisations taking part in this business process, where each is responsible for executing a certain element of the cooperative work process. The process model is used to make the relationships between activities explicit, by specifying their control flow. The representation subscribes to the IDEF and BPNM notations, to capture the process activities adequately.

To capture the coordination dynamics of the cooperative work process two perspectives are presented, viz. the structured activity process view and the transaction feedback-loops of the respective activity elements in the process, assuming the roles of customer and producer. The process view portrays the control, resource and data relations useful in representing the overall scenario. The control-flow reveals the dependencies between the inter-organisational activities, showing their relationships and sequences. The resource illustrates who is responsible for the task, along with the various input and output artefacts. Inputs enter from the left, outputs exit from the right, with the controls and mechanisms portrayed at the top and bottom, respectively. The process model in Figure 5.6 represents the activities of the capacity building process life-cycle, presented in Figure 5.3.

Layer 2 is explicit, representing the vertical collaborative process that ensues from the local municipalities to agencies at the national level. Initially, there is the skills needs gap analysis and/or planning activities by the SDFs of the municipalities; succeeded by the review and approval by LGSETA; third is the training implementation, with training providers and municipal workforce as the mechanisms, and finally, there is the impact evaluation stage, which reflects the responsibility of CoGTA and the NNUMMCC committee. The connected model reflects the action/effect relationship.

Details of the existing dependencies and coordination mechanism are available in Appendix C. The peer collaboration process pattern is represented in Figure 5.7, which indicates the possible collaboration between municipalities in an effort to leverage economies of scale; however, this rarely occurs owing to the existing loosely coupled arrangements, and other factors, which will be highlighted in Section 5.4.2. Another peer relationship is shown in Figure 5.6, between the donor process and the municipalities. This may cause duplication, given that peer municipalities or collaborators along the vertical process are not aware of such interventions.

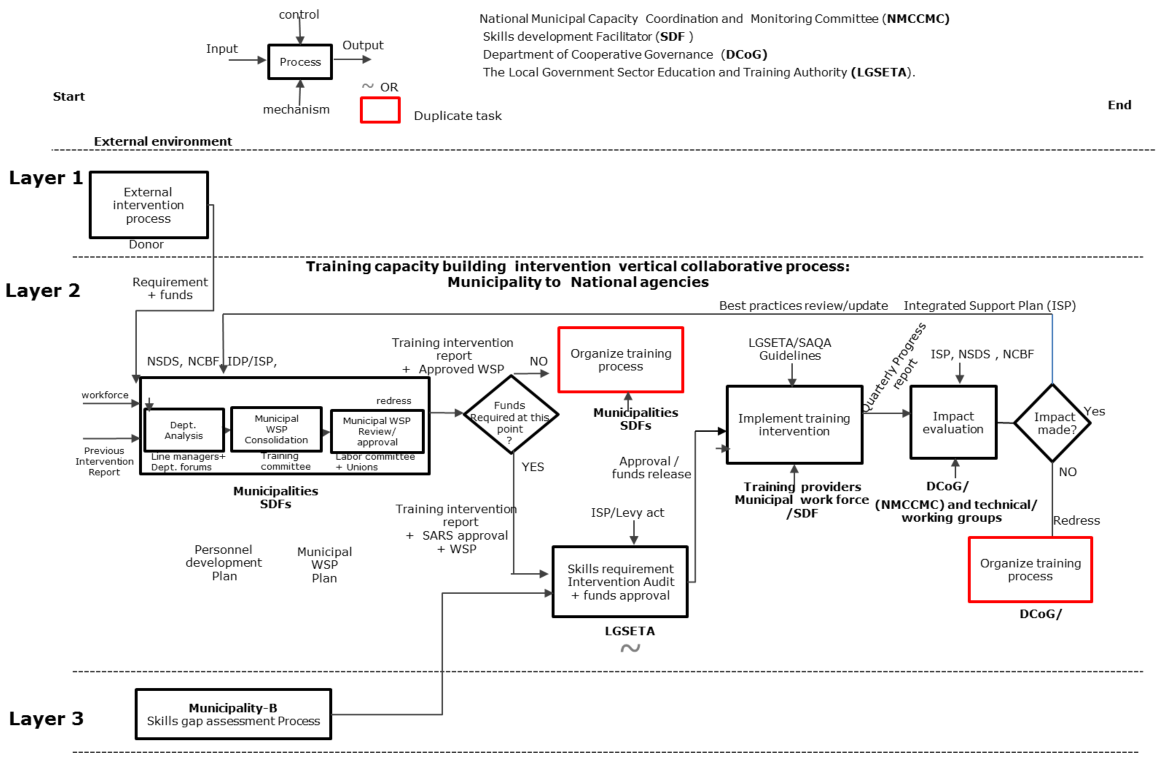


Figure 5.6: The Vertical Collaboration Process Pattern (as part of Figure 5.5)

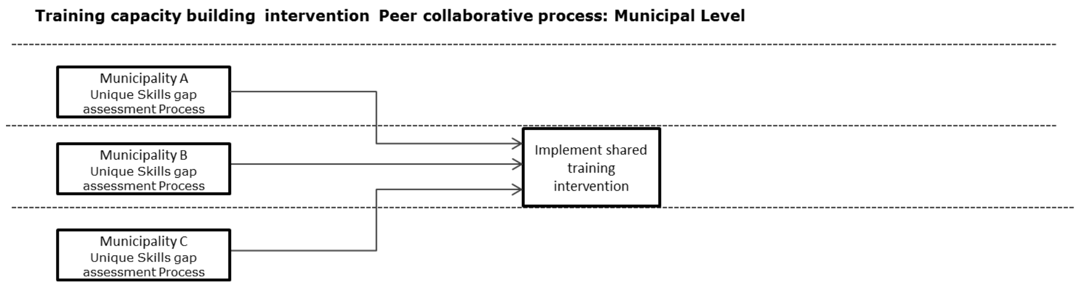


Figure 5.7: Peer Collaboration Pattern (as part Figure 5.5)

In the cooperative process some activities are relatively unstructured, resulting in coordination occurring through improvising rather than pre-specified rules. Commonly, in such instances, a plan or template can provide a frame for situated action. Taking into account the dynamic nature of the environment, uncertainties arise, with actors commonly needing to invent workarounds for convenience or to adjust for exceptions or conditions not anticipated when the process was designed. To capture conditions that occur in these situations, the analysis considers the communication feedback loop as existing between activities and therefore actors, who can negotiate in a customer/producer capacity providing a service. The premise is that they can easily negotiate to meet objectives.

Therefore, shifting from the strictly activity oriented structure, the traditional transactional workflow-loop is employed to help reveal coordination acts between actors, where tasks are defined by request and commitments expressed in loops. This is focused particularly on making explicit the always present customer and performer relationship, where one provides services to the other, based on the request conditions. It is intended to reveal adaptations to workflows that result in workarounds and informal communication. This kind of analysis can assist in finding flaws in the process, which can be leveraged through information technology.

The actors and their relationships are presented in Figure 5.8, with the coordination mechanisms used made explicit in Table 5.2. The loop phases proceed at each point in the relationship as follows: the proposal phase constitutes the customer request (or based on performer offer) for a particular service in accordance with some stated condition of satisfaction (WSP requirement); the agreement phase results in mutual agreement on conditions, as well as the schedule and outputs expected, resting on an equally shared background of assumptions and standard practices between actors, but subject to negotiations during performance; the performance phase is also dependent on other production workflow loops towards the service/output, eventually declaring the completion of service, where the customer indicates satisfaction after delivery, and dissatisfaction or partial satisfaction of the customer always results in mutual adjustment through negotiation between the performer and customer. The performer gets a direct feedback result from the requestor with which to assess delivered results.

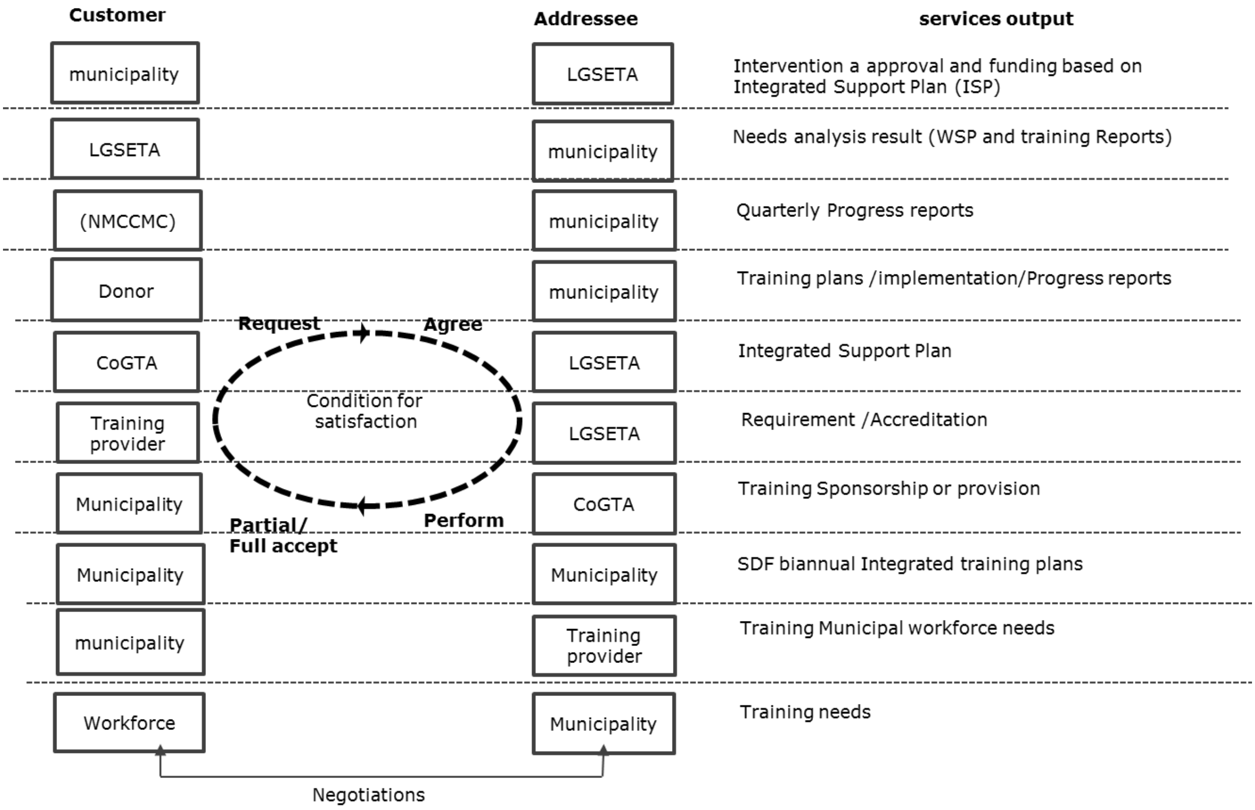


Figure 5.8: Ad-hoc Workflow Loop Model (as part of Figure 5.5)

Table 5.2: Coordination Dependencies and Mechanisms

ENTITY RELATIONSHIPS	DEPENDENCIES	COORDINATION MECHANISMS
Municipality/LGSETA	Prerequisite/usability/shared resource precedence dependency/ sharing dependency	Integrated development plan, work skills plans/ proposed training schedules, document specifications, budget allocation, completeness of Information Form (Check list) feedback, communication (asynchronous (post-mail/email)/fax /synchrony (spontaneous telephone/ annual meetings in shared physical space) SDF Liaison Devices (boundary spanners
NMCCMC /municipalities	Flow dependency: Prerequisite Fit	Reports, informal hierarchy, ISP workgroups/technical committees/ quarterly meeting shared physical space Focus area, modular groupings Asynchronous communication, SDF, NCBF
CoGTA/LGSETA	Shared/common object of work (municipalities)	Integrated support plans/NCBF Annual meetings
Training Provider/LGSETA	Fit dependency Prerequisite	SAQA guidelines
Municipality/CoGTA	Prerequisite Sharing	Progress reports/ email/NCBF Budget allocation Manual Training Calendar (Excel)
Municipality/municipality	Shared resource (finance/ training providers) Shared/common object **(**taking advantage of economies of scale)	Bi-annual physical meetings, Plans Schedule, priority/ budget allocation, spontaneous face to face social interaction
Municipality /training provider	Task to resource Actor- activity dependency fit dependency	LGSETA/ schedule Managerial decision Market-like bidding
Municipality/donor	Prerequisite	Donor specification, communication devices Budget allocation
Municipal SDF/ departments	Fit Sharing	Working groups/committees , Department-liaison devices, Personnel Development Plan , progress reports more consistent face-face meetings, directives, email Budget allocation

The means through which a request is made, the state awareness, and the delivery mechanism can be analysed to identify the coordination mechanisms employed, in conjunction with whether it is influenced by some form of technology. Predominantly asynchronous means are employed to establish some condition of satisfaction and usually interact through legislation, policies, plans, specifications, and standard documentations. These work-based mechanisms are generally made available to members in a hardcopy format or a project repository, associated with a role player and made electronically accessible. However, considering the number of players involved such artefact transition results in multiple communications and distributed reporting paths. Although a shift to subjective synchrony means of interaction is rare, it is sometimes necessary to confirm or re-establish commitments when responding to external changes, as seen with rare periodic meetings or telephone calls to accommodate shifting goals.

Apart from the numerous information sources with which actors have to deal, there appears to be dual paper and electronic recording and transfer of similar information, leading to redundancies and inefficiencies in information and work practices. Other coordination devices include rigidly defined paper forms, used to guide communication to redress issues. Usually, with the dynamic nature of the environment, the forms fail to account for issues worthy of note and possibly valuable to other members. For instance, the case of the WSP rigidity fails to account for the uncertainties that may occur in which others may share interest if distributed.

(d) Collective Actors

Aside from the general community members who, in one way or another influence capacity building, as shown in Figure 5.2, the collective actors referred to in this instance, are the autonomous stakeholders directly engaged in the capacity building programs or objectives. This encompasses all of the national/provincial/local government agencies and non-governmental agencies responsible for the capacity building intervention programmes directed at the municipalities. Figure 5.9 provides an overview of relevant players.

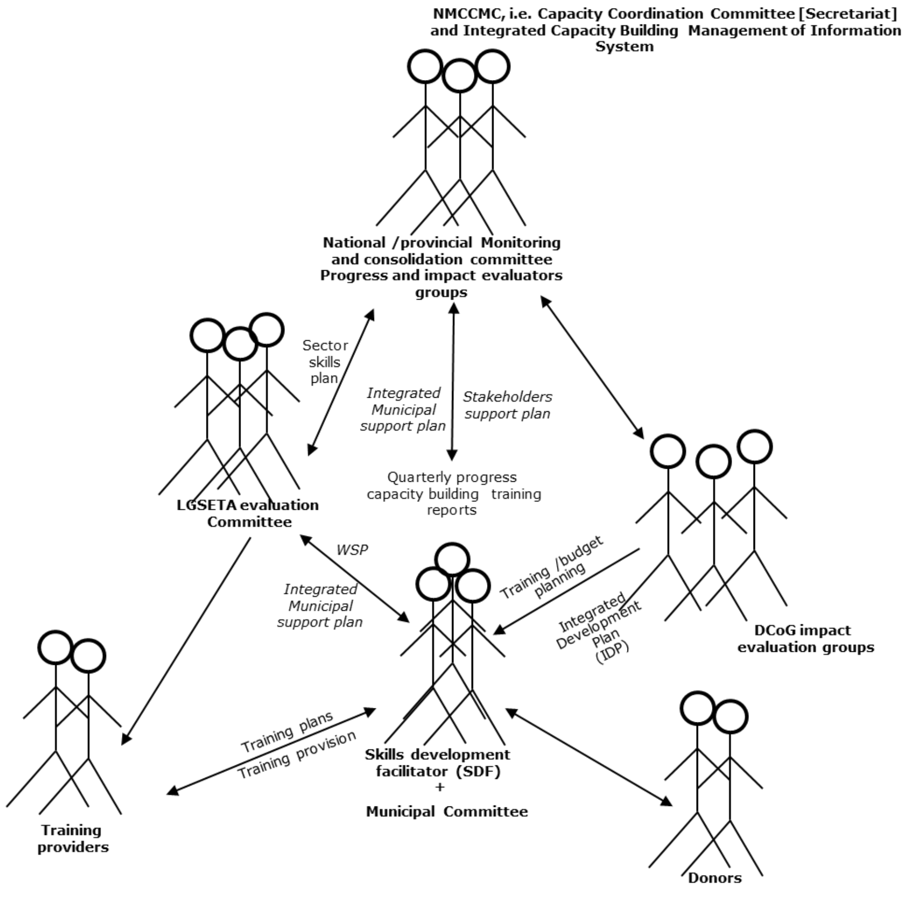


Figure 5.9: Collaborating Actors' Relationships

They are required to be aware of the actions of each other to coordinate their activities successfully; making the nature of their relationship and how it is regulated, important. Several actors are involved in the capacity building initiative. Those who play active roles in the collaborative process are captured in Figure 5.7, alongside the activities they perform. Essentially, the activities are assigned to roles corresponding to an actor or group of actors, with the obligation to realise the activity objectives.

As depicted in Figure 5.8, the actors, through the execution of their activities, provide a service to a corresponding activity, based on certain agreed conditions. The groupings of actors occur at different levels of granularity. For instance, the LGSETA, CoGTA, and NMCCMC, always embrace a broad range of committees or working groups to help coordinate programmes. They serve as critical integrators and coordinators in capacity building programmes.

Specialised committees are set up in order to deal effectively with a situation. However, significantly, certain members are not quite represented as they should be. This is made explicit in Section 5.4.2 and Appendix B2. Although members may belong to a certain working group or committee, they appear not to be in accord, as they often do not possess the same information, which eventually causes duplication of efforts. This can be attributed to the rarity of meetings and the obvious lack of a sound technological support system.

Moreover, the donor, often directly liaises with municipalities, without the involvement of other national agencies. This factor results in a lack of insight, with corresponding duplication, as revealed in Section 5.4.2. Relative to governance roles, the NCBF documentation describes responsibilities for stakeholders and committees pertaining to coordination of capacity building efforts.

While within municipalities the formal hierarchy of authority, as well as rules and procedures tends to regulate behaviour, the capacity building support hierarchy appears to suffer from having the responsibility of oversight without much authority, considering levels of autonomy. Additionally, the lines of responsibility and expectations are not always clear, entailing a diffuse lack of accountability, resulting in committee decisions for which no individual is accountable. An inventory of the roles of actors that stakeholders may assume, in consort with their relationships, is important for the analysis, as portrayed in Figure 5.5.

(e) Means of Interaction and Networking, Information/Knowledge Sharing

The communication system in the collaborative activity employs both traditional and electronic means of communication. For instance, communication between the municipal SDF and the LGSETA, as shown in Figure 5.8, illustrates that the interaction strategy requires the electronic copy of a WSP and the paper based copy posted by mail, thus, the process is inefficient in its use of resources. The communication tools such as traditional telephones, e-mail, intranets, extranets, and web sites, are often used in the course of the collaborative activity, where each tool potentially affords a different type of convenience. The telephone offers a service of mutual adjustment, when entities involved need to negotiate, parameters are filled out on forms. In addition, it provides a fax service by which confirmation of acceptance and acknowledgment of fields may be made. Telephone calls are often expensive, and are frequently the last resort, which affords synchrony when the situation warrants it, except for the occasional face-to-face encounter in meetings, which requires some form of travel. Other approaches employed subscribe to the more affordable asynchronous means of communication. However, the burden of using the tools effectively is solely in the hands of the user. For instance, email, sometimes utilised to communicate, can introduce information overload, which often results in sorting difficulties. Moreover, in an effort to minimise information asymmetry, some form of codification is employed. However, while established policies and procedures seem totally mundane, they create constraints. An example, as described in Section 5.4.2, reflects on the limitation of codified forms/templates, which cannot account for every situation and results in municipalities attempting to work around these. Explicit knowledge is recorded, in documents (NCBF), rules, and other forms; however, the maintenance of both explicit and tacit knowledge is challenged, through its recording, cataloguing, and accessibility. This is predominantly due to the limited and inadequate set of tools employed to support information and knowledge management, with further issues pertaining to information and knowledge considered in Section 5.4.2.

As previously mentioned, communication and coordination may be improved through utilising a structured documentation format to guide conversation; however, a review of certain document contents suggests that not all information is recorded in the document and shared. The limitations of this form are guided by the focus areas established and revolved around rigidity - not being easily adaptable to new issues that may arise. With the frequently fragmented nature of groups it becomes easy to have isolated and varied terminologies describing the same thing.

(f) Means of Works, the Instruments:

Tools, techniques and actions are used to transform organisational inputs into outputs with most various, basic technologies in place. Some technological elements are employed to elevate aspects of the paper-based approach towards better coordination services. However, this is realised in a very limited capacity. The technology within the collaborative system and the technical infrastructure that supports it, are at best, focused on office automation. These consist of a general set of all- purpose tools, inclusive of word processors, spreadsheets, and small databases, which are too trivial to support distributed collaborative activity effectively. The principal technological support artefacts are predominantly engaged in a local capacity to fulfil the work functions of individual entities. There appears to be a reliance on spreadsheets to produce plans and calendars. For example, currently, information is being collected quarterly in the format of Ms Excel spreadsheets to support Integrated Capacity Building Management of Information System (ICBMIS). This has a specific focus on the collection of information. Although a level of sophistication is envisaged in future to assist with data analysis, to support decision making adequately, currently a great deal of time is spent to reconcile information from various sources.

Existing artefacts produced (e.g. CoGTA, excel-based calendars) to support coordination are limited in several ways, for instance providing only a single project manager calendar view, a lack of information sharing functions, an absence of decision support mechanisms, monitoring activity states or deviations, scalability and analytical constraints. Furthermore, it is subject to data entry errors, as the manual burden is placed on personnel. Entities both at the local and national levels use spreadsheets, which most often are manually consolidated at different levels of aggregation. The approach has proven to be too cumbersome and frustrating, as emphasised in Section 5.4.2**.** Therefore, the need to support knowledge sharing to achieve coherence, as specified by the national strategy for instance, is contradictory to the availability of technological resources to support such activity, emphasising the need for a more efficient support.

(g) Means of Organising/Synchronising/Adjusting and Integrating Work:

The artefacts engaged in a coordination capacity are the predefined organisational constructs, which include informal structures; procedures; methods and plans, which predominantly functioning as rules which mediate the Actors interaction with members of the community and objectives of work. Taking into account the distributed nature of participants, they are commonly required to perform work in a prescribed manner based on prearranged rules. The division of work is central to the collaborative activity, involving the structuring of work groups and committees to integrate the modular distribution of work; accentuating the need to be able to support multiple structures and groups.

For example, the NMCCMC consists of a web of multi-structured groups to account for the varying programmes at national, provincial and local government levels. However, decisions taken by working groups must be run by the NMCCMC, as they provide the oversight function ensuring that feedback from these groups filters through to the NMCCMC, to enable informed coordination within the local government sector. Work groups are required to meet at least quarterly, to track the progress made with the support plan, to redress identified challenges and to measure progress or impacts made. The primary aim of the multiple structures is better coordination of the initiatives of stakeholders aimed at local government, to improve the impact made in the public sector. However, this results in multiple reporting paths, frequently with repeated information, and concurrently, may mask relevant or useful information. However, while the human support infrastructure appears in control, the same cannot be said regarding the technical and information infrastructures, which should exist to support such distributed activities. Unfortunately, the technical and information infrastructures necessary to support the coordination and integration efforts effectively, is deemed lacking.

The form of awareness employed frequently relies on periodic meetings with, in some instances, occasional voice phone calls engaged to clarify issues of understanding and confirmation. However, the asynchronous means of awareness constitute a more dominant approach, employing the use of artefacts embedded with standard protocols, rules, schedules or plans to support integration and mutual adjustment. For instance, municipalities use a WSP template to document their training needs. Plans and progress reports are submitted every 3 months, and consolidated into the sector skills plan, integrated development or support plan at the national level. However, this is often subject to manual integration, and at a level of abstraction that loses relevant information, which may have assisted other national bodies in coordinating with municipalities. Information associated with these plans may comprise various forms and be transferred in various ways - on paper, over telephone, fax, e-mail and traditional post-mail - as collaborators are distributed. These tools are categorised as instant communication/feedback (telephone) for tightly-coupled situations vs. asynchronous communication (e-mail or fax) for the inherent loose coupling. Their use depends on their circumstances. Greater detail pertaining to the coordination mechanism, from a process perspective, is discussed in the succeeding section.

5.4.1.3 Summary of Collaborative Activity Analysis

The coordination strategies employed, taking into account the loosely coupled nature of the collaborative activity, subscribe to a more objective than subjective means of coordination. To capture the essence of the collaborative activity the analysis strategy first identified the goal, the actors involved and the activities in which they are engaged; the ordering of the activities; the resources allocated; and the level of synchronisation between the activities. The interdependence between entities shapes the coordination mechanisms, as shown in Table 5.2. The interdependence subscribes to standardisation by developing rules and routines or procedures to guide practice, aimed at coordinating work with minimal effort. By planning and scheduling work activities, the flow or serial interdependence is managed and designed to reduce the burden on the organisation, except where unexpected events cause revisions in the sequence of work activities.

Finally, reciprocal interdependencies exist, as entities mutually influence the plans of each other, requiring some form of conjoint adjustment, which often demands significant effort, as entities must monitor one another and communicate work activities. Entities monitor and respond to other units through discretional communication and sporadic meetings. Details of dependencies and the coordination mechanisms subsequently employed are discussed in Appendix C.

It appears that several different communication scenarios are utilised, ranging through dynamic information updates, simple phone consultation to clarify uncertainties, synchronous meetings, and engagements for more complicated consultation and common problem solving. The means of interaction employs different communication channels, from text based to voice and visual, according to the complexity presented by the situation. This accentuates the need to facilitate real-time and asynchronous text, voice, and video communication.

Examples include the receipt of simple updates in a structured process, where users receive meta-information for instance, checklist based confirmation, as in the submission of a WSP, thus employing both voice and visual interaction between the parties involved, with shared access to data. Owing to the variety of processes employed, there is a need for highly flexible and adaptable workflow functionality, to support the inter-organisational workflows, containing structured and unstructured processes. This denotes the requisite for knowledge and information sharing support, to account for more dynamic and emergent aspects during process execution.

The composition of the integrated committees should be well represented and balanced. The governance arrangements and procedures for the committee should support efficient adaptations. Coordination mechanisms, for instance frameworks, should be clarified, as with established structures, to ensure, *inter alia*, coherence, prevent duplication of effort and ensure clear lines of accountability and decision-making.

In summary, it appears that efforts have been made to manage the dependencies encountered in the capacity building process. However, as the coordination problem still persists, a deeper, more comprehensive evaluation of the existing mechanism is warranted. Thus, the fit and support capacity of the mechanism comes to the fore. The argument is that perhaps the mechanism is not well supported, whether in terms of management, organisation or technology. For instance, an appropriate technology and a well-designed process may be in place, but an uninterested or unwilling participant can cause problems. Implicit dependencies not accounted for may exist latently, not explicit enough to be detected. To acquire a deeper sense of what the problem(s) may be, an assessment of coordination relative to its service support capacity was undertaken. Fundamentally, if coordination is considered as a service provided towards the successful execution of production acts, it should have a sound support system to enable its effective reinforcement of the production acts. For instance, the SDF, which fulfils a coordination role between the municipalities and the LGSETA, for instance, must have the necessary tools or resources at their disposal to perform work. The cooperation of line managers from the municipalities and a functional committee to help the SDF perform their duties effectively, is important. The dependency relationships of the coordination mechanisms themselves must be considered, as well as being perceived as separate from the primary work, to make it more visible so that it is not seen as background work which happens to be part of a primary task. This kind of attitude can result in, for instance, the over-extension of staff, which can indirectly affect the work system overall. The following section considers this view from a service capacity perspective, using the proposition in Chapter 4 to guide the analysis and to help visualise alternatives that may not have been obvious, ensuring that important issues are not ignored. For instance, although the environment may promise a culture of knowledge sharing, it is not necessarily true that an entity will be willing to cooperate, perhaps well within reason, given the level of autonomy present.

Certain questions like: *Are there built-in delay points that exist in the process, such as unnecessary inspections, sign offs or hand off points, which may cause delays?* or *Are the existing technologies compatible enough to support the level of integration required*? are implied in the next section.

5.4.2 Low-Level Analysis

The analytic instrument, at a high level, provides a guide towards a more executive summary type analysis. This considers the immediate collaborative situation while identifying the direct influences elements effect upon each other, in conjunction with whether appropriate management mechanisms are in place. However, when analysis at a high level does not yield the required results, a systematic and rigorous approach that takes cognisance of what was initially abstracted at the high level becomes important. The low level analysis comprehensively examines, in depth, the situation that may surround mechanisms, considering issues that may have been overlooked.

Therefore, in order to uncover the latent attributes that could affect coordination, the low level analysis contemplates additional dimensions employed from a service perspective. It is possible that a coordination mechanism may be recognised as already in place, based on the macro context analysis; however, it may be lacking the necessary capacity (resource and capability), at different levels of granularity to provide the required support. By engaging the stakeholders, in consort with a critical look at documentations, implicit requirements are uncovered. This section is intended towards an empirical exposure of certain of these challenges, making the latency explicit. Where areas are affected, findings are supported by direct quotes from respondents or precise extracts from the NCBF documentation, to provide evidence of the views expressed, as made explicit and coded in Appendix B2. The quotes in Appendix B2 are verbatim, although in some instances segments have been omitted for brevity (denoted by '…'). The service based dimensions discussed in Chapter 4 frame the analysis. Indications of the problems, together with the identified requirements, are summarised and discussed in the subsequent subsections. Table 5.3 presents a summary of the requirements at the low level. The column entitled Indication of Problem is founded on evidence retrieved from Appendix B2 (e.g. B2.1 (a)) referring to a section. FR represents functional requirements and NFR non-functional requirements.

Table 5.3: Low Level Requirements

LOW-LEVEL					
DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**FUNCTIONAL REQUIREMENT**	**NON-FUNCTIONAL REQUIREMENT**
Management	1.1	Strategy	B2.1(a) Cooperation and scalability concern B2.1(b) Willingness, Insecurity and lack of common understanding	FR24: Facilitate dynamic collaboration opportunity identification and make explicit expected value (T/P)	NFR13: Foster and leverage economy of scale (T/P) NFR14: Ensure flexibility (T) NFR16: Facilitate decision-making with real-time end-to-end process visibility (T)
	1.2	Control	B2.1 (c) Autonomy, authority, implementation and accountability concerns. B2.1(d) Clearly defined roles and responsibility concern	FR25: Assign clear roles and responsibility (T/P)	NFR17: Preserve autonomy (T) NFR18: Balance authority and mandate (P)
	1.3	Monitoring	B2.1(g) Unclear and inappropriate and ambiguous metric B2.1(h) Streamlined tracking and opportunity finding concerns	FR26: Monitor resource use (T) FR27: Filter and personalise awareness information to relevant party (T/P). FR28: Facilitate controlled and filtered awareness information (T).	NFR19: Appropriate metrics to assess process performance over time (T/P)
	1.4	Communication	B2.1 (e) Unclear and inadequate communication and reporting paths/structure. B2.1 (f) Information influx and awareness overload concerns	FR29: Facilitate both synchronous/ asynchronous communication/ notification (T) FR30: Define clear communication and reporting paths (T/P) FR31: Make explicit relevant stakeholder and preferred communication means (T/P) FR32: Screen, segregate and filter communication (T).	NFR20: Facilitate adaptability and usability (T)

LOW-LEVEL					
DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**FUNCTIONAL REQUIREMENT**	**NON-FUNCTIONAL REQUIREMENT**
Organisation	2.1	Design	B2.2(a) Size, work pattern and dynamic structures concern	FR33: Support adaptive team formation, partitioning and structuring (T/P)	NFR21 Support task modularisation and allocation (T/P)
	2.2	Configuration	B2.2(b) Modular adaptations and flexibility concerns	FR34: Visibility to existing configurable resources (T)	NFR22: Flexibility to support dynamic scenarios (T)
Process	3.1	Process definition and support	B2.6(a) Unclearly defined process goals and specifications B2.6 (d) Manual processes, errors and delays concern.	FR35: Leverage manual processes (T) FR36: Facilitate process modelling and resource tracking (T) FR37: Align infrastructure and human resource practices to support processes (T/P)	NFR23: Offer dynamic and configurable templates (T/P)
	3.2	Process measurement	B2.6(b) Process monitoring concerns	FR38: Set intermediate measuring goals (P) FR39: Logging of functional aspects and support data analytics and reporting (T)	NFR24: Support real-time analysis (T)
	3.3	Operation/ stewardship	B2.6(e) documentation and change management concern B2.1 (c) Unclear owner/lack of authority to enforce implementation and deliver results. B2.6(c) Responsiveness and efficiency concerns	FR40: Support adaptive workflow execution cognisant of global operational process (T) FR41: Automate routine and approval processes (T) FR42: Facilitate customisable process forms (T/P) FR43: Support automated exception handling with well specified business rules FR44: Support status tracking (T)	NFR25: Leveraging process automation of disparate and manual processes(T) NFR26: Support process execution orchestration with predefined process templates (T)
	3.4	Process integration	B2.6 (d) Manual processes and seamless integration concern.	FR45: Seamlessly automate and extend internal IT and business processes to external partners	
Knowledge	4.1	Utilisation	B2.4 (a) Information exploitation concern; B2.4(d) B2.3 (d) Lack of information sharing concern	FR46: Support federated data analysis	NFR27: Facilitate seamless access control (T) NFR28: Process interoperability(T)
	4.2	Acquisition	B2.4 (b) Context-based integration and customisation concerns	FR47: Facilitate Inferred Personalised recommendations (T)	
	4.3	Codification	B2.4 (e) Knowledge creation and validity concerns	FR48: Build online resource bank to share information and experience (T/P)	NFR29: Facilitated semantic based knowledge archiving (T)
	4.4	Awareness	B2.4 (c) Lack of insight & presentation concerns B2.4 (d) B2.3 (d) Hidden information concern B2.8 (d) Seamless data access across boundaries	FR:49 Facilitate awareness specification/ distribution (T) FR50: Proactively send alerts to both senders and recipients (T)	NFR30: Manage possible information overload (T)
Information	5.1	Accessibility	B2.3 (a) Data	FR51: Enable secure	NFR31: Document

LOW-LEVEL					
DIMENSION	**ITEM**		**INDICATION OF PROBLEM**	**FUNCTIONAL REQUIREMENT**	**NON-FUNCTIONAL REQUIREMENT**
			jurisdiction, semantic and integration concern B2.3 (b) Numerous players and manual approaches.	sharing of information (T) FR52: Facilitate intelligent search (T)	necessary information and facilitate secure and seamless integration of silos information (T)
	5.2	Completeness/ asymmetry	B2.3 (c) Information capture inadequacy concern	FR53: Automation/data entry validation (T)	
	5.3	Presentation/ language	B2.3 (e) Timely delivery concern B2.3 (F)Consolidation and multiple view concern	FR54: Facilitate semantic integration and new ways of correlating data (T)	
Application	6.1	Applicability and usability	B2.8 (b) Functionality support concern B2.8 (c) Concern for ad-hoc and isolated design and use constraint	FR55: Dynamic context driven tools integration (T) FR56: Support seamless single sign on (T)	NFR32: support Customisable forms (T)
	6.2	Tools and features	B2.8 (a) Tools integration and streamlined analysis capability concern B2.8 (d)	FR57: Facilitate new ways to analyse, visualise and correlate data (T)	
	6.3	Data Integration	B2.8 (d) Seamless data access concern		NFR33: Semantic interoperability (T)
Infrastructure	7.1	Interoperability	B2.7 (a) Limited resources and infrastructure mismatch concern B2.7 (c) Incompatibility concern B2.7 (B) Concern for duplication occurrences	FR58: Facilitate automated cross boundary service/tools invocation and resource awareness (T). FR59: Facilitate process awareness (T) FR60: Facilitate cross boundary needs/conflict detection (T)	
	7.2	ICT facility integration	B2.7 (d) Multipurpose consolidated analysis concern.	FR61: facilitate seamless service invocation (T)	NFR34: Seamlessly automate and extend internal IT (T)
Funds	8.1	Funds limitation	B2.5 (a) Funds Limitation concern	FR62: Facilitate conflict management, monitor resource use (T) FR63: Facilitate intelligent analysis (T/P)	NFR35: Facilitate forecast-based budgeting (T/P)
	8.2	Funds misappropriation	B2.5 (b) Misalignment concern	FR64: Facilitate shared infrastructure investment (P)	
People	9.1	Capacity	B2.9 (a) Lack of enough skilled personnel to drive and support process.	FR65: Facilitate knowledge sharing and monitor personnel progression (T) FR66: Facilitate knowledge codification (T/P)	NFR35: Personnel capability documentation (T)
	9.3	Staff turnover	B2.9 (a)	FR67: Facilitate proactive processes (T/P)	NFR36: Document and forecast needs (T/P)
	9.2	Accountability	B2.9 (c) Responsibility and commitment concerns		NFR37 Facilitate traceability (T)
	9.4	Interaction	B2.9 (d) Concern for shared space and sharing and socialising	FR68: Support for social /formal interaction (T/P)	NFR38: Facilitate adaptability (T)
	9.5	Role Definition	B2.9 (b) Over-extension of staff concern; B2.9 (c)	FR69: Monitor conflicts (T)	NFR39: Document and support awareness (T)

5.4.2.1 Management

The effective implementation of a long term strategy for cooperative governance in the public sector requires taking advantage of economies of scale, in order to account for commonalties through cooperation, preventing waste and duplication and maximising resource use. However, the flexibility afforded by organisational autonomy and a decentralised form of governance must be preserved. This denotes that support for need based collaboration between distributed entities is desirable. Where collaboration opportunities are presented, whether at horizontal or vertical levels, entities may, at their discretion, initiate contact with potential partners.

To engender a cooperative collaboration effort effectively certain factors are requisite, advantageous and/or preferred, inclusive of:

- Personalised awareness and recommendations based on the specified interests of an entity, as opportunities to cooperate need to be made known.
- User subscription and notification setting capabilities, to prevent possible information overload resultant of the magnitude of potential opportunities;
- Leveraging performance management capabilities with business intelligence tools, to support management decision making.
- Monitoring, not only to ensure control that legislative frameworks are complied with and properly administered, but also to indicate when support or interventions are required.
- Support for transitions between loosely and tightly coupled communication, to manage the possibility of a situation change requiring real-time negotiation, ensuring that uncertainties are clarified.
- Close monitoring of the work and cooperation effort to facilitate both horizontal and vertical collaboration patterns and to maximise control.
- An asynchronous communication pattern is frequently indicated, as it accommodates the need for flexibility.

