A Reference Task Model for Supply Chain Processes of Humanitarian Organisations

Dissertation
zur Erlangung der Würde eines
DOKTORS DER WIRTSCHAFTSWISSENSCHAFTEN
(Dr. rer. pol.)
der Universität Paderborn

vorgelegt von
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Paderborn, September 2009

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Acknowledgements

This doctoral thesis resulted from the research I conducted at the working group Business Computing, especially CIM at the Heinz Nixdorf Institute of the University of Paderborn. Carrying out the research was enabled by funding I received from the Fraunhofer Institute for Material Flow and Logistics in Dortmund. The successful completion of doctoral studies was a challenge in multiple ways: Professionally, personally and even physically. It is my desire and pleasure to acknowledge a few of the many who have supported me in mastering these challenges.

First and foremost I would like to thank my advisor and academic teacher Professor Dr.-Ing. habil. Wilhelm Dangelmaier for accompanying the research process. Although the discussions with him were tough at times, they were necessary in order to streamline my research efforts. He ensured that I remained focused on the goal. I extend these thanks to Professor Dr.-Ing. Bernd Hellingrath who also supervised my research. I am grateful for their advice and personal support when walking through this academically sparsely explored area.

I would like to express my gratitude to all the interview partners at the humanitarian organisations for their time, expertise, and confidence. I know how erratic working in disaster and humanitarian relief can be and truly appreciate the time you took aside to offer me insight into your work. Moreover, during the course of the past three years, I met plenty of fascinating people from academic institutions, industry, humanitarian organisations, and the military. Frequently, the discussions at conferences or the various organisations showed me new perspectives and sparked new ideas.

Furthermore, I am indebted to Professor Dr. Marianne Jahre, Dr. Sabine Schulz, and Dr.-Ing. Philippe Tufinkgi for their reflections on my ideas and their mental support. Your encouraging words and constructive feedback have helped me to keep a high level of motivation and to sustain constant progress on the work.

My appreciation goes to my colleagues at the working group Business Computing, especially CIM for the open atmosphere and the good collaboration. Furthermore, I would like to thank all people who have supported me by proof-reading the initial manuscript, especially Zoë Bedford, Dr.-Ing. Christoph Kallenberger, Stefan Kiesel, Dr. Bernd Langohr, Sylvia Langohr, Dr. Thomas Möbius, Cori Peet, Miriam Schütte, Karsten Weber, and Dr.-Ing. Florian Weißel for their valuable feedback. I extend these thanks to my close friends in Germany and abroad for their moral support, kind words at the right moments, and for accepting that I frequently just “vanished” for several weeks or months. I promise to make up for it in the future!

I want to thank Claudia, Sonja, and Thomas for being the best siblings one could imagine. My deepest gratitude goes to my parents, Professor Klaus and Gudrun Blecken, for their love and their enduring support throughout my education and professional life. They have raised me to take responsibility for my actions. In loving memory, I dedicate this work to my father.

Paderborn, November 2009
Alexander Blecken

Abstract

The past decade has seen an ever increasing number of natural and man-made disasters, which frequently lead to humanitarian crises. The international community generally addresses these crises with concerted efforts and supports the affected community in its struggle to survive, by delivering essential goods and services ranging from food aid, water and sanitation services, to shelter and basic health care. Although logistics and supply chain management activities account for a large part of total expenditures in such operations, they have frequently not been recognised as key levers for improving the effectiveness and efficiency of humanitarian organisations and as being crucial to operational excellence.

This thesis investigates the tasks and responsibilities of humanitarian organisations and their supply chain partners, in the context of designing, planning, and implementing supply chain processes for humanitarian operations. A reference task model is developed, which differentiates between these various tasks at the strategic, tactical, and operational levels and separates them functionally, through adapting a common supply chain management framework. Generic roles and responsibilities are assigned to support the application of the model.

