Chapter 1
Introduction

"Small changes can produce big results - but the areas of highest leverage are often the least obvious."

Peter Senge [1990:63]

"The real leverage in most management situations lies in understanding the dynamic complexity, not the detail complexity."

Peter Senge [1990:72]

1.1 Purpose and outline of the chapter

The purpose of this chapter is to provide an introduction and overview of the research undertaken. Some background and basic definitions for logistics are provided to demonstrate the different viewpoints that exist which leads to the research problem and the research hypothesis. The basic premises for the research are stated. The research design and research methodology are briefly introduced, followed by a roadmap to explain the logic and layout of this thesis. The principal results of the research are stated, followed by the principal conclusions of the research.

1.2 Background to logistics

Logistics is a term that has been defined many times in many different ways. Gourdin [2002:1] states that "*logistics is a term that many people have heard of but few can define*". It was (and still is) the topic of many heated debates. It is the topic of many text books. Several professional organisations exist serving the different logistics communities. Logistics has been studied from many different angles. Table 1.1 gives an indication of some of the different ways in which logistics is viewed, illustrating that the viewpoints are based primarily on a functional perspective.

Interest group	How logistics is viewed
Design engineers	Design of system support
Manufacturing	Scheduling of processes and resources
Purchasing	On-time supply of raw material from suppliers
Material management	Warehousing and materials handling
Marketers	On-time delivery to customers and distribution
Financial managers	Cost of logistics activities
Customer relations	Customer satisfaction
Military	Availability of equipment, supplies & personnel

Table 1.1 Different viewpoints on logistics

Because logistics has been defined in so many different ways, it provides for many different viewpoints towards logistics. A number of these definitions are provided in Chapter 2. It can however be stated that the definitions can be categorised into two major categories namely those definitions relating to the military and military operations and those definitions relating to movement of material with the aim of satisfying customer requirements within a business.

The two primary viewpoints on logistics can probably be best summarised, on the one hand by the Webster Dictionary definition (Webster,1963:497): *"The procurement, maintenance, and transportation of military material, facilities, and personnel"*. The Council of Logistics Management (CLM), on the other hand, offers the following definition: *"Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming to customer requirements"* [Lambert and Stock, 1993:4].

M'Pherson [1980:550] provides a different viewpoint to logistics when he defines four sub-systems within any system. They are the operational, the management, the information and the support sub-systems. The function of the support sub-system is to supply and maintain the other sub-systems. M'Pherson breaks the support sub-system down into two functions, namely logistics and maintenance. However, he always treats logistics and maintenance together as the support sub-system.

1.3 The nature and the scope of the problem researched

As a large number of definitions for logistics as a discipline exist, which do not seem to relate to each other and which create confusion, it leads to a lack of understanding with regards to the integration of these "islands" of logistics, resulting in sub-optimal designs of organisations, products and services, even though many of these definitions claim to describe an integrated approach to logistics. From the different definitions that exist for logistics, many which have been included in Chapter 2, it is concluded that these definitions of logistics are primarily based on a functional view of logistics. Functional in this sense pertains to the functions of an organisation. This functionalisation of logistics is confirmed by the different views of logistics expressed in Table 1.1. Senge [1990:3] confirms that functionalisation and fragmentation are creating enormous problems: *"From a very early age, we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden, enormous price. We can no longer see the consequences of our actions; we lose our intrinsic sense of connection to a larger whole."*

Organisations exist as complex systems. Organisations interact with other organisational systems; they also exist as part of a bigger system called the supply chain, which creates interdependencies and new complexities amongst these systems. Organisations produce systems in the form of durable products, many times complex in itself, which creates interdependencies and complexities between the suppliers and the customers of the durable products.

Complexity within systems can be handled in two ways. The first way to handle complexity is to handle many variables at the same time; this is called detail complexity. The second way to handle complexity, is dynamic complexity where cause and effect are subtle, and where the effects of interventions are not obvious [Senge, 1990:71] or stated differently: *"Cause and effect may be separated in time and space"* [Gharajedaghi, 1999:49].

Gharajedaghi [1999:xv] expresses the following views on interdependencies and complexities: *"The imperatives of interdependency, the necessity of reducing endless complexities, and the need to produce manageable simplicities require a workable systems methodology and a holistic frame of reference that will allow us to focus on the relevant issues and avoid the endless search for more details while drowning in proliferating useless information."* He [Gharajedaghi] further clarifies what the difference is between a multidisciplinary approach and a systems approach: *"Contrary to a widely held belief, the popular notion of a multidisciplinary approach is not a systems approach. The ability to synthesize separate findings into a coherent whole seems far more critical than the ability to generate information from different perspectives. ...*[systems thinking] *deals with the challenges of interdependency, chaos, and choice using an elaborate scheme called iterative design.*" It is thus clear that in order to understand the dynamic complexities of the integrated logistic support system, a systems approach needs to be taken to provide a holistic frame of reference to identify the focus areas that allows high areas of leverage.