Additionally, relative to communication, the opportunities either for formal or for informal face-to-face communication are rare; however, they are sometimes necessary. While paper printouts, post-mail, the occasional email and static web pages play central roles in coordination, facilitating data exchanges and file transfers, situations arise when telephonic or real-time meetings are utilised as a means of synchronous or concurrent mutual adjustments for uncertainties. Existing commination technologies may be leveraged to support varying communication needs seamlessly, especially when they are context aware.

5.4.2.2 Organisation and Structure

Given the distributed nature of role players, with only infrequent periodic meetings – bi-annually for peers and quarterly for vertical teams – where they meet and discuss issues and future plans, results in opportunities to identify commonalities to engage in collaborative acts being limited. Because distributed workforces are deprived of the awareness information usually gathered from a physical workspace during scheduled meetings this necessitates the need for a smart socio-technical artefact to augment and mediate awareness and to support cross boundary communication in the distributed environment.

Teams and overarching workgroups or committees are usually formed to ensure integration as well as the alignment of strategy and execution. The existing governance structures relative to aggregating committees are largely ineffective, arising from the wide-spread distances between members and the unclear ownership of the problem. In order to combat these issues the following elements are considered necessary:

- Relative to organisation, the ability to form teams, workgroups or committees dynamically, with the participation of all relevant players for coordination purposes.
- Proactive cooperation between all spheres of government, for municipalities to succeed in developmental planning and delivery.
- Modelling assets (processes, people, and resources) with support for visualisation tools to establish a unified public model that can be leveraged to inspire collaboration and to facilitate contact initiation.

The lack of insight into the many interrelations between the various organisational subsystems results in a lack of coherence involving multiple policies arising from different agencies, missed opportunities and duplication. The absence of clear, concise distributions and definitions of roles and responsibilities appears to be a problem. Furthermore, some management vision and goals are not expressed in terms of specific actions, often consisting of broad mandates and ignoring the practicality or the implications thereof. To mitigate these issues the solution should incorporate the features listed below:

- Augmenting shared physical spaces with virtual collaborative community areas can result in the awareness of the activities and interests of others.
- This aids in facilitating explicit communication, as well as the participation of the relevant players in collaborative acts.

- Additionally, it provides support for the explicit formulation of goals and documentation, supplying a sense of purpose and drive for people and processes in collaborative communities.
- Support for asynchronous and synchronous work that is common, mutual or conjoint, with uncomplicated functionalities. This enables users to query and manipulate the shared space content, as well as to subscribe to events which occur.
- Provision for an adaptive organisational structure, thus dynamic team formation, configurability and governance, to meet unique and different collaborative efforts. This ensures that working patterns are explicit, and assists in defining clear roles and responsibilities for operation.

5.4.2.3 Process

The capacity building process constitutes several procedures that must work together to ensure successful intervention across local government. Therefore, it is advantageous to support the entire spectrum of processes (from strictly structured to unstructured), including activity- or document-centric and people-intensive, in consort with their adaptive integration. Additionally, it is necessary that adaptive process definition and composition is supported, with the intelligence for automatic process definition inference, given different situations which may call for variations in the process. Essentially, there are diverse, different requirements for task coordination and cooperation within and between activities, considering the diversity of processes.

Other elements necessitated, preferable and/or beneficial within this component encompass:

- Modelling workflow, useful in defining roles and delineating how teams understand their job functions and work processes. It is also important to determine the degree to which it is routine, with pre-specified actions requiring limited discretion.
- Automation of manual processes to the greatest extent possible, aids in mitigating delay, along with utilising templates, for a degree of customisation.
- Leveraging routine activities with process automation to increase operational efficiency, as well as to capture audit trails of activities and data, through tracking what has been done and monitoring deviations from plans.
- Monitoring performance (consistency, speed, output rate), to avoid built-in delays, in conjunction with the provision of support for information or knowledge sharing for the most unstructured, and support for organising in the most structured instances.

Insight into how these processes perform in practice is critical to avoid failure. The execution of processes consists of people inefficiently doing their jobs amid a multitude of bureaucratic controls, with little or no visibility and control over what is happening outside the scope of their specific job function. Facilitating process awareness allows an awareness and perception into the impact of the actions of participants, as well as how sub-processes affect the global process or the organisations as a whole and their contribution to the strategic objectives.

Additional factors considered advantageous or crucial to realising the objectives of a collaborative effort include:

- A common and shared understanding of objectives, needs, and results with intermediate impact measuring metrics.
- Supporting seamless access to process support resources with ability to work on, share, and manage process models in a collaborative online environment creates greater insight, effectiveness and efficiency.
- Reinforcing integration across a diverse set of systems, platforms, and services. Process ownership, aligned responsibility and authority to drive process implementation.

5.4.2.4 Knowledge

Standardised operation and process terminologies, concepts, techniques and tools, in consort with harmonising all associated components and factors are crucial to ensure effective communication. An absence of knowledge results in a lack of insight, which affects the involvement or participation of stakeholders. Knowledge sharing of coordination mechanisms, such as schedules and plans to facilitate mutual adjustments to the activities of others without the need for negotiation, is critical to facilitate collaboration.

As people are involved in performing tasks, they need whatever knowledge is necessary to execute such tasks and to encourage the appropriate use of judgment. While some of this knowledge is extant in the mind of the user, and arises from experience (tacit knowledge), other forms of knowledge extend from external sources, for instance documents (explicit knowledge). Additionally, particular types of knowledge emanate from contextual information, which increases the awareness of people of the situation and circumstances, taking into account factors and contingencies related to other users.

This makes certain elements and factors requisite, appropriate or expedient to ensure effective collaboration, in relation to knowledge, incorporating:

- Support of knowledge integration and providing simple access and manipulation mechanisms for querying distributed knowledge repositories or knowledge bases.

- Facilitating methods and procedures to correlate and analyse data effectively - intelligently query, infer, and reason over the cumulative data.
- Presentation of information in an easy-to-understand manner.
- The usage of ontologies and specified vocabularies, engendering shared terminology and machine-readable codes to be used in specific instances.
- Providing context driven and personalised automated query/dissemination to avoid overload, and to mitigate manual searches by supporting automated search and translation processes.
- Matching heterogeneous data by employing ontology-based integration to support and provide an underlying structure for the alignment of meanings of data and context.
- Intelligent archiving and content management, which assists in capturing, retaining and distributing information, in accordance with a planned and strategised life-cycle.

5.4.2.5 Information

Disparate archiving standards exist in the public sector. Relative to their autonomy, organisations archive their documents using individually selected methods. The distributed agencies can collaborate with each other by exchanging data; however, they have different data formats and communication methods. Similarly to knowledge dissemination, this necessitates the need for a common dictionary to attempt to consolidate different concepts and their interpretations or meanings. Through a shared vocabulary, and associated ontology links, the foundation and capability of machine logic, interpretation, and inference can be provided.

Factors, issues and components which relate to information and are deemed necessary, beneficial or valuable include:

- The provision of the capacity for individuals in an organisation to decide or dictate what information they wish to provide about their activities to entities from various other organisations.
- Ensuring integration, in order to eliminate multiple versions of the same document, inconsistent coding, manual re-entry of information. and misinterpretation.
- Unifying fragmented information, to improve information access and awareness, which will assist collaborative interaction between distributed organisations.
- Supplying a single point of access to information from multiple sources, in conjunction with support for data visualisation, to spot trends and patterns utilising graphs, considering the potentially large volumes of information.

- Automating information processing, while maintaining support for participants to use individual judgment in decision making.
- Monitoring of ease of use, access time, relevance, timeliness, completeness, appropriateness and conciseness.
- Semantic interoperability, to enable machine processable logic, inference, knowledge discovery, and data alliance between different information sources or systems, allowing systems to exchange and interpret data based on a predefined ontology of shared meaning of terms and expressions; however, this must be done securely.
- Customising access to large amounts of information through the usage of context information, considering the large number of role players.

5.4.2.6 Application

Different tools are employed in the public sector to support coordination related work. In addition to technology utensils, such as spreadsheets or word processing documents, there are a range of different implements and initiatives that gather and analyse information on progress, relative to capacity building in municipalities. Many are ad-hoc, and subscribe to unique specifications. The predominant information management programmes employed subscribe to creating and managing content centrally, while primarily depending on individuals for achievement. This emphasises the need to provide a well-designed, integrated tool for analysts, instead of an awkward combination of disjointed utensils. Currently, spreadsheets do not provide adequate functionality and guidance; they are mostly sporadic and disorganised and the use of technology consumes a great deal of time and effort. As information exists in diverse, varied parts on multiple systems, in several geographic locations and is not directly controlled, the existing approaches to managing information and knowledge are deemed too basic for the complexity of the environment. To mitigate these factors there are certain elements, implements and components which could assist in engendering effective collaboration towards a common objective, encompassing:

- Better user interfaces, with aggregation and effective decision making guides.
- Supporting a scalable/seamless application level integration of tools, which assumes different roles in a collaborative environment, to alleviate the burden and frustration from manually combining tools towards a particular purpose.
- The ability to present applicable information in different ways to various users, based on the user profile, through a customised and personalised setting.
- Supporting the dynamic integration of several visualisation applications to make information more meaningful.

5.4.2.7 Infrastructure

Presently, work systems operate largely in isolation from one another. The current strategy of establishing a human infrastructure to effect integration and coordination in the public sector is inadequate. There are no computerised links between systems, meaning that an ICT facility to expedite asset improvement and possible automation is lacking.

Existing support applications are provided by different vendors, with members using multiple applications to support their coordination efforts, including legacy applications. The lack of integration causes extra work and delays as pertinent information or knowledge from other agencies is not accessible and, considering the partially paper based approach, is difficult. Principally, the attainment of network or infrastructure interoperability may be facilitated through taking advantage of the internet. Engendering an efficient, effective collaborative venture across distributed environments and ensuring integration therefore requires certain mechanisms and capabilities in a shared technical infrastructure, considered prerequisites, advantageous or critical, inclusive of:

- Contemporary technological support that assists in understanding the environment and value of content, requiring minimal human intervention.
- Enabling interoperation and integration between various participants, at assorted levels of granularity, from basic communications and information exchange to the organisational level, extending beyond boundaries.
- Expediting communication between heterogeneous information systems and software applications, to ensure the accurate, effective and consistent exchange of data, which is then utilised in a meaningful manner.
- The solution must incorporate and be applicable to unstructured and structured information systems.

Essentially, the infrastructure should provide support for a loosely coupled approach to account for cross-platform distribution, interoperability, scalability, integration of applications, and legacy systems across diverse, heterogeneous environments.

5.4.2.8 People

An absence of knowledge can result in a lack of insight, or awareness, which can affect participation and commitment in collaborative activities. Some stakeholders asserted that meeting their counterparts when the opportunity presents provides great benefits, relative to learning and sharing views on training issues. This is in addition to the need to avoid manual error-prone processes and the necessity for tools to make intelligent queries or reasonable inferences from data, given limited manpower. Staff turnover causes inefficiency, for instance, overloading or the over-extension of personnel.

Therefore, it is necessary to facilitate collaboration, communication and knowledge sharing among the different parties within the process and network. The attainment of this could potentially be achieved through the inclusion of some or all of the following dynamics, aspects or components:

- Support for advanced synchronous communication, including voice and video, in addition to simpler forms, such as instant messaging.
- Utilising a shared workspace to facilitate user involvement, representation, cross-functional communication, and informal social interaction.
- Engendering the creation of a heterogeneous working group, comprising representatives from various departments.
- Enabling balancing the load of work, through employing role and responsibility auditing, and monitoring work distribution to prevent overload, which, in turn, ensures accountability.
- Providing a single point of access to shared spaces, which facilitates social gathering and interaction.
- Support role based access control.

5.4.2.9 Finance

Regarding funding, incidents may occur where the current task exceeds the monies available. Alternatively, the funding allocation may not be measured in terms of value return. For instance, continuous investment into storage devices is not a sustainable approach to solving unremitting growth in content information, whereas conjoint investment into shared, existing infrastructures that provide such services may be more cost effective and sustainable. To ensure effective monetary management the most crucial elements within the mechanism are:

- The need to monitor and track budget allocation.
- The exploitation of visualisation tools to support evaluation, forcasting and/or prioritisation.

5.5 Abstracted Summary Requirements for a Coordination Support System in a Distributed Collaborative Community

The requirements identified in the case study are synthesised and summarised into composite requirements for the purpose of convenience and brevity. As such, each composite requirement consists of both the functional and the non-functional requirement attributes from both macro and micro contexts. This infers that, for a system to be successful, it is necessary to concurrently meet the functional requirement in conjunction w the non-functional requirement. Of course they remain tagged for traceability purposes, so as to pin point exactly what aspect needs to be accounted for, to fulfil the non-functional requirement of a function. Essentially, to find the variant that is required to satisfy the quality requirement, whether it reflects availability, capacity or continuity for instance.

The composite requirements tagged 'RQ' in Table 5.4 brings together requirements with comparatively similar objectives for fulfilling a particular function. For example, a requirement of the 'Enabling environmental' factor, as part of the macro context analysis in Table 5.1, the 'socio economic' item suggests the need to facilitate resource finding and sharing (FR1 and 2), similarly, the strategy item of the management component, in Table 5.3, that forms part of the micro context analysis, suggests the need to 'facilitate dynamic, collaboration opportunity identification (FR24)', thus are composed under RQ1 in Table 5.4. RQ1 suggests the need to facilitate streamlined coordination and more focused collaboration. Another example involves the 'organisation/institutional factors', item 2.1 'work pattern', which calls for autonomous and loosely coupled work, and somewhat relates the non-functional requirement the management component item 1.2 'control' in Table 5.3, which suggests the need to preserve autonomy (NFR17), thus are classified together in RQ8. Furthermore, RQ2, suggests facilitating contact initiation (FR5) which reflects the requirement of item 1.6 'geographical distribution of workforce' in Table 5.1, which maps the need to facilitate 'communication' FR29 of item 1.4 Table 5.3, for example. The section generally advocates that to ensure reliability and effectiveness of the proposed system both functional and the non-functional requirement must be accounted for. Thus, are composed in Table 5.4

The findings present several implications for designs to support coordination in a distributed environment. For instance, the findings suggest that the loosely coupled work patterns afford municipalities the authority and flexibility to deal with the unpredictability of the work setting without consulting others. As such, one effect for design is that the flexibility and autonomy afforded by loose-coupling must be preserved, as entities must contend with the unpredictability and uncertainty that the work settings present, often resulting in dynamic and unique requirements. The requirements presented in Table 5.4 should characterise designs that aim to support coordination in a distributed environment. A suggestion of possible solution characteristics is presented in the next chapter.

Table 5.4: Abstracted Summary Requirements

DESIGN REQUIREMENT	REQUIREMENT DETAILS	DESCRIPTION
RQ1: Identify/Match shared interests	NFR1, 4; FR2,23,24	Facilitates streamlined and focused collaboration
RQ2: Facilitate contact initiation	FR5,29 NFR1,13,6	Facilitates interaction between possible collaborating entities
RQ3: Components interoperability	NFR28,33; FR60,61	Promoting Open systems, Technology/semantic uniformity, Agreement /standardisation towards integration among different representations
RQ4: Real-time federated data analysis and forecasting (predictive/feasibility assessment) for decision making (	NFR,14 16,19,24,35; FR39 57,63,67,	Facilitates decision making through streamlined analytics and forecasting
RQ5: Seamless semantic/process/tools integration	FR14, R22,45,54,55,61	Facilitates ubiquitous accessibility of data and transcends beyond problems with exchanging data between applications to semantic integration of understanding those data.
RQ6: Agile process definition/modularisation and configuration	FR6,11,18;58; NFR7,10,38	Represent the ability to respond to changes quickly to a given cooperative business process circumstances.
RQ7: Spontaneous communication	NFR11,20 FR29,68	Support synchronous/asynchronous discussions and negotiation
RQ8: Support autonomy and loose coupling	NFR2,5,6,17	Support jurisdictional constraints and desirable preferential connections.
RQ9: Subscription/ Personalised notification and recommendation	FR1;2,4,27,28,47,49,50; NFR,30	Prevent information overload through tailored and streamlined service provision
RQ10: Access control/compliance	FR23,25,51 NFR17,18,27,31	Preserve logical autonomy, protect information integrity Clear-cut roles and responsibility domains
RQ11: Augment Shared workspace with Cooperative Object sharing and documentation support.	FR2, 6,7, 68	Asynchronous/synchronous information transfer. Support the realisation that cooperative business processes leads to artefacts (documents, tools) which need to be shared among project community members.
RQ12: Dynamic and adaptive process composition (structured +unstructured) scheduling and execution	FR11, 12, 21,40, 41; 59; NFR2,12, 25,	The ability to compose services at various levels of granularity, with event-driven and asynchronous styles of interaction that can account for various use scenarios
RQ13: Unified service access point	FR55,56,57, NFR32	Single sign on point and access to resources and attain instant visibility into the entire workflow chain via a graphical, user-friendly dashboard.
RQ14: Information diffusion, Context awareness and reporting	NFR1,3,4,8;R14,26,27,37,39 FR30,31,34,36,39,59,62;69	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.
RQ15: Flexibly/Scalable/extensible/reusable/ distributable	NFR1,2,5 9,26,23, 34; FR42,66	Accounting for a greater degree of variability to support varying scenarios regardless of context + individual participation in shared processes regardless of location using smart endpoints.
RQ16:Knowledge base support, Content management (Smart Archiving/Knowledge sharing)	NFR10,29,31,35;37; FR39,48, 53,65	Managing and storing information, tailoring of content and advertising to a user's specific characteristics based on user information + support and augment, repository with semantic/ontology based indexing, search and retrieval features.
RQ17: Support for usability with User interface adaptation	NFR,32; FR54,57,42	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.
RQ18: Adaptive/Ad-hoc group formation (structure)	FR3, 10, 3033; NFR7	Support dynamic formations of groups to augment governance models and clearly defined policies.
RQ19: Automation and customisation	FR41,42,R43,44; NFR32	Support levels of customisation and process automation to streamline accelerate and standardise processes (e.g. complex procurement/deployment procedures).
RQ20: Dynamic object administration, tracking and configuration	FR3,13,15,19, 20,25,30,31,32,33	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

5.6 Conclusion

In this chapter a multidimensional requirement elicitation instrument was used as the basis to identify requirements that characterise coordination in a distributed environment. The case study illustrated the applicability of the instrument to gain insight into the requirement. Based on the instrument, the case study highlighted the characteristics that made explicit the requirements associated with coordination in a distributed environment. The analysis revealed the challenges associated with collaboration in the distributed environment, greatly influenced by the loose coupling pattern of work. The results provide evidence that the elicitation instrument is particularly useful in revealing obstacles to coordination from the case study. The findings imply that the technological inadequacies of the artefact or people and process can affect coordination. The problem of coordination is identified as crucial in the public sector. Existing tools for coordination in the sector, for instance phone, e-mail or fax, are limited with respect to the issues identified; especially relative to certain issues, viz. it is not always clear what has been already done by whom, what is currently going on and what the next steps are.

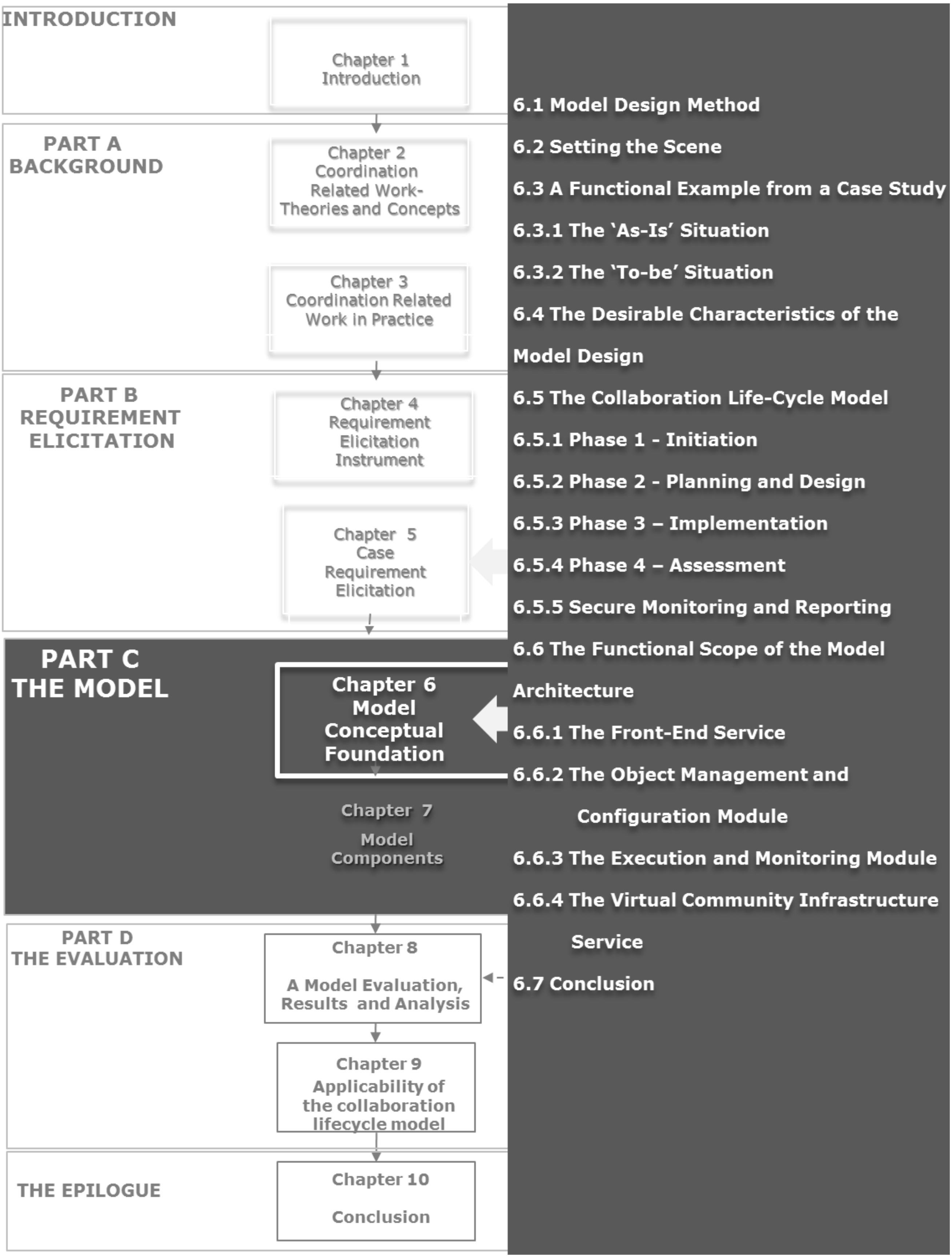
The need to coordinate has conditioned various government agencies to expect up-to-date information regarding training. Unfortunately, these expectations are not being adequately fulfilled, as the existing information technology tools, architectures and frameworks of the government are not comprehensive, sufficient or suitable. In fairness, efforts have been made towards organising communication, information flow and decision making structures, whether formal or informal structures; however, the problem is perceived in terms of effectiveness and efficiency. Unfortunately, the current state of the information sharing between agencies, institutions, and other third parties, as well as the level of tools to query, infer, and reason intelligently over the cumulative data, do not meet these expectations adequately. Essentially, there are no tools to make intelligent queries or reasonable inferences from the applicable data. The case study approach provides significant benefits relative to features that should be considered in design to account for coordination in a distributed environment.

The requirements suggest the need for a solution that is context sensitive, and capable of providing coordination support for activities of collaborating organisations in dynamic situations. Given the requirements identified the research advocates that a virtual community perspective provides great potential, as it can be leveraged as a decentralised coordination support collaborative infrastructure. The identified requirements suggest a perspective that should be leveraged to inspire collaboration, guide improvement and enable the alignment of cooperative strategies in conjunction with their execution, visibility into the impact of decisions, collaborative opportunities, the execution of decisions and actions, and the ability to track deviations from goals. The subsequent chapter looks to satisfying the requirements identified in this section, by designing a model to support the coordination of a distributed collaborative community through leveraging the virtual community infrastructure from a service perspective.

PART C

Taking into consideration the requirement sourced in 'Part B' and the lessons learnt from the evidence based knowledge revealed in 'Part A', 'Part C' concerns the formative development of the solution model, towards an IS design theory. The solution artefacts provide knowledge-driven guidance as to how to design and support an IS solution for coordination support in a heterogeneous and distributed environment. The primary contribution of 'Part C' constitutes a model artefact and supporting architecture, predicated in design support principles identified in Part A. Therefore, 'Part C' resolves the query: "*What are the elements/constructs that characterise the solution space and how can they be interwoven to support coordination in the SA public sector?*"

The answer is divided in two chapters. **Chapter 6** provides the conceptual foundation of the solution artefacts, while **Chapter 7** supplies a more detailed, comprehensive discussion regarding the functions of the proposed artefacts, their constructs and relationships.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CHAPTER 6

MODEL CONCEPTUAL FOUNDATION

After defining the research objectives, reviewing related work and examining relevant technologies the thesis now moves on to propose a solution. The primary question to be answered in this chapter is: *What functionality should characterise a model aimed at supporting coordination in a distributed environment?* With this query, the current chapter overviews the model aimed at addressing the problem of coordination in the distributed South Africa public sector, with the model definition progressing from a conceptual aspect to a more comprehensive, detailed view.

The model is prescriptive, in that it defines the core features and functionality, from which an implementation can be developed. The core is drawn from previous research and relevant technology architectures. The characteristics that influence the design of the model are derived through analysis of the distributed environment. The correlation and combination of proven theories and existing technologies, with specific focus on facilitating coordination, allows the achievement of a unique combination; thereby facilitating and producing a novel approach to the research problem.

The current chapter provides a conceptual overview of the model. In order to provide an overview of the situation, the next section reviews the problem domain from a high-level perspective. This is followed by an introduction of the model and its components. Thereafter, the functional scope of the architecture is described, defining the core features and functionality of the supporting architecture. This is succeeded by the design consideration and a discussion of the underlying design principles, followed by an overview of the primary constructs and relationships which form the building blocks for the model, and thus the subsequent chapters. The model is then summarised, followed by the conclusion of the chapter.

6.1 Model Design Method

The purpose of this study is to develop a model with the intended functionality of supporting and promoting sustainable coordination in the SA public sector. The model, which possesses prescriptive attributes, reveals the approach used to develop the collaboration life-cycle and its supporting architecture. A '**model**' is the amalgamation of certain organising principles, the structure of a system and the elements or objects making up a system (Zager 2002). Figure 6.1 presents an overview of the design method employed. As previously stated, design science research emphasises the need to build and evaluate an artefact. The build aspect of the design, as depicted in Figure 6.1, outlines the model components required to address the problem and to satisfy the needs of the targeted users. The created model is founded on a knowledge base, providing theoretical grounding. Additional input to the model design is produced in practice from the environment, courtesy of the developed requirement elicitation instrument. Therefore overall the model is informed by lessons elicited from the knowledge base, augmented by the specific knowledge added by this study and the environment.

Furthermore, in order to ensure that the artefact is useful to practitioners and that it contributes to the body of knowledge it must undergo rigorous evaluation and justification. The second part of the design, aimed at assessment, employs descriptive methods (informed arguments and scenario) (Hevner et al., 2004). Thus, the model validation process gauges how well the needs of the target audience are satisfied and how it addresses the identified problem.

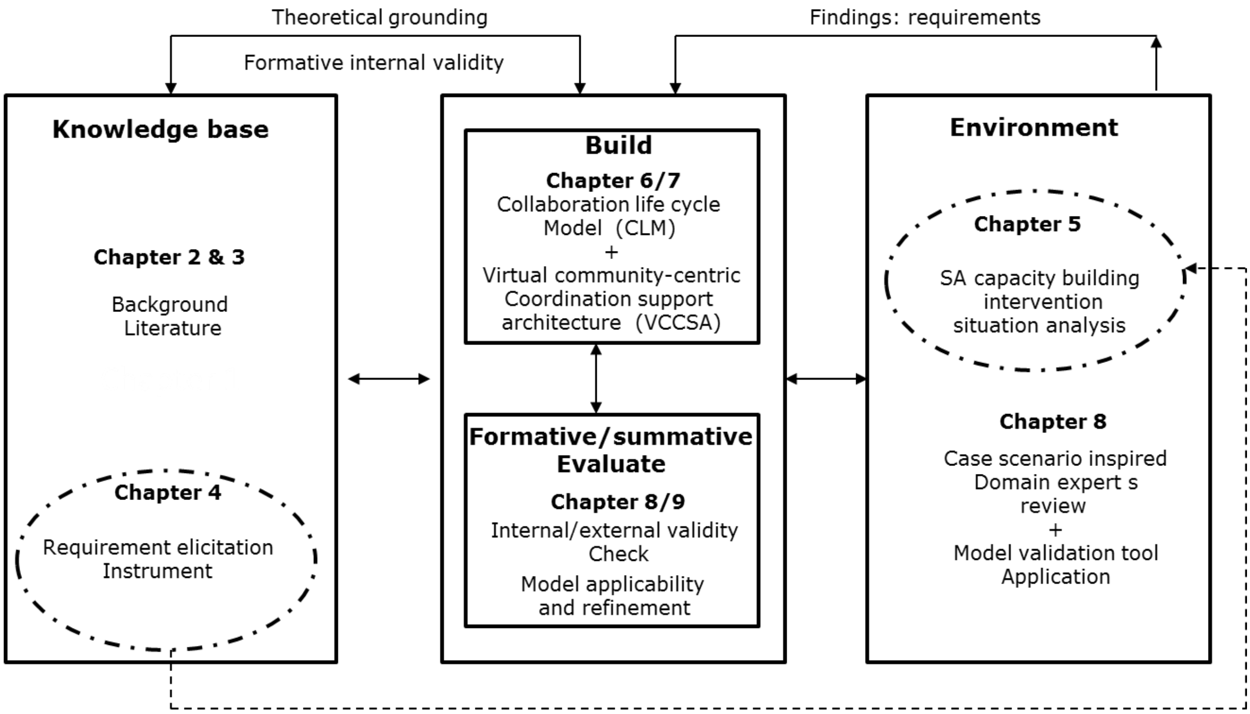


Figure 6.1: The Design Method Used for the Model

The accomplishment of the process of model evaluation is intended to assess the relevance and rigour of the model components, in consort with their underlying supporting principles. The formative evaluation features throughout the research, with the summative evaluation predominantly highlighted in Chapters 8 and 9. The formative build aspect of the model utilises information from the knowledge base to build arguments for the utility of the artefact. This is in addition to the feedback from the academic publication, which took place as the research progressed, where constructs were tested in terms of their usefulness, the relevance of components and how well they met the requirements. The formative approach concerns the internal validity relating to how well the model meets its envisioned or intended purpose. To achieve external validity the summative evaluation employed a validation tool, to help endorse the applicability and relevance of the model; therefore, to test whether the needs of the target audience are met in solving the problem identified. The summative evaluation also served a formative role, providing input towards model refinement. The subsequent section provides an abstract 'As-is' description of the environment, which through utilising the knowledge base, provides the 'To-be' representation that produces the model aspects proposed.

6.2 Setting the Scene

From having reviewed the requirements in Chapter 5, it is evident that the South African public sector exhibits the complexity associated with distributed coordination, which factors include: *inter alia*, size, the governmental structures, the number of role players, and its loosely-coupled work pattern. The magnitude of the complexity imposes a crucial need to develop a coordination support mechanism which encompasses the dynamic collaborative requirements of the public sector. Figure 5.5 in Chapter depicts the 'As-is' environment, which is duplicated in in Figure 6.5 for convenience.

The assumption is, that by leveraging the virtual community properties, as illustrated in the predominant portion of Chapter 3, seamless and sustainable coordination may be achieved. Essentially, this can change the 'As-is' situation to the envisioned 'To-be' status, as illustrated in Figure 6.5. The paper entitled *Virtual Communities as a Mechanisms for Sustainable Coordination in the SA Public Sector* in Appendix D1, illustrates the possibilities promised by such an infrastructure. As an inherently socio-technical environment, a virtual community extends beyond the traditional environment to support distributed interaction; fusing the virtual community with the real world community, as the interaction is still contextualised in reality. As revealed within Chapter 2, Section 2.2, and the lesson in Sub-Section 2.3.3, the sub-systems are intended to interact and support each other, consistently striving for balance.

Figure 6.2 abstracts the situation, fundamentally answering the question: *How can we move from the 'As-is' to 'To-be'?* Figure 6.2 depicts the goal for this thesis. It attempts to use the 'As-is' situation, as reflected in Chapters 4 and 5, in conjunction with the knowledge from the theoretical background/current practices as outlined in Chapters 2 and 3, to develop the 'To-be' situation portrayed in Figure 6.2. The 'To-be' situation is depicted on the right hand side; however, not everything will have to change. This is illustrated by the shaded areas in Figure 6.2, which indicates the aspects that require specific attention.

Essentially, the same work is conducted in both cases, with the aspects pertaining to how it is carried out being what changes. For instance, while the object of work, the intended outcome and the actors may remain the same, with possible minimal adaptation, the means of articulating work is what changes. Fundamentally, by this it refers to the means of work that enable coherent and orderly accomplishment of the production work (training provision) within the collaborative project. The shaded areas of interest in the micro context, representing the collaborative context, consist of the means of organising, synchronising, adjusting, and integrating work; the means of interaction, networking, information and knowledge sharing; and the means of work, representing the instrument or tools employed. The macro context, is also shaded, in the 'To-be' aspect of Figure 6.2, which illustrates that a technical shared services infrastructure, in the form of a virtual community infrastructure, extends the 'As-is' support infrastructure to assist in supporting the collaborative efforts of the sector.

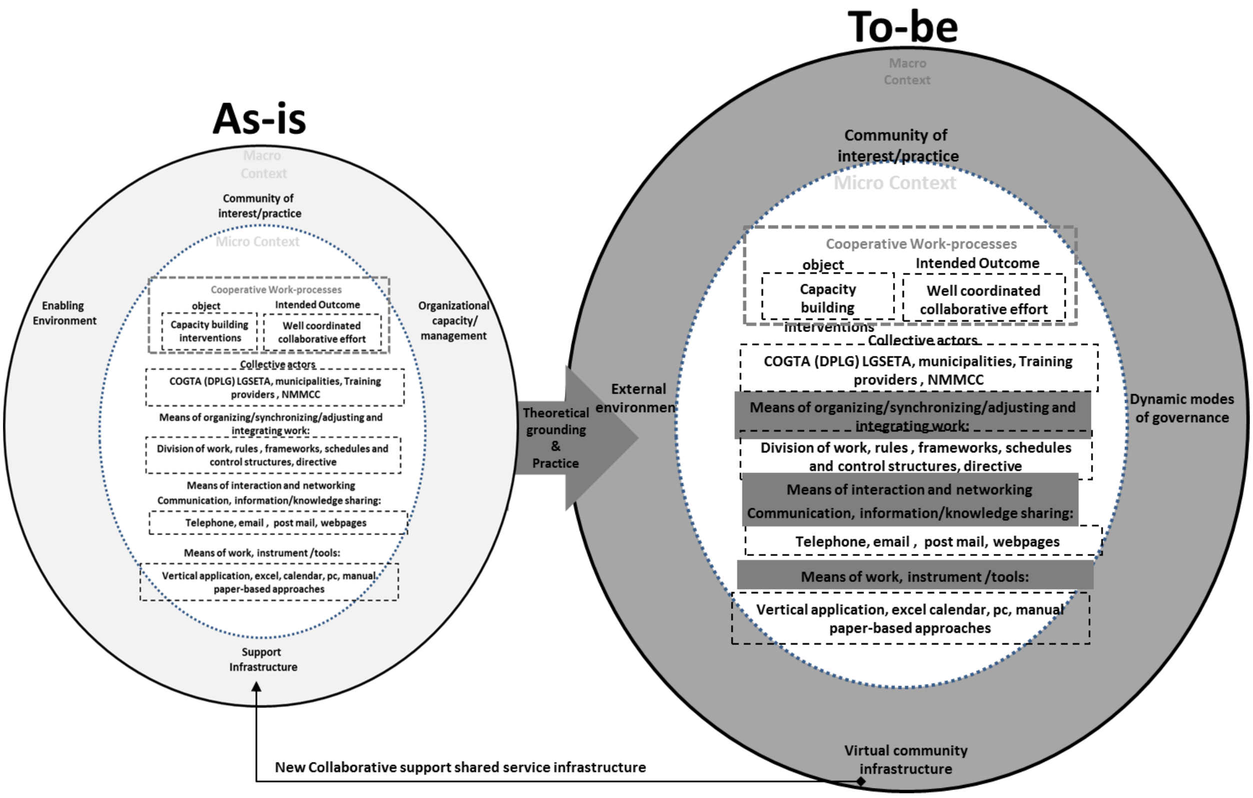


Figure 6.2: From 'As-Is' to 'To-be'

Considering the distributed nature of the environment, as well as the number of decentralised and dispersed players, the virtual community could function as a coordination support platform, bringing, uniting and keeping community members and their activities together. This denotes that, to account for coordination support in a distributed environment, a context-sensitive virtual community middleware infrastructure, which is open - thus, extensible, scalable and reconfigurable - is emphasised, to meet the dynamic coordination needs. Essentially, what this signifies is that the proposed model to be discussed in the chapter consists of two parts, viz. a static and a dynamic part. The static component represents the supporting environment, required in place for the architecture devised. The dynamic element denotes the support process of how things occur, as per the means of work, for which a life-cycle model is devised. However, before these are further elaborated upon, the following portion of the discourse considers how these are reflected in a functional example from the case study.

6.3 A Functional Example from a Case Study

Having considered the requirements, in order to provide a situational overview, to set the scene for the solution model, this section previews the expectations in practice, through reviewing the practical ‘As-is’ to ‘To-be’.

6.3.1 The ‘As-Is’ Situation

A preliminary view of the status quo of the extant capacity building situation is provided in Figure 6.3, which recaps the problems encountered. The predominant problem evident is involved in the consolidation of documents, demonstrated in the representation of the document flow. The figure shows a number of the primary role players engaged in the capacity building efforts of the sector. Basically, the problem spans three phases in the capacity building process, viz. the Requirement Elicitation, Tactical, and Evaluation stages. The problems are presented in the diagram in red heptagons, with the interpretations supplied in Table 6.1.