A design-science research approach is adopted in order to conduct the investigation. The reference task model is developed using Schütte's established procedure model for the development of reference models, taking into account further recent developments to the model. While the reference task model is based on a broad literature review of existing reference models with a focus on supply chain management and logistics processes, the empirical data is integrated thoroughly into the development of the model, in order to obtain semantic correctness and acceptance by potential model users.

A number of cases illustrate the flexible application of the model in different scenarios and types of humanitarian operations, such as emergency and post-emergency contexts. Based on the cases and the reference task model, requirements for the supply chain management systems of humanitarian operations are formulated and a requirements profile deduced. This profile is used to assess currently available supply chain management systems geared to support humanitarian operations. It is found that no software tool is able to comprehensively and simultaneously address all requirements for supply chain design, supply chain planning, and supply chain execution. While some of the tools contained in the survey fulfil the requirements profile partially, none of the tools is able to satisfy all requirements. Supply chain management systems specifically developed to support humanitarian operations lack supply chain design and supply chain planning capabilities, while supply chain management systems from the commercial domain do not satisfy the general requirements. Thus, the use of a combination of tools to cover all functional and non-functional requirements is proposed.

This thesis systematically presents and depicts core supply chain management tasks associated with humanitarian operations, taking into account the polarity of short-term disaster relief in immediate response to a disaster and medium-term humanitarian assistance in post-emergency contexts. The research offers a template for humanitarian organisations that wish to describe, manage, and communicate the tasks and processes within their supply chains. The developed reference task model provides a flexible solution for process modelling and design. It is also flexible enough to be extended and modified as the roles of humanitarian organisations in the geo-political context of humanitarian operations in the 21st century change and as new actors enter the humanitarian supply chain.

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List of Abbreviations

APO	Advanced Planner and Optimizer
ARIS	Architecture of Integrated Information Systems
bn	Billion
BPDM	Business Process Definition Meta model
BPEL	Business Process Execution Language
BPMN	Business Process Modelling Notation
BPMN 2.0	Business Process Model and Notation
BSC	Balanced Scorecard
CICR	Comité international de la Croix-Rouge
CPFR	Collaborative Planning, Forecasting, and Replenishment
CSCMP	Council on Supply Chain Management Professionals
CSR	Corporate Social Responsibility
DB	Database
DPWN	Deutsche Post World Net
ECHO	European Community Humanitarian Office
Eds.	Editors
EM	Emergency
EPC	Event-driven process chain
EPK	Ereignis-gesteuerte Prozessketten (Event-driven process chains)
EPREP	Emergency Preparedness Plan
ERM	Entity-Relationship Model
ERP	Enterprise Resource Planning
et al.	et alii
etc.	et cetera
FTE	Full Time Equivalent
GIS	Geo Information System
GoM	Grundsätze ordnungsmäßiger Modellierung (Guidelines of modelling)
GUI	Graphical User Interface

HLA	Humanitarian Logistics Association
HLS	Humanitarian Logistics Software
HO	Humanitarian Organisation
HPC	Humanitarian Procurement Center
HQ	Headquarters
HSCPR	Humanitarian Supply Chain Process Reference Model
ICRC	International Committee of the Red Cross
ICVA	International Council of Voluntary Agencies
ICVA	International Council of Voluntary Associations
IFRC	International Federation of Red Cross and Red Crescent Societies
IHL	International Humanitarian Law
INGO	International non-governmental organisation
IPCC	Intergovernmental Panel on Climate Change
IPO	International Purchase Order
IS	Information Systems
ISO	International Organization for Standardization
IT	Information Technology
KPI	Key Performance Indicator
LRRD	Linking Relief, Rehabilitation and Development
LSP	Logistics Service Provider
m	Million
MRO	Maintenance, Repair and Overhaul
MRP	Material Requirement Planning
MSF	Médecins Sans Frontières (Doctors without Borders)
NATO	North Atlantic Treaty Organization
NGO	Non-governmental organisation
NPO	Non-profit organisation
OCHA	(United Nations) Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Cooperation and Development
OHCHR	(United Nations) Office of the High Commissioner for Human Rights
OMG	Object Management Group
Ops.	Operations
OR	Order Request
OS	Operations support
OXFAM	Oxford Committee for Famine Relief
PL	Packing List
PO	Purchase Order
PPC	Production Planning and Control