From the above, the research problem has been defined as follows:

> **Too much focus is placed on logistics as a functional discipline (detail complexity) without an understanding of the integrated nature of logistics within a system (dynamic complexity). This focus on the detail complexity of logistics many times result in actions that are counterintuitive[1] without considering or recognising how these counterintuitive actions negatively influence system success over time.**

[1] *Counterintuitive* actions refer to actions intended to produce a desired outcome, but causing the opposite outcome [Gharajedaghi, 1999:48]. The counterintuitiveness of a system is a consequence of the dynamic complexity (delays between cause and effect) within a system [Senge, 1990:89-92].

The research hypothesis is the following:

> **A whole-life whole-system approach to integrated logistic support (an approach to the dynamic complexity) will allow each definition of logistics (the different approaches to the detail complexity) to be understood and applied correctly within the system context of organisations and product systems, thus supporting system goals.**

To prove the hypothesis, a graphical model explaining the dynamic complexity of integrated logistic support will be developed and validated, demonstrating the need and validity for the whole-life whole-system approach to integrated logistics. This model will be limited to man-made systems.

The basic premises (each of which will be confirmed by the literature study) of the research are the following:

- A systems approach is required to solve systems problems.
- Systems go through a birth-life-death cycle (the system life-cycle).
- A formal process is necessary to bring systems into being and take it through its life-cycle.
- An organisation is a system which may itself deliver (or affect) new man-made system solutions e.g. durable products.
- Logistics (or support) form part of any system.
- Logistics consists of a technical dimension and a managerial dimension, both of which are to be designed using a formal process.

Thus, a system approach is required to view logistics within the system throughout the entire life-cycle of the system.

As opposed to the many functional definitions that exist, the Integrated Logistic Support Guide definition for logistics [adapted from Blanchard, 1998:3] will be used as a valid definition for logistics. The term integrated logistic support is used (rather than only the word logistics) and is defined as follows:

Integrated logistic support is a disciplined, unified and iterative approach to the management and technical activities necessary to:

- **Integrate support considerations into system and equipment design.**
- **Develop support requirements that are related consistently to readiness objectives, to design, and to each other.**
- **Acquire the required support.**
- **Provide the required support during the operational phase to ensure safety, ability, availability and affordability of the system of interest.**

In this definition, logistic support has the meaning of supplying and maintaining the system sub-systems, according to M'Pherson's [1980:550] system view of the support sub-system that includes both logistics (supply) and maintenance (support).

This definition has been chosen for the following reasons:

- It takes a whole-system approach.
- It takes a whole-life (life-cycle) approach.
- Objectives of the integrated logistic support have been clearly stated.
- It caters for all processes (management and technical, supply and maintenance).

1.4 The method and objective of the research

This research is an empirical model-building study using secondary textual data to construct a schematic (graphical) model of the dynamic relationships between the managerial and technical integrated logistic support activities of a system throughout the full system life-cycle. The objective of the research is to improve the understanding of system design and operation in order to enhance the overall system performance parameters of ability, availability and affordability. The model is validated by using implication diagrams and logical deduction (thought experiments) to compare the logical consequences of ignoring a systems approach to integrated logistic support with the logical consequences of using a systems approach to integrated logistic support.

1.5 Thesis roadmap

Figure 1.1 provides a roadmap of the thesis and shows the logical sequence of chapters. The roadmap will be included at the beginning of each chapter highlighting the position of the relevant chapter within the overall scheme of the thesis.