Table 6.1: Some Case Based Coordination Problems

PROBLEM LABEL	PROBLEM DESCRIPTION
P1	Multiple duplicated planning documentation
P2	Multiple, dynamic and distribute work groups
P3	Isolated offers
P4	Wasted collaborative opportunity
P5	Duplication of training interventions
P6	Information timing
P7	Manual integration

As illustrated in Figure 6.3, the **Requirement Elicitation phase** consists of numerous documents, located in several different places, aimed at a common purpose. This phase engages many manual approaches, making coordination a difficult task. For instance, as shown in Figure 6.3, plans as separate entities are derived from others, but not from the same document nor in the same place. These are periodically accessed and compiled by human workers to aid coordination. As indicated, multiple Personnel Development Plans (PDPs) feed into a Work Skills Plan (WSP); many WSPs form the Sector Skills Plan (SSP), which in turn feeds into the National Skills Plan (NSP). The overwhelming burden that the situation presents cannot be ignored. The challenges associated with the geographic dispersal of documents, their manual integration and the limited application support, impact on coordination as there is limited overview regarding activities and resources. This results in conflict bookings and the overextension of staff, as well as numerous other issues.

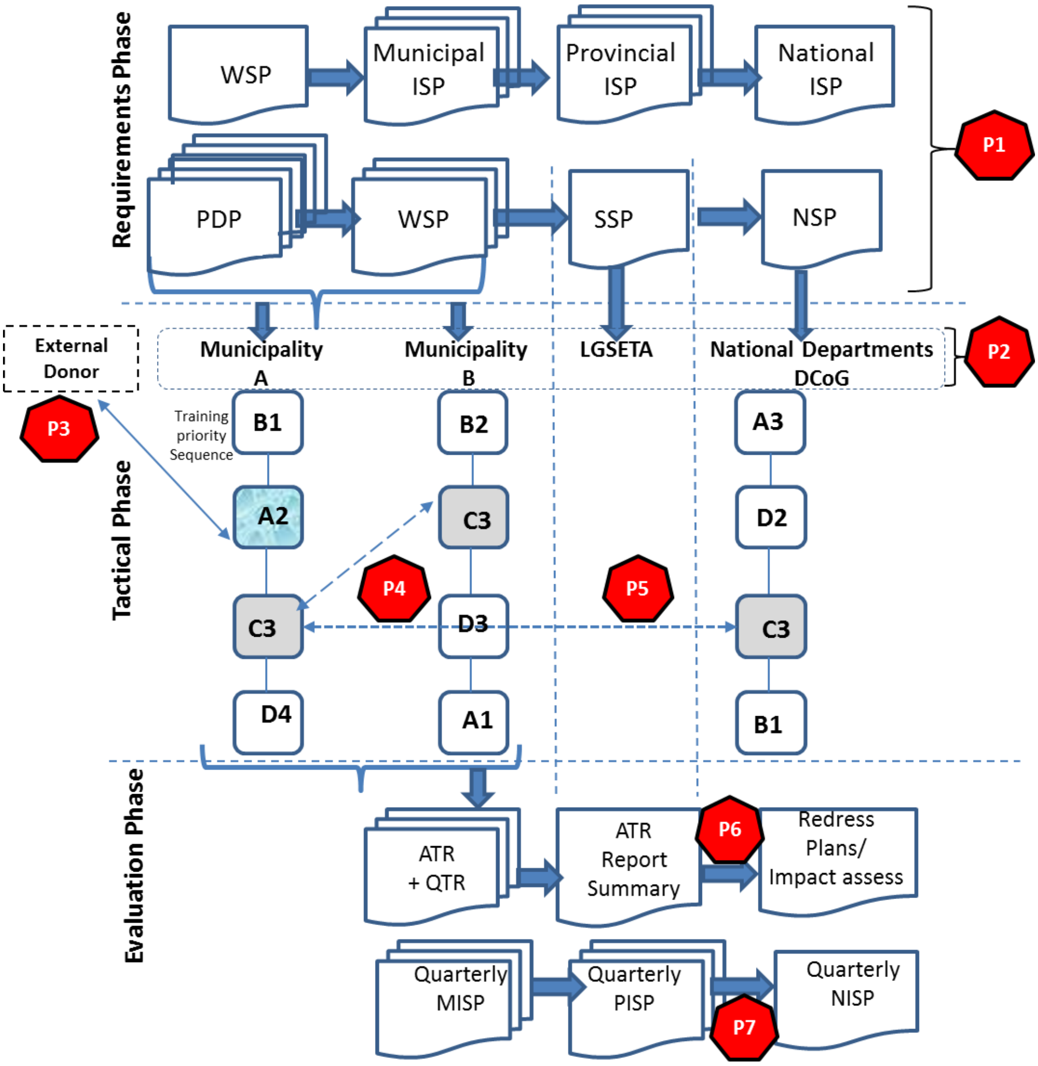


Figure 6.3: A Preliminary Coordination Status-Quo

In the **Tactical phase,** the lack of insight into the ongoing intervention activities of peer municipalities and national bodies results in wasted collaboration opportunities and the duplication of interventions. This is shown in the replication of the C3 training interventions activity in Figure 6.3, which occurs in all agencies. Moreover, some of these interventions may not be reflected in the plans and may only occur because a third party player, for instance an external donor, sponsors a certain intervention. Therefore an event, for example A2, may be completely hidden. Thus, such isolated offers make it difficult to plan and to coordinate efforts.

The **Evaluation phase**, similar to the planning phase, consists of numerous distributed reports, generated and distributed across several paths. This phase is plagued with distribution and integration challenges, which in turn affect progress and impact on assessment timing. This affects the redress intervention effort negatively. Additionally, quality control and success measures relating to coordination are hindered and made more difficult. Besides the difficulty in accessing information, in consort with the existence of multiple versions of the same information, other issues include the use of obsolete or inaccurate information, inconsistent coding, the misinterpretation of information, and the manual re-entry of information. Thus, a fundamental function of the proposed solution is to provide management and awareness information services to collaborators, as elaborated in the next section.

6.3.2 The 'To-be' Situation

In response to the problem situation, as presented in Figure 6.3, this section provides an envisaged virtual community based solution, as depicted in Figure 6.4. The solution promises a system that provides integrative, immediate and continuous access to information relating to the activities of others, focussing, *inter alia*, on information integration and an ongoing, continuous awareness of all activities. It is significant to observe the principal difference between the figures. In Figure 6.4 the implementation results in a system from which documents can be produced. Figure 6.4 reveals that the support for requirement elicitation, planning, execution and evaluation are all initiated within, and arise from, the system. In this solution, different aspects of the same information may be provided, as portrayed in the **Requirements phase** of Figure 6.4. The information physically distributed in Figure 6.3, at the requirements phase, is consolidated in Figure 6.4.

This is conceptually positioned in one place and monitored, with the potential for generating documents or views from the single information source. The requirements phase depicts how the information from several documents may be contained in a single view, possibly from multiple information sources. The red coded bar represents context driven requirement elicitation, while the cyan colour corresponds to continuous monitoring. This reflects having insight into several problem contexts, through which collaborative opportunity identification is made possible, by continually monitoring and documenting environmental needs. This level of awareness is integral to the initiation of the collaboration life-cycle model in the tactical phase. The virtual community infrastructure, portrayed in Figure 6.4, promises to help match user interest requirements to the offerings made by publishers, as well as monitoring and tracking actions as they occur.

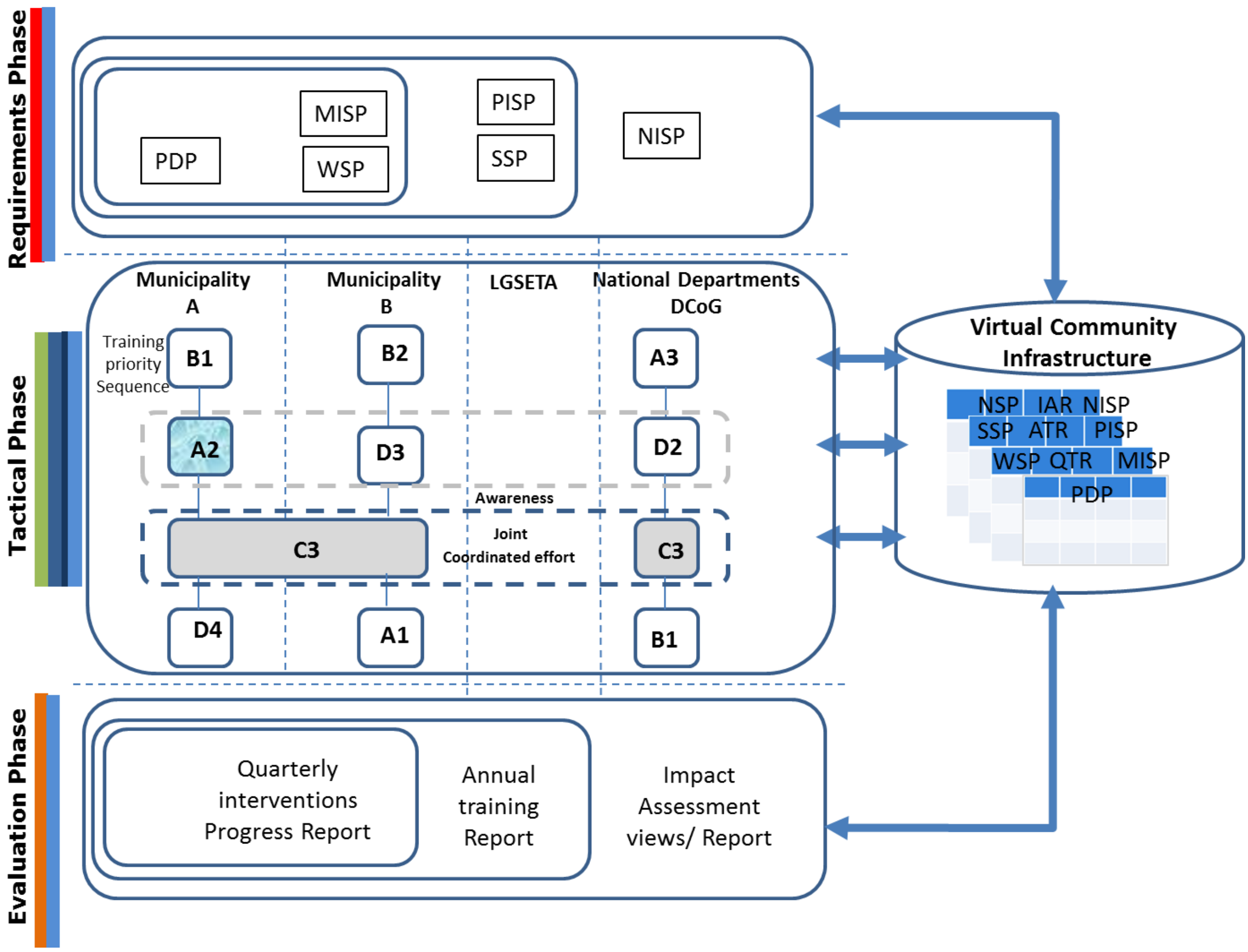


Figure 6.4: Coordination 'To-be'

The **Tactical phase** signifies the identification of multiple occurrences of similarly planned activities, aimed towards collaboration, exclusion or transfer in order to mitigate duplication and reduce or eliminate waste. While the agencies conduct their individual tasks, the system should provide them with information as required. Within the tactical phase multiple conversations occur inside the system to keep stakeholders informed of ongoing activities. The possibility of one intervention taking place among the three agencies is represented by the broken lines in Figure 2, within the execution phase. Two C3 activities exist within a dotted line, indicating that, although there might still be more than one occurrence of C3, it will not be for the same municipalities. At this point two municipalities may still work together, but the intervention from the national body may be offered to another municipality. The larger C3 box indicates that two municipalities may choose to work together, depending on their proximity, taking advantage of a collaborative opportunity. The smaller C3 box represents the national department, which after gaining insight into the existing interventions occurring within the municipalities, as a result of collaborative efforts between them or donors may choose to join efforts or instead, to re-channel their interventions to alternate, less fortunate municipalities, which may require them more. The colour coding in the tactical phase represents the necessity to define certain elements, viz. the working objectives (green), planning and design (blue), control implementation (dark-blue), and monitoring for deviation (cyan). The **evaluation phase**, with the orange colour coded bar, focuses on the timeous and effective assessment of progress and impact, to ensure or facilitate appropriate and timely intervention. The evaluation may also be conducted by utilising a single information source, with the capability of generating multiple reports as the situation presents, while monitoring quality and success rates. The colour coding of the bars utilised in Figure 6.4 corresponds to those that depict the model in Section 6.5. The ensuing two sections elaborate on the value of the proposed artefacts towards the support of an overall collaboration process, while streamlining coordination.

6.4 The Desirable Design Characteristics of the Model

The benefits of having a methodological framework and a leveraging environment that is flexible, scalable and configurable to support collaboration, as emphasised in Chapter 3 Section 3.5, is desirable to assist in streamlining coordination in a distributed environment. Lesson L9 in Table 2.11, Chapter 2 , accentuates the requisite for an IT based model as integral to the solution Firstly, the dynamic aspect of work, as shown in Figure 6.5, emphasises the need for a process model, which is made evident as an awareness driven collaboration life-cycle. Secondly, to account for the supporting environment, a static model is made manifest, in the form of a Virtual Community-Centric Coordination Model (VCCM). Figure 6.5 overviews both the shared and unique desirable design characteristics of the two aspects of the proposed solution.

The model characteristic in the design space echo virtual community properties as noted in chapter 3. Essentially virtual communities provide a suitable base for the model development as they represent self-organising socio-technical systems that exhibit dynamic properties such as flexibility, adaptability, scalability and robustness among other things. Based on a the premise that a certain environment needs to exist to host a particular behavioural style, the subsequent section as per figure 6.6 present a static model that accounts for the technical environment and the dynamic model that accounts for the operations or behaviour.

Relative to the architecture, to leverage the potential benefits of Virtual Communities, a flexible, context sensitive middleware infrastructure, capable of coping with the needs of diverse collaborative scenarios, is stressed. Its *flexibility* reflects the capability of the envisioned system to adapt rapidly to any of a variety of emerging and evolving behaviours in collaborative organisations; signifying that the proposed model must be open with regard to the integration of technologies and tools, as it must account for existing tools and concurrently, be extensible, in order to accommodate new solution models with minimal difficulty. This is accentuated in lessons L2 and LI6 of Tables 2.11 and 3.8, respectively. To encompass the complexity associated with coordination in a distributed environment, a loosely coupled approach is employed, taking into account the separation of concerns through modularisation.

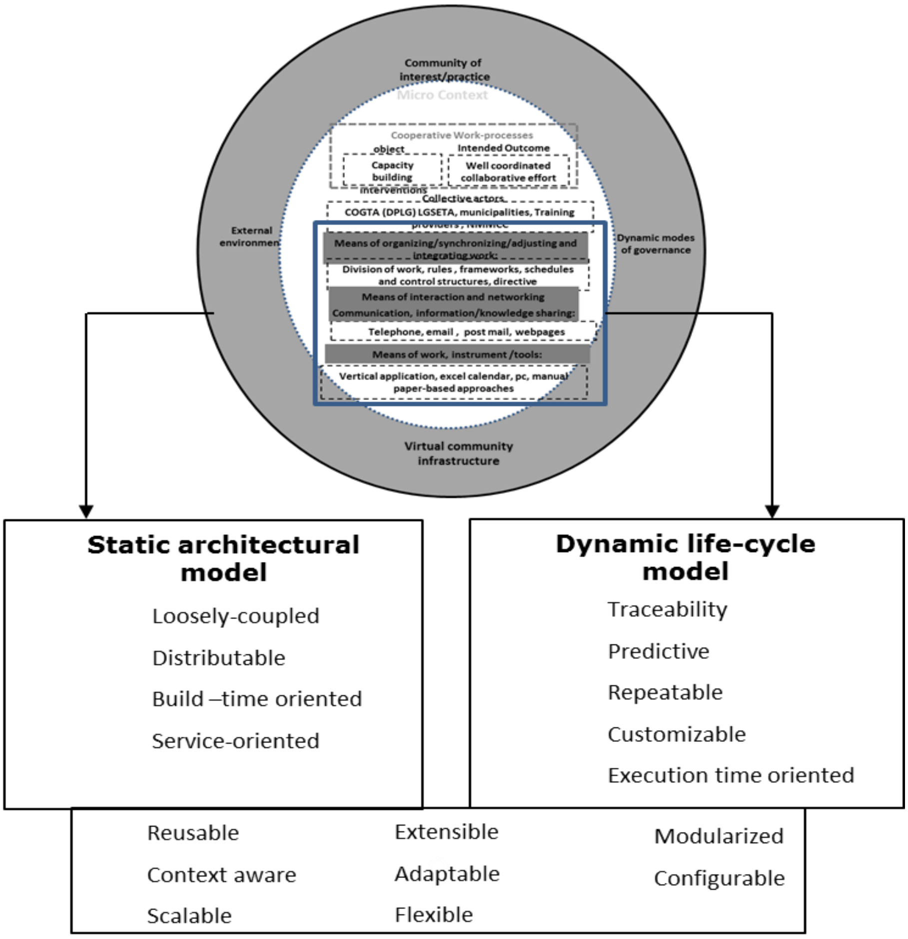


Figure 6.5: Desirable Design Characteristics

The principle of loose coupling makes applications more flexible, more easily adaptable, with greater responsiveness to changes. The loosely coupled pattern reflects the modularity principle, indicative of the modular separation of concerns, as highlighted in L8 of Table 2.11, Chapter 2, Section 2.3.7 and Chapter 3, Section 3.2.1.4.

Modularisation, as the design pattern, reduces the complexity of the system through subdividing the complex whole into smaller parts (modules or components), which can be created independently, and can then be utilised in different systems to drive multiple functionalities. Components are designed to be independent, with minimal inter-related or connected dependencies to other components. They exhibit standard interfaces, allowing callers to utilise their encapsulated functionality, without revealing details of the internal processes, internal variables or state, signifying that they are capable of operating in different environments and contexts. The ability to compose services dynamically in environments requires a level of loose coupling, necessitating that the architecture is targeted towards attaining a degree of loose-coupling, in order to facilitate business agility.

The modularisation principle focuses on the decomposition of the design into individual functional or logical components, which reveals well-defined communication interfaces containing methods, events, and properties. Functions are partitioned into discrete, scalable, reusable modules, consisting of isolated, self-contained functional elements with well-defined modular interfaces, to facilitate the interaction necessary to meet certain task objectives. Therefore, components can be deployed into any appropriate environment without affecting other elements or systems. By applying the principles of composability and loose-coupling it is ensured that the design can be *configurable* or re-configurable (to meet varying needs), denoting that it can be highly adaptive and extensible. Components should be designed to be reused in different scenarios with diverse applications. These elements should be capable of being readily substituted for other similar components, thus replaceable and extensible from existing components, in order to provide new behaviours.

Furthermore, the envisioned support infrastructure must be distributable, providing standard procedures or processes for invoking functionality remotely across different platforms, used by several people in different locations. This is supported by lesson L16. It must be scalable, to accommodate growth. It must possess the capabilities and capacities to cope and perform at an increased or expanding participation level or in cases of larger operational demand and, in addition, must be context sensitive. Context-awareness is imperative in a situation where the operating environment is constantly changing. In order to recognise, react rapidly and cope with the unpredictable changes in the environment, the envisioned infrastructure must account for context. This is highlighted in Chapter 3, Section 3.2.1.4 and lessons L4, 10 and 13. Context, principally, refers to all types of information pertaining to a service and/or to the user of the service. The proposed model must take advantage of context information to provide services that will aid in the coordination of collaborative activities, from recommendation to the execution and monitoring of tasks.

A consequence of the dynamic approach, which is the Collaboration Life-cycle Model (CLM), and its sustainability, is that it must be repeatable, measurable, flexible, reliable, predictive, and modular, with clear inputs and output, customisable, configurable, and adaptable to changing operation contexts, environments or system characteristics; and it must support dynamic integration and the reuse of processes and tools. The life-cycle accounts for proactive and reactive properties to predict occurrences and respond appropriately when uncertainties arise. Thus, behaviour is adjusted relative to the perception of the environment and continuous improvement. These are highlighted in lessons L5, L6, L7, L9, and L14-16 portrayed in Tables 2.11 and 3.8, respectively. Other properties include goal orientation, to align design and configuration and to provide traceable planning, implementation and evaluation; and traceability, which links related artefacts and provides insight to resources and actions. In addition there is scalability, to accommodate various situations and allow configurability to be customised to the needs of collaborative projects.

6.5 The Collaboration Life-Cycle Model

The Collaboration Life-Cycle Model design is founded on the premise that virtual communities offer an ideal platform for collaboration. This is further substantiated by the requirement element, as identified in Chapter 5. The model incorporates and exploits the operational functions of the envisioned virtual community infrastructure. Through these operations, concealed or obscured opportunities for collaboration could be identified or revealed. This would facilitate better management, as well as streamlining and structuring coordination efforts in a distributed environment, for instance the public sector. Five principal stages are involved, viz. the initiation, planning and design, implementation, and the assessment, as well as the monitoring and reporting phase, which is a continuous process, as illustrated in Figure 6.6. The 6th component at the core of the model is the environment responsible for providing the input that initiates the process. The pattern exercised is prompted by Lessons 4 and 5, in summary Table 2.11, which subscribes to the universal pattern of coordination, as detailed in Section 2.3.3 and classic project management principles. Additionally motivating aspects of the process component is the collaboration process, highlighted in Chapter 3 Section 3.5.

Essentially, the entire process entails some form of interaction to accomplish a task, with the resultant feedback utilised to test for effectiveness, allowing for the implementation of corrections to remain in accord with the request requirement. The approach follows a sequential route. This involves taking cognisance of a certain request, an agreement to perform this request, articulating goals, followed by the delivery of the expected results, as per the agreement. Each operational phase of the proposed model consists of activities aimed towards the support of a collaborative project and streamlined coordination. The model activities explore the symbiotic relationship between the subjective and objective mechanisms, respectively emphasised in Sections 2.3.2 and 2.3.3 of Chapter 2.

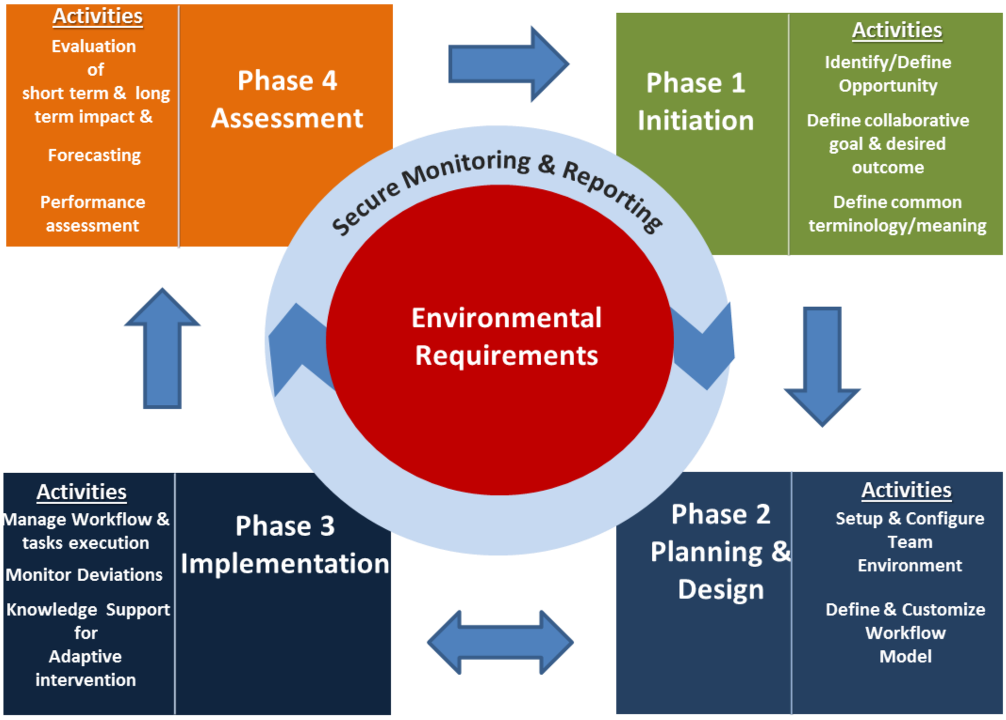


Figure 6.6: The Collaboration Life-Cycle Model

Furthermore, it is significant to take into account Lessons 4 and 5 in Table 2.11, which reflect shared perceptions, established on certain areas and instances of common understanding, defining the needs requirement that will initiate collaboration. The awareness of needs is central to the collaboration life-cycle model, represented by the environmental requirement component. An opportunity for collaboration is suggested at the initiation phase, based on this knowledge awareness. Additionally motivating the proposed model operation pattern is the design science research process utilised in this thesis, highlighted in Section 1.8. For instance, as stipulated by the design science research process, designing a solution artefact begins with an awareness problem.

Similarly, within the proposed model context, an initiated collaborative project is based on informed knowledge, relative to the needs of the environment (termed the environmental requirement). Extracted from multiple sources, this knowledge information is used as the inference, foundation and initiation point for suggesting a collaborative project. This is similar to the process stage, where suggestions for problem solution(s) are formed. Subsequent to the initiation of a joint project, is the process of planning and design, aimed towards guided implementation. This process is analogous to the development stage in the process, where the suggestion is implemented as an artefact.

The final phase is the evaluation stage, where an artefact is studied and deviations from expectations are accounted for. This is comparable and reflective of the assessment, as well as the monitoring and reporting components proposed in the model, towards the elimination, transformation or improvement of collaborative projects based on results. The collaboration life-cycle model is intended to facilitate the initiation of collective projects by actors (whether human or machine) through awareness of common knowledge pertaining to needs and interests. When interests that implicitly or explicitly coincide are discovered, a request for collaboration can be initiated.

The environmental requirements, which occur at the centre in the context of Figure 6.6, reflect the needs in the training environment, as highlighted in Chapter 5, Section 5.3. This serves as input for the initiation phase, which, based on the requirement, can determine collaborative opportunities arising from similarities, which may then be presented to interested members of the community. The need to maximise limited resources leads to the formation of alliances to share assets, means, supplies and funding. This is reflective of the initiation phase in RQ1, 2, 7, 9, 10 and 11 of Table 5.4. The summary lesson in Chapter 3, from People Category L10 (Section 3.2.1.1), which explores the shared interest of community members to identify opportunities, is thus stressed. The tactical phase, in Figure 6.4, relates to the actions undertaken in the planning/design and implementation phases.

The assessment phase in the model is comparable to the evaluation phase, which will result in state changes within the requirement, eliminating it if it has been fulfilled or re-modifying it. The planning and design phase subscribes to Lessons 6, 7 and 8 in the summary Table 2.11, in Chapter 2. These lessons concern organisational modelling, which results in the process modelling that the organisational model will execute (L3, Table 2.11). This is realised by defining, demarcating and unifying certain dynamic groups of actors, as well as their roles, in conjunction with the actions for which they are responsible in a specified process. The process modelling capacity is motivated by the adaptive approach accentuated in L15 Table 3.8, as discussed in Chapter 3, Sections 3.1 and 3.2.2. RQ6, 11, 18 and 20 are particularly underscored in Phase 2, which leads to Phase 3 - implementation. The implementation phase is demarcated in RQ12, 14, 19, which advocates dynamic process composition, the support for automation and customisation, transitioning between Phases 2 and 3, while being cognisant of deviations. The implementation phase endorses the lessons L15 and L16 in Table 3.8, which are detailed in Chapter 3, Sections 3.2.2.1-2 and 3.2.3.2.

The assessment phase is delineated in RQ4, 10, 14, 16 and 20, underscoring the necessity for checking and evaluating whether the initiated goals/objectives are being achieved, as suggested in Sections 2.3.2 and 2.3.3. Finally, the secure monitoring and reporting component is presented in RQ9, 14, 17 and 20. This element highlights lessons 5 and 7 of Table 2.11, as explicated in Section 2.3.4. The overall environment reflective of Category 9, and reviewed in 2.3.8, concerns the potential utility of IT services to attain the flexibility and capacity required for coordination in a distributed environment, as per RQ15. Furthermore, Section 3.1 proffers certain services, requiring proper integration to achieve the necessary, efficient and desired result. A brief overview pertaining to each of the phases and the functions thereof ensues.

6.5.1 Phase 1 - Initiation

The initiation phase involves the finding, establishing and inaugurating of the project. It concerns the identification of possible challenges and the establishment of guidelines and procedures to support future activities. In order to leverage the economies of scale, as highlighted in the previous chapter, the initiation phase consists of multiple activities, which incorporate defining and identifying collaborative opportunities from environmental requirements; providing a shared environment to support the subsequent specification of the goals and objectives of the desired outcome; as well as agreeing on common terminologies and meaning. The initiation phase is primarily intended to satisfy the requirements, as identified in Sections 5.4.2.1 and 5.4.2.8, which highlight the need to cooperate, in consort with taking collaborative advantage of commonalities. This, essentially, reflects the value of co-construction to produce the identical result or to share the same resource as per dependencies, stressed in Chapter 2, Section 2.3.1 and lesson L2 in Table 2.11. Table 6.1 present a summary of the requirements that influence phase 1 from chapter 5.

Table 6.1: Relevant requirement in phase 1

DESIGN REQUIREMENT	DESCRIPTION
RQ1: Identify/Match shared interests	Facilitates streamlined and focused collaboration
RQ2: Facilitate contact initiation	Facilitates interaction between possible collaborating entities
RQ7: Spontaneous communication	Support synchronous/asynchronous discussions and negotiation
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ10: Access control/compliance	Preserve logical autonomy, protect information integrity Clear-cut roles and responsibility domains
RQ11: Augment Shared workspace with Cooperative Object sharing and documentation support.	Asynchronous/synchronous information transfer. Support the realisation that cooperative business processes leads to artefacts (documents, tools) which need to be shared among project community members.

6.5.2 Phase 2 - Planning and Design

This stage sets up and configures the team environment. It establishes the project supporting structures and specifications, which serve as a reference model or template to guide resource deployment and the execution of collaborative projects. This ensures that requirements are enforced during execution. The activities in this phase include: *inter alia*, setting up teams, defining roles, and delineating reporting structures and working procedures. Essentially, it involves defining clear, distinct activities and the work required to complete the procedures for each individual project. It develops a baseline project plan, concurrently defining the project team scope and the work breakdown structure. It estimates the resource requirements, and outlines the communication procedures among all stakeholders. Therefore, this phase primarily concerns the requirements in Chapter 5, Section 5.4.2.2. Intrinsically, at this juncture the mechanistic, organic, communication pattern and organisation/decision making structures, discussed in Chapter 2, are leveraged. The modelling and configuration tools described in Chapter 3, particularly in L 15 and 16 of Table 3.8, are accentuated in this phase. Table 6.2 present a summary of requirements that influence phase 2 from Table 5.4 in chapter 5.

Table 6.2: Relevant requirement in phase 2

DESIGN REQUIREMENT	DESCRIPTION
RQ6: Agile process definition/modularisation and configuration	Represent the ability to respond to changes quickly to a given cooperative business process circumstances.
RQ11: Augment Shared workspace with Cooperative Object sharing and documentation support.	Asynchronous/synchronous information transfer. Support the realisation that cooperative business processes leads to artefacts (documents, tools) which need to be shared among project community members.
RQ18: Adaptive/Ad-hoc group formation (structure)	Support dynamic formations of groups to augment governance models and clearly defined policies.
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.5.3 Phase 3 – Implementation

This enforces the specifications established in the planning and design phase, while monitoring deviations from plans, and accounting for any problems (exceptions) that may occur adaptively. It provides concurrent access to the knowledge base, to facilitate and support ad-hoc human intervention when warranted by a situation. The implementation phase, with monitoring support, tracks event occurrences from the activity progress status, warning events on resource utilisation, and exception events where immediate action is required when things do not go according to expectations. Transitioning from the planning/design phase to the execution element, this phase predominantly relates to Chapter 5, Section 5.4.2.3. The modularisation concept (Section 2.3.7), also employed in the planning and design phase, is extended to simplify machine supported task implementation. Chapter 3, in Sections 3.2.2 and 3.2.3, highlights certain approaches that can be integrated to support runtime operations, and thus, to fulfil L15 and L16 of lessons learnt in Table 3.8 of Chapter 3. Table 6.3 present a summary of the requirements that influence phase 3 from Table 5.4 in chapter 5.

Table 6.3: Relevant requirement in phase 3

DESIGN REQUIREMENT	DESCRIPTION
RQ12: Dynamic and adaptive process composition (structured +unstructured) scheduling and execution	The ability to compose services at various levels of granularity, with event-driven and asynchronous styles of interaction that can account for various use scenarios.
RQ13: Unified service access point	Single sign on point and access to resources and attain instant visibility into the entire workflow chain via a graphical, user-friendly dashboard.
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.
RQ19: Automation and customisation	Support levels of customisation and process automation to streamline accelerate and standardise processes (e.g. complex procurement/deployment procedures).

6.5.4 Phase 4 – Assessment

This stage evaluates whether the goals and objectives, as defined in the initiation stage, were met - resulting in altered requirements, while documenting changes for future overall impact assessment. A more summative form of evaluation is stressed in this phase, which customarily occurs at the culmination of the project, although it may occasionally occur mid-term. It indicates whether a project has met its objectives, as outlined in the initiation phase, and whether it is realising the desired effects among its beneficiaries. What was promised at the initiation phase is compared with what has been accomplished, and the project impact is measured against the strategic plans agreed to at the outset of the project. Additionally, the process of execution is appraised, after an intermediate or final stage of the project has been reached. The assessment phase deals with requirements that pertain to knowledge, information and data manipulation capabilities, as emphasised in Sections 5.4.2.1-6. The knowledge management and business intelligence tools, highlighted in Sections 3.2.1.4 and 3.2.3.1, are underscored. Table 6.4 present a summary of the requirements that influence phase 4 from Table 5.4 in chapter 5.

Table 6.4: Relevant requirement in phase 4

DESIGN REQUIREMENT	DESCRIPTION
RQ4: Real-time federated data analysis and forecasting (predictive/feasibility assessment) for decision making	Facilitates decision making through streamlined analytics and forecasting
RQ10: Access control/compliance	Preserve logical autonomy, protect information integrity Clear-cut roles and responsibility domains
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.
RQ17: Support for usability with User interface adaptation	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.5.5 Secure Monitoring and Reporting

This phase represents a continuous process of collecting and analysing information, to compare how well a project is performing against expected results. As an on-going activity, it tracks the progress of the project during its lifetime. To account for dynamic changes in the environment, this component continuously tracks the activities and changes in the environment, which consequently facilitate subsequent collaboration and improvement. Therefore, the components constitute a type of formative evaluation, with the ability to provide an evaluation report, not only on completion of the project, but through continuous monitoring. This provides feedback to improve forthcoming or on-going processes. It identifies the strengths and weaknesses, as well as the target areas requiring attention, immediately addressing problems or issues. It monitors the development process closely, towards better control. The management component also takes advantage of prior summative evaluation results, aimed at improving or maximising subsequent projects. Similar to the circumstances in the assessment phase, it takes advantage of knowledge and information. The implicit cognition, emphasised in Chapter 2, Section 2.3.4, towards generating insight for decision making, maintaining and guiding the course of actions, is supplemented by Section 3.2.1.4, which also stresses the need for awareness at different level of granularity regarding collaborative support. To effectively account for coordination in the public sector, the collaboration life-cycle operation must be well supported; thus, the requirement, as described in Table 5.4, must be represented and taken into consideration. Table 6.5 present a summary of the requirements that influence phase 5 from Table 5.4 in chapter 5.

Table 6.5: Relevant requirement in phase 5

DESIGN REQUIREMENT	DESCRIPTION
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.
RQ17: Support for usability with User interface adaptation	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

Therefore, to support coordination and the move towards adhocracies to enrich collaborative work in a distributed environment, a flexible, generic and configurable base infrastructure is required. This stresses the significance of the requirement established in Chapter 5, Sections 5.4.2.7-8. A flexible, dynamic and agile virtual community-based infrastructure is accentuated, to provide highly adaptive coordination support mechanisms and tool sets, for which current technologies and infrastructures do not sufficiently cater. The envisaged virtual collaborative community infrastructure should provide standardised services, which may be tailored or customised to the coordination needs and circumstances of a specific collaborator. The primary advantage arises from its ability to use context information to provide awareness and to adapt service provision. In order to realise this concept, the subsequent section of this chapter introduces the model architecture of the envisaged platform, capable of supporting the collaboration life-cycle and the coordination needs of a distributed environment. Conceptually, this model architecture should provide functionalities to account for dynamic collaboration circumstances. It should utilise embedded knowledge and possess the capability to establish possible user circumstances towards context sensitive collaborative workflow execution of tasks. This denotes that it should reinforce the development of context-aware collaborative support applications, in consort with adaptation of the user interface and the workflow execution to a specified context at runtime. Other functionalities supported by the model architecture include, *inter alia*: communication, security, and storage services.

6.6 The Functional Scope of the Model Architecture

This section of the discourse overviews a loosely-coupled virtual community based architecture, designed to host the collaboration life-cycle operations; thereby meeting the coordination needs of a distributed environment. The approach combines and benefits from various technologies and approaches, based on certain principles, as discussed in Chapters 2 and 3. The underlying design concepts are inspired by the physical workspace, the service-oriented computing, personalisation, and publish/subscribe paradigms, in order to attain the level of support necessary to sustain and reinforce coordination in a dynamic distributed environment. The proposed model architecture firmly builds on these principles, as described in Section 6.3, which inform the model architecture design and satisfy several important identified requirements. As part of the design process, a pattern towards producing a suitable solution is employed. The architectural perspective employs general design principles, which suggest grouping common things together to effect easier understanding and management. Therefore, reflecting on the solution in that manner suggests several possible ways of considering the architecture. For convenience and logic the following choices are selected. Since only certain aspects of the virtual community deal directly with the user, such functions will be grouped under 'front end services'.