RAM	Responsibility Assignment Matrix
RM	Reference Model
RP	Reference Process
SCC	Supply Chain Council
SCD	Supply Chain Design
SCE	Supply Chain Execution
SCEM	Supply Chain Event Management
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference model
SCP	Supply Chain Planning
SOP	Standard Operating Procedure
SR	Stock Request
SUMA	Supply Management System
tr	Trillion
UML	Unified Modelling Language
UN	United Nations
UNDHA	United Nations Department of Humanitarian Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UNHRD	United Nations Humanitarian Response Depots
UNICEF	United Nations International Children's Emergency Fund
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
VENRO	Verband Entwicklungspolitik deutscher Nichtregierungsorganisationen e.V.
viz.	videlicet (namely)
w. r. t.	with respect to
WB	Waybill
WMO	World Meteorological Organization
ZfB	Zeitschrift für Betriebswirtschaft

1 Introduction

One's work may be finished some day
but one's education never.

Alexandre Dumas

The world today has to face a number of severe problems: Some three billion people live on less than two dollars a day. Moreover, the past decade has seen an increasing number of medium to high impact disasters to which the poor are most vulnerable. The humanitarian crises caused through these disasters are frequently addressed by the international community with concerted efforts and humanitarian operations. Humanitarian operations range from short-term humanitarian relief in response to acute emergencies to medium and sometimes long-term assistance focusing on recovery and reconstruction in post-emergency contexts. Due to the substantial mobilisation and deployment of material and financial resources involved, these kinds of operations rely to a large extent on effective and efficient supply chain management.

Humanitarian operations seek to alleviate suffering and save lives of victims of natural or man-made and human-induced crises.[1] Humanitarian organisations, which carry out these activities, have existed at least since the late 19th century, when the International Red Cross was founded on a battlefield as a reaction to the inhumane suffering and lack

[1] In April 2007 the Intergovernmental Panel on Climate Change (IPCC) released its fourth extensive report on the state-of-the-art knowledge on the development of climate on earth, cf. Intergovernmental Panel on Climate Change (2007). In this report it is shown even clearer than in the preceding reports that climate change on earth is indeed happening and is induced by humans. With raising global temperature, the magnitude and multitude of disasters such as floods, earthquakes and hurricanes are going to increase. Alongside natural disasters, human-induced disasters are increasing due to increasing technological dependencies and increasing population density in urban areas, combined with housing in high-risk areas such as hurricane-prone coastal regions, on instable hillsides, in the vicinity of airports, power plants etc., cf. auf der Heide (2007), Chapter 1.

of provision given to the wounded.[2] In carrying out their operations, humanitarian organisations adhere to certain principles, such as humanity, neutrality and impartiality, i.e. they deliver their services on a basis of need without any discrimination regarding religion, ethnicity or gender. Since the first humanitarian organisations were founded, the multitude and magnitude of humanitarian operations has risen dramatically. Nowadays, these operations include services and goods to provide food, water, shelter and medical care, to protect victims of natural and man-made disasters as well as bear witness to their plight, to name just a few examples of the broad range of different operational foci.

Between the 1970s and 1990s, the number of disasters has tripled.[3] It has been predicted that for the next 50 years both natural and man-made disasters will increase five-fold[4] and that world-wide costs due to these events will sum up to $64tr in the next 50 years. For Germany alone, the cost will be around $800bn.[5] In 2008 between 150-220 million people were affected by disasters. These disasters claimed more than 240,000 fatalities and between $190-270bn financial losses.[6] More than 90% of the victims of natural and man-made disasters live in developing countries. This shows that "poverty, population pressures and environmental degradation exacerbate suffering and destruction."[7] Figure 1 presents some key indicators of the effect of disasters during the past 10 years.