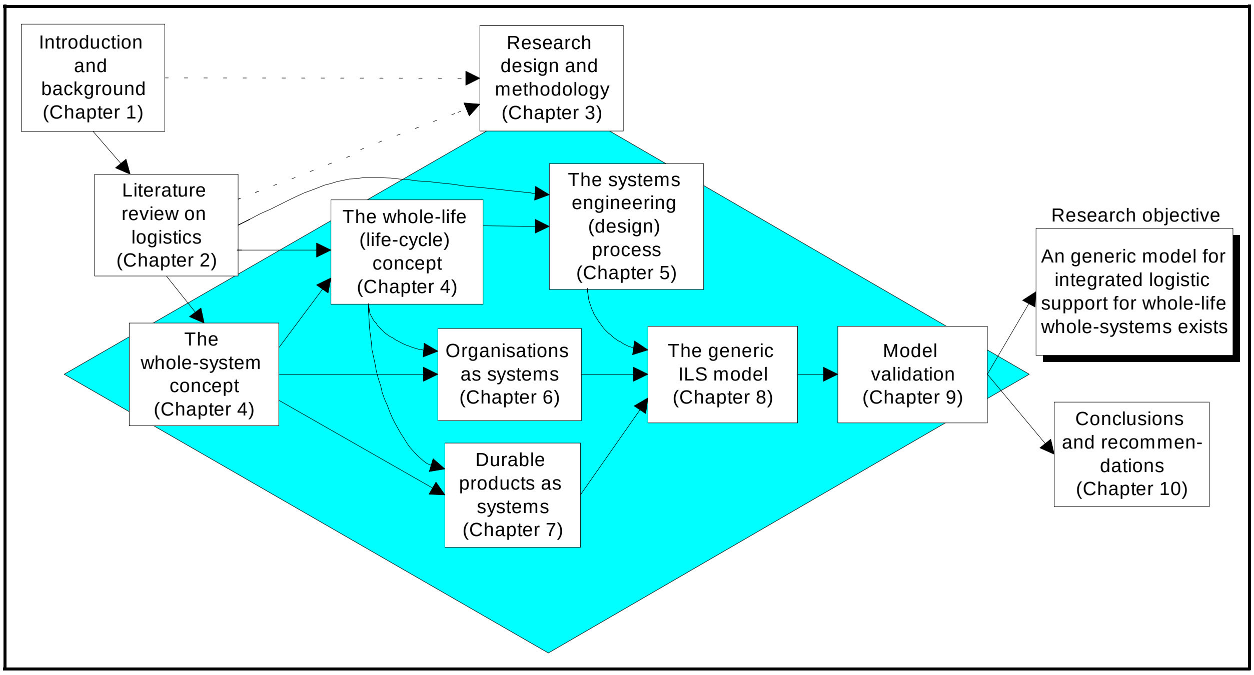

Figure 1.1 Thesis roadmap

The first three chapters provide the introduction and background to the research, along with the research design and research methodology. Chapters 4 - 7 provide the theoretical background that serve as the building blocks for the model for integrated logistics. The main building blocks for constructing the model are the systems and life-cycle concepts, the way in which systems are brought into being, how organisations and durable products exhibit system behaviour, and how organisations and durable products require logistic support to be able to meet the system requirements. The literature review of logistics (Chapter 2) is required for the discussion of the whole-systems concept and the whole-life (life-cycle) concept (both in Chapter 4). These two concepts, are required to explain that both an organisation (Chapter 6) and durable products (Chapter 7) exist as systems.

Chapter 5 explains how systems are engineered. Chapters 2, 4, 5, 6 and 7 are required to establish the foundation for an integrated logistic support model, which follows in Chapter 8. Chapter 8 is the main contribution of this thesis, where the generic approach to integrated logistics for whole-life whole-systems is presented as a schematic (graphical) model explaining the dynamic complexity of the technical and managerial processes over the life-cycle of the system and its influence on system success. Within Chapter 9 the model is validated using thought experiments and implication diagrams. With some further refinement, these implication diagrams can be used as the basis of a system dynamic model for simulation and prediction of system performance. The conclusions and recommendations of the research are presented in Chapter 10.

1.6 The principal results of the research

Generic sub-systems exist within every system regardless of the type of system investigated. The support sub-system (from here on it will be referred to as the integrated logistic support system) is one of the generic sub-systems of a system, and this sub-system is crucial for system success. When the integrated logistic support system is ignored, the whole-system concept is not valid anymore and the system as a whole not be optimised, as one of the generic sub-systems that is required for a complete system and its contribution towards total system success is not considered. Systems exist in time (they follow a natural birth-life-death cycle). For each phase of the life-cycle different managerial and technical activities are required. Taking the whole-system and whole-life characteristics of systems into consideration, generic measurements of system success can be defined, namely ability, availability and affordability. These measurements are applicable to any system irrespective of the type of system or the system hierarchy level on which the system exists and functions.

All organisations (public and private, for-profit and not-for-profit) organisations exist as systems. Many products (those categorised as durable products) exist as systems. Services and consumable goods are not systems in themselves but exist as part of organisational systems.

A system and life-cycle approach to logistics allows the creation of a model that explains integrated logistics support as part of a system that goes through a birth-life-death cycle. Different managerial and technical activities are required as the system goes through each phase of the life-cycle in order to achieve the overall goal of the system measured as system ability, system availability and system affordability. The dynamic nature of integrated logistic support is obvious as most of the effects experienced by the system during its operational phase are caused by actions taken during the design phase.

Implication diagrams provide a mechanism to conduct a thought experiment to allow the comparison of systems whose creators choose to employ a whole-life whole-systems approach to integrated logistic support and those systems whose creators choose not to employ a whole-life whole-systems approach to integrated logistic support.

1.7 The principal conclusions of the research

For any system to be successful over its entire life-cycle, a whole-life whole-system approach to integrated logistic support (as advocated by the model that has been developed) needs to be followed. If this is done, the system will be more successful in its goal achievement expressed as ability, availability and affordability. Integrated logistic support is required and essential for its contribution towards system success. Integrated logistic support have to be viewed form both an operational as well as a maintenance perspective, as both these perspectives contribute towards ability, availability and affordability. The major impact of integrated logistic support is caused early in the life-cycle, in the design phase of the system, but only realised during the operational phase due to the dynamic nature of integrated logistic support. If integrated logistic support is ignored, the cost and time implications to improve the system later in its life-cycle may be prohibitive to improve ability and availability. It must also be recognised that different requirements exist for the management and technical activities as the life-cycle progresses. Within the model it is also shown that some of the managerial and technical activities may overlap for periods of the life-cycle.

Further research is necessary to investigate the detail complexity of integrated logistic support to ensure that it ties in with the dynamic complexity of integrated logistic support i.e. how counterintuitive actions can be eliminated from the detail complexity of integrated logistic support to fully support the dynamic complexity of systems expressed as optimum ability, availability and affordability.