The specifics of managing the environment, fit together as management services, but two sets are distinguishable. These distinguished sets include those that deal with design and configuration aspects, grouped under 'object management and configuration' and those that deal with the more dynamic runtime aspects, grouped under the 'execution and monitoring module'. Furthermore, as certain functions are primarily central or core to the system, they are grouped under 'virtual community infrastructure services'. Essentially, the model uses a hierarchical design pattern, in which the complex whole is divided into smaller and simpler parts, aimed at reducing the complexity of the system. Figure 6.7 depicts the architecture model, with four hierarchical components, consisting of several mechanisms that will actually do the work. Each of these functions plays an equally important role in the architecture, together representing the solution to the research problem. The following sub-section introduces and motivates these components, discussed as sub-sections.

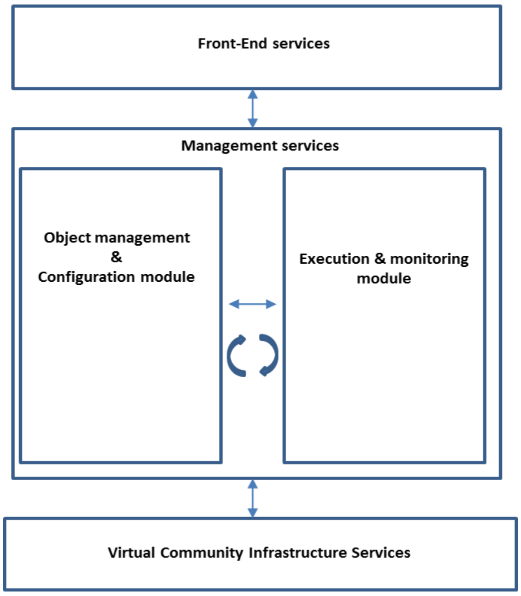


Figure 6.7: Virtual Community-Centric Coordination Model (VCCM) Support Architecture Overview

6.6.1 The Front-End Service

The Front-End Service incorporates the user interface employed to collaborate with others utilising the collaboration support services. It provides a portal service, used simultaneously to access several services. The portal aggregates service programmes as portlets, which are accessible from a single Web-based interface. It accounts for subscription and notification capabilities, as well as facilitating personalisation through content customisation. This component delineates RQ1, 2, 5, 8, 13, 14, 15, 16, 17, 18, 19 and 20. Considering the requirements RQ13 and RQ17 from Table 5.4, The **Portal** collects, organises and distributes information, representing the focal points for information and knowledge exchange. RQ5, 6 and 15 accentuate seamless tools integration, ubiquitous, modular and unified data accessibility, realisable with web portal technology. The next sub-section briefly explores the importance of the portal components, by indicating how they satisfy the requirements laid out in Table 5.4, considering certain sub- components.

6.6.1.1 Status Monitoring/Reporting

RQ1 and RQ2, RQ14 described in table 6.6 emphasise the finding of share interests, facilitating contact and reporting on environmental context. To facilitate any collaboration project, requires initially monitoring and reporting environmental changes, regarding commonalities and interests between potentially participating community members. Thereafter, relative to an established collaborative project, the monitoring and reporting are essential in ensuring that projects are implemented as efficiently and effectively as possible. The continuous process of assessing and reporting on the status of project implementation, in relation to the approved work plan and budget, is made possible by this component, allowing timeous adjustment if required.

Table 6.6: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ1: Identify/Match shared interests	Facilitates streamlined and focused collaboration
RQ2: Facilitate contact initiation	Facilitates interaction between possible collaborating entities
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.

6.6.1.2 Profile Organiser

RQ1 and 2 described in table 6.7 initially require establishing how individuals can be contacted, utilising several channels of communication to connect with potential collaborators. Several need profiles can be created, aided with context information filters. Members of interest in the community can be added, organised and categorised within several profiles to easily manage contacts and means of communication. These administrate and monitor potential member collaborators, and non-experts and specialist of interest.

Table 6.7: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ1: Identify/Match shared interests	Facilitates streamlined and focused collaboration
RQ2: Facilitate contact initiation	Facilitates interaction between possible collaborating entities

6.6.1.3 Design/Specification Tools

To mitigate poor design, based on unclear assumptions, in order to improve successful project execution, where even the best monitoring is unlikely to ensure its success, RQ, 18, 19, 20 described in table 6.8 emphasise a realties design consistent with its input, process and output. This facilitates traceability, through the systematic documentation of what is required to be accomplished or transformed. Explicit information on how activities, artefacts and resources are put together through modelling, for instance, with other means of configuration and specification employed towards a collaborative end.

Table 6.8: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ18: Adaptive/Ad-hoc group formation (structure)	Support dynamic formations of groups to augment governance models and clearly defined policies.
RQ19: Automation and customisation	Support levels of customisation and process automation to streamline accelerate and standardise processes (eg complex procurement/deployment procedures).
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.6.1.4 Visualisation Tools

RQ3, RQ 4 and RQ 14 described in table 6.9 denote access to distributed data, which is aggregately displayed as if from a central source in a meaningful way. Data visualisation tools will aid in identifying trends and patterns utilising graphs, when considering a potentially large volume of information that needs to be graphically aggregated to provide value. These tools are exploited to support evaluation and forecasting, which tracks outputs and measures contributions to results by assessing changes from established baseline conditions or metric.

Table 6.9: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ3: Components interoperability	Promoting Open systems, Technology/semantic uniformity, Agreement /standardisation towards integration among different representations
RQ4: Real-time federated data analysis and forecasting (predictive/feasibility assessment) for decision making	Facilitates decision making through streamlined analytics and forecasting
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.

6.6.2 The Object Management and Configuration Module

The Object Management and Configuration Module account for both object and activity level coordination and comprises administration and design features. These administration and design features serve to ensure that the coordination requirements of a collaborative effort, or an opportunity to collaborate, can be enforced effectively at runtime. The module serves as a source of context and provides input for the Execution and Monitoring process.

6.6.2.1 *Process Manager*

RQ, 5, 6, 8, 12, 15 and 20 described in table 6.10 denote the need to provide order to work activities over time. Using design/speciation tools it can manage and utilise both fixed and adaptive processes, to form a collaborative workflow that can benefit from dynamic composition. This, in partnership with workspaces, assists with basic *project management* activities, including task management; calendaring; workflow planning and routing; and time tracking.

Table 6.10: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ5: Seamless semantic/process/tools integration	Facilitates ubiquitous accessibility of data and transcends beyond problems with exchanging data between applications to semantic integration of understanding those data.
RQ6: Agile process definition/modularisation and configuration	Represent the ability to respond to changes quickly to a given cooperative business process circumstances.
RQ8: Support autonomy and loose coupling	Support jurisdictional constraints and desirable preferential connections.
RQ12: Dynamic and adaptive process composition (structured +unstructured) scheduling and execution	The ability to compose services at various levels of granularity, with event-driven and asynchronous styles of interaction that can account for various use scenarios
RQ15: Flexibly/Scalable/extensible/reusable/ distributable	Accounting for a greater degree of variability to support varying scenarios regardless of context + individual participation in shared processes regardless of location using smart endpoints.
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.6.2.2 *The Community Manager*

The community manager reflects RQ1, 10, 15 and 18, described in table 6.11 to provide support for the management of users and groups, their registration, profiling and preference specifications. In relation to workspace, it supports Team Definition; the User Profiles of participants; Social Presence Management; Contact Management; and access control definition.

Table 6.11: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ1: Identify/Match shared interests	Facilitates streamlined and focused collaboration
RQ10: Access control/compliance	Preserve logical autonomy, protect information integrity Clear-cut roles and responsibility domains
RQ15:Flexibly/Scalable/extensible/reusable/ distributable	Accounting for a greater degree of variability to support varying scenarios regardless of context + individual participation in shared processes regardless of location using smart endpoints.
RQ18: Adaptive/Ad-hoc group formation (structure)	Support dynamic formations of groups to augment governance models and clearly defined policies.

6.6.2.3 *The Workspace Manager*

The workspace manager supports RQ 6, 7, 8, 11, 17 and 20 described in table 6.12, which essentially suggest the administration, configuration, distribution and monitoring of work. It manages the virtual office space; supports the co-creation of goals in real-time or asynchronously; facilitates consensus building through group discussions and polling; while uploading and sharing files. It accommodates a wide variety of activities and behaviours that are not predefined, but can be considered as unique cases unfold.

Table 6.12: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ6: Agile process definition/modularisation and configuration	Represent the ability to respond to changes quickly to a given cooperative business process circumstances.
RQ7: Spontaneous communication	Support synchronous/asynchronous discussions and negotiation
RQ8: Support autonomy and loose coupling	Support jurisdictional constraints and desirable preferential connections.
RQ11: Augment Shared workspace with Cooperative Object sharing and documentation support.	Asynchronous/synchronous information transfer. Support the realisation that cooperative business processes leads to artefacts (documents, tools) which need to be shared among project community members.
RQ17: Support for usability with User interface adaptation	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.6.2.4 The Resource Manager

The resource manager denotes RQ4, 5, 17 18 and 20, described in table 6.13 by improving operational efficiency; knowledge optimisation; and improvement. It provides data aggregation and virtualisation capabilities that facilitate new methods of searching, correlating and analysing data from various sources, while taking cognisance of existing resources, their configurations, versions and availability to support decision making.

Table 6.13: Relevant requirement, extract from table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ4: Real-time federated data analysis and forecasting (predictive/feasibility assessment) for decision making	Facilitates decision making through streamlined analytics and forecasting
RQ5: Seamless semantic/process/tools integration	Facilitates ubiquitous accessibility of data and transcends beyond problems with exchanging data between applications to semantic integration of understanding those data.
RQ17: Support for usability with User interface adaptation	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.
RQ18: Adaptive/Ad-hoc group formation (structure)	Support dynamic formations of groups to augment governance models and clearly defined policies.
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.6.3 The Execution and Monitoring Module

The Execution and Monitoring Module comprises runtime enforcement service characteristics. It receives input from the Object Management and Configuration Module, for instance, serving as context sources. It handles context information, in conjunction with managing action invocation and personalised notification and recommendations to applications or users. The module is responsible for shared workspace, as well as the social and task awareness that informs participants as to the state of affairs, founded on specified policies. It comprises the context manager; the awareness and recommendation manager; and the runtime manager, who work together, undertaking decisions on actions to be executed and/or whether to send notifications to participants.

6.6.3.1 The Context Manager

The context manager manages context based information to support RQ1, 2, 9, 11, 12, 14, 16, 17, 18 and 19 described in table 6.14. Thus, it facilities the shared interest matching of collaborators, artefacts and tools, to populate a shared workspace, enable awareness based operation, communication and process instance definition. In addition, it enables streamlined subscription and personalised notifications/recommendations, to prevent information overload and unnecessary intrusion through customised service provision.

Table 6.14: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ1: Identify/Match shared interests	Facilitates streamlined and focused collaboration
RQ2: Facilitate contact initiation	Facilitates interaction between possible collaborating entities
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ11: Augment Shared workspace with Cooperative Object sharing and documentation support.	Asynchronous/synchronous information transfer. Support the realisation that cooperative business processes leads to artefacts (documents, tools) which need to be shared among project community members.
RQ12: Dynamic and adaptive process composition (structured +unstructured) scheduling and execution	The ability to compose services at various levels of granularity, with event-driven and asynchronous styles of interaction that can account for various use scenarios
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.
RQ16:Knowledge base support, Content management (Smart Archiving/Knowledge sharing)	Managing and storing information, tailoring of content and advertising to a user's specific characteristics based on user information + support and augment, repository with semantic/ontology based indexing, search and retrieval features.
RQ17: Support for usability with User interface adaptation	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.
RQ18: Adaptive/Ad-hoc group formation (structure)	Support dynamic formations of groups to augment governance models and clearly defined policies.
RQ19: Automation and customisation	Support levels of customisation and process automation to streamline accelerate and standardise processes (eg complex procurement/deployment procedures).

6.6.3.2 The Runtime Manager

The runtime manager function coordinates actions and provides awareness information in a shared workspace, while executing multiple process instances, representing RQ6, 9 and 20 described in table 6.15. It manages sessions and support service invocation, composition, personalisation and scheduling. It essentially orchestrates the actions of other components.

Table 6.15: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ6: Agile process definition/modularisation and configuration	Represent the ability to respond to changes quickly to a given cooperative business process circumstances.
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ20: Dynamic object administration, tracking and configuration	The ability to design and document goals and administer objects through specifications, monitoring and evaluation, and rules to guide behaviour.

6.6.3.3 The Recommender/Awareness Service Manager

The recommender and awareness service manager provides personalised notification and recommendations services, accounting for RQ1, 2, 9, 14 and 16 described in table 6.16. Opportunities for collaboration are identified and recommended, with progress continually monitored during execution. Additionally, it accentuates streamlined information diffusion and content management.

Table 6.16: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ1: Identify/Match shared interests	Facilitates streamlined and focused collaboration
RQ2: Facilitate contact initiation	Facilitates interaction between possible collaborating entities
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.
RQ16:Knowledge base support, Content management (Smart Archiving/Knowledge sharing)	Managing and storing information, tailoring of content and advertising to a user's specific characteristics based on user information + support and augment, repository with semantic/ontology based indexing, search and retrieval features.

6.6.4 The Virtual Community Infrastructure Service

The Virtual Community Infrastructure Service function accounts for loosely coupled integration and communication between interacting components and applications. It employs a service-oriented computing pattern to seamlessly integrate collaborative service applications. The need for ontologies is emphasised, to ensure that applications can understand and interpret the information they access. This transcends simple system interoperation to semantic integration, in order for disparate systems to be able to gain and maintain the same understanding of any particular set of data or its representation. The virtual infrastructure advocates the use of ontologies to achieve interoperability at the semantic/process level, in pursuit of seamless data integration. This level is targeted towards accounting for data, process, application/portal and sematic level integration. The level adopts a service-oriented computing model to seamlessly integrate applications and share or reuse generic applications. Furthermore, the infrastructure advocates the publish/subscribe communication paradigm - a message-oriented middleware that promises synchronisation between users. The sub-component of this intermediary service is discussed in the sub-sections.

6.6.4.1 The Communication Component

The communication component facilitates real-time and asynchronous text, voice, and video communication, based on context. In addition, it supports query/notification management services, denoting RQ 2, 7, 9 11 and 16 described in table 6.17.

Table 6.17: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ2: Facilitate contact initiation	Facilitates interaction between possible collaborating entities
RQ7: Spontaneous communication	Support synchronous/asynchronous discussions and negotiation
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ11: Augment Shared workspace with Cooperative Object sharing and documentation support.	Asynchronous/synchronous information transfer. Support the realisation that cooperative business processes leads to artefacts (documents, tools) which need to be shared among project community members.
RQ16:Knowledge base support, Content management (Smart Archiving/Knowledge sharing)	Managing and storing information, tailoring of content and advertising to a user's specific characteristics based on user information + support and augment, repository with semantic/ontology based indexing, search and retrieval features.

6.6.4.2 The Integration Broker

The integration broker facilitates the dynamic process, application, data, and infrastructure integration services. It promotes an open system by facilitating interoperability at different levels of granularity**.** It emphasises registration**,** discovery and dynamic service composition, accounting for RQ3, 5, 8, 12, 15, 16 and 17 described in table 6.18.

Table 6.18: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ3: Components interoperability	Promoting Open systems, Technology/semantic uniformity, Agreement /standardisation towards integration among different representations
RQ5: Seamless semantic/process/tools integration	Facilitates ubiquitous accessibility of data and transcends beyond problems with exchanging data between applications to semantic integration of understanding those data.
RQ8: Support autonomy and loose coupling	Support jurisdictional constraints and desirable preferential connections.
RQ12: Dynamic and adaptive process composition (structured +unstructured) scheduling and execution	The ability to compose services at various levels of granularity, with event-driven and asynchronous styles of interaction that can account for various use scenarios
RQ15: Flexibly/Scalable/extensible/reusable/ distributable	Accounting for a greater degree of variability to support varying scenarios regardless of context + individual participation in shared processes regardless of location using smart endpoints.
RQ16:Knowledge base support, Content management (Smart Archiving/Knowledge sharing)	Managing and storing information, tailoring of content and advertising to a user's specific characteristics based on user information + support and augment, repository with semantic/ontology based indexing, search and retrieval features.
RQ17: Support for usability with User interface adaptation	Allow user interfaces to adapt to various contexts and thereby enabling a flexible and multi-purpose environment.

6.6.4.3 Repositories

Repositories represent accessible**,** scalable, flexible service and context information storage services. This tier employs the use of ontologies to achieve deeper interoperability integration, from the data to the process level. It focuses on the use of ontology to solve issues of semantic heterogeneity, providing a rich, predefined vocabulary; thus enabling interoperability and representing RQ3, 4, 5, 15 and 16 described in table 6.19.

Table 6.19: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ3: Components interoperability	Promoting Open systems, Technology/semantic uniformity, Agreement /standardisation towards integration among different representations
RQ4: Real-time federated data analysis and forecasting (predictive/feasibility assessment) for decision making	Facilitates decision making through streamlined analytics and forecasting
RQ5: Seamless semantic/process/tools integration	Facilitates ubiquitous accessibility of data and transcends beyond problems with exchanging data between applications to semantic integration of understanding those data.
RQ15: Flexibly/Scalable/extensible/reusable/ distributable	Accounting for a greater degree of variability to support varying scenarios regardless of context + individual participation in shared processes regardless of location using smart endpoints.
RQ16:Knowledge base support, Content management (Smart Archiving/Knowledge sharing)	Managing and storing information, tailoring of content and advertising to a user's specific characteristics based on user information + support and augment, repository with semantic/ontology based indexing, search and retrieval features.

6.6.4.4 **The Security Component**

The security module is employed for access control and authentication purposes. It accounts for access to common information spaces, whether central or distributed, along with work space tools or resources. It is intended to preserve logical autonomy, ensure clear cut roles, responsibility, streamlined service provision and general compliance to policies, underscoring RQ4, 8, 9, 10 and 14 described in table 6.20.

Table 6.20: Relevant requirement, extract from Table 5.4

DESIGN REQUIREMENT	DESCRIPTION
RQ4: Real-time federated data analysis and forecasting (predictive/feasibility assessment) for decision making	Facilitates decision making through streamlined analytics and forecasting
RQ8: Support autonomy and loose coupling	Support jurisdictional constraints and desirable preferential connections.
RQ9: Subscription/ Personalised notification and recommendation	Prevent information overload through tailored and streamlined service provision
RQ10: Access control/compliance	Preserve logical autonomy, protect information integrity Clear-cut roles and responsibility domains
RQ14: Information diffusion, Context awareness and reporting	From organisational mindfulness, to taking cognisant of objects and their state of affairs in terms of teams and their subsequent activities, resource, and schedules among others, towards informed proactive behaviour.

The proposed model architecture assumes that by providing a flexible and agile infrastructure, enhanced by context-aware middleware services, through a one-stop access point (portal), will allow the realisation of coordination benefits. The model architecture encompasses a flexible infrastructure that hosts modular component services, which should interoperate to provide a seamless coordination support service. A detailed depiction of how the components fit together is provided in Figure 6.8.

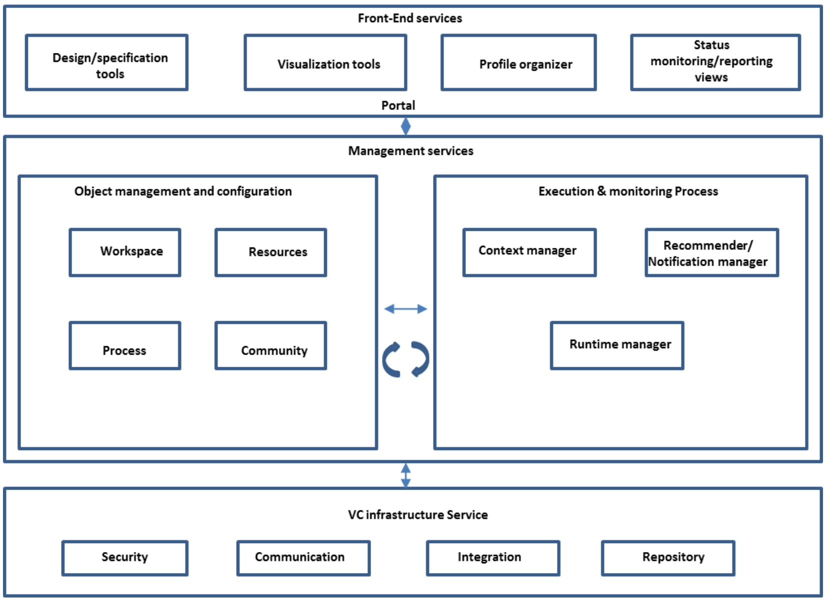
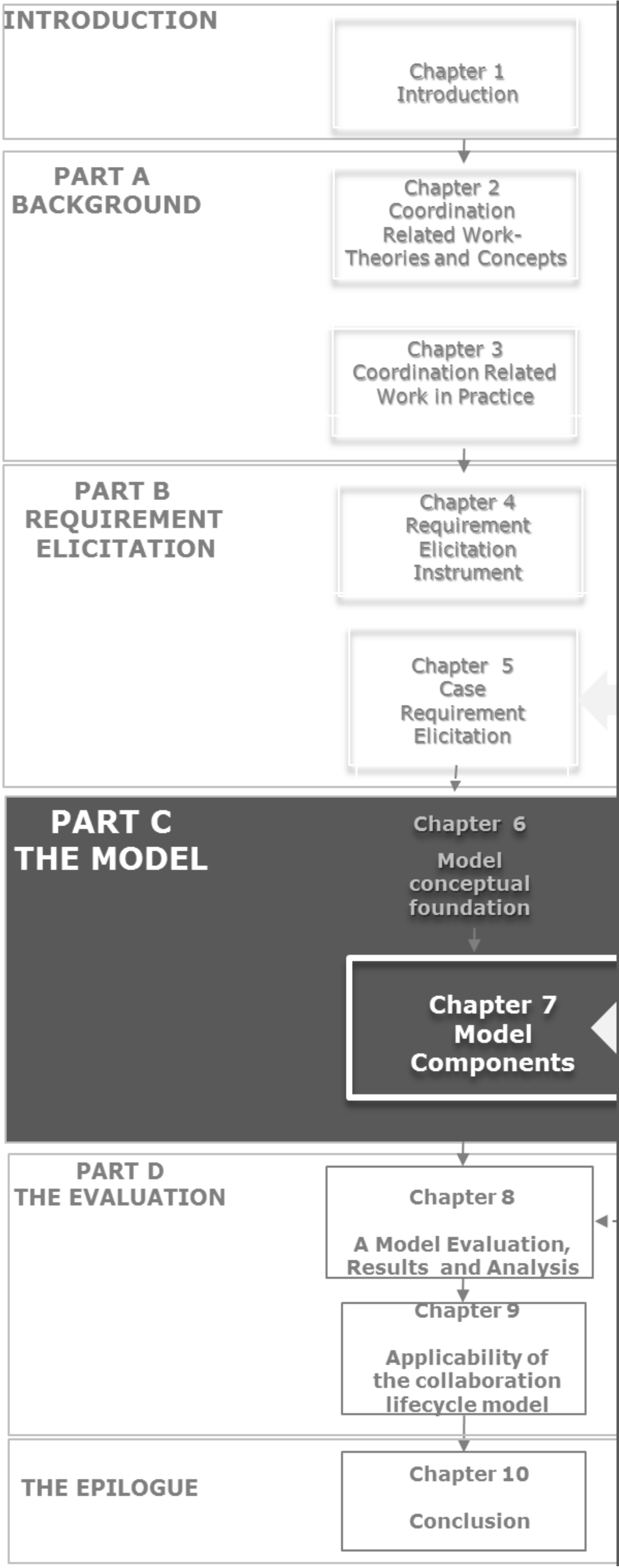


Figure 6.8: Model Architecture Summary

6.7 Conclusion

The preceding information in this chapter provided a conceptual overview of a prescriptive model, proposed as a solution to the research problem. It presented a high-level look at the fundamental functions of the model, as well as its constructs and their relationships, providing the necessary insight and situational milieu for full comprehension and understanding of the subsequent chapters. The following chapters will define each of the fundamental functions in more detail, providing a detailed, comprehensive and complete view of the model.



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CHAPTER 7

THE MODEL COMPONENTS

The previous chapter provided a conceptual overview of the proposed solution. It was established that a virtual collaborative environment is crucial for coordination support in a distributed environment. This is primarily because the distance between collaborators means difficulties in coordination, resulting in inadequate project outcomes making the use of technology to bridge this gap essential. The integration and amalgamation of various collaborative tools allows distributed stakeholders to collaborate, coordinate and communicate efficiently on projects. The primary purpose of this chapter is to illustrate and detail comprehensively the features and the underpinning technology of a collaborative platform, which has been designed to facilitate effective coordination between collaborators. The platform unites diverse resources; facilitates semantic interoperability; and, through context-awareness, supports the adaption and integration of features and services to a wide range of circumstances. As previously established, coordination in a collaborative distributed environment requires an electronic community integrated with several complementary services. An overview of the model architecture towards the development of a platform intended to provide coordination support in a distributed environment has been presented in the previous chapter. This chapter supplies a comprehensive overview of the high level capabilities of the model components in terms of the high level specifications, therefore answering the question: *What are the service capabilities that need to be considered when addressing the problem of coordination in distributed environment?*

The answer provided in this chapter assumes a basic understanding of IT technologies. However, in the case of less common technologies, some cross references will be provided for further reading should the reader require additional background. The initial portion of the chapter relates to the model architectural components, succeeded by a consideration of collaboration lifecycle components from an awareness perspective. The following section begins by reviewing the base layer of the proposed architecture.

7.1 Virtual Community Infrastructure Services

The VC infrastructure service requires that security, communications, integrations and repository services are in place. Thus, this section focuses on what is required of these concepts to design a support solution. Figure 7.1 provides a catalogue of the components.

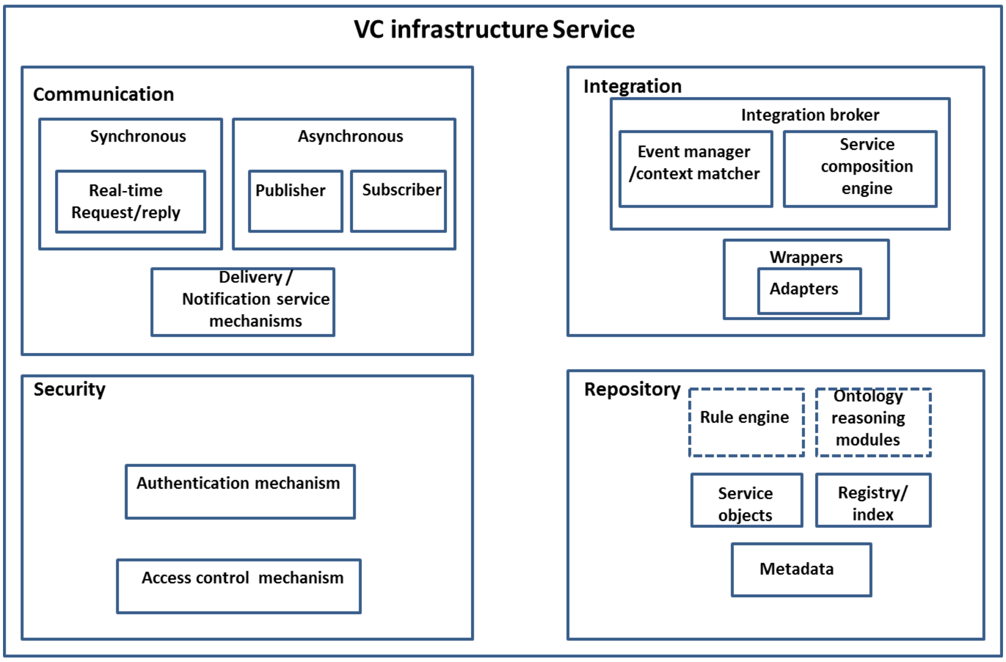


Figure 7.1: Virtual Community Infrastructure Services

7.1.1 Communication Services

The disparate nature of the environment, together with the number of people involved, all potentially with different needs, motivates the need for more flexible communication models and systems. The communication component therefore must reflect the dynamic and decoupled nature of the environment, as opposed to the usual point-to-point communications styles.

Chapter 3 illustrated how a point-to-point style leads to static applications reliant on the user to manage the content, thereby making support for a dynamic and large scale environment cumbersome. This suggests that a flexible, loosely coupled communication model, which subscribes to a publish-subscribe paradigm, is indicated. This loosely coupled form of interaction allows subscribers to register their interest in a topic or pattern of events and then receive notification of events matching their interest asynchronously, regardless of the publisher of the event. A broker, known as a notification manager, is necessary as an intermediary between the subscribers and the publishers, to manage subscriptions, and to match events against a large number of subscribers, in order to ensure efficient distribution. Additionally, the system should support both push- and pull-based mechanisms, allowing users to select their preferred means of interaction.

To promote personalisation and to prevent unnecessary overload, the scalable event-notification service should allow publishers to publish events that they want others to be aware of, as well as to permit interested subscribers to connect and establish subscription specifications pertaining to the set of messages that they are interested in receiving. Matching should be accomplished based on the query or predicate issued by subscribers and notifications delivered to a subscriber by invoking the notifiable interface(s) (synchronous or asynchronous notification mechanism) of a subscriber as specified during subscription, to ensure efficient and meaningful distribution. By taking advantage of context, synchronous (telephony, chat, sms) and asynchronous (mail, newsgroups, forums) communication can be leveraged. Table 7.1 indicates the concepts that underlie the model specification, relative to the communication component, from a general baseline.

Table 7.1: Communication Component Specifications

CATEGORY	MODEL SPECIFICATION
Interaction style	Dynamic/mediated
Participation	Shared interest + Subscription based
Coupling	Flexible/loosely coupled interaction
Delivery system	Context based and personalised
Delivery mechanisms	Callable services

As communication and interaction between collaborating entities is crucial to avoid misunderstanding and mismatches, it should be possible to select the appropriate means across various channels for several activities.

7.1.2 The Integration Broker

Meaningful interactions between the various stakeholders regarding integration require true interoperability extending beyond the mere exchange of information. The objective is for the interoperating systems to be capable of performing useful actions based on what has been exchanged. The primary aim should be the achievement of process level interoperability, to enable the integration of business processes and workflows beyond the boundaries of a single organisation. This should be in addition to enabling different systems to exchange data in a meaningful way, while allowing the systems to make changes to the data in a manner that is consistent and understandable to other interoperating systems without undesirable effects.

While technical and syntactic interoperability enable successful exchange of data between two systems, an understanding of exchanged data is not possible without semantic interoperability, which results in the predefined and shared meaning of terms and expressions. Systems that supports semantic interoperability are implicitly interoperable both technically and syntactically (Obrst, 2003; Epinoza, et al., 2011). Therefore, these integration levels need to be accounted for. As traditional integration has frequently been limited and is usually tightly coupled, this research employs a loosely coupled approach, considering the dynamic and widely distributed nature of the players involved. This is in addition to the level of interoperability required which is at the process level. Thus, to achieve the level of integration necessary, the architecture advocates a service oriented computing and ontological representation. This supports meta-level service descriptions, using dynamically callable service interfaces, which hide unique implementation and are understandable and interpretable, in order to provide a required service. This element will be highlighted further in the section pertaining to the repository.

Additional components required to support the integration broker include: the service registry, providing lookup services as it handles service registration and discovery, which can integrate public services via registration mechanisms; and the event manager/context matcher, for managing event conditions, matching services and providing support for the composition engine. Thus, it controls and manages the composition of services and allows the adaptive orchestration and automated execution of business processes. A service-based approach will permit the integration of existing systems, applications and users into a flexible architecture, which can accommodate changing needs easily, thereby enabling loosely coupled and asynchronous communication between distributed applications or systems.
Collaborative business processes are dynamic in nature, owing to changes in policies, rules, partners, and events. This motivates the requirement for an event-driven, service-oriented platform to model, compose and execute these fluctuations and variances. By employing open standard protocols, in conjunction with a service registry to register and discover a service, interoperability and integration can be realised and existing resource packages may be linked effortlessly. Additionally, as many partner solutions and packages can be combined, the creation of a large variety of systems is simplified and uncomplicated.

Essentially, service components should additionally provide access to existing applications or legacy applications and varied data sources, by wrapping them (adapters) and exposing them as services. This facilitates the re-use of existing applications in a service-oriented manner. As highlighted in Chapter 3 a service-oriented approach presents a route which, through using services as building blocks, facilitates the construction and integration of distributed heterogeneous applications.

The integration component advocates the use of ontologies in order to model and reason effectively regarding the environment and the entities within, while providing context-aware adaptation. Ontologies offer great potential in supporting personalised and contextualised reasoning. The indexing of services in the service directory should be based on the domain and context ontology to facilitate faster service retrieval at runtime. A context based index enables service discovery within a service directory, based on contextual attributes. The context based approach therefore has the capacity to complement the standard search mechanisms, including searches undertaken by the organisation or service category, as provided by directory specifications. Table 7.2 indicates the concepts that underlie the model specification, relative to the integration component, from a general baseline.

Table 7.2: Integration Specifications

CATEGORY	MODEL SPECIFICATION
Level of integration	Process level integration
Integration coupling	Loosely coupled
Indexing	Domain and context ontology driven
Standard and composition style	Open and service oriented

The research advocates the use of ontologies in order to effectively model and reason about the environment and entities within, while providing context-aware adaptation. Ontologies offer great potential in supporting personalised and contextualised reasoning across distributed entities as they can represent and facilitate semantic interoperability and the integration of domain knowledge.

7.1.3 Repository

The repository should be able to handle distributed sources, provide aggregation views and storage, and support distributed inference from data sources. Owing to different data representation in the environment, an interpreter should be callable anywhere in a distributed environment, leveraged by some ontological representation to support translation between formats.

The repository, utilising services based calls, should provide features to manage the metadata required to create, maintain and control views and data services in a distributed environment. Following a service model permits a specific service operations metadata to be wrapped and made explicit in a callable service interface, to be used by a client to form a request. A call is made to a source (data or application), execution is realised and relevant results are returned, without knowledge of the implementation at destination. Thus, relative to data sources, persistent connection will be localised to prevent unnecessary overhead.

Essentially, an interpreter should use meta-ontological information to decipher what is required for a query in order to produce useful results. For example, an ontological representation of context and domain models should assist in responding to a query, for instance “training intervention in Eastern Cape”, and to be able to comprehend immediately if it reflects those in municipalities in a specified location radius that capture the Eastern Cape. The reasoner should have the capability to negate ambiguities in high-level requests, reducing them to lower level query requests. For instance, in a search for Microsoft Word training, the request may be interpreted as looking for short-term capacity training information or services in the capacity building context.

Chapter 3 demonstrated that organisations utilise different database management systems to store and to search their critical data. Relative to heterogeneity, data integration is concerned with unifying data that share some common semantics, but that originate from unrelated sources. In the distributed environment, ways of representing the information in different fashions, translating it to another and aggregating it in a presentable and meaningful way is necessary to achieving coordination. Therefore, the approach employed in the research is a services and context based approach to handle, inter alia, physically distributed sources and the reliance on flat-files to support aggregation necessary to support decision making.

Generally, information repositories serving as knowledge bases provide a means for data to be collected, organised, shared, searched and utilised. The material may be either machine-readable or intended for human use. A knowledge based system should be designed as part of the platform in order to support integration, interoperability and usability. In this case the repository should contain an ontology component to achieve semantic interoperability for mapping the connotations. Ontologies should be employed to facilitate semantic integration where conflicts occur, when information items appear to have the same meaning, but differ in reality, or in instances of naming conflict, when the nomenclature or designation of information schemes differ significantly, but are represented as the same. To negate issues of insolvability in data standardisation and modelling, the use or development of ontologies should be considered.

To contextualize effectively, repositories should provide basic storage services, in a scalable and reliable fashion. The reasoning engine should comprise a collection of various pluggable reasoning modules, to manage, process and control the facts present in the repository, as well as to enable the production of composite contexts. It is required to be extensible, to permit the connection and linkage of various, diverse ontology reasoners.

Besides content, data repositories may store and retail service such as context ontologies, service directories and user profiles, among others. Thus, a meta-level description of data or applications wrapped in a standard service interface and registered to be callable anywhere, at any time is advocated. Service ontology can present service profiles that describe the wish of the functionality services to provide a community to support dynamic requests. Following the use of context models in ubiquitous computing, and the semantic web, ontology provides the vocabulary to represent the knowledge of a domain, and descriptions of specific situations in the domain.

Therefore, a context model is necessary to provide users with an appropriate means to describe context information. Furthermore, it is required to allow infrastructure, applications, and external or third party service providers to be in agreement, regarding the syntax and semantics of context information. This enables interoperation, in conjunction with affording context processing components with proper channels for conducting context information reasoning. Through reasoning, a multitude of high-level, implicit contexts can be derived from low-level, explicit contexts. Table 7.3 indicates the concepts that underlie the model specification, relative to the repository component, from a general baseline.

Table 7.3: Repository Specifications

CATEGORY	MODEL SPECIFICATION
Storage	Context/Service indexed metadata registry
Meta-level descriptions	Service interface descriptions
Interpreter	Modular callable service reasoners
Information modelling/ Representation	Context based ontological representation
Interoperability	Semantic level

7.1.4 Security

Information dissemination and access across distinct authoritative domains, heterogeneous platforms and a large, dynamic population of publishers and subscribers raise new security concerns. This component considers security such as access control and authentication at the most basic level to help preserve the jurisdictional autonomy. What is more, since subscribers may be anonymous at initiation, content should be authenticated. The capabilities to regulate who can perform operations on resources should be provided by authenticating users and enforcing user and group privileges to support and facilitate control and accountability.

Collaborative environments need to be designed to facilitate groups of people, from a diverse set of organisations and locations, working together easily and securely. Users require straightforward, simple and secure routes to represent, identify and distinguish themselves to the other collaborating users and resources. The security component focuses on the community and access control relating to information sharing. Considering the autonomic nature of the environment, services should ensure that the relevant information is discernible and available, while taking cognisance of the security. When sharing information in virtual communities, accessibility should be subject to restrictions, which provide parameters that outline and limit who may retrieve data.

Distributed access control can be realised within a virtual community comprising multiple information providers, through demarcating individual and local access-control systems, supplying retrieval and visibility regarding their documents and regional policies. However, universal community policies should regulate these local policies indicating that there is a requirement for a rational, workable balance or equilibrium between global versus local control in virtual communities.