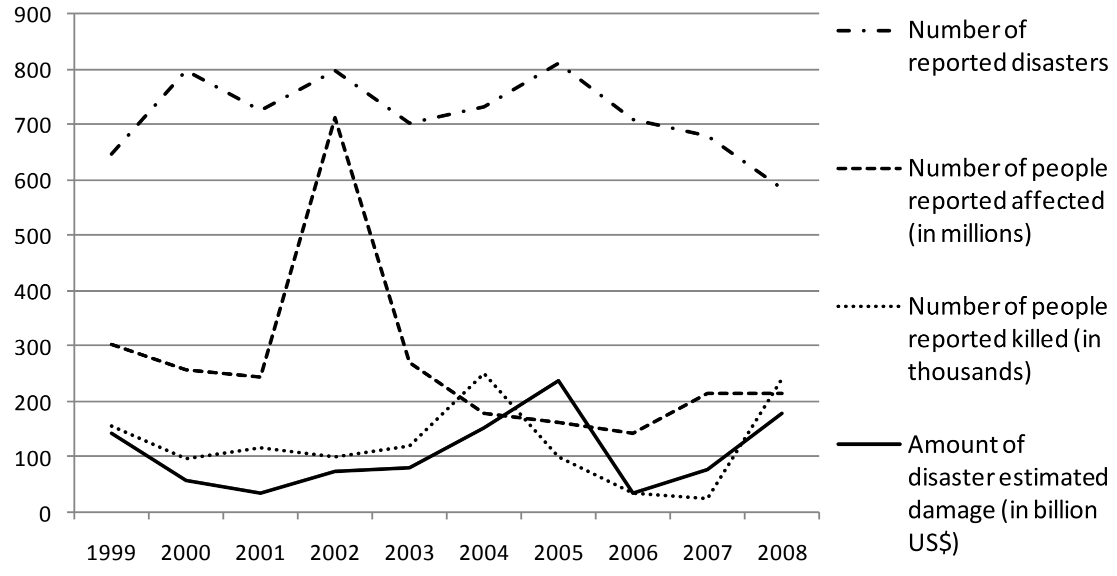

Figure 1: Disaster indicators[8]

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[2] A comprehensive historical review of humanitarian operations is presented in Appendix A.
[3] Cf. Burton (1997), p. 187, Swiss Reinsurance Company (2007), pp. 4-6, and Swiss Reinsurance Company (2009), p. 5.
[4] Cf. Thomas and Kopczak (2005).
[5] Cf. Kemfert (2005).
[6] Cf. Swiss Reinsurance Company (2009), pp. 5-10 and International Federation of Red Cross and Red Crescent Societies (2009).
[7] United Nations, http://www.un.org/aboutun/basicfacts/haction.htm, accessed September 10, 2007.
[8] Cf. International Federation of Red Cross and Red Crescent Societies (2009), pp. 162-173.

The before-mentioned figures refer to disasters with a natural human-induced trigger only, and do not include wars, conflict-related famines, diseases or epidemics. However, humanitarian operations also take place during or in the aftermath of armed conflicts such as civil wars and wars between states.[9] While wars between states have remained at a relatively low level since World War II, intra-state conflicts have risen considerably in the last decades.[10] During the past decade, the number of high intensity conflicts has risen only slightly, whereas medium intensity conflicts have doubled. Since the end of World War II, a total number of 228 armed conflicts have been recorded, of which the majority took place after the Cold War. A total number of 20 million people have been killed and 50 million injured in 160 major armed conflicts. 100 million people were forced to flee.[11]

In the following, the structure of the thesis is elaborated on. In Chapter 1 the research domain is introduced and the rising importance of humanitarian logistics due to changing environmental factors is illustrated. Some figures illustrate the importance of humanitarian operations and associated supply chain activities.

In Chapter 2 the problem statement is presented. The research problem is identified through the presentation of the results of an empirical survey involving a representative sample of humanitarian organisation involved in logistics and supply chain management in the context of humanitarian operations. Based upon the results of the empirical survey, problems of the application domain are identified. The research problem of this thesis is subsequently presented and elaborated taking into account the findings of the sector survey. The research objectives are formulated and a methodology for achieving these objectives is selected.

In Chapter 3 the application domain is analysed. A system theoretic perspective is taken and the respective theory is presented. Based on an introduction and the definition of basic terms, the notion of reference information models is explained. Following, humanitarian operations are further elaborated and the current state of affairs with respect to supply chain management and logistics in the context of humanitarian operations is presented. Specific challenges of humanitarian logistics are focused on in order to set the foundation for developing requirements for the desired solution.

In Chapter 4 state-of-the-art solutions with relevance to the research problem and the research objectives are investigated. Here, it is identified whether existing solutions can be (partially) used to solve the problem at hand. The guidelines of modelling give general guidance on the construction of models. Modelling techniques are presented and it is evaluated which modelling technique is most suitable for the construction of a reference task model and reference business processes for supply chain management in

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[9] Arguably, such conflicts can also be categorized as man-made disasters. Some authors, however, separate conflicts from natural and man-made disasters. This notion is followed here since such conflicts put special requirements with respect to security on humanitarian operations and are specifically targeted by humanitarian organisations.

[10] Source: Heidelberg Institute for International Conflict Research (HIIK) (2008), p. 1.

[11] Cf. McGuire (2006), p. 1.

the context of humanitarian operations. Supply chain management frameworks are presented and evaluated. A broad review of general and specific reference models from which a reference task model for supply chain processes of humanitarian organisations could benefit are assessed.

In Chapter 5 the work packages are concluded. The requirements for the solution, which needs to be developed in order to achieve the research objectives, are discussed. The requirements are deduced from the findings of the previous chapters.

Chapter 6 is dedicated to the reference task model for supply chain processes of humanitarian organisations. Here, a methodology for the construction of reference models is presented and suitably adapted in order to reflect the most recent findings in reference model development. Thereupon, a framework for the reference task model is developed and described. This framework serves to help users navigate in the reference task model. The reference tasks are presented in detail. Following, example reference processes are built using the tasks from the model in order to illustrate the application of the reference model. The chapter closes with an excursus on differences and commonalities between humanitarian logistics and military logistics.

The objective of Chapter 7 is to assess supply chain management systems for humanitarian organisations. Supply Chain Management systems are not widely used in today's humanitarian organisations. Therefore, the scope and objectives of SCM systems is presented briefly. Based upon the specific challenges of humanitarian logistics as found in the previous chapters, a requirements profile is developed for SCM systems for humanitarian operations. This requirements profile is then used to assess a number of current and future SCM systems which are either currently used in humanitarian organisations or in the industrial domain.

In Chapter 8 the findings of this thesis are summarised. The results of the thesis are critically reflected upon; limitations of the conducted research are presented. Open fields of research in the area of supply chain management in the context of humanitarian operations are identified and a possible roadmap for future research is given.

2 Problem Statement

In this chapter the research problem tackled in this thesis is presented and elaborated. In the first section the initial situation is outlined (2.1). The research problem is identified by presenting the results of an empirical survey investigating a representative sample of humanitarian organisations involved in logistics and supply chain management in the context of humanitarian operations (2.2). Based upon the results of the empirical survey, problems of the application domain are identified and research questions are formulated (2.3). The research problem of this thesis is subsequently presented and elaborated, taking into account the finding of the sector survey. The research objectives are formulated and a methodology for achieving these objectives is selected (2.4).