The autonomy of collaborators is thus ensured by imposing exclusions and permission parameters on access to the knowledge base. Participants should not be required to cede their autonomy. An institution can maintain its own security infrastructure, to identify its users and to protect its resources. The rules of policies for secure knowledge management should not only concern the limitations of access prohibitions or permissions, but should also pertain to which regulations providers are obliged to enforce. Resource providers are, therefore, not forced, but motivated by the global authority to behave as required.

A typical collaborative work platform for virtual teams or groups should cater for several, diverse account types to provide flexibility and security across organisational boundaries. To establish trust and confidence, a secure collaborative environment needs to supply mechanisms for authentication (identity of participant), authorisation (privileges of participant), privacy (access control for and encryption of sensitive data), and data integrity. While there are multiple tools that can be applied to the task of securing collaborative environments to maximize data protection, a combination of mechanisms can be employed to provide secure collaboration. The extent of the security measures imposed must be defined and based on the requirement of a given project or task, as warranted by the circumstances. Table 7.4 indicates the concepts that underlie the model specification, relative to the security component, from a general baseline

Table 7.4: Security Requirements

GENERAL	MODEL-SPECIFIC
Access control	Community and remote access control
Authentication	User/ service level
Privileges	Design/runtime resource access and execution permissions
Access management	Design: User/groups/roles and profiles specification
Specifications	Global policies based
Integrity	Data/service level

7.2 Management Services: The Object Management Service Module

The object management service and execution layer provides the functionalities to manage collaboration service objects, from their specification to their execution. These service objects include, *inter alia*, the process composition and configuration, user, community, resource, and context managers. Figure 7.2 presents the object management service components, in association with how they relate to and support each other. The objects observed in this module are conceived of as entities that can be observed and manipulated to achieve an objective. As context does not exist on its own, the 'object management and configuration' module of the model focuses on the context entities which influence on coordination support. This denotes effectively that the 'object management and configuration' component provides administrative and design guidance. The objects represented in the module are context sources. The entities serve as the providers and consumers of context information.

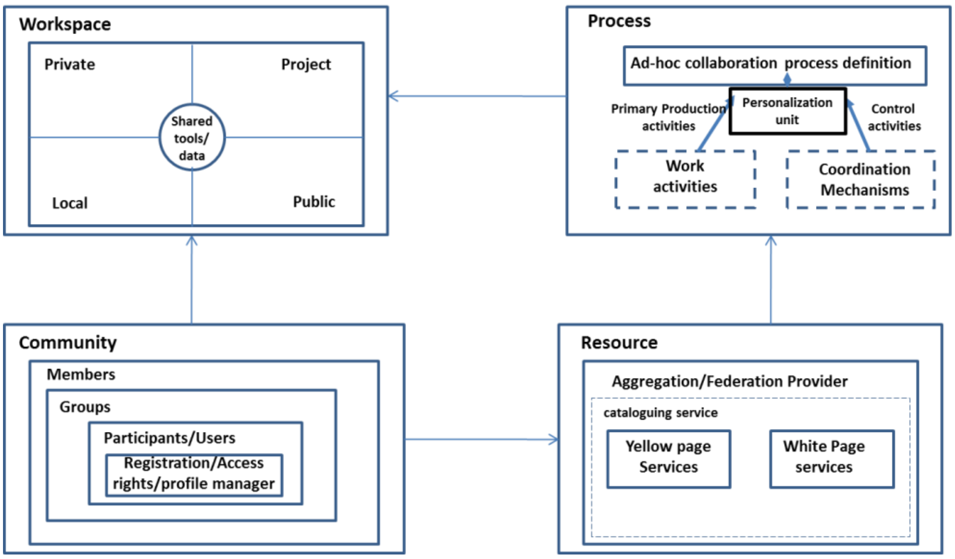


Figure 7.2: Object Management Service Components

The behaviour of the objects, based on certain circumstances at runtime, is determined in the module. To ensure that context and personalisation requirements are enforced effectively at runtime the design time models the information to be used in the service provision. The modelling of services, the environment, tasks, rules and users are achieved in the module. For instance, a business context model would identify the actors (people, organisations, systems) who will assume a significant role in the business process or domain, taking into account the scope of the work. Furthermore, since personalisation relates to defining services to better fit the user, by focusing, *inter alia*, on the user needs, interests, preferences, workloads, expertise, and task recommendations for services, it is also supported. Arising from the multiple potential activities and interests in which a user might be involved, the current or pertinent activity of the user has to be taken into account, to avoid irrelevant recommendations.

Subscribers should be able to define the characteristics of content that are of interest to them, in order to receive notifications when such content becomes available. Stated differently, users should be capable of specifying settings regarding how a particular application should behave in a given situation. The components required in realising personalisation incorporate user profiles (where preferences are stored) and personalisation rules that match user attributes and content.

Generating a situation based profile (contextual profile) through a process of contextualisation (mapping user preferences to a given context) can provide better defined and more specific or apposite recommendations. The recommender may utilise, as input, the contextual profile and circumstances of the current user to produce a listing of context-based recommendations. Therefore, to provide relevant and precise notifications about certain objects for management in the module, generating the awareness specific for the objects is critical. Fundamentally, the awareness specification in this module would indicate the need to profile a given object (user, process, workspace, or resource, etc.) to provide notification requirements or criteria or instantiation. The subsequent divisions provide a detailed review of the entities that provide administrative, design and configuration services to support collaborative and coordination efforts in a distributed environment. The awareness specification constitutes the profiling segment for all objects, which are represented in Figure 7.3. The setting up of user profiles, based on specified preferences and context information, affords the achievement of personalisation at runtime.

Similarly, the configuration templates should reflect how a shared work space should be presented, with the relevant tools at runtime. User profiles are utilised to share standard information pertaining to participants, to the context-ware machinery, allowing agents to offer user-personalised content and services. For example, a recommender system, based on a specified user preference, can provide several context based profiles as needs and service requirements can change according to certain contexts. Thus, by analysing all profiles in a specified context, an active profile can be generated where, combined with the stipulated context and in consort with the profiles of other participants, service recommendations can be personalised, with corresponding notifications.

The output of this section encompasses, *inter* alia, the personalisation model for workspace service loads at runtime, the user model for personalised feedback, and process aware event models.

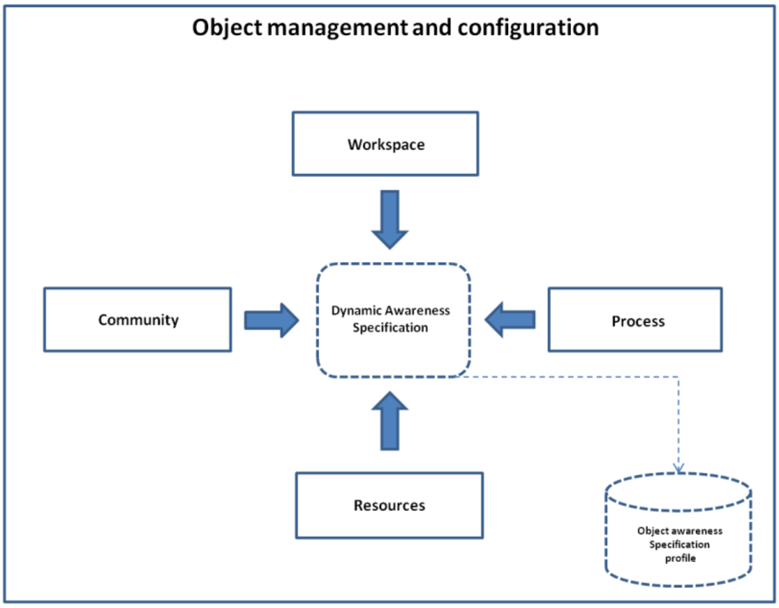


Figure 7.3:Object Awareness Specifications

7.2.1 Workspace

Virtual communities enable users to construct a shared space, which facilitates interaction and sharing. In addition, the development of expertise, instruction and learning to be shared results in greater, more comprehensive and detailed individual and collective knowledge. It is essential that there is a repository of knowledge supporting the activities performed by the members of a virtual community, the structure of which provides an interface to stored objects. Repositories manage services and their artefacts. A workspace helps to setup a coordinated work situation for collaboration.

It constitutes an online attempt or approximation of a physical, co-located shared office or location. Workspaces provide the management capability for data or tool sharing as highlighted in Chapter 3. The implications thereof include: in addition to data storage, object-based access control, versioning, and concurrency control**.** It may rely on the resource manager for access to certain supporting shared object(s). A workspace also integrates the tools for users, in conjunction with organising a structure for storage, in order to facilitate the retrieval of elements in context. The shared workspace, it is emphasised, should provide the ability to share documents both in real-time and offline to account for work flexibility. To transcend distance barrier, members with shared interests should be invited to discussions, while enabling problem solving, structuring and the configuration of teams or tasks. Fundamentally, a workspace should allow the creation of groups with the right tools and specifications to support diverse and varied activities.

Essentially, an envisaged shared workspace provides a virtual place to work, the tools for performing the work, and channels for communication for its inhabitants. Additionally, a shared workspace should not compromise flexibility in the support that it provides, as it can be used for a variety of tasks. A workspace should provide integration capabilities to accommodate relevant tools (like task lists and calendars), hold discussions, share documents and generate reports as the need arises. The system should offer as much flexibility as possible to team members, in order for them to perform whatever actions are deemed necessary to achieve a particular goal in compliance with agreed rules, of course. The envisaged workspace should be designed to be adaptable and customizable to meet given requirements. The creation of a new workspace affords the opportunity to define which tools are required and suitable for a specific situation. In addition, access to the workspace can be controlled, to ensure that data is visible or retrievable only by those who are authorised, appropriate or approved, with the capacity to invite external or additional guests to share the workspace.

Different workspaces can be created to cover the diverse needs of certain tasks. This form of structural capability corresponds with the modular and hierarchal structure of work highlighted in Chapters 2 and 3. Every community member or user may have a private workspace, which will contain the objects of that user, as well as any other relevant information. A user may belong to one or more groups. The private group workspace, accessible only to the members of the group, provides a location for them to share objects, tasks, tools and the results of their common work. The common workspace is the referential *directory*, which contains all the objects shared in a given project. (Multiple workspaces can exist at the same time to handle the composite of several reusable tools for several tasks. A service based approach as described in Section 7.1.2 is employed for the integration purposes in this section as well. Table 7.5 indicates the concepts that underlie the model specification, relative to the workspace component, from a general baseline.

Table 7.5: Workspace Component Specifications

CATEGORY	MODEL SPECIFICATIONS
Shared workspace configuration	Adaptive
Interaction style	Context based/standard models
Specification	Goal oriented
Members	Project specific
Security	User/artefact access control

7.2.2 Community Manager

The community manager service should provide certain functions, which incorporate the registration of new members, managing member profiles, and their roles. It further comprises the functionalities required to create, join, access and search sub-communities, and to publish, get and subscribe to information in existing sub-communities. A community consists of users who have profiles and preferences and who may be members of groups based on interests or projects. The community perspective considers the user, roles and group concepts as the composition of a community. Possible collaborators can be identified and reached via the concept of a community, which is easily transformed into various cooperative groups with shared goals, as a type of project group. The community concept facilitates the building of teams for specific purposes and tasks, as the basis for distributed collaboration. Participants and artefacts are connected in communities and can share their information in a peer-to-peer style.

Managing the community and its users includes the setup or partitioning and configuration of community leaders, members and partners. Furthermore, it entails the addition to or removal of participants from a community; granting participants specific access rights to resources; and defining their responsibilities. A community is intended to provide tools to support groups in the sharing and exchanging of information. The introduction of support for awareness into the community establishes a medium for initiating contact with unknown collaborators with similar interests and preferences. The overall interest of the community is becoming cognisant rapidly of predominant personal interests; allowing various interest groups to emerge in order to solve situational problems. The formation of groups creates a medium for contacting and interacting with known collaborators to achieve a mutual objective. If several groups are cooperating, *boundary spanners* can intermediate exchanges between different groups. As Chapter 3 highlights the governance model should be in place to support control and accountability.

The community object must work in conjunction with the rest of the administrative objects, as machinery to initiate and carry on the cooperation process, relative to finding and matching possible collaborators, contacting support, supporting knowledge and trust building to establish common understanding; the identification of goals; and the negotiation support required for the achievement thereof; as well as bolstering the execution of individual work and the communication between participants necessary to coordinate activities and work plans.

Supporting the process of selection and the matching of possible collaborators requires the definition of the attributes describing suitable individuals. The focus is primarily related to preferences and interests, as established by the user. An awareness of current occurrences regarding the specified object is essential for establishing contact. Because awareness information must be relevant and must mitigate information overload for users, employing the idea of context as part of the awareness mechanism is necessary. This denotes that awareness specification is critical, to ensure more precise and personalised information, when opportunities present themselves or certain events occur. The research considers the activities and the status of the group as an element of the perception of context handled by the system as significant. Table 7.6 indicates the concepts that underlie the model specification, relative to the community manager component, from a general baseline.

Table 7.6: Community Manager Specifications

CATEGORY	MODEL SPECIFICATION
Control	Several governance models
Structure and configuration	Dynamic
Interaction style	Dynamic and personalised
Formation	Dynamic

7.2.3 Resource Management

Resource management concerns the data access services relating to a resource, including both the meta-information about artefacts and the artefact itself, providing directory service type functionality. Resources, in this instance, refer to various kinds of complementary artefacts required in the planning and design of particular cooperative processes and organizational structures. Resource management aims to deliver a common and abstract way of handling artefacts. The resource manager should facilitate data federation, built specifically for intelligence gathering to enable decision support. It is especially valuable when decisions depend on the comprehensive, detailed analysis of large amounts of data, collected from a variety of (possibly) heterogeneous data sources for, for example, impact assessment.

The resource management service considers an aggregated service directory, wherein data, in association with corresponding metadata, are converted into callable data services to support virtualisation. Virtualisation can be applied to meet resource and critical information needs, in order to search, aggregate and make available resources that are distributed and may be required to support coordination effectively. While additional data in the environment are available in various forms (relational databases, flat-files, and other application sources), the means of making that data instantly accessible, and turning it into useful and usable information, is necessary. The agile federation method simplifies information access, as compared to alternate integration approaches, for instance data consolidation via data warehouses and ETL, or replication, like FTP. Data virtualisation should query data from diverse sources on demand, without requiring extra copies, while fulfilling business information needs more rapidly, thus utilising fewer resources. Hence, a service based approach will enable complex federation and transformation functions.

Given the distributed nature of data sources, a service model is advocated to query, access, federate, abstract and deliver data securely to the consuming entity on demand. Local drivers\ adapters are exposed as services that can be called and executed, thus, hiding the irrelevant implementation details from the consumer. The resource engine should employ ontologies to perform the relevant search effectively and to integrate data from multiple, disparate sources in a unified, logically virtualized manner for consumption by front-end service applications including portals, reports, applications and searches, among others.

Essentially, the proposed architecture consists of a number of components, enveloping a service interface which collects coordination support information from various sources and stores the information in a shared repository. This information may then be made discernable to practitioners, utilising various visualisation tools. To ensure that the information is meaningful and comprehensible to users, it is linked to context. Supplementing back-end systems with semantic ontology to translate and infer meaning provides data federation components with the capacity to provide data services. The service capability match can result in adverts of selected service providers, along with their reference ID to the service registry records, which is subsequently forwarded to the requestor. The indexing of services in the service directory should be based on the domain and context ontology to facilitate faster service retrieval at runtime. A context based index enables service discovery within a service directory, based on contextual attributes. The context based approach therefore has the capacity to complement the standard search mechanisms, including searches undertaken by the organisation or service category, as provided by directory specifications. Table 7.7 indicates the concepts that underlie the model specification, relative to the resource manager component, from a general baseline.

Table 7.7: Resource Manager Specifications

CATEGORY	MODEL SPECIFICATION
Aggregation style	Federated data virtualisation
Interaction and Delivery mechanisms	Service oriented adapters
Integration	Loosely coupled
Security	Access control

7.2.4 Process Management

Collaborative business processes are dynamic in nature, owing to changes in policies, rules, partners, and events. This motivates the need for an event-driven, service-oriented platform to model, compose and execute these fluctuations and variances. The envisaged platform should provide seamless interoperable integration of cooperative work processes regardless of the process type involved.

Following a service oriented publish/subscribe paradigm, work practices can be published dynamically, discovered and invoked as services. Thus, finding suitable resources to accommodate collaborative projects becomes possible. Business processes can be provided as services so that users are free to use the services regardless of their location or differences in interface. Additionally, several types of service adapters should be provided for seamless linkages with the existing system/tools, to ensure that a single, comprehensive service is easily realised.

The support for dynamic process specification should be possible in order to manage change. Alternative paths for anticipated business processes should be predefined and automated to the extent possible based on rules and context to mitigate possible human errors. By adopting an event-driven service-oriented design (Maréchaux, 2006), an automated activation or composition of business processes can be achieved. Context specific event triggers should be employed to cut down dependencies on humans and to ensure that appropriate action is taken whether structured or unstructured. More so, the collaborative process configurations should be concerned with the adaptive and efficient management of the relationships between process activities, the participants involved and their supporting artefacts and other resources to support awareness.

To facilitate dynamic collaboration in a distributed environment the approach employed is inspired by positives of both WFMS and cooperative groupware in Chapter 3 where structured predictable workflows are extended to accommodate unstructured tasks. This permits the dynamic refinement and alteration of any process during its execution. A well-structured or defined process (or its components) should be automated to reduce workload. Automated processes, in this instance, can be inserted as callable services during the design time of a potential collaborative process. A collaborative process activity may consist of a collection of service-based activities, which would be subject to constraints from dependencies upon their execution. Activity types and their intended objectives can be defined semantically, through a specified ontology, to assist in the instantiation of a required process model. It is not necessary always to structure the considered requirements and behaviours rigidly when solutions are deployed, because, as the process progresses, users should have the capability to add tasks and documents as required.

When new working patterns emerge they can be codified as templates, over time and based on experiences, as determined by analytics to support reusability and to facilitate sustainability. If enveloped in a service interface, templates can be combined into more complex services, applications or cross-functional business processes. As services exist independently, they can be composed and reused with maximum flexibility. This ensures that as business processes evolve, business rules and practices can be adjusted without constraints arising from the limitations of any underlying applications. This signifies that the process manager can employ the composition services, which serve as a workflow orchestration mechanism, towards rapidly fulfilling a business process. Table 7.8 indicates the concepts that underlie the model specification, relative to the process manager component, from a general baseline.

Table 7.8: Process Manager Specifications

CATEGORY	MODEL SPECIFICATION
Integration style	Loosely coupled
Process type	Adaptive
Monitoring/triggers	Events based
Means of interaction	Standard service interfaces/protocol
Visibility, traceability and control	Governance models

7.3 Management Services: The Execution and Monitoring Module

The 'execution and monitoring' module provides services to users at runtime, through the contextual information modelled at design or build time, by enforcing service policies during the execution. The module consists primarily of the context manager, runtime manager and the personalised recommender and notification system, as illustrated in Figure 7.3. The context module focuses on the knowledge acquisition process, encompassing context extraction, abstraction and modelling, together with the storage required to process recommendations prior to collaboration, as well as reminders or alerts during the collaboration process.

The personalised recommender module holds the functionalities for the personalisation of notifications; customising content according to the users' or objects' preferences. The module is intended to meet an individual's (customer's) needs more effectively and efficiently. It reduces overloading through unwanted or irrelevant messaging, making interactions faster and easier to manage. The model proposes the separation of functions to achieve efficiency, as part of the design consideration, characterised at the middleware, by separating the context activities from the personalised notification activities.

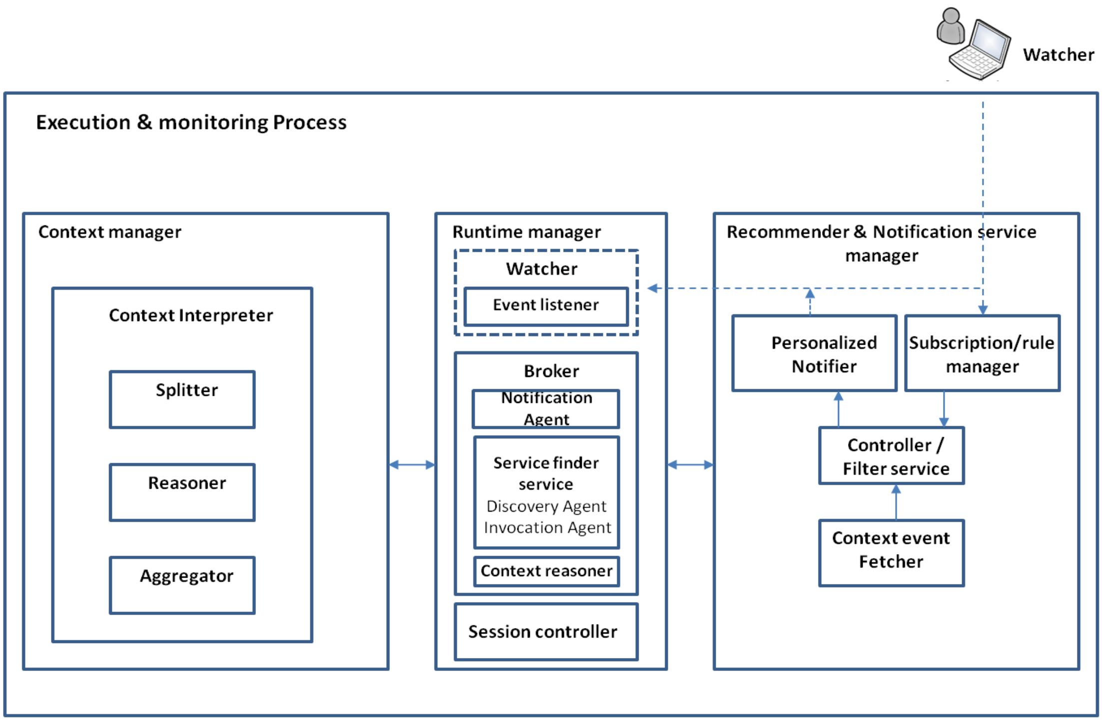


Figure 7.3: The Relationship of Components in the Execution and Monitoring Module

Through the adoption of the service-oriented archetype, where components are conceived from a service perspective (hiding internal implementation detail), the mediator is unaware of the details concerning how context information is obtained by context sources and how events are generated. Having briefly discussed the function of the execution and monitoring module in this section, the next section overviews the virtual community infrastructure services layer, which further elaborates on the issue of interoperability.

7.3.1 The Context Manager Component

Context-awareness is important to match the needs of a user to corresponding service capabilities, and to adapt services as situations change, in order to improve availability and reliability. The dynamic and distributed nature of the environment necessitates a context-aware service which considers the value context information promises as highlighted in Chapters 2 and 3. Contrasting with previous context-aware systems, where the components are tightly coupled, customarily in a closed environment, an open service based approach for context acquisition and sharing is employed to accommodate the size and distributed nature of the environment. Therefore, to support the concept of context awareness in the solution, a modular service based component, in the form of the context manager is introduced. The context manager should subscribe to the modular concept that embraces the publish/subscribe model, which is service oriented to manage context acquisition and distribution information dynamically; therefore, utilising a loosely coupled context coupling technique.

The context manager handles the extraction, configuration and abstraction of the context information, as queried, polled or subscribed to by an entity (watcher). The module models the components of the context sources or providers according to the requirements of the requesting entity. Figure 7.7 portrays the main components defined in the Context Manager (CM). The main element of the model is the interpreter, whose operation is dependent on the aggregator, context reasoner and splitter. Following a service-oriented paradigm, context sources can be registered into a service registry, and can utilise a service finder mechanism, to make them visible and discoverable by other participants. Context sources acquire various items of context data from distributed physical or virtual sensors, which can be represented as context events, based on a specified ontological description.

The transformation by the context interpreter of context data from lower to higher level context with the help of ontology provides the logic reasoning services to process context information. Furthermore, it functions as a context provider, as it can deliver deduced contexts; and consists of a context reasoner that can be called from a context Knowledge Base (KB). Multiple logic reasoners can be incorporated into the context interpreter, or can be invoked to support assorted types of reasoning tasks. Different inference rules can be specified and preloaded into various reasoners. Essentially, a context reasoner serves as a reactive inference component, which rationalises the stored context knowledge, utilising ontologies to deduce context knowledge, in conjunction with detecting and resolving inconsistent knowledge. A splitter can be used to reduce the composite context request into a series of individual messages, each containing data related to one context source. An aggregator may be employed to collect and store individual context data, until a complete set of related messages has been received. Basically, the *aggregator* publishes a single message distilled from multiple individual messages; it composes context atoms, either to collect all context data concerning a specific entity, or to build higher-level context objects. Figure 7.4 summarises the manner in which the context manager functions with other context providers or consumer components in the model.

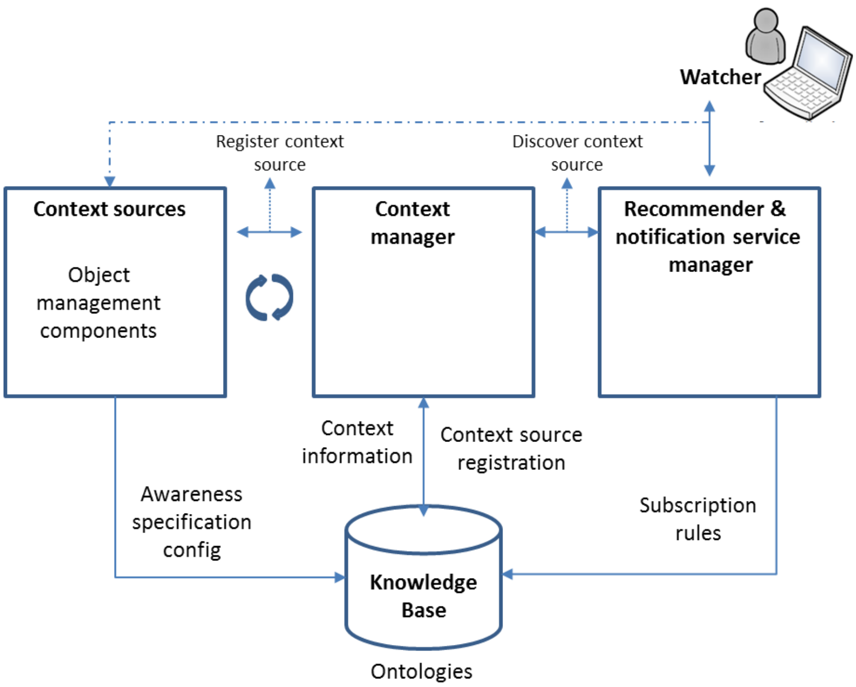


Figure 7.4: Context Processing Components Relationship

The flexibility afforded is emphasized in interaction style. For instance, context providers and context-aware components use different styles of interaction. In the most basic cases the context-aware components need to poll the context providers for the context in which they are interested, while the registration of call-backs are more sophisticated, and are triggered upon the satisfaction of filter conditions. Systems should allow specifications that declare which operations should be invoked upon a component when certain contextual conditions occur. A shared context model defines context information concepts and their relationships formally, ensuring that context information can be distributed and interpreted unambiguously by interacting system parts. A context model is necessary to provide application developers and users with an appropriate means of describing context information. Table 7.9 indicates the concepts that underlie the model specification, relative to the context manager component, from a general baseline.

Table 7.9: Context Manager Specifications

CATEGORY	MODEL SPECIFICATION
Interaction style	Mediated
Access/Delivery mechanisms	Standard service interfaces/protocol
Coupling style	Loosely coupled
Interpretation	Ontology based representation/reasoners
Context sources	Distributed

7.3.2 The Recommender and Notification Service System

Recommender systems, for instance item based collaborative filtering, apply knowledge discovery techniques to make personalised recommendations of information, products or services during a live interaction (Sarwar, et al. 2005). However, they are usually subject to scalability and quality recommendation issues, as the amount of information and number of users increase. Thus, this RNSM component employs a publish/subscribe model to manage context based subscriptions and notifications, in order to account for scalability, quality and flexible recommendation. The RNSM module uses pre-specified user preferences to manage and provide recommendations. Furthermore, the context information and notification mechanisms utilised are service oriented. Thus, they are dynamically invoked - an indication of the separation of concern of modules that can dynamically work together to accommodate diverse situations.

The recommender and notification service system handles functionalities required for the personalisation of information (e.g. preferences, interests) required to infer relevant notifications for the subscribing entities (watchers). The recommender and notification service manager (RNSM) is concerned with monitoring, controlling and managing contextual information towards providing a user specific service, and may be described as the context-ware service. Watcher or client applications are responsible for their subscriptions, registering monitoring rules with the subscriptions manager. The rules define the context to be monitored, in association with the reasoning or/and notification to be submitted once the expected context arises. Once the client application has subscribed to, and initiated the monitoring rules, the RNSM starts gathering the required contextual information. In circumstances where the triggering condition contained in the monitoring rule holds, the RNSM proceeds to notify the client application, according to the notification message specified in the rule.

Four components are presented in the RNSM, as depicted in Figure 7.6. The context event monitor receives context data events from context sources, through the context manager utilising the service bus. The context event monitor or fetcher sends these events to the control or filter service, which monitors them and evaluates the registered rules. When the triggering condition of the rule is evaluated as true, the personalised notifier is instigated, to perform the suitable action, whether this is an evaluation for recommendation as a service (an opportunity) or simply sending reminder alerts. The notification action is also dependent on the context of the user (defined or mined in real-time). Personalised notification requires that services are personalised and adapted to user context; generating personalised recommendation from context data obtained from the context module, for example, sending a notification via SMS instead of e-mail, according to the circumstances of the user (e.g. engaged, in a meeting, etc.). The subscribed rules and the ontologies used by the CM and the RNSM are stored in a knowledge repository and made available both to the subscription or rule manager and to the context event monitor. Through the employment of a service-oriented paradigm the external entities that interact with the RMNS can be services, for instance, the client applications and the CM. The components described should also be invoked as separate modular services, to eliminate undesired messages, based on a set of specified criteria, as in the awareness specification module. This allows context to serve as a filtering mechanism, returning only the subset of retrieved services conforming to the current context of the user. User subscriptions enable content filtering to minimise overload and the receipt of an excessive number of irrelevant or uninteresting messages. Table 7.10 indicates the concepts that underlie the model specification, relative to the RNSM component, from a general baseline.

Table 7.10: RNSM Specifications

CATEGORY	MODEL SPECIFICATION
Specification	Preference based
Subscription Style	Mediated
Notifiers	Dynamic callable service
Coupling	Loosely coupled
Filtering	Context based

7.3.3 Runtime Manager

The runtime manager coordinates and manages the execution functions, which arise from scheduling, receiving and brokering events, as well as from triggering actions. The runtime manager is responsible for handling all interaction sessions, receiving context data from the context module and initiating context triggered action. This includes invoking a service personalization module to compose the service to suit a certain context. Denoting it interacts with both context sources and action providers. As the runtime manager is tasked with the responsibility of controlling the functionality of the model, it should mediate with the broker who handles the communication or information delivery between publishers and subscribers. The runtime manager should control multiple sessions of watcher (user) client instances and in collaboration with another element, should orchestrate all the model components, which includes the virtual community infrastructure services layer to ensure tailored specific service provision.

The runtime manager, with support service discovery, invocation and monitoring, is responsible for the execution of actions. It receives requests from the application for the execution of specific actions and responds with their actual execution or with an exception, if the action cannot be executed. It assumes the role of the scheduler and invokes the required services at runtime. It hosts the session controller, and manages the routing, tracking and controlling traffic between interacting entities. The runtime manager will adapt to user specific needs, according to established requirements or configurations and should be leveraged by a service finder. The service finder service provides a mechanism whereby context sources and the context interpreter can advertise their presence. Thus, it enables users or applications to discover and locate these services. The service presents a discovery or invocation agent, which must be notified by external interpreters, aggregators and widgets relative to their presence and contact possibilities. The process fosters scalability, dynamism and multi-matching capability.

The service finder service should be able to track and adapt to the dynamic changes of context sources, with the aid of a given ontology. By employing the context ontologies stored in the database, and context instances, as advertised by different context sources or interpreters, a semantic matching mechanism can establish the source of context information. When a match is located, the reference to the context provider or the context interpreter can be returned to the application. During publication the providers, their services and service properties can be related to existing ontologies, in order to facilitate more efficient and powerful searches in the service registry.

Through querying the service registry, context-aware services are able to locate all the context providers offering a set of interesting or relevant contexts. To obtain contexts, a context-aware service can either query a context provider, or listen for events sent by context providers. A notification listener, as a service, should monitor for updates matching the subject of the notices pertinent to the subscriptions of their clients and should distribute the relevant messages. Context-aware services can specify actions triggered by a set of rules whenever the context changes. Predefined rules can be uploaded to a context reasoner, which determines what methods are to be invoked when a condition becomes true. Table 7.11 indicates the concepts that underlie the model specifications, relative to the runtime manager component, from a general baseline.

Table 7.11: Runtime Manager Component

CATEGORY	MODEL SPECIFICATION
Execution Style	Context-aware/personalised
Discovery and invocation style	Service based
Coupling/Integration style	Loosely coupled
Registry management	Compose service indexed +context/domain ontology guided

7.4 Front-End Services

Front-end services provide a user interface or application interface to handle interactions (requests, notices and acknowledgement). It should provide a user interface to handle notices and, when appropriate, to acknowledge them. Accessibility through the interface (e.g web browser) provides a gateway to the design and specification tools, analytical visualisation tools, and community profile organiser, as well as supporting general status monitoring and reporting. Figure 7.5 presents these services, as expected from a portal interface. Utilising, for instance, web portal technology will enable the achievement of secure, customisable, personalisable and integrated access to dynamic content, from a variety of sources, in an assortment of source formats, wherever required.

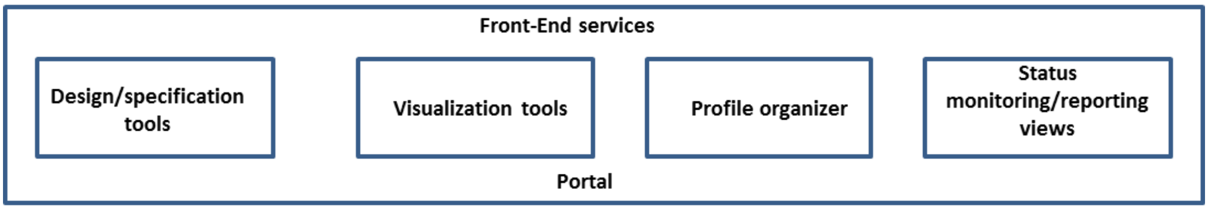


Figure 7.5: Front-End Services

The employment of a selected portal technology offers integration, service access and configuration facilities to support coordination. The portal is equipped with a presentation component, which permits the user interface to introduce inputs to and to receive outputs from the application. A user agent (watcher client) acts on behalf of the user. Principally, the client interacts with the presentation component to obtain user inputs and to present user outputs, providing the runtime manager with user input events for subsequent reactions, for example, initiating the necessary tools or artefacts in a workspace tailored for a particular user, according to a specified configuration.

The front-end service should present an information portal service, which integrates services in a pluggable manner. A portal window consists of components termed 'portlets', which exchange data with individual services and display the output results from services (Margulius, 2002). For example, if a certain range of services, for instance, ERP, CRM, web sites, Knowledge Warehouses, trend forecasts, order elements, and communication components, are offered as portlets, a user can create a personalised window, through the selection of only the services deemed necessary or desired. Figure 7.6 presents an illustration of the portal infrastructure. This reinforces the one-stop service concept, where data is automatically linked between services. Additionally, service menu items related to the current operation being performed by a user, are displayed, to provide guidance to the user. The front-end service is capable of being personalised relative to their needs and preferences. Fundamentally, it represents a secure interface, which affords a one-stop interaction, with appropriate intellectual capital, applications, expertise, and services for all individuals involved.

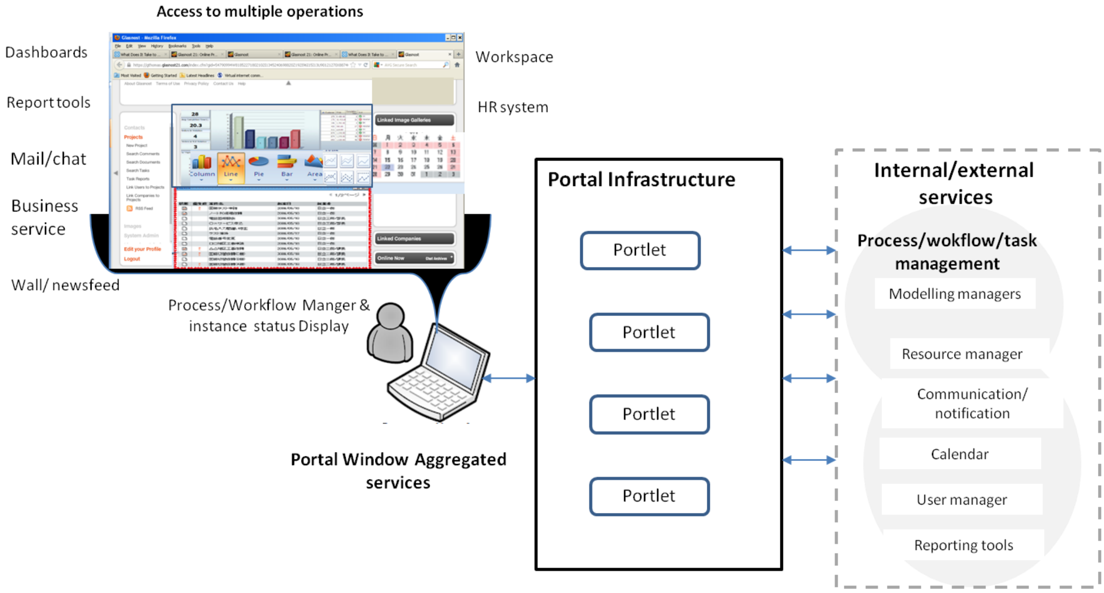


Figure 7.9: The Portal Infrastructure

Table 7.12 indicates the concepts that underlie the model specification, relative to the front-end portal component, from a general baseline.

Table 7.11: Portal Specification

CATEGORY	MODEL SPECIFICATION
Tools integration	Dynamic/Loosely coupled/service based
Knowledge base	Distributed
Security style	Single sign-on
Adaptation	Context specific

7.4.1 Design/Specification tools

The design/specification tools should primarily provide explicit information regarding the cooperative work requirements, in association with how they should be realised. This accentuates the need for a shared artefact, which should be defined as a mental representation of what is intended to be accomplished. Thus, an environment that models design views and services is desirable, along with automatically probing, combining data across disparate sources to select resources, without concern relating to source access and its format complexity. This component can benefit from the resource manager, which can present virtualisation of resources beforehand.

The design specification should provide a model which, *inter alia*, describes the structure of tasks and activities, along with their assignment to roles or actors. This, as a notational covenant, allows the sharing and re-use of the design artefacts. The design specification component should present callable or pluggable service based tools, to assist in the modelling process. The shared model that is constructed should be created and conveyed in an understandable manner, thereby forming the basis of the collaborator mental model. Graphical representations should be employed to help visualise the relationships among structures, composition and elements.

The front-end should provide the user with the ability to interact with services and to modify their behaviour. The user, through the application of design and specification tools helps to initiate the business process in the system. Furthermore, the layer provides the capability of managing the workspace relative to assigning artefacts and community spaces to particular collaboration or project teams. Depending on the pre-set, specified conditions, communication between the front-end application and services in other layers may be as relatively simple, effortless and straightforward as a parameterised invocation of the service from the front-end component or, in contrasting, extremely complex through negotiations,.

The portal can provide access to the set of design and development support tools, including a business process modelling utility, a data modelling utensil, as well as service development instruments and support tools for technical standards usage. Sharing automated operating procedures in design can facilitate the cross-use of knowledge, with users being capable of work where their own experiences are not the exclusive influential factors, improving the business efficiency and quality of the organisation. New knowledge and know-how acquired by sharing within the organisation can be fed back to the operating procedures, augmenting and constantly improving the expertise, information and knowledge base of the entity. All windows available to users should contain a flowchart and guidance. An entire operation can be viewed in the form of a flowchart, with the operations required for each step displayed in the guidance area, according to the operational flow.

7.4.2 Profile Organiser

The profile organiser represents an initial step to participation within a community. It assists in setting up the profile of a user, to establish his existence or digital presence and identity. The user profile created provides other community members with a way to learn about the experience, skills, and interests of other users. When key words contained in the created profile are entered and searched, the profile should be presented and should show in the search results. The ability, at any time, to edit/update preference information, which may include interest or awareness delivery specifications, should be provided.

When conducting user registration onto a system, users may submit their preferences to establish corresponding user profiles, which may subsequently be updated, based on their behaviour. User preferences provide a personalisation mechanism, which enables service discovery, in a manner best matching the explicit or implicit user requirements. Typically, a filtering task entails contacting scattered resources, performing an initial search to gather a subset of documents, which are then represented, classified and presented, based on the user profile. A context based reasoner has the function of providing deduced or inferred contexts as specified to the organiser.

The profile organiser facilitates personalisation by providing specifications that support the customisation of content, along with the 'look and feel' of the interface. Users should be able to select what appears on their window, by creating templates. This includes subscription and notification capabilities, wherein users can opt to have knowledge or applications delivered to their desktops, controlling delivery and presentation. Support for content management and searches, which includes easy navigation of, and access to, corporate knowledge (organised by the content management system), providing the user with the capability of extracting the required information from a comprehensive, wide-spread knowledge base.

A filtering component is advocated to mitigate the challenges arising from personalisation and the problem of information overload from distributed systems. Users desire to receive selected, appropriate and individualised information, based on their preferences, from scattered repositories.

7.4.3 Status and Reporting

The principal questions pertaining to this module are: *How can collaborative opportunities of interest be delivered and how can the project be ensured to remain on track?* Dynamic status monitoring and reporting should be made available to any relevant user by whichever means they deem suitable or preferable. The tailorability or customisation process promises great value, whether a synchronous or an asynchronous means is employed. Thus, communication or delivery is assured and likely to be seen by the recipient.

Activity monitoring in a portal, for instance, should permit the building of interactive, real-time dashboards, along with facilitating proactive alerts for monitoring business processes and services. It should provide collaborators with timeous information, enabling better decision making. Real-time event updates allow users to gauge the impact of key performance indicators affecting the business, ensuring that corrective actions can be implemented to improve the operations.

A portal infrastructure, for instance, should provide a perspective overviewing all the process stages and underlying systems, delivering visual cues to the user pertaining to breaks or challenges within the process. Thus, it should provide a holistic view of the situation in a timely manner, preferably unobtrusively. Corrective actions may be straightforward and simple, for instance, sending an alert via email or automating a dynamic change in the business process via a third party service. Portals support access controls for groups and individuals, in association with access to notification and messaging tools. Focussed on integrating applications, services and knowledge, portals afford users both a manageable window and a powerful decision making tool.

7.4.4 Visualisation

Provision for decision support tools and applications which perform knowledge mining to support business intelligence is critical. Data visualisation tools are desirable, to aid with analysis. Data visualisation is the representation of data in a simplified and meaningful way. Distributed information should be abstracted into a format which ensures that it is easily understandable. Especially where very large data volumes are involved, patterns can be spotted quickly and easily with the help of visualisation tools. Visualisation should aid in ensuring that analysis reports are explicit, despite their not being immediately apparent or obvious previously. Visualisation tools should convey information in a universal manner and should make it simple to share ideas with others, with the intention of a singular perception and comprehension of the facts by all players involved, and facilitating readjustments if necessary. While traditional electronic spreadsheets cannot represent large volumes of data visually, owing to data presentation limitations, suitable visualisation tools should be made available and easy to locate. This can be expedited if they are transformed into registered callable services, which can be found easily, regardless of location, and are integrated dynamically, to suit assessment needs as required.

Benefits of visualisation tools encompass understanding and discovering the narratives embedded in raw data, empowering more concise presentations and more reasoned decision making. Designed properly, charts can call attention to certain points or salient trends in a data set quickly, making them a powerful analytical tool. Data visualisation tools should enable greater insight, through the interpretation and representation of data at a glance, along with the capability to exercise the analysis necessary. Furthermore, several diverse visualisation tools should be managed, accessible or pluggable when required, as with their translator. Thus, the dynamic integration of such tools as services should be supported. The indexing of services in the service directory should be based on the domain and context ontology to facilitate more rapid service retrieval at runtime.

7.5 The Collaboration Life-Cycle Model Components

This section discusses the CLM components in terms of what is necessary before, during and after collaboration as far as awareness levels are concerned to streamline coordination and to promote sustainability. Also made explicit is how the components of the architecture contribute to the entire CLM process. The discovery of opportunities for collaboration from the environment initiates the process. In essence, the environment is scanned for needs similarities and recommendations are then made to entities for collaboration. The CLM consists of the initiation, planning and design, implementation and assessment of a collaboration process.

The needs awareness that eventually results in opportunities for collaboration must be realised prior to the initiation phase. The environmental requirement elicitation component focuses on understanding and documenting needs with a level of detail which allows for the identification of analysis and opportunity. The initiation phase follows with the analysis and interpretation of the requirements, to define an opportunity to collaborate, as well as to set goals and parameters. The planning and design phase provides the specification and configuration of people and artefacts, which characterises the project transformation plan. Thus, it includes all the activities necessary to acquire and establish the resources required to carry out the project. The implementation phase ensues with the execution of plans, processes, or procedures in accordance with the specifications defined in the master plan or reference template, in order to produce outputs, while managing any changes that may occur. The evaluation phase determines whether the collaboration requirement has been satisfied, to eliminate it, or whether redress action is still required. The monitoring and reporting phase occurs prior to, and during various phases of the project in order to, *inter alia*, monitor environmental changes, requirements status, resources, schedule, quality, risks, exceptions, and overall project status.

Awareness reflects that if the proper information concerning what other people are doing, is sent at the correct time, to the right people, coordination can be facilitated effectively. The decision to integrate awareness as a core aspect of the solution platform is reflected in the collaboration process life cycle, with the most significant feature constituting the monitoring and reporting cycle, as highlighted in Section 6.2. The cycle reflects the three different stages of awareness information required, viz. pre-awareness, necessary before a collaborative project can be initiated; in-awareness, which occurs after the project is initiated**;** and post-awareness, which follows once a project is completed. The monitoring and reporting component, in the middle of Figure 6.2, indicates the continuous awareness capability that drives, manages and improves the collaboration process. The up-to-the-minute or contemporary insight that collaborators have concerning occurrences within the community and task environment, the comprehension of its meaning, and an understanding of its future implications regarding the task, are all necessary for coordination. Essentially, team awareness of a certain situation, at any particular point in time, can yield collaborative success. Streamlined awareness may be achieved by engaging architectural components, such as the community, context and recommender/notification managers. Appendix F provides a table that illustrates how architectural components collate to provide such support. Examples of team awareness encompass knowing about an upcoming deliverable deadline or knowledge of the progress status of a particular project. To aid in comprehending the operation and functionalities of the model, the architectural components involved are discussed relative to the aforementioned levels of awareness. The discussion highlights the type of services to be expected, with the succeeding division focussing on the form of awareness necessary to instigate a collaborative activity.

7.5.1 The Pre-Awareness Level

This section considers the context-aware matchmaking service capability, which is intended to unite possible collaborators according to the needs requirement in the environment. This phase allows the identification of potential members for the community who have specified interests, and facilitates the easy identification of others who might share an interest in collaboration. This is courtesy of the preferences enabled by the **profile manager**, which establishes a collaborator identity prior to joining a **community** of members that may have a shared interest. The **security** specification emphasised is centred on the established reference identity to ensure controlled access to resources.

Awareness of the environmental requirement is significant at this level. It reflects a needs assessment to provide the basis of identifying collaborative opportunities at the **initiation phase**. This is made through sifting intelligently through the dynamic distributed information sources, which characterise several needs scenarios. A virtual community should support and facilitate the identification and selection of potential collaboration partners. Thus, the envisaged platform must find individuals with the correct skills, willing to collaborate and to exchange information. This tier leverages the **recommendation service**, according to the defined interest of a user and informed on specified notification mechanisms. The virtual community platform serves as a medium for initiating contact with known or unknown collaborators with similar interests and preferences. The awareness component at this stage facilitates contact building for future cooperation towards a shared objective by taking advantage of the **communication component**.

The pre-awareness level encapsulates the necessary awareness information, which stimulates the opportunity to collaborate. This opportunity for identification is aided and made visible by a variety of **status monitoring and reporting views** as part of the front- end service. The services of interest, functional at this level, include recommendation and contact management services. In accordance with the context information offered by the **context manager** and the user-defined profile from the **repository**, the context aware application (**recommender and notification service system)** provides recommendations of interest to the user. There is a connexion between the needs (or preferences) of the user and the content delivered, allowing resources to be tailored for the user in a personalised way. A recommendation should be offered to the user, through a usable and accessible user interface. Figure 7.10 illustrates how recommendations are achieved based on context information.

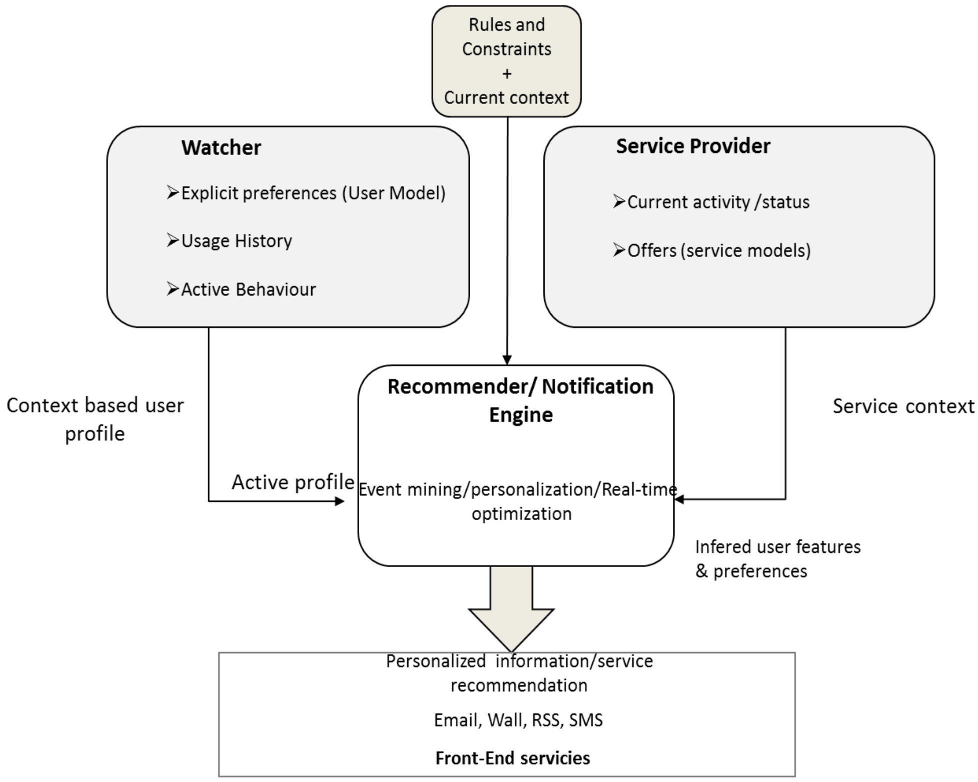


Figure 7.10: Recommendation Process

Presence or awareness information concerning the state of members (availability or absence) may be required to initiate a conversation with a potential candidate. Informal awareness is necessary, as is support for direct communication, which can be realised with standard **synchronous and asynchronous** methods of computer and network-based communication, viz. telephone calls, video and audio conferences, text talk, and email or news. Informal awareness is the general sense of community members, concerning what individuals are doing, as opposed to what team members are doing - central to the subsequent section. Awareness facilitates casual interaction, which may form the backbone of everyday coordination and work.

7.5.2 The In-Awareness Level

This is the predominant awareness level and is essential when members agree to collaborate. The **planning and design phase**, as well as the **implementation phase**, are the focus of this section. They employ the services of the **workspace manger** which creates a shared workspace for discussion and for establishing agreement of objectives roles and responsibilities in relation the engaged collaborative project. More so, the front-end service **design and specification tool** and the **process manager** help to define the adaptive workflow reference template or process model to guide the actions of the **runtime manager** at implementation. The services of interest constitute the task and process management; in-awareness advocates process awareness, which involves, *inter alia*, context information pertaining to process instances, the team configuration (i.e. participants and their roles), and their associated artefacts and tasks. Work lists generated to fulfil the collaborative activity are produced for each participant. This is followed by their arrangement according to scheduling and the order of execution, within an overall global process. In situations where templates exist, a work list is introduced from a **knowledge repository**. Activities may then be selected for a specific business. These activities or tasks are presented in the form of services. Keeping track of the activity processes and execution engenders the need for awareness: knowing who is responsible for what, and when, to send alerts or reminders. This form of notification is necessary during the course of execution.

Establishing an opportunity to collaborate results in contact initiation and the creation of **workspace**, where collaborating members conduct planning and design. There are certain steps, with the initial building of a common understanding, followed by the identification of a goal, in conjunction with the manner by which the objective should be attained. The execution of individual work, and communication between co-workers in order to coordinate activities and work plans, is necessary. However, where there is no abstract work model detailing the steps necessary for performing a task, the system must offer as much flexibility as possible to team members, enabling them to conduct what measures they deem necessary to achieve a particular goal. This requires a high degree of group awareness, with co-workers aware of the history of each other, and their current and potential future activities within the shared environment. The propagation and exchange of group awareness information results in the implicit coordination of team work. Users may have their personalised workflow defined, as it relates to the general collaborative objective.

At this level, process awareness is critical. When collaborators agree to work together towards a shared goal, they generally agree on certain well-defined tasks, which are more or less formalised. Members require knowledge pertaining to the multiple relationships between the artefacts and the context in which they were created, shared, and distributed (i.e. who, what, when, in which context), making organisational awareness (e.g. roles) relevant. The systems facilitate the mobility of content and the context of activities in the business process to group members. Essentially, they provide information concerning process instances, the team configuration (i.e. participants and their roles), their associated artefacts, and connectivity modes of group members. A project manager and other relevant stakeholders may need to be informed constantly regarding all work activities and status information. Overall, typically members require status information relating to all work activities performed by other team members in a joint project (process-awareness).

The support for process variety and adaptive workflow modelling and composition is also emphasised at this level aided by the **process manger**. It should be possible for a virtual team to initiate an ad-hoc process and, from any particular activity, to link it back to the defined process model. Additionally, the system should also allow starting from a process template, as well as to permit deviation, for example, through simply deleting activities modelled in the process template or by adding new activities from a given task library. With an event-driven service design, dynamic composition and integration of heterogeneous services can be achieved. Business processes are dynamic in nature owing to changes and alterations in polices, rules, partners, and events. An event-driven service-oriented architecture should be capable of providing seamless integration, the automation of business processes, support for state management, transaction and notification, and services monitoring execution. The event-driven automation of business processes allows service provision regarding reactions to events, which activate according to defined rules or configurations. For example, based on the specification of a training type (online or physical), a given training process template can be activated.

At the 'in-awareness' level the proposed platform presents a way to manage the flow of activities or events, which are passed to appropriate partners for service provision. The platform proposes the use of dynamic compilation service-based modules that support workflow management. As a user-oriented design, users may customise their services as required.

The dynamic compilations are carried out as a back-end operations, as instigated by the **integration broker** and the event monitor. This is aided by the **design/speciation**

tools. In the front-end, users can complete their workflow requirements through interaction with their respective portal applications. The operation, therefore, consists of the three layers, viz. the data layer (database servers), the business process layer (service driven composition) and the presentation layer (aggregated portal). The service broker should select, compute and determine the sequences of the tasks to be conducted, and based on the business logics; a suitable activity schedule for participants can be generated and presented as a web application. Thereafter, participants may adhere to their work schedule, in accordance with the correct sequence, to complete the assigned work. The presentation layer represents a portal interface layer, which provides the facilities to construct and customise user interfaces, suitable for each level of users. The dynamically compiled work schedule is communicated to and interacted with by the users, who can observe changes to their portal pages, via the media. Figure 7.11 shows the functional relationships of the service elements, ranging through the profession or business profile service, function or activity service, and function or activity design and operation services.

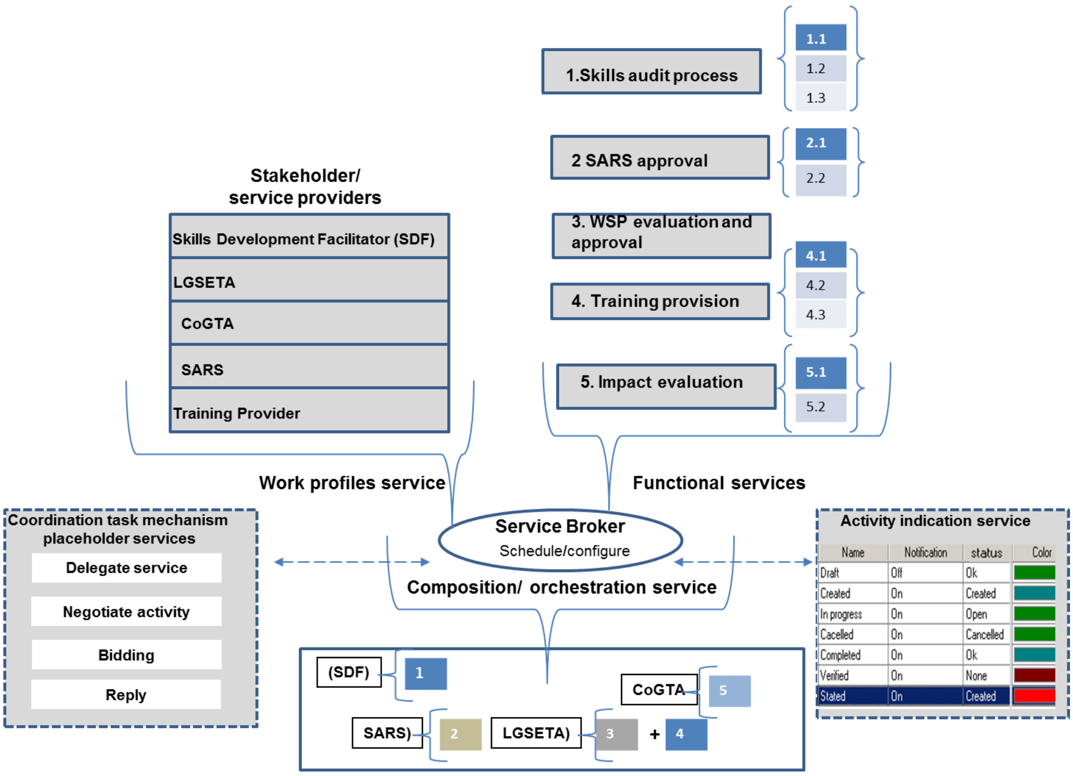


Figure 7.11: Dynamic Process Configurations

The profession or business profile service contains all potential job descriptions, as well as the service briefs of registered stakeholders. The function or activity service encompasses the required service activities, which define all business processes and their function tasks. For example: (1) A skills audit is a functional service consisting of four sub-functional or activity services which include: (1.1) Conducting a preliminary analysis; (1.2) Interviewing line managers; (1.3) Setting skills development objectives; (1.4) Identifying scarce and critical skills; and (1.5) identifying training opportunities, etc. The services design should comply with the work practice requirements during the design-build-store process. The function or activity design and operation services incorporate the desired job functions, which may be allocated to relevant participants.

At run-time, the project manager can assign new tasks or modify previous assignments whenever necessary. The platform should recompile the changes into the best possible schedule, according to the work functions required, assigning newly arranged customised tasks to a role player. Templates can be designed and used for routine assignments, which provide standard sets of services and work specifications. Participants are afforded full control in customising the workflow schedules and the deliverables required. Through monitoring and evaluation progress can be reviewed, and problems in planning and execution can be identified and adjustments can be made.

7.5.3 Post-Awareness Level

This level reiterates the need to monitor and to evaluate the quality and impact of work, in accordance with the agreed collaborative objective. This level highlights the requirements of the assessment phase, as illustrated in Figure 6.2. While tracking project status, the supporting of artefacts is important, to ensure that the planned execution is occurring correctly. The evaluation resulting at the end of project implementation, determining the impact of the project on the shared cooperative goal is also significant. This necessitates familiarity with the circumstances of the beneficiaries before a project was implemented, providing the baseline data, which is collected during the needs or requirement assessment before project initiation. This information allows the assessment of improvements instigated by the project implementation over time. An impact assessment informs the efficacy of an intervention, whether it has made a difference to the problem situation that was being to address. Through comparing data describing the situation before an intervention was initiated and information generated after completion of the intervention project, changes in the circumstances of the beneficiaries can be measured. Furthermore, lessons may be drawn from the changes linked to the implementation of the project, towards facilitating other collaborative projects, as well as identifying inconsistencies and missed feedback loops, among other things. This emphasises the advantages of having access to repositories and tools for intelligent analysis to support decision making.

Performing an intelligence analysis requires access to tools and applications that perform knowledge mining, for analysis and decision-support sessions. This feature engenders the defining of new opportunities. The capabilities highlighted in Section 7.2.1.3, as components of the **resource manager** functions, to support data virtualisation and analytics are relevant. The seamless integration of analytics and **visualisation tools** to support the requests of various managers is emphasised. This level aims to facilitate new methods of correlating and analysing data, in an easy and understandable manner, while providing the ability to make decisions, as well as predicting future interventions and the resources required. By employing a service approach, the solution allows organisations to use whatever data sources they may require, ensuring that services can encapsulate several, assorted data sources.

7.6 Conclusion

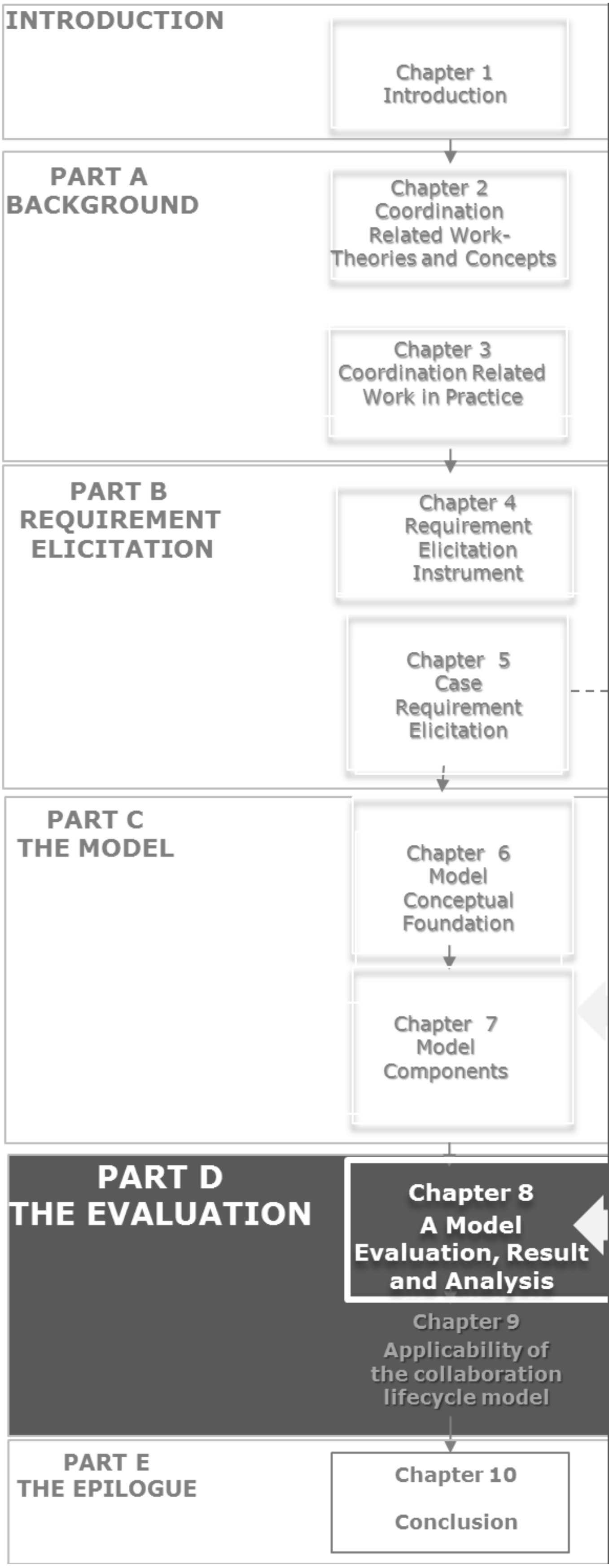
This chapter focused on extending the functionality described in Chapter 6. Although certain solutions considered are not new, a service spin on their usage presents a unique and all-inclusive solution to the research problem. The architecture advocates the use of loosely-coupled services and context information, to make applications more flexible, while allowing for quicker responses to environmental changes. Tracking awareness information prior to and subsequent to the initiation of projects ensures that coordination relative to the collaboration lifecycle may be better streamlined.

The extension employed in the solution defined several additional functions, ranging from object-based configuration to context management services. As made explicit in this chapter, context plays a crucial role for coordination support in a distributed environment. The chapter reveals the complexity involved in the attempt to achieve seamless coordination, illustrating, however, that intelligent use of context can assist the process. As explicated in this chapter, a comprehensive insight into the problem can help to resolve coordination issues. Since the problem of coordination extends beyond simply having a technical artefact that presents some automated solution, the solution considers the social relationship as an important dimension. Defining, partitioning and assigning functional groups and structures afford management simplicity and accountability.

Concerning information and knowledge management, data virtualisation approaches are employed in a manner accounting for heterogeneous and distributed environments, through utilising an extensive use of services, founded on service-oriented computing principles. The architecture makes it possible for organisations to develop coordination support systems through the utilisation of visualisation tools, databases and other system components, which organisations may currently employ, that are open source or are affordable, which prompts re-use.

PART D

Considering that design theories or IT artefacts aim to support the resolving of practical problems or issues in a manner through which desired outcomes are reached, Part D is focused on testing the applicability of the services proposed by the model in Part C. Part D thus, is intended to resolve the question: *How can the usefulness and applicability of the model artefact be verified?* As rigorous evaluation methods are required to demonstrate utility, quality and efficacy of the design artefact, formative as well as summative modes of evaluation are employed to account for both internal and external validity. Part D focuses on testing the proposed artefact in the application environment, for completeness or refinement. Taking into account the challenges associated with evaluating cooperative work support systems, the evaluation method utilises descriptive methods, in the form of informed arguments and scenarios. This is achieved through **Chapter 8,** reviewing the process followed, in order to evaluate the applicability and usefulness of the proposed model, in conjunction with **Chapter 9,** verifying its potential use in practice, as well as accounting for redesign.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CHAPTER 8

A MODEL EVALUATION, RESULTS AND ANALYSIS

This chapter discusses the process followed in order to evaluate the applicability, functionality and utility of the proposed coordination support artefact referred to as the collaboration life-cycle model.

The fundamental question resolved in the chapter is: *How can the applicability and usefulness of the model be determined?* The chapter commences with an description of the purpose of the evaluation, indicating what the assessment exercise is intended to expose. This is succeeded by a discussion of the techniques utilised for evaluating the model, followed by a presentation of the findings stemming from the evaluation. The chapter concludes with a review of the constraints pertaining to the evaluation process, entailing a synopsis of the elements discussed.

8.1 Purpose of Evaluation

The purpose of the evaluation is to ensure that the proposed model is relevant, practical and useful to practitioners. It is required to satisfy the requirements for coordination effectively in a distributed environment and, additionally, to contribute to the body of knowledge. A design artefact is only complete and effective when it satisfies the requirements and constraints of the problem it was intended to resolve (Hevner et al., 2004). The evaluation process aims to validate the relevance and rigor of the constructs and content of the identified model. It assesses how well they satisfy the needs of the target audience and address the identified problem. The output from the development phase facilitates assessing whether the model is useful and applicable to the case in question. Thus, the goal of the evaluation is to determine whether the proposed model and its components will assist with coordination in a real world setting. Two forms of evaluation modes are used, namely formative and summative evaluations. Formative evaluations are iterative and explorative in nature, with feedback from the assessment used to modify and refine design. The summative evaluation latching to the formative role also provides input towards the model refinement based on the external validation of its relevance and applicability.

8.2 The Evaluation Process

The designing of the coordination support mode is guided by the principles of design science as described in Chapter 1. As mentioned in Chapter 1 design science consists of

two essential actions namely build and evaluate. The build action constructs an artefact to
address a problem and the evaluation action measures how well it performs (March & Smith, 1995). These two activities usually follow a set process, as described in the research methodology section in Chapter 1. The appraisal techniques selected constitute descriptive methodology, prescribed by Hevner et al., 2004 based on informed arguments and scenarios. This is augmented by domain expert reviews, in conjunction with a validation tool submitted to and filled in by the experts, accompanied by feedback from conference publications. Figure 6.1 illustrates how the methods of evaluation inform each other.

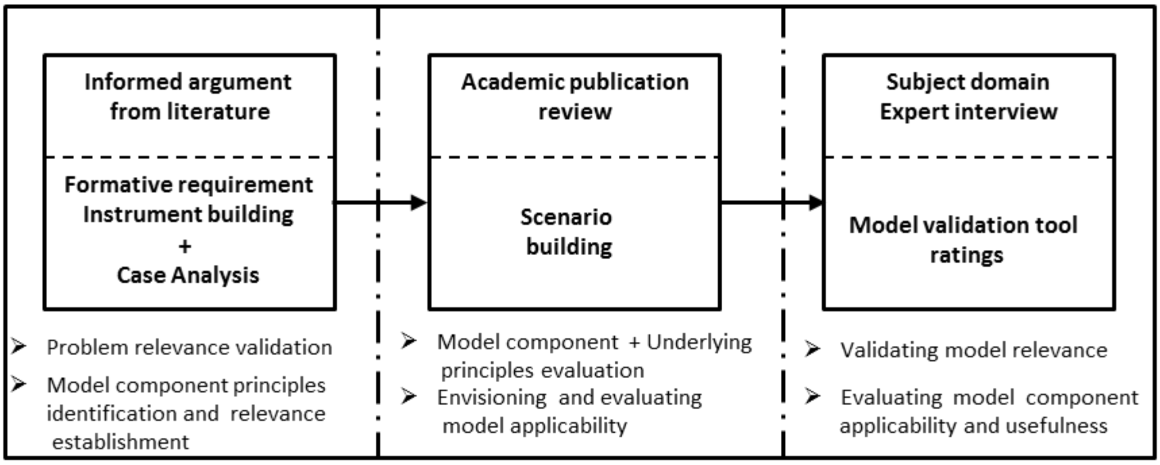


Figure 8.1: The Evaluation Process Methods

To account for the complexity of the system in reality, a scenario based approach is used. The scenario based approach is utilised to provide an external description of the envisioned functions and operations of the proposed solution. The collaboration scenario described originates from the cooperative work practices derived from the Chapter 5 case study analyses. This resulted in requirements that were generated to guide the design of the solution. The textual narrative provides insight as to the effectiveness or ineffectiveness of the proposed solution. By means of a walkthrough process of the model and scenario, with subject domain experts, reviews were realised to validate the model. The descriptive methods in the form of argumentation and expert review selected as suitable for evaluating the proposed model are further discussed in subsequent sections.

8.2.1 Argumentation Utilising Existing Literature

Through informed arguments, a thorough literature study relative to coordination aided in revealing the need for coordination support in a distributed environment; assisting in validating the relevance of the problem. This is discussed in Chapter 1, Section 1.1. Furthermore, through argumentation, informed by literature, formative evaluation was realised in assessing the appropriateness of the recommended components of the proposed solution model and architecture.

Additionally, academic publications, submitted and presented in conferences, established the problem relevance and substantiated several model and architecture components. As with paper, in Appendix D3, chapter 1 section 1.8 accentuates the problem relevance, with respect to the environment and the methodology proposed towards providing a solution. The second paper emphasises the pertinence of certain components of the architecture, based on lessons learnt from grid-computing, concurrently confirming the feasibility, relative to existing technologies and supporting principles, inclusive of, *inter alia*, SOA, web-services, and web portals.

The synthesis of the literature, through informed arguments, provides the foundation from which the conceptual components and requirements of the model are identified. The feedback from the review of academic publications underscores the importance of establishing the usefulness and relevance of the model.

While paper Appendix D3 highlights the problem relevance and Appendix D2 stresses the solution feasibility from a technological viewpoint, paper Appendix D1 emphasises the solution in the more comprehensive context of virtual community, from a service lens perspective, underlining the necessity for validation within the SA context. This illustrates how the requirement elicitation instrument, elucidated in Chapter 5, was iteratively developed from its implementation in the case study, towards the requirements necessary for the solution model development. The requirements led to the construction of the model, as deliberated in Chapter 6 and 7. This directs the focus of this chapter relating to the summative evaluation of the model, to serve as input to the improvements, adaptation and transformation of the model, made explicit in the subsequent chapter.

The components and requirements that were validated through the argumentation of the literature and feedback case analysis in Chapter 5 were used to develop the model and architecture. Expert reviews, through interviews with domain experts, were conducted to evaluate the utility, practicality and applicability of the proposed model. The interviews were guided with a detailed scenario containing specific characteristics that correspond, are compatible and harmonise with the use cases of the model. A Scenario was constructed to mimic the context in which the model will be employed through which the model utility, feasibility and applicability were validated through expert reviews. The scenario was created mimicking the actual usage of the system, in order to make the model operation as realistic as possible, thus dealing with the obligation of affording its practicality and realism, so that the assessment could extend beyond the theoretical.

8.2.2 Expert Reviews

The purpose of these expert reviews is to evaluate the relevance of the proposed components of the model and architecture; additionally, to establish whether the potential users of the model found the proposed model to be useful and applicable in streamlining coordination through collaborative means. As such, the expert reviews using subject domain experts were conducted to validate the model. The expert reviews were accomplished through interviewing subject domain experts, comprising experienced practitioners, in conjunction with the completion of a model validation tool. As qualitative research, the sampling approach employed to select the participants is purposeful. As such participants were not randomly selected, but rather for reasons like their experience in the public sector service, the operational managerial and executive roles they assume, which reflects an oversight function with the responsibly to coordinate action across departmental or organisational boundaries.

- **Selection of the Experts**

The participants selected represent a cross sectional balance in the domain of interest, which in this study is the distributed environment exemplified by the public sector service. As such, participants with the requisite experience are regarded as subject domain experts. The interview participants were selected from subject domain experts, who represented a cross sectional balance, relative to the areas of interest, throughout the different spheres of government. The representation presents participants from the local government, provincial and national government respectively. In addition, participants are included who have in the past worked in the public sector and still engage in various capacities with the various different spheres at different levels of granularity. Twelve participants, each with in excess of 6 years of experience in their domain, from the local municipalities and provincial and national government were engaged to assist in evaluating the proposed model through interviews. The respondents evaluated the proposed components of the model and provided feedback as to their perceptions of the utility, feasibility, functionality and applicability of the model relative to resolving the defined problem. The diagram in Figure 8.2 below portrays the distribution of the practitioners employed, representing the distribution of expertise of the selected participants.

The diagram in Figure 8.2 depicts the intersections relating to the distribution of participants. All twelve have experience in public service. At the local level, three participants - two from the Eastern Cape and one from KwaZulu Natal - were interviewed. Another is seen at the intersection between ties to the public service and currently engages with the public service in a consulting capacity.

The biographical information of the participants is presented in the results Section 8.2.3. This selection of participants sample aided in the assessment of the model, in order to provide credible results, as the experts examined the components of the model and its usefulness from the perspective of how it will be applicable in their respective domains.

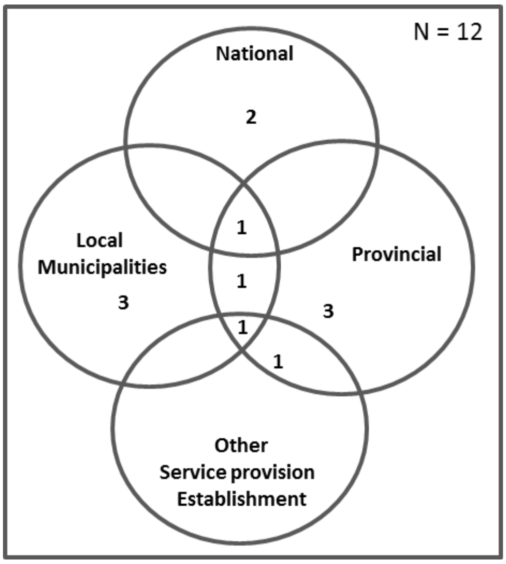


Figure 8.2: Distribution of Domain Expert Participants

➢ The Collaborative Scenario Design Process

A Scenario was developed to represent how the model will be used in practice. It focused on discussing the entire actions and workings of the model comprehensively, mimicking the use of the Coordination support model as it will apply in practice. The participants then commented as to their perceptions of the functionality, utility and applicability of the model in the specified circumstances. The motivation for the collaborative scenario was shaped by the collaborative pattern and actions identified during the case analysis requirement elicitation process in in Chapter 5.

A first draft of the scenario was developed and used for a pilot study which was then refined into the version employed during the interviews with the experts. The final scenario employed is presented in Figure 8.3.

Scenario:

Rick, Martha and Stu are training coordinators for their respective municipalities (A, B and C). They are responsible for identifying the training needs of their personnel and for organizing their training. As they only meet every quarter to update on events, they often find out too late that they have identified training needs which their personnel have in common. In order for them to save costs and to streamline coordination, they recognize that they need to find a way to make visible the many hidden opportunities to work together. Rick then mentions to Martha and Stu that there is a community website he has heard of where they can register and find other interested partners to work with if it happens that they share similar interests. Stu indicates that the site hopefully provides the flexibility and option to specify interests and to set notification priorities and delivery channels to prevent unnecessary information overload or intrusion when recommendation updates are received.

Rick continues that it would be nice to have a shared workspace where people can meet, discuss, organize tasks, assign roles, gain permissions and specify communication structures in addition to their goals and objectives, as they would in their quarterly meetings. They all wish to be able to define groups to handle different projects simultaneously; configure and schedule their tasks and resources for execution while tracking resource conflicts and overload. Stu hopes that they can manage multiple projects at the same time, each with their own calendars, tasks, discussions, shared files, common access to shared service providers and other contact lists, all the while keeping track of legislative requirements. In addition, they wish to set up teams dynamically ; create and reuse/modify their work templates; integrate external tools; and access external data sources; performing demonstrations, initiating chats and conference calls, as well as tracking discussions and commentary as the need arises. In addition, they all wish to share with other users and to invite other business partners to collaborate, either as observers or as contributing participants as they are mostly geographically dispersed and should use any suitable communication device as the situation warrants.

Martha indicates that it would be nice to be able to identify where a participant belongs in the entire workflow and how he/she contributes to the entire plan. At the same time it would be good to be able to make announcements and to have an overview of what is happening in a summary view. They all hope that the platform will support task execution as specified in the execution calendar timeline; track and monitor any deviations from the plan from different perspectives and that it could manage approval/signoff points. Stu hopes that it will also allow changes to the plan if the situation arises; that it will recommend solutions, and inform relevant participants to take action or to negotiate. In addition, it should continually track and assess ongoing projects and measure progress, success and eventual impact based on defined metric. Rick indicates that it would be nice if the community allows training participants to stay in touch and to share knowledge, or to engage in social interaction if they wish.

Since Martha would like to deal with some private information she would like secure access to her local data centre and a private work space to run her activities, regardless of her location. In addition, she would like to store, share and manage her documents securely as well as search, aggregate and analyze data, among other things.

Based on your experience and the accompanied scenario, how relevant do you think the envisioned actions in the work tool are?

Figure 8.3: Collaborative Scenario

➢ The Interview Procedure

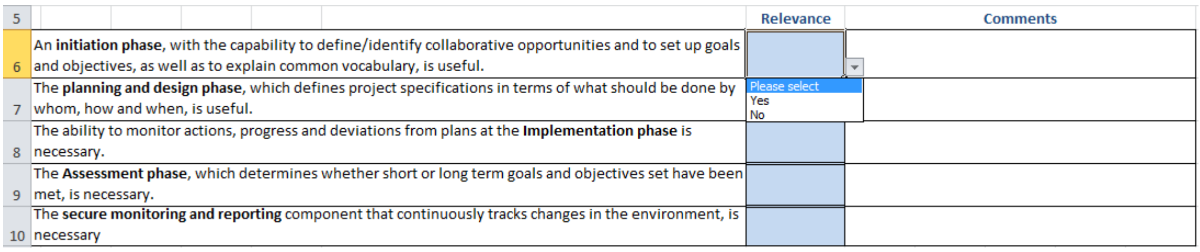
Of the twelve participant interviews, seven were conducted face-to-face; two were accomplished using Skype and the remaining three were conducted telephonically. The PowerPoint ‘broadcast-slide-show’ function was used to achieve visual presentation to remote participants. An email requesting participation in the interview was sent to all the targeted participants. Upon agreement of participation, appointments were made for interviews with each respondent. A brief of the model, with a description of its components, was sent to participants a week prior to the confirmed date of the interview.

On the day before commencing the interview, the respondents were asked to complete a consent form (Appendix A2). The interview was initiated with a briefing of the proposed model, explaining its components and its envisioned operation and function. Certain participants interjected, commenting on how they perceived the components of the model to be appropriate, as the interview progressed. Thereafter, the participants were presented with the scenarios and were asked to comment on the applicability and usefulness of the model to the situations presented. During the interview the participants were asked for observations, critiques and commentaries relative to the tool document or to certain aspects of the model component. The sessions were recorded, particularly in the face-to-face settings; however, recording the telephone based sessions was a little more challenging. The comments made during interviews are provided in Appendix G.

The participants were asked to rate the relevance of the proposed components of the model, using the questionnaire contained in the validation tool, which was sent together with the concise model description (Appendix E1) and consent forms. The relevance ratings were achieved using the Yes/No select options as shown in Figure 8.4.

➢ The Model Evaluation Tool

The validation tool was designed in a Microsoft Excel format, consisting of three worksheets. The first worksheet provided instructions as to how to use the evaluation tool. The second was used to capture the biographical information of the participants, while the third contained the components, requirements and activities of the model under assessment (Appendix E2). Figure 8.3 illustrates the questions structure of the validation tool.



5		Relevance	Comments
6	An **initiation phase**, with the capability to define/identify collaborative opportunities and to set up goals and objectives, as well as to explain common vocabulary, is useful.		
7	The **planning and design phase**, which defines project specifications in terms of what should be done by whom, how and when, is useful.	Please select Yes No	
8	The ability to monitor actions, progress and deviations from plans at the **Implementation phase** is necessary.		
9	The **Assessment phase**, which determines whether short or long term goals and objectives set have been met, is necessary.		
10	The **secure monitoring and reporting** component that continuously tracks changes in the environment, is necessary		

Figure 8.4: Extract of the Validation Tool

The participants were asked to rate the components, activities and actions of the model based on a simple Yes/No rating. 'No' signified that the respondent disagreed with the utility and applicability of a proposed component in a collaborative exercise, denoting that it is irrelevant. Conversely, 'Yes' indicated that the respondent agreed with regard to the functionality and suitability of a proposed component, thus making it relevant.

Furthermore, a comment column was provided for the respondents to allow observations, critiques and remarks relating to a proposed component or action(s). The results from the validation tool are presented in 8.2.3.

8.2.3 Model Evaluation Results and Analysis

The result of the qualitative evaluation is presented in this section. The processes and methods employed to evaluate the model were outlined in Section 8.1. The purpose of this section is to present and analyse the findings of the model evaluation process. Qualitative data pertaining to the applicability and usefulness of the conceptual model was collected. The results for the summative evaluation of the conceptual model serve as valuable formative input in the model improvement, alteration or redesign. This division encompasses biographical data of the experts, along with the ratings relating to the relevance of the model from the validation tool and interview comments regarding the utility, feasibility, functionality and suitability of the model.

8.2.3.1 Validation Tool Results

As far as **the Biographical Data of the Experts** is concerned, a total of twelve domain experts were interviewed. Their biographical information is presented in Table 8.1. A total of seven male and five female South African pundits participated in the interviews, from varied levels of government, in an endeavour to cover as comprehensive a range of perspectives as possible. Certain respondents were very active in the public service; others had previous experience in government and were engaged in various forms of consulting roles, or on loan to government departments. One fulfilled the role of a service provider to other government departments, at the national level.

The practitioners evaluated the model, in terms of the envisioned functionality suitability in their everyday operations, job functions and practices. The length of experience of these experts in the public service ranged from 6 years (three participants), 7 years (one participant), 9 years (one participant), 10 years (one participant), 14 years (one participant),15 years (one participant), 17years (one participant), 19 years (one participant), 20 years (one participant), and 28 years (one participant) . A frequency count of the number of participants who rated the proposed components of the model is presented next.

Table 8.1: Biographical Data of Expert Participants

PARTICIPANT	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Country	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
Occupation:	General Manager-IS	Executive Director Cooperate services + Former regional manager of public works	Senior Manager	Deputy Director IT	IT Manager	Director-FIS	Senior Manager: Local Government Support and Capacity Building	Senior Manager: Capacity Building Coordinator	Skills Development Facilitator	Director : Skills development and employment equity	Senior Training specialist	Senior manager: municipal ICT
Years of experience at public sector:	6	17+	19+	9+	6+	14+	20+	28+	7+	10+	6 +	15
Public sector department:	Provincial Treasury Department	Municipal + Provincial department	Municipality	Provincial Treasury department	Provincial Treasury department	Provincial Treasury Department	National department	National department	Municipality	Municipality	National	Provincial Department of local government and traditional affairs

8.2.3.2 Ratings of the Relevance of the Proposed Components

The participants were asked to rate in what way they viewed the proposed components to be relevant. They were also asked to provide additional comments or viewpoints on the components as they felt necessary. The results from the participant ratings are presented as a count of frequencies of the ratings in each phase and of the overall components. Appendix E2 contains the validation tool interpreted in this section. The interpretation commences with the initiation phase, followed by the assessment and then a general overview of the component ratings is provided. In each case, the frequency count is outlined, with comments made by participants in each phase highlighted.

Phase 1: the Initiation Phase

Each of the twelve participants rated the actions in this phase, with respect to the scenario, as relevant and useful. Although on two separate occasions, participants who chose to fill in the questionnaire after the presentation, called for confirmation on what personalisation meant. One of the participants (P7) commented on the personalisation action (see Figure 8.5, line 17), stating it was relevant to the scenario, but insisted that personally, she is glad it is optional as she deems it of little importance. The participant accentuated that she does not mind using email, or even sifting through it, and considered its usefulness to be relative to the willingness and capability of a person to peruse through correspondence.

However, she emphasised that she feels that it is good to be provided with the choice. She maintained that context based specification, as per Figure 8.5, Line 20, is crucial if participation was to be realised. She further asserted that not everyone likes to use ICT elements. Others strongly maintained that it is essential. Although P8 added a condition to her comment that "*as long it does not mean belonging to a particular person; as it will restrict collective ownership and buy in from relevant stakeholders, this it is a yes"*. At this point I reaffirmed that the personalisation referred to was in terms of the technology enabling, dynamic insertion, customisation and suggestion of content in a format that is relevant to individual users based on their specified preferences and interest. The statement reassured her stance on its usefulness.

In a general reference to the phase, participant 8 (P8) suggested the need to make explicit the requirement of clearly specifying the measuring metric at the initiation of a project, in order to support effective post project test analysis when evaluation commences. Participant 5 (P5) emphasised the need to take cognisance of mobile devices, and how they can be extended to support such collaborative platforms, while noting their limitations. According to the overall, general ratings from the participants in this phase it can be concluded that the proposed components are considered useful and applicable to managing collaboration and to streamlining coordination. A summary of the participant ratings is provided in Figure 8.5.

13	**Phase 1: Initiation**		
14	In order to leverage economies of scale the intiation phase consists of activities which include: defining and identifying collborative opportunites from environmmental requirements and providing a shared environment to support the subsequent specification of the goals and objectives of the desired outcome, as well as agreeing on common terminologies and meaning.		
15	Possible support actions	Relevant	Not-Relevant
16	Is it relevant to have a system that will help to define and identify opportunities for collaboration?	12	0
17	Is the personalization of such opportunities relevant?	12	0
18	Is the ability and flexibility to use any communication/notification means necessary?	12	0
19	Is it necessary to have a system that provides a virtual environment to set up goals and objectives by supporting meetings, discussions and problem-solving?	12	0
20	Is it relevant to be able to specify the dates and locations for the events that you are interested in?	12	0
21	Is establishing a shared vocabulary of terms, concepts and their meanings relevant to understanding project specific functions?	12	0

Figure 8.5: Ratings Applied in the Initiation Phase

Phase 2: Planning and Design Phase

The response of the participants with regard to their perceptions of the utility and applicability of the planning and design activities to support collaboration and streamline coordination is provided in Figure 8.6. As is evident in Figure 8.6, each participant referred to all actions in the phase as relevant towards coordination support. P5 further emphasised the obligation for role clarification for effective coordination. Relative to Line 26, P7 suggested the need to ensure that agreements to participate and to be a part of the team allocation are in place. P6, relating to Line 27, in Figure 8.6, emphasised the need to ensure compliance with the relevant legislation. P10 accentuated the importance of being aware of the challenges associated with the supply chain. P7, asked the question 'how seamless?' regarding Line 27 in Figure 8.6 and stressed that, for instance, such seamless operation must take cognisance of the procurement policies. Participant 11 (P11) maintained the imperative of having a centralised lookup database for service providers and of ensuring the transparency of operations.

All participants strongly believed that the activities proposed for in this phase are of essential importance, with the verdict indicating that the planning and design phase components are relevant. Therefore, it can be concluded that the actions in the phase are useful and applicable towards coordination support in a distributed environment.

23	**Phase 2: Planning and Design**		
24	The planning and design phase sets the project supporting structure and specifications that that serve as a reference model/template to guide resource deployment and the execution of collobrative projects. This ensures that requirements are enforced during execution. The activities in this phase include: setting up teams, roles, reporting structures and working procedures, among others.		
25	**Possible support actions**	**Relevant**	**Not-relevant**
26	Is the ability to dynamically define groups to handle different projects simultaneously; organize and configure teams, tasks and resources for execution while tracking conflicts necessary?	12	0
27	Is the ability to look up and invite service providers seamlessly, as well as to check their accreditation and requirements important?	12	0
28	Is it necessary to be able to map tasks, schedule the order of execution and possible resource deployment in a calendar or process view form?	12	0
29	Is the ability to create, reuse and adapt templates for both design and execution relevant?	12	0
30	Is the ability to seamlessly create and securely manage/share files or documents important?	12	0

Figure 8.6: Ratings Utilised for the Planning and Design Phase

Phase 3: Implementation

The results of the perceptions of the users towards the requirements and activities for the implementation phase are presented in Figure 8.7.

32	**Phase 3: Implementation**		
33	Implementation enforces specifications provided in the planning and design phase while monitoring deviations from plans and accounting adaptviely for problems (exceptions) that may occur.		
34	**Possible support actions**	**Relevant**	**Not-relevant**
35	Is the ability to monitor deviation from established plans, during the course of execution relevant?	12	0
36	Is it necessary for a system to have the flexibility to reorganize tasks and redefine a workflow definition or specification, as well as support human interventions during the course of execution?	12	0
37	Is an execution system that can adapt dynamically to situations relevant?	12	0
38	Is the ability to track and detect conflict during resource distribution and deployment relevant?	12	0
39	Is automating predefined tasks, tracking the resources, performers, as well as approval and sign-off points important?	12	0

Figure 8.7: Ratings Utilised in the Implementation Phase

Every proposed action was rated as relevant. P11 emphasised checking for compliance to established rules, continuing by advocating the need to document reasons for deviation(s) from the plan, when they occur, to serve as input for decision making. Based on the feedback it can be concluded that the requirements and activities of implementation are deemed functional and apposite to managing coordination in a distributed environment.

Phase 4: Assessment

The feedback of the participants regarding their viewpoints relative to the activities in the assessment phase of the collaborative project is presented in Figure 8.8.

41	**Phase 4: Assessment**				
42	Assessment evalautes whether goals and objective set out at the initiation stage were met resulting in changed requirements, while documenting changes for future overall impact assessment.				
43	**Possible support actions**	**Relevant**	**Not-relevant**		
44	Is the ability to track and assess performance relevant?	12	0		
45	Is the ability to evaluate both short term and long term impacts of events relevant?	12	0		
46	Is having secure access to multiple data sources for analysis and forecasting relevant?	12	0		
47	Is the ability to integrate visualization tools and issue specific assessment tools necessary?	12	0		
48	Is having access control to local resources even towards consolidated data analysis relevant?	12	0		
49	Seamless search, categorization, and storage of information is relevant.	12	0		

Figure 8.8: Ratings Utilised in the Assessment Phase

All the participants indicated that the each of the activities in the assessment phase is relevant. Participant 11 observed the need to track individual performances over time to challenge and reveal weaknesses from service providers. P11 also stressed the importance of customised analysis and reporting tools to account for various needs. P7 suggested the need to make explicit the redress phase, in case performance is flawed. The results denote that having monitoring and assessment activities is useful and applicable to coordination support in a distributed environment.

Phase 5: Continuous, Secure Monitoring and Reporting

Figure 8.9 shows the ratings of the participants as to the possible actions of the continuous monitoring and reporting component. All the participants rated these activities as most relevant to continuous monitoring and reporting. P11 stressed the importance of documenting and consolidating the lessons learnt throughout the life-cycle of the collaborative project. Overall, it is indicated from the results that the phase is functional and applicable towards coordination support.

51	**Phase 5: Continous and Secure Monitoring and Reporting**				
52	To account successfully for dynamic changes in the environment there is an encompassing secure monitoring and reporting component that continuously tracks the activities and changes in the environment which, in turn, facilitates subsequent colloboration and improvement.				
53	**Possible support actions**	**Relevant**	**Not-relevant**		
54	Is the continuous tracking and monitoring of performance and changes in the environment as well as requirements necessary?	12	0		
55	Is the ability to monitor and report at different stages in an entire collaboration process relevant?	12	0		
56	Is support for various but streamlined and targeted reporting necessary?	12	0		
57	Is collecting and analyzing information systematically as a project progresses relevant?	12	0		

Figure 8.9: Ratings Regarding Continuous Secure Monitoring and Reporting

8.2.4 Overall Comments on Proposed Model and Its Components

Once the phases had been processed, participants were asked to comment on the overall relevance of the phases. The coding method employed is discussed in Chapter 5. Figure 8.11 indicates the ratings of the participants as to the overall applicability and usefulness of the components. The frequency count of the ratings of the participants on the proposed components, and their possible actions confirms that the collaboration life-cycle model is practical, useful and applicable towards managing and streamlining coordination in the South African public sector. It is deemed that the model has great potential, as its usefulness and applicability was acknowledged from the multiple perspectives of the various domain experts.

5		Relevant	Not-Relevant
6	An **initiation phase**, with the capability to define/identify collaborative opportunities and to set up goals and objectives, as well as to explain common vocabulary, is useful.	12	0
7	The **planning and design phase**, which defines project specifications in terms of what should be done by whom, how and when, is useful.	12	0
8	The ability to monitor actions, progress and deviations from plans at the **Implementation phase** is necessary.	12	0
9	The **Assessment phase**, which determines whether short or long term goals and objectives set have been met, is necessary.	12	0
10	The **secure monitoring and reporting** component that continuously tracks changes in the environment, is necessary	12	0

Figure 8.9: Ratings Regarding the Overall Component Functions

Participant 6 (P6) stated *"It's nice to see you seem to have covered all the relevant areas from what I can see. It's quite a nice idea to build it in with workflow. Auditors will love you".* Participant (P12) concurred saying *"They are all relevant and necessary issues to be covered, especially when it comes to project management and workflow process."* This provides an indication of the potential value the model holds, towards the mass management and streamlining coordination in a distributed environment.

8.2.4.1 Domain Expert Interview Results - Benefits

Comments on the collaboration life-cycle model and its components were obtained through interviews with the experts. A total of twelve interviews were conducted to evaluate the proposed collaboration life-cycle model towards coordination support in a distributed environment. A summary of the comments and results from the perspectives of the experts engaged is presented in this section.

During the interviews the participants commented on the conceptual model and its components, which each of them identified as useful and applicable to streamlining coordination of collaborative projects. All of the participants agreed that the proposed model and its components are functional, practical and appropriate. According to the specified scenario they remarked that the components of the model are well defined, with consideration paid to all the necessary aspects which frequently require attention. The value envisioned from the model is presented verbatim, below:

P3 asserts "*the model is clear and it is quite generic in terms of its phases: so conceptually I think it is very clear and it's sound, I think it works. Working with municipalities, I certainly think it's relevant to have an online system".*

P1 contends *"the purpose of the Intergovernmental Governmental Relation (IGR) Act is what you are trying to give effect to by strengthening the Intergovernmental relationship, which is about collaboration, so it's very important*." Essentially, structures for coordination exist as part of the IGR Act, which the model can leverage. P1: *"Based on the scenario it should be intended for both centralised and decentralised approach to skills development in the public sector.*"

P2 remarks: "*the idea you are coming up, with, collaborating to share training provider is a good idea. We should train for the broader society, track development of personnel so that they can fit in anywhere by standardising your model, reminds of the shared services we have in Gauteng province, because it has to minimise cost as well*" thus, reemphasises the need to leverage economies of scale. "*Training is good, but without monitoring and evaluation it is useless."*

P5 maintains *"Instead of spending money on travel and accommodation, this kind of model will help save costs as it will help aggregate similar trainings together for a more efficient collaboration by bringing in just one trainer rather than multiple for the same purpose. You save a lot of money for the government, and have record of who has and has not been trained."*

P4 asserts "*all of model aspects are important, as they reflect project management phases*.*"* P8: *"The model accommodates my current situation right now. It captures all the relevant problems which makes it useful*." P9 comments "*the system is very practical; you can share the information with us for what we trying to do as a tool we are trying to develop an impact assessment tool which mostly relate to what we call return on investment. We want to know whether the money that we spend on training really makes an impact. Is there any performance, improvement, should we use same service provider you know, what you say here*". This accentuates the importance of support for monitoring and evaluation.

Furthermore, according to P6 "*in terms of auditing, if it makes it a lot easier for using this system a lot of people will be willing to, as you've touched the main points. I think it is a great initiative you are undertaking, I like the idea, all we need is to convince people on how it will benefit them"*

Questions regarding the readiness of the public sector, specifically municipalities, to embark on such project, however, came to the fore. The predominant concerns encountered during the interview process are discussed in the next section.

8.2.4.2 Domain Expert Interview Results: Concerns

Referring to the willingness to cooperate, along with technological readiness, P2 asks *"Are the municipalities ready for that yet?"* This respondent maintains that it will be a difficult endeavour, given that usually, *"the bigger municipalities want to remain bigger and want to ensure the smaller remain smaller,"* a sentiment that indicated the impediments to cooperation.

P3 notes *"I think it's relevant to have an online system, my concern though, the extent to which, practitioners will use such online collaboration tools, given the ICT infrastructure capability challenges in, especially, the local municipality where it is difficult to have… basic email support. For example many …municipalities are battling with basic ICT systems, I'm not sure whether having an online system of collaboration, will be effective. While the tool is very appropriate for well-developed context, so it will work well in the global north and the metropolitan areas. It might be challenging for areas that really need to collaborate, such as the district and the local municipalities.* This denotes that a level of technological maturity is required to be successful.

Whether the system was to be seen as a replacement for a face-to-face approach was discussed. It was made clear that the system is aimed to function in a complementary capacity to leverage the face-to-face approaches. P11 remarks "*don't forget physical human interaction,*" which is also emphasised by P3.

Technological readiness, together with skills, were definite concerns; however, they were not exclusive. P4 emphasised the lack of cooperation and the unwillingness to compromise in the municipalities, asserting: "They *usually want nothing to do with the other municipality, which affects cooperation and brings a barrier on the technology, as municipalities work in silos…also another issue, is that the infrastructure is not there to begin with."* P6 avers "*municipalities see themselves as independent entities and that affects accountability"*. P6 accentuates the need for a higher authority to guide such an undertaking, establishing consequences for non-compliance.

Concerning municipalities that are self-sustainable, P10 points out *"there many systems that need to be integrated together…they are just all scattered around,* (Silo mentality) *driven by political ambition, with heads just wanting to outshine the other*...*in as much as ? want to see the consolidation and integration, there is the human nature that needs to be taken care of, which is mostly associated with political ambition. Hopefully* we *can get value administratively …we are still battling to understand systems that provide M & E. detects supply chain rules, then initiates, say the tender process... and tracks the rules and activates, creates, reuses and adapts - that will save costs!*

Corresponding with P5, P10 points out "*there is a lot government can save if we can track and eliminate duplications and track deviation.*" As far as monitoring and evaluation are concerned, P1 emphasises the need to be able to integrate any analytical model, for any specified need context under study.

It can be concluded from the feedback from the interviews that the model and its components can be useful and fully embedded into the environment, if certain requirements are met. The recommendations and suggestions for improvements have been noted and will be included to refine the conceptual model, as explicated and clarified in the next chapter.

8.2.5 Triangulation

Data triangulation is employed in the research. Data is triangulated from informed arguments arising from literature, the review of academic publications and interviews with domain experts. The objective of triangulating data from the various sources is to obtain diverse and different, but complementary, data on the usefulness of the proposed model. Figure 8.1 illustrates the data collection methods employed in the triangulation approach.

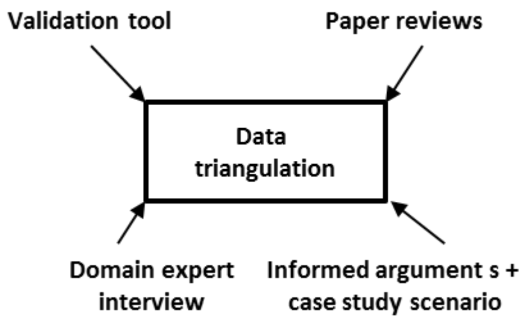


Figure 8.1: The Data Collection Methods Utilised for Data Triangulation

The primary data collection procedures employed included interviews and the questionnaire integral to the validation tool. The significance of establishing a comprehension of how the model will be applied in actual situations was previously iterated. Interviews were conducted with potential users of the proposed model, comprising domain experts in the public sector. These experts were asked to comment regarding the utility and applicability of the model, relative to managing and streamlining coordination based on a provided scenario. The scenarios were developed to simulate the real problems that the model seeks to address.

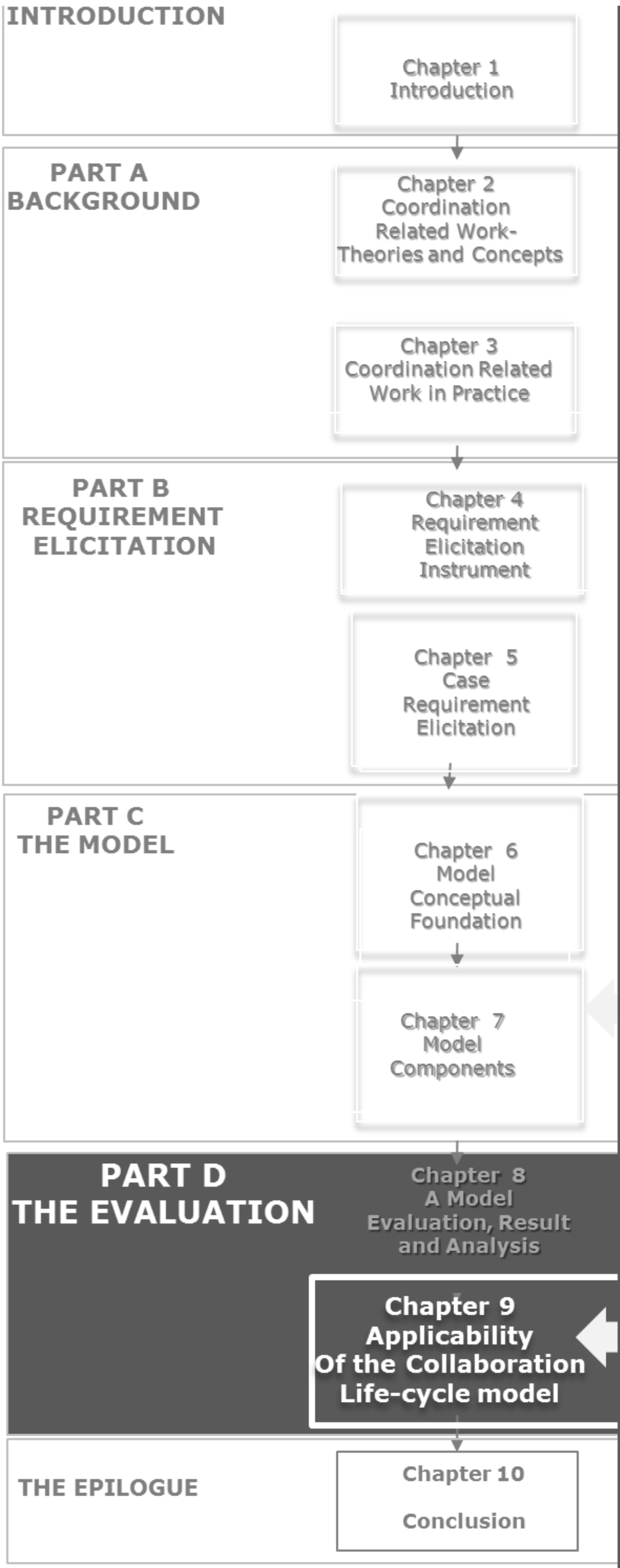
A review and analysis of literature provided secondary data in support of the argument for the necessity of a coordination support model. Primary data, motivating the utility of the proposed model, was obtained from expert review, through interviewing subject domain experts, in consort with the completion of the validation tool, and comments from a review of the academic publications. The data collected was inductively and logically analysed, to interpret and structure the derivable meanings. This inductive approach aims to reveal the pertinent realities, with respect to subjective perceptions on the usefulness and applicability of the model. Essentially, argumentation of literature, review of academic publications, validation tool ratings and expert interviews were data sources used in order to refute or support the utility, feasibility, functionality and potential applicability of the proposed model.

8.3 Evaluation Constraint

Since evaluation is limited to a single work environment and restricted to a scenario it is not possible to determine conclusively the coverage and precision of the model and its functions. While due diligence was considered in validating the proposed model in order to attain the desired level of credibility as far as possible, a few challenges were encountered, which hindered the achievement of full satisfaction in validating the model. The validation progress suffered from time constraints, as time to implement the model practically in a real context of use, was limited. Practical implementation of the model would require encompassing the initiation of a project, from the requirements elicitation, through the post implementation phase, to the evaluation phase. Such a process requires a longitudinal study which is not practical given the time constraint allocated to the academic study. Scenarios simulating the practical usage of the model were modelled in an effort to circumvent the issue. This challenge was alleviated by selecting domain experts with the necessary experience to participate in the assessment of the model.

8.4 Conclusion

This chapter provided details on the purpose of the proposed model, along with the processes followed, pertaining to the validation thereof. Methods used during the validation were explained. Furthermore, the results of the evaluation exercise were presented and analysed. It appears that the functions and action of the proposed model covered the majority of the coordination mechanisms envisioned in the public sector environment. However, the constraints faced during the validation process were noted and the means used to circumvent these challenges were explicated. Overall, it can be concluded that the findings from the evaluation reveal that the model has been proven to be useful and applicable. The findings obtained during the evaluation of the model will be used as feedback to refine the model, as explained in Chapter 9.



9.1 Applicability of the model

9.1.1 Step 1: Environmental Needs Awareness

9.1.2 Step 2: Initiation

9.1.3 Step 3: Planning and Design

9.1.4 Step 4: Implementation

9.1.5 Step 5: Assessments

9.1.6 Step 6: Continuous Monitoring and Reporting

9.2 Refinements of the Collaboration Life-Cycle Model

9.3 Model and Architectural Component Evaluation Mappings

9.4 Conclusion

CHAPTER 9

APPLICABILITY OF THE COLLABORATION LIFE-CYCLE MODEL

This chapter ensues from the previous chapter in verifying that the proposed model has the potential for practical use in real-life circumstances. Through verification the feasibility of the Collaboration Life-Cycle Model is evidenced, as a result of the reports and feedback pertaining to the usefulness and applicability of the model. The main approach employed to evaluate the usefulness and applicability of the model constituted interviews of domain experts and their completion of the validation tool. A discussion on the applicability of the model and its supporting architecture will be illustrated, based on how the domain experts perceived the model utility in addressing the scenarios. Details of the scenarios were discussed Chapter 8. The process followed to evaluate the model was reviewed in Section 8.1.

This chapter initiates a discussion of the model applicability; followed by the refinements of the collaboration life-cycle model, according to the concerns raised by participants in the previous chapter. This is succeeded by the model and the architectural component evaluation mapping and the conclusion.

9.1 Applicability of the model

To illustrate the applicability and usefulness of the model, the phases in the model were followed in Figure 9.1. This section reports on the results of each step.

9.1.1 Step 1: Environmental Needs Awareness

This step indicates that applicability of the model is reflective of the successful identification of needs in the environment. As such the collaborative project begins with awareness of the problem acted on by collaborators as knowledge, which is generated drawn and accessed from multiple sources. By drawing from this knowledge a suggestion for a collaboration opportunity is made. This in turn will lead to setting up objectives, planning, guided execution, the eventual evaluation and the monitoring of deviations from expectations of collaborative projects. While participants responded positively to the capability, they reemphasised the importance of having the access control mechanism in place. More so, one participant noted the importance of having audit support tools to assist with needs assessment.

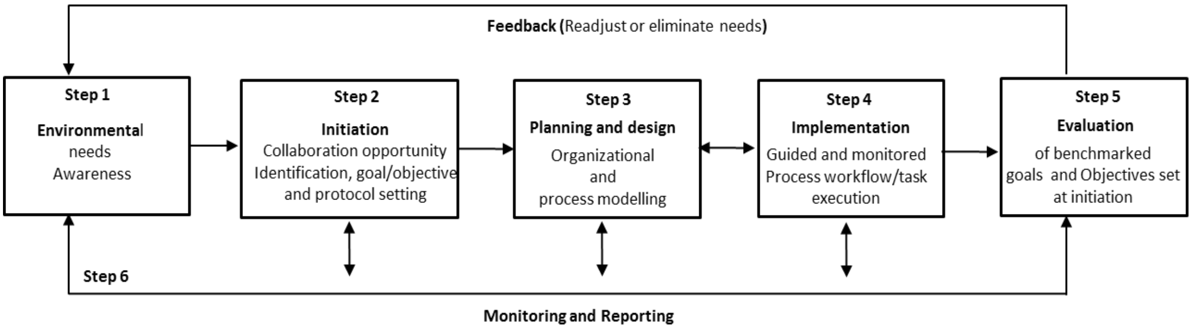


Figure 9.1: Steps for Using the Collaboration Life-Cycle Model

9.1.2 Step 2: Initiation

The initiation phase, as mentioned, aims to identify the opportunity for collaboration, and helps to define the objective of such collaborative effort, in conjunction with creating a consensus regarding terms, vocabularies and meaning. All participants interviewed agreed to the applicability and utility of the envisioned coordination support action in this phase, relative to the scenario. Generally, participants maintained that it is, for instance, important in the context of scarce resources, as there is a need to look at joint opportunities to minimise costs through engaging a single service provider. In addition, it is a good idea to personalise opportunities and to customise the features. One participant noted that if the tool is to be powerful it has to build in flexibility, and be robust enough, along with being able to adapt and meet several contexts. Furthermore, the ability to know dates, times and general calendar related factors, was deemed critical, as was having a common set of understanding, through a shared vocabulary and consensus as to the meanings of terms. The use of private and shared workspaces by participants to coordinate activities, as long as it was complemented with periodic face-to-face meetings was well received. In addition, communication and notification flexibility was welcomed.

9.1.3 Step 3: Planning and Design

The planning and design phase utilises a workspace and the possible myriad of tools to set up and configure teams, as well as to define workflows. This phase facilitates organisation, which manages size and complexity by dividing work into manageable chunks that may operate in a loosely coupled manner. The participants highlighted the importance of the activities in this phase. Participants especially accentuated the relevance of managing complex and multiple projects concurrently, using a capable task and project management tool. They noted the importance of automation and of having support configuration templates, while taking cognisance of the varying supply chains, management process and procedures utilised by municipalities. The evaluation findings indicate that support for autonomy was welcomed as was each organisation having their own Activity Workspace to manage their activities. Participants liked the scheduling, documentation and deployment plan, as well as shared and controlled access to tools and document capabilities.

9.1.4 Step 4: Implementation

Overall, the findings suggest that tracking on-going activities and the capability to manage deviations was well received. In the scenario, the need for transparency to monitor tasks is stressed. Generally, the participants reflected that the phase activities are useful and practical in the portrayed scenarios. Participants noted that monitoring in order to ensure that things are proceeding on track is very important. For instance, it was noted that because in Local Government different things occur, with alterations according to political correctness and executional demands, having the ability to monitor and redefine workflow is necessary. Managing the elaborate signing off process securely at strategic points in the project, complemented with face-to-face meetings was advocated. Also highlighted was monitoring deviation and documenting the reasons for such deviations, towards fulfilling the function of a knowledge base aimed to simplify future actions and decision making. Deemed crucial were the requisite for notifications of changes, communication of feedback and reminders to approve or take action within a workflow. The ability to detect supply chain rules that initiate, for example the tender process, and thereafter track the rules and activate, create, reuse and adapt and eliminate duplications, was welcomed. Thus, process awareness which, *inter alia* determines whether a project is operating within its defined parameters and delivering expectations was well received.

9.1.5 Step 5: Assessments

The assessment phase underscores the need to evaluate. The ability to collect and analyse data systematically to determine whether, and to what degree, the objectives have been or are being achieved for decision making was considered valuable. Participants noted the importance of reflecting on goals set and on the achievement of the desired outcome. The establishment of short term execution points was accentuated to overcome ambiguities. Additionally, considering that all municipalities are required to adhere to the service delivery and implementation plans and budgets, the ability monitor compliance was welcomed. Participants maintain that the significance of collecting and analysing information is tacit, for a periodic and targeted reporting in an audit capacity to ensure continuous development, while minimising duplication. The ability of the system to customise reports was appreciated, with statements such as, *"it should have an option for me to be able to plot my own requiring. We don't need to just keep a system that is very generic and specifics can't be put in or analysis can be done to suit* *your needs because analyses that are general may not necessarily give the required result."* Furthermore, the need for integration to prevent duplication was deemed critical. Participants indicated the importance of having systems that talk to each other, where dynamic simulations and reporting can be realised in order to assess whatever was required. Overall, merging disparate information sources into a shared repository was welcomed. Thus the monitoring and evaluation support capability was tagged as relevant.

9.1.6 Step 6: Continuous Monitoring and Reporting

This dimension is intended to ensure sustainable coordination. The ability to monitor projects and to provide feedback, which allows for structure and work process adjustment to facilitate improvement, was well embraced. The facility to monitor and summarily see performance, providing information relative to the status quo and identifying trends that can be leveraged, was stressed. All respondents indicated that the monitoring and evaluation ability is applicable and important for sustainable coordination. The participants contend that report visualisation should be based on preference, and therefore, should be customised to the needs of the users. As they customarily report to different departments, a paperless system like this where councillors who require information may log in to a computer, punch certain keys and then draw whatever they are looking for is desirable. One stated: *"we won't be having all these reporting issues. If we can have that kind of a system, there should be no reason why. They won't know challenges and weaknesses."* As gaps were noted during the evaluation process of the model, the feedback validated the practicality, feasibility and utility of the monitoring phase towards model improvement. The modifications recommended to fine-tune the model, based on lessons learnt during the evaluation process are presented in in the next section.

9.2 Refinements of the Collaboration Life-Cycle Model

Overall, the model was well received by the domain experts, who applied it as given in the depicted scenario. However, although the model was deemed applicable, some concerns were raised. Predominantly, the concerns related to the technology and skill readiness of practitioners to engage the model functions in order to collaborate and streamline coordination successfully. Additional issues involved the willingness of practitioners to collaborate and whether the model was intended to replace the traditional face-to-face approaches. Figure 9.2 attempts to address these concerns.

Regarding replacing the tradition face-to-face encounter, the model merely complements it and extends or facilitates the shared service resources employed in the face-to-face encounter, in the most basic form, archiving and knowledge sharing. Some suggestions made during the evaluation process are highlighted in the phases in yellow colour codes.

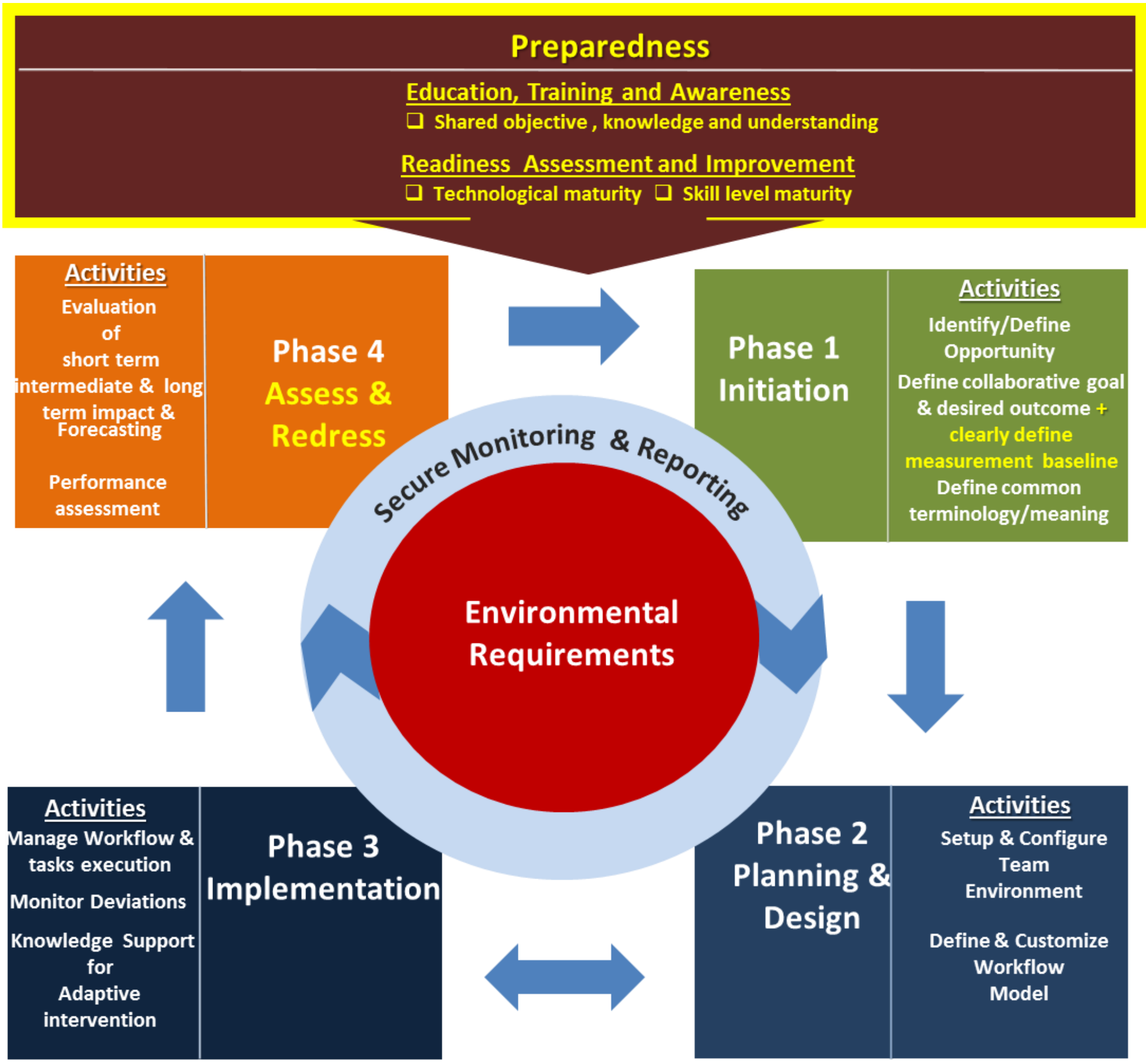


Figure 9.2: Refined Model

To address the readiness concern, as shown in Figure 9.2, a new dimension was introduced to the model. The dimension is reflected in the 'preparedness component'. Two major aspects are introduced, viz. the readiness assessment and improvement, as well as the need for general education, training and awareness activities. This reflects the readiness assessment which represents a systematic way of analysing the ability of the organisation to undertake such collaborative support intervention. The approach should address the issues, in order to afford the opportunity to remedy or overcome these gaps either before, or as part of the implementation plan. The technology readiness assessment assesses the maturity of critical infrastructure in terms of the hardware and software technologies to be used in the systems. Complementarily, the skills readiness assesses the level of skill gap that needs to be bridged to meet the operational requirement needed to run a successful intervention.

The readiness and improvement activities reflect the need to define a baseline infrastructure and skill level requirement for municipalities and practitioners, so as to measure the gap and bridge it. This approach can aid in the redistribution of budget, towards infrastructure development, which can be achieved in stages, extending practitioners to a level they can take advantage of in the model envisioned services. As noted by a participant, instead of continuously allocating budget for infrastructure for every single municipality, perhaps a better investment is looking towards leveraging existing shared infrastructures, which will help to streamline integration.

Furthermore, the concern which reflects the willingness of participants to collaborate can be leveraged through ETA. This is because emphasis on the problem from the findings suggests a lack of understanding or common goal being the root of the problem. If role players are made to understand the shared value and incentives of collaboration, as a cost saving mechanism, rather than conceived of as a competition or replacement of a job then it is likely that they will be willing to collaborate.

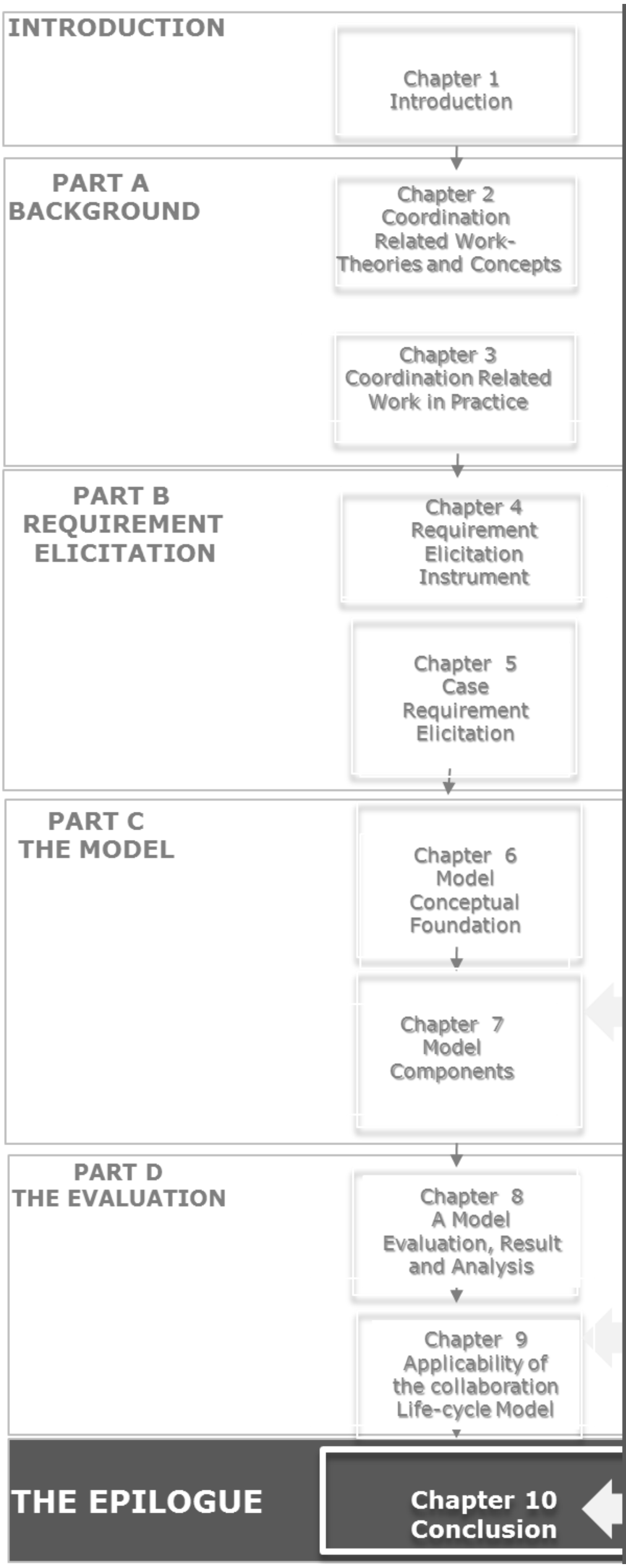
Another suggestion from the evaluation occurred in Phase 1, where it was suggested that the activity should make explicit the need to form a measurement baseline to support and facilitate efficient analysis. A question, for instance *"how much have we improved?"* can thus be answered. The other alteration that was made in the model was the assessment phase being renamed "assess and redress". The need to make an adjustment afterwards, if the objective were not completely met was brought forward, which led to the assessment phase being changed to the asses and redress phase. This is in an effort to highlight the evaluation made at this phase resulting in the forecasting of future activities, ensuing in the planning for their achievement.

9.3 Model and Architectural Component Evaluation Mappings

To evaluate the collaboration life-cycle model and the architectural components proposed in Chapter 6, a scenario was designed to expose the potential functionality of the model, serviced by the architectural components. The exposure portrayed the envisioned services that users will engage with at different stages of the life-cycle. The scenario, as previously stated, mimics a practical way in which the model can be used as a means of demonstrating the applicability of the model. At each phase of the model certain tasks to be accomplished are highlighted. The section briefly shows how the architectural components map the activities envisioned at each phase of the collaboration life-cycle model. Appendix I provides the mapping of the possible actions envisaged in each phase of the collaboration life-cycle model, in conjunction with the functions of the architecture supporting service functions. For instance, Phase 1 of the collaboration life-cycle model underlines the identification of the opportunity for collaboration, agreement on goals and the establishment of common understanding and meaning. This result from the architecture invokes the services of the profile organiser (A3 Appendix F) to work with the community manager (B4 Appendix F) to get the potential and interested collaborators registered to a community portal. Thereafter, details of user and context based preferences, based on user input, are hosted in a repository (D4), which is called upon by the execution and monitoring module (C1,2 and 3) to provide recommendation services of opportunities identified. The opportunities identified are founded on the context based information (location and time of event interest) as provided by the user. The communication mechanism (D2) is called upon to notify the user of interesting activities. Eventually, shared workspaces (B1) are created to support meetings and other coordination activities, which utilise communication tools. The resource manager (B2) provides access to shared documents and the runtime manger (C3) handles sessions and archives of activities and commentary, while processing. Phase 2 will, *inter alia*, employ, for instance, the workspace services, design and specification tools (A1) and process manager (B3) function to define and schedule process or workflow activities. Appendix F further details mappings between the model activities and the corresponding architectural components.

9.4 Conclusion

The refinement of the model is presented, founded on the concerns participants shared during the evaluation. Pertaining to these respondent concerns, an important initial step on collaborative support interventions requires a level of preparedness. This was explored, along with the technology and skill readiness concepts. Additional activities highlighted were also reflected respectively in the affected phases.



10.1 Revisiting the research objectives

10.2 Contribution of the research

10.3 Reflection

10.3.1 Scientific Reflection

10.3.2 Methodological Reflection

10.3.3 Meeting Design Science Principles

10.3.4 Substantive Reflection

10.4 General realizations and challenges

10.5 Limitations of the Research

10.6 Further Research

10.7 Epilogue

CHAPTER 10
CONCLUSION

This research has identified the fact that coordination in a distributed environment is inadequately addressed by current models. To address the issue this study developed a model to support coordination sustainably in distributed environment, specifically that of the South African public sector. With design science as the underlying research paradigm, the study was based on the tenet that constructing an artefact will contribute to the existing body of knowledge. The artefact in question was conceived by exploiting and leveraging virtual community properties through service and context lenses to enable and to ensure sustainable coordination in the SA public sector.

This chapter concludes the study by revisiting the research objectives, arguing that they were met. Thereafter, the contributions that this research made are enumerated, followed by a critical reflection on the study in terms of its scientific contribution, the methodology, design science principles and the interdisciplinary touch points. The challenges and limitations of the study are discussed before the discourse finishes with recommendations for future research and an epilogue.

10.1 Revisiting the research objectives

This section overviews the research by revisiting the problem and the mapping of the research questions to resolve the research objectives, as well as looking at the techniques employed to meet the objectives.

The purpose of the study was to design suitable models that will support the coordination of dynamic collaborative activities in a heterogeneous and distributed environment. The coordination of capacity building training intervention management in the SA public sector motivates the research. The initial problem presented is that:

Currently, a model to support and promote sustainable coordination in the South African public sector is lacking.

The main objective of the research is to design a model (an IT artefact) to mitigate the coordination problem in the South African public sector.

This raised the question:

***What functionality should characterise the proposed IT artefact exhibit to meet the coordination requirements of the South Africa public sector*?**

In order to meet the main objective and the research question some sub-objectives came into play. How these sub-objectives were met are discussed next.

Sub-objective 1: ***Identify the problem and solution constructs that characterise coordination in a dispersed environment***

To meet Sub-objective 1, **Part A** of this study focused on reviewing the existing knowledge, which reflects both the problem and solution domains. Informed by theory and practice, the knowledge base provides suggestions for resolving the research problem. Essentially, Part A, through a detailed literature survey, considered the question: *What are the known coordination constructs that can characterise and transform the problem and solution spaces?* Therefore, by conducting a systematic review, Part A made sense of the body of literature relating to coordination in a distributed environment.

The answer to the primary research question, as stated above, is divided into two chapters. **Chapter 2** reviews the relevant theories and concepts, in relation to how they characterise coordination and how they are applicable in a distributed environment. Table 2.11 provides a summary of lessons learnt. **Chapter 3** considers the existing socio-technical practices employed to alleviate the coordination problem, focussing particularly on the distributed environment. The output of this portion of the discourse reveals suggestions, informed by both theory and practice, towards a solution to the problem. Among the suggestions is the apparent need for an instrument of analysis, to evaluate the nature of coordination in a specified environment, along with the requirement to leverage the potential of virtual communities towards a solution.

Sub-objective 2: ***Determine what is required to support coordination in the South African public sector.***

Part B served as a mini research project to meet sub-objective 2, supplying the first contribution of the study, in the form of an instrument of analysis. In order to provide a solution that addresses coordination in the SA public sector, Part B of the study focused on understanding the environment, addressing the query: *What requirements characterise the environment?* The limitation of existing frameworks to account adequately for the factors that may influence coordination in a distributed environment, as discussed in Part A, engendered the need for the development of an analysis instrument which would account holistically for these aspects. In an effort to understand the application environment, **Chapter 4** considered the design of an all-inclusive investigative instrument to adequately evaluate problem areas. The analysis framework was developed through traversing between an extensive literature study and empirical evidence. The range of issues considered extends beyond the frequent and common, narrow considerations of existing techniques. The issues deliberated encompass, *inter alia*, the enabling environment, the organisation, infrastructure, processes, and the group and individual worker dynamics. The utilisation of a case study approach facilitates modifications to the framework, based on initial evaluation results arising from this technique. The case study identified gaps and limitations requiring resolution. This allowed the formation of a premise, which theorises that the framework extends to presenting multi-category propositions towards attaining a holistic understanding of the coordination status quo. The application of the framework is conducted in **Chapter 5**, relating to the SA public service capacity building endeavours. The application of the framework resulted in the environmentally specific requirements, which serve as input for the solution development. Thus, the section provided an analysis framework and a set of propositions utilised to evaluate and to identify the requirements specific to supporting coordination in the context of a distributed environment. Furthermore, the results obtained from the analysis function as input for scenario building, aimed at the summative evaluation undertaken in Part D of the proposed model support services, as portrayed in Part C.

Sub-objective 3: *Construct the model artefact that can support coordination in the South African public sector*

Part C supplies the second and third contributions of the study in the form of the collaboration life cycle model and its supporting architecture. Considering the requirements sourced in Part B, in conjunction with the lessons learnt from the evidence-based knowledge, as revealed in Part A, Part C relates to the model and its supporting architecture development in the quest for a solution. Part C addresses the inquiry: *What are the elements and/or constructs that characterise the solution space and how can they be interwoven to support coordination in the SA public sector?*

Utilising the set of requirements generated in Part B, along with the foundation theories and concepts and the current sociotechnical practices and trends, Part C proposed a collection of design and development principles. These principles were utilised as the basis for motivating a set of possible system features, which have the potential to facilitate coordination support in a heterogeneous distributed environment. For instance, considering the need for flexibility, adaptability, scalability and reuse, a loosely coupled approach to the architecture design was employed, subscribing to the modular service design concept and the publish/subscribe paradigm. **Chapter 6** provides the conceptual foundation of the model and the architecture. **Chapter 7** augments and extends Chapter 6, with more detailed coverage of the components, evaluating and explicating their operation and relationships. Firstly, a lifecycle model was presented as meta-process aimed to streamline coordination of dynamic collaborative actives or projects. Secondly to adequately host the process based operations, an architecture that will enable the technical virtual-community-centric, context-aware environment was produced.

The methodology employed was synthesis through informed argumentation. Information from existing knowledge and feedback contributed by publications and discussions was utilised to build the artefact and to accentuate its utility. Furthermore, the formative evaluation process was amplified by case based examples, to convey and aid in understanding the capability of the artefact. The academically based arguments and publications comprise an element of evolving the proposed design of the artefact iteratively; however, the artefact evaluation was also extended to the environment. This demonstrates the feasibility of the approach in resolving the problem, relative to its applicability and utility in a real world setting. This was achieved through the summative evaluation undertaken in Part D.

Part D discerned whether the proposed model met the coordination needs of the environment. Part D focused on testing the applicability and usefulness of the services proposed in the model and the architecture outlined in Part C. This division addressed the question: *How can the usefulness and applicability of the model artefact be evaluated?* As design science establishes and advocates, rigorous evaluation methods are required to demonstrate the utility, quality and efficacy of the design artefact. Extending the formative evaluation towards design refinement, Part D employed a summative form of evaluation to test the proposed artefact in its application environment. In accordance with the challenges associated with cooperative system evaluation, as explicated in Chapter 1, the evaluation methods utilise a descriptive method, in the form of informed arguments and scenarios. **Chapter 8** reports on the evaluation, results and analysis. **Chapter 9** focuses on the applicability and refinement of the model.

10.2 Contribution of the research

Several contributions are made in this research. As put forward by Hevner, et al., (2004) design science can produce multiple contributions. Figure 10.1 depicts the research cycle as defined by Hevner. It positions four contributions indicated by “contrib” on the shaded blocks.

Firstly, there is a contribution in terms of understanding the environment through analysis. Secondly, there is a contribution in the form of the collaboration life cycle model that manages the dynamic aspects of work. Another contribution is the architectural model which presents the environment that builds on the premise that virtual communities provide an ideal platform for collaboration. Finally, there are the validation tools that acquisition feedback from experts. As such, in terms of design science as depicted in figure 10.1 several contributions are made to the knowledge base, reflecting the research subject areas, methodology and the applied aspect of design science. Details of each contribution are further highlighted below.

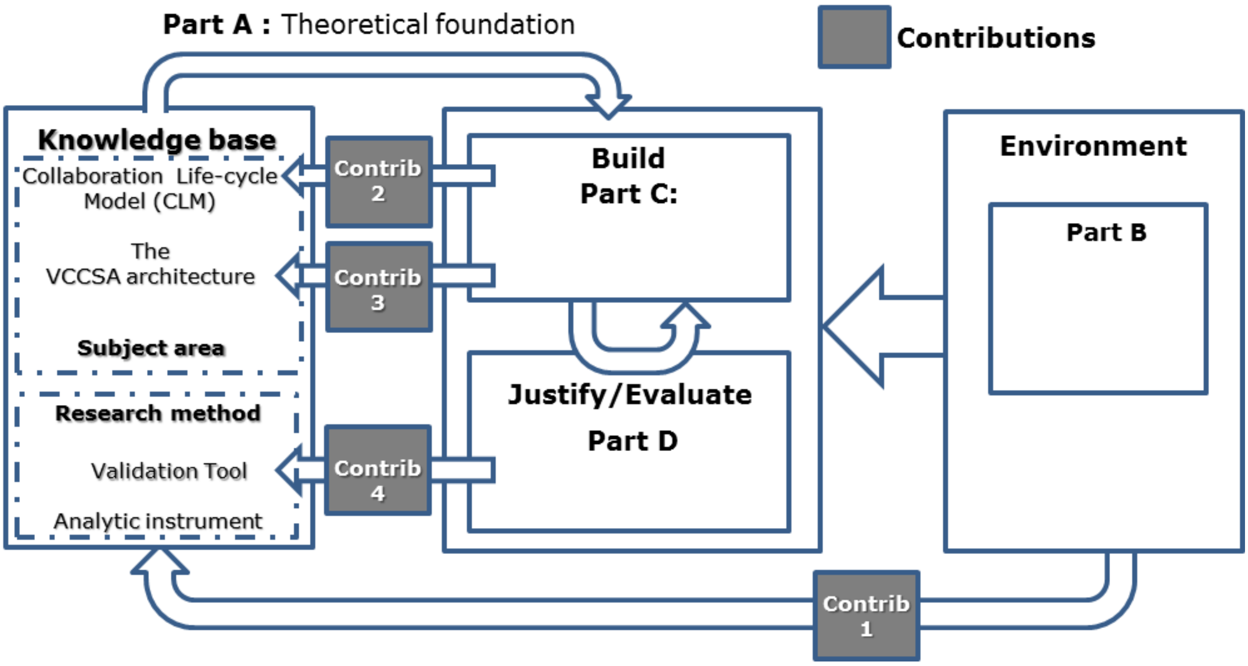


Figure 10.1: Design science based contribution

Contribution 1: The analytical instrument which is applied to understand the environment made a contribution to sub-objective 2.The instrument specifically developed in Chapter 4, Sections 4.3, 4.4 and applied in Chapter 5, Section 5.4, helped in understanding the environment. The instrument can be used by a business analyst or by an enterprise architect to elicit requirements for coordination. Thus, the descriptive instrument aids in understanding the coordination state status quo of existing collaborative acts and in pinpointing possible problem areas in a distributed environment.

Contribution 2: The awareness based collaboration life-cycle model (CLM) contributes the IS and CSCW domain of discourse. It represents a model that aims to manage the dynamic aspect of articulation work as it provides guidance on how things should happen during collaborative acts by streamlining the coordination of multiple collaboration instances. This contribution is resident in Chapter 6, Section 6.5, and Chapter 7, Section 7.6. The refined version of the chapter model is in Chapter 9, Section 9.2.

Contribution 3: The architectural model presents a static model representing the context –aware technical environment that exploits virtual community properties to host the CLM operations. The mappings of the architectural components to the lifecycle support phases are in Chapter 7, Section 7.6 and Chapter 9, Section 9.3. The criteria for the components allow, *inter-alia,* the flexibility and adaptability required to ensure sustainability. It defines the core features and functionality from which an implementation can be developed. The prescriptive model artifacts have the potential to provide interventions to achieve sustainable coordiantion. The refined lifecycle model is presented in chapter 9 section 9.2.

Contribution 4: The validation tool adds to the pool of knowledge of the research method, in its capacity as an applied validation method. The manifestation and results from the tool are in Chapter 8, Section 8.2.3. It has been shown to be useful and can be adapted for further evaluation of similar conditions.

These contributions are summarized in Table 10.1.

Table 10.1: Research contribution summary

CONTRIBUTION	PURPOSE	RELATED OBJECTIVE	CHAPTER SECTION	RESEARCH METHOD
Analytical instrument	Understand the environmental conditions	Sub objective 2 : requirements	4.3 & 4.4 5.4	Literature survey + case interviews, content and artefact analysis
Collaboration Life Cycle Model (CLM)	Meta process model to streamline articulation tasks	Sub objective 3 : elements/ Constructs	6.5 7.6 9.2 (Refined model)	Literature survey, interviews Scenarios and informed argumentation
VCCSAM Architecture model	Technical environment to support articulation tasks	Sub objective 3 : elements/ Constructs	6.6 7.1	Literature survey, interviews Scenarios and informed argumentation
Validation tool	Acquisition validation feedback from experts	General research method	8.2 Appendix E2	Literature review Inductive reasoning Pilot interview

10.3 Reflection

In this section the researcher reflects on the contributions, value and shortcomings of the strategy and methods employed in the study. Three perspectives are considered, viz; the scientific, methodological and substantive perspectives.

10.3.1 Scientific Reflection

As previously stated, this study is geared towards an IS design theory for sustainable coordination support in a heterogeneous distributed environment. This investigation is defined as such, relative to the design method employed and the artefacts that resulted, as IS design theory contributions may be in the form of an artefact, an extension to an existing foundational theory and/or new design evaluation knowledge. In order to enhance design theory or an artefact effectively it has been established that the modifications should be grounded continuously in foundational theories or previous research. Through reviewing existing theories, knowledge of people and information technology capabilities, the design and development of new IS artefacts (model, architecture and analysis instruments) towards coordination support in a distributed environment is considered informed. The output of Part A provides suggestions towards a solution, for instance, the need for an instrument of analysis to understand the constraints that the environment imposes and the realisation of the properties that the potential virtual communities present towards a solution.

The review of the multiple information sources reveals that there is no fully functional solution catering for the coordination needs in the heterogonous and distributed SA public sector. This establishes the need for a flexible and adaptive mediating technological artefact.

The proposed artefacts promise great benefits. For instance, in an effort to understand the problem environment, the insufficiency of existing artefacts to cater adequately for the circumstances, as discovered in Part A, instigated the requirement for the development of the instrument of analysis to evaluate the nature of coordination holistically. The instrument of analysis was developed through combining information from an extensive literature study with empirical evidence.

The shortcomings of existing ICT solutions in providing support adequately for sustainable coordination in a heterogeneous and distributed environment have been established in this study. The dynamic and continually changing environment and the need context of diverse groups contribute to the difficulties associated with a single solution for meeting all coordination needs. It has been demonstrated that there is a deficiency of models that provide a coordination management capability holistically. Practitioners and CSCW designers require a means to manage and promote sustainable coordination holistically. The synthesised analytic instrument and the collaboration life cycle model, in association with its supporting architecture, contribute to the body of knowledge.

Examining the utility of the artefacts by testing their applicability in practice is somewhat limited. This is due to a single case study evaluation being conducted, relative to the proposed model, without further or multiple studies being undertaken to accumulate supporting substantiation towards evidence saturation iteratively and continuously. Despite this, the single evaluative case study summative test results allowed reflection, consideration and design refinement. Further evaluation is suggested in the future research section.

10.3.2 Methodological Reflection

This section provides my reflections on the appropriateness of the chosen research paradigm and the research process. The study reflects a typical interpretive research project, which involved data gathering through qualitative research methods; however, the interpretive research paradigm was deemed inadequate. This is because it did not quite correspond with the requirements for an artefact, which go beyond simply understanding the problem, to help address the research problem. The design science paradigm was a more suitable candidate. Therefore, the interpretive philosophy was employed in a complementary capacity, to help understand the environment that contributes to the design science research.

Design science presents the most adequate description for this research, as it is a technology-oriented endeavour aimed at creating things that serve human purposes. The process undertaken in developing the proposed artefacts required an extensive literature investigation by this researcher of various disciplines.

The study employed the use of a case study and argumentation of the literature as elements of the research strategy to answer the stated research questions. The methodology utilised in this study, with respect to data collection and its analysis, predominantly comprised qualitative techniques, with a small component of the quantitative approach to eliminate researcher bias. The rationale behind the research process employed has been previously stated and motivated in the thesis. Regarding the methodology, the limitations encountered during the study are discussed in Section 8.4

Data triangulation was employed to increase the validity and reliability of the research information, indicating that different sources of information were used. A combination of the argumentation of literature, the review of academic publications and expert review of the model through interviews was utilised to provide resolutions to the research questions.

10.3.3 Meeting Design Science Principles

As discussed in the first chapter, design science establishes seven guidelines for effective research. This section examines the guidelines consecutively, together with how this research satisfies each of them.

1) Design as an artefact: This research produced several novel or innovative artefacts, including a Collaboration Life-Cycle Model, as well as architecture and evaluation instruments
2) Problem relevance: Relevance was based on a real world coordination problem in the SA public sector, with confirmation from existing literature.
3) Design evaluation: In addition to the formative evaluation obtained through informed arguments, publications and discussions, the functionality, utility and applicability of the model was confirmed, using expert-based interviews, through the employment of a scenario and a validation tool. This demonstrated the operation and feasibility of the model.

4) Research contributions: Novel contributions were made through the development and subsequent testing of the artefacts. The research contributions are examined in further detail in the subsequent section.
5) Research rigour: The artefacts were defined comprehensively, with the research making effective use of the knowledge base, and an evaluation of the artefacts within appropriate environments.
6) Design as a search process: The build/evaluation activities employed, as prescribed by the research process, represent a circumscription process. Thus, the general design cycle enabled a search process for an effective solution.
7) Communication of research: Paper publications targeted at designers and practitioners, as well as the thesis itself, represent the communication medium.

It can therefore be concluded that, from a design science perspective, the research was executed aptly and produced adequate results. A review of the research contributions of the thesis ensues.

10.3.4 Substantive Reflection

It has been established that the existing approaches for managing coordination are inadequate, considering the diversity of factors, which, although frequently ignored, may influence coordination. This research incorporates aspects from various fields of study, denoting that it adopts an interdisciplinary approach. The predominance of these fields is closely related, although in certain more obscure or unconnected fields a component within it relevant to this study. As the research primarily concerns issues of coordination this investigation is principally located within the domain of computer supported cooperative work (CSCW). CSCW considers issues surrounding the collaboration of groups and the coordination of activities using computer systems (Carstensen & Schmidt, 1999). Improving coordination in a distributed environment is the fundamental objective of this research, utilising virtual communities as an initiation point towards a solution. Furthermore, this research draws knowledge from the context-aware computing field, within ubiquitous computing. Thus, the research advocates the sharing of context information (described as the awareness facet within CSCW) as critical to coordination support. Context-aware computing concerns systems that are cognisant of their context and adapt to it. Such systems take action automatically without unnecessarily involving the user (Loke, 2007, pp. 7–8). As a context-aware system, the research will enhance coordination support, by sensing the context of an object, in order to deduce general or overall invocation, recommendation, or subtle notification for collaborative activities.

The goal of improving coordination through the filtered communication, interpretation and presentation of awareness information for decision making support is closely linked with human-computer interaction (HCI) research. HCI is a multi-faceted field with numerous sub-domains. Overall, HCI *"is the study and the practice of usability"* (Carroll, 2001). In relation to this the research addresses the presentation and interpretation of context-specific information to users, attempting to engender it useful and usable.

Furthermore, the dynamic and autonomous characteristics of participating domains pose major challenges to security and privacy, resulting in the study incorporating a minor component of the field of information and computer security. The research empowers the user to determine awareness specifications for externalising context and personalisation of notifications pertaining to filtered access control, while generally preventing information overload and mitigating disruptions (Gross, Stary & Totter, 2005). Essentially, the research provides mechanisms to control the information supplied to interested parties under specified conditions.

In an effort to understand the work patterns, along with targeting users and their social and organisational work contexts, this research explores the field of organisational research and management sciences (Pinelle, 2004). Studies in organisational research provide details relating to the environmental, organisational and work practices that may influence coordination.

Management practices are aimed at achieving coordination, since it is the essence of management, considered implicit and inherent in all functions thereof (Sangwan, et al., 2006). It implies that an analysis of current management practices will provide value in this research.

Furthermore, to establish factors that may influence coordination (Danese, et al., 2004) research explored the field of service sciences, in order to gain a deeper perspective on coordination problems and on the solution space from a service lens. This included service in the business context as a value producing process between an organization and its customers, and service in the software-engineering context as the modular representation of self-contained tasks as services (reusable and composable) that support the execution of business processes (Autili, et al., 2006).

10.4 General realizations and challenges

A key requirement for multiple entities to cooperate and to fulfil a collaborative objective is interoperability. This is to ensure that all entities, human or system, can work in unison, by interacting, utilising an agreed upon medium to transfer data, relating to hardware or communication protocols, in conjunction with speaking the same language with consensual meanings. The interoperability between the system components emphasizes the socio-technical approach towards coordination management. The realisation was that a readiness assessment and adjustment was necessary for a successful intervention, to embed a system in the distributed environment in order to support coordination. This assessment concerns the required skills level development, mutual understanding of benefits and risks, as well as the availability of the basic infrastructure that is required to support the intervention.

Distributed teams, by their nature, are denied the informal information gathered from physically shared workspaces. Additionally, a lesson revealed during the investigation demonstrated how environmental factors influence collaborative work projects. An initial approach employed in this research was the qualitative ethnographic research method, to facilitate the design, testing, and evaluation of the envisioned information systems artefact towards coordination support. A combination of ethnography with the design of the intended collaboration systems would have resulted in tightly coupled dealings within the natural setting. However, this did not occur. After on-going discussions with the case of interest, the decision made in a focus group meeting was to establish a memorandum of understanding. While the MOU was drafted, completed and left for signing, the case study leadership changed and the initiative was halted, because it was not the priority of the newly appointed leader. The researcher improvised a research strategy, employing a more loosely coupled participatory design approach, which still engaged with the necessary stakeholders as the need emerged. The stakeholders were consulted at different stages, at their workplaces, initially to aid in understanding the coordination problem to the eventual evaluation of the proposed artefact. This supplied a lesson that offered first-hand experience as to how changes in environment do affect work and the realisation of what was required to overcome the associated challenges.

10.5 Limitations of the Research

Although the research was conducted in a manner aimed at obtaining results as reliable as possible the following limitations were encountered:

- A primary limitation of this study is that it considers a single work setting, so it is unclear whether the findings will generalise to other distributed settings.
- There is a lack of an empirically validated model through actual use. This is deemed an issue towards generalizability that looks to establish an IS design theory for coordination support in a distributed environment. Therefore what is required is the application of summative evaluation that extends beyond a scenario based evaluation to an actual system implementation and monitoring in the field.
- The indirect and limited scope of the architecture evaluation is a further limitation. However, developing a prototype of this scope is unfeasible for the purpose of this research.

10.6 Further Research

The following aspects contribute avenues for further research.

- Evaluating the applicability of the analytic instrument in this study regarding other similar systems.
- Chapter 6 touched upon on the phases of the collaboration lifecycle model. Possible directions for future research include a detailed practical implementation of the proposed model.
- Increasing the evaluation scope of the artefact towards generalisation is necessary.
- Application of the model through the implementation of an actual support system to manage collaboration and to streamline coordination in a real life context.
- Exploring what benefits cloud computing can provide, considering infrastructure limitation.
- Conducting multiple case studies in different contexts, to evaluate the extent to which the model can be generalised.
- A longitudinal research undertaking could evaluate how the model may be improved, based on the consolidation of lessons gathered.
- The need for an ontology-built methodology and readiness assessment methodology is essential. Although ontologies provide benefits to solving data, integration describes how a system should interpret the meaning of the data that it receives in a machine-understandable, interoperable manner is a challenge. The notion of a hierarchy, or taxonomy, of information that relates various data constructs to others in a well-defined system needs to be accounted for. As a process that requires humans to define relationships among elements, a guiding methodology is necessary to avoid misrepresentation. As with ontologies the refinement of the collaboration life cycle model in Chapter 9 suggests the readiness assessment component. Thus, a methodology is necessary to assess and measure infrastructure, skill and capacity maturity towards the implementation of model operations.

10.7 Epilogue

Future structures in government may be better conceived of as networks of shifting projects. This would engender support for adhocracies and will enable more flexible and adaptable collaborative organisations. The model produced was conceived of as relevant to help address the coordination dilemma in the distributed environment and, to enable sustainability. More so, to make visible coordination processes that are necessary to perform. Considering properties of the model and its accompanying artefacts there is an abundant potential for extension embracing the move towards the internet of services. The research essentially advocates a distributed context-ware service system to support coordination in a distributed environment. The virtual community centric model can be leveraged, extending the shared services concept through taking advantage of cloud computing services, transcending infrastructure and distance concerns. The problem and issues of costs associated with infrastructure procurement, together with the lack of skill and capacity for its maintenance can be mitigated through collaboration. Through the provision of cloud services to organisations or local municipalities their focus and attention could centre on service delivery, with less concern regarding uptime. By leveraging cloud services with the proposed solution greater benefits could be attained. An integrated cloud service, making the service available to all government departments could be inordinately beneficial.

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INDEX OF APPENDICES ON CD-ROM

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A.1: Case analysis

A.2: Model Validation.

Appendix B: Feedback from submitted conference papers

B1: Analytic Instrument Micro-context proposition

B2: Case analysis result and specifications

Appendix C: Case coordination dependencies and mechanisms

Appendix D: Paper publication

D1: Paper 1

D2 Paper 2

D3: Paper3

Appendix E: Validation tools

E.1: Excel based tool

E.2: Model description

Appendix F: Mapping

Excel based collaboration life-cycle and architecture components mapping