2.1 Initial Situation

Supply chains of humanitarian organisations have become increasingly complex within the last decade. While material, information and financial flows have become more and more convoluted, only few efforts have been undertaken to analyse these flows. There are hardly any economically-driven studies on the optimisation of logistics processes in disaster relief. Research that is available on disaster management has a strong sociological focus and does not incorporate economic-technical perspectives.[12]

When examining the challenges of supply chain management in the context of humanitarian operations, two major trends can be revealed: The first is that commercial companies are becoming increasingly interested in getting involved in humanitarian operations in general and humanitarian logistics in specific.[13] Privatisation of humanitarian aid, such as the provision of security services by private enterprises or the outsourcing of logistics services to third parties, has elicited widely differing opinions among practitioners. With respect to supply chain activities, logistics for humanitarian operations has been recognised by large commercial corporations as giving rise to unique challenges. Companies have started drawing up new business units which exclusively deal with humanitarian logistics. Lufthansa Cargo, for instance, transports medical equipment and

[12] Cf. Tufinkgi (2006), p. 3.
[13] Cf. van Wassenhove (2006).

personnel from Frankfurt to Nairobi on a daily basis and supports construction projects.[14] Deutsche Post World Net (DPWN), one of the largest logistics service providers world-wide, has defined corporate social responsibility as one of the companies' core values.[15] Projects that implement this value can be found within the disaster management activities conducted by DPWN. DPWN puts a strong focus on coordination and cooperates with UN agencies.[16] Jan Egeland, former UN Undersecretary-General for Humanitarian Affairs and Emergency Relief Coordinator, stresses the importance of logistics for humanitarian operations and emphasizes the possibility that humanitarian organisations can learn from private companies with regards to their logistics activities.[17] These and other initiatives motivate the application of methods and tools from commercial supply chain management, which promise to be beneficial to humanitarian operations, to the humanitarian domain. These tools can contribute to a more professional humanitarian supply chain management.[18]

The second trend is that, parallel to the operations themselves, humanitarian logistics has recently seen a somewhat increased interest from supply chain management academics as well as logistics practitioners.[19] A main reason for this attention stems from the extent of logistical costs involved in humanitarian operations. It has been estimated that costs attributed to logistics and supply chain activities can sum up to 80% of the expenditures of a humanitarian organisation.[20] Some researchers have analysed and compared the current state of supply chain management in humanitarian organisations with private sector supply chains of fifteen to twenty years ago.[21] McGuire (2006) summarises:

> "A detailed report based on in depth research of humanitarian organisations, points to the similarities of the state of logistics in humanitarian assistance

[14] Cf. Kloss (2007).
[15] Cf. Deutsche Post World Net (2007).
[16] Eg. UNOCHA and UNDP.
[17] Cf. Deutsche Post World Net (2007), p. 34.
[18] Cf. Blecken and Hellingrath (2007).
[19] Cf. Kovács and Spens (2007), Kovács and Spens (2008). Specifically, humanitarian logistics has received increasing attention by both the media and research institutions since the Asian tsunamis at the end of 2004. However, supply chain management in the context of humanitarian operations can be considered a largely under-researched areas as will be elaborated in the following, cf. also Table 1.
[20] The fact that 80% of disaster relief spending can be attributed to logistics efforts has been observed by Long and Wood (1995) in a food aid supply chain. This figure was estimated for a food relief supply chain. On average, the number is likely to be around 40-60% of the overall budget, cf. also van Wassenhove (2006). Moreover, the tsunamis caused an unprecedented international humanitarian response as a major cash inflow took place to many humanitarian organisations. As an example, for the humanitarian medical relief organisation Médecins Sans Frontières (MSF) some €30m had been donated for the humanitarian response to the Indian Ocean tsunamis alone. This compares to an annual cash inflow in 2005 of approximately €69m, cf. Médecins sans Frontières (2007). The entire humanitarian aid sector is estimated to have risen from $2.1bn to $5.9bn in the 1990s (Buchanan-Smith and Randel (2002), p. 1). In the year of the Asian tsunamis, the budget of humanitarian organisations rose to $12bn and is today estimated to comprise between $10-20bn (Source: Thomas and Kopczak (2005), p. 3, and Professor K.-D. Eberwein, head of the working group on International Politics of the Social Science Research Center Berlin, at the IX. Humanitarian Congress in Berlin, October 26–27, 2007).
[21] Cf. Beamon and Kotleba (2006), van Wassenhove (2006), de Brito et al. (2007), Thomas and Kopczak (2005).

> today with the situation of corporate logistics management 20 years ago […]. The report […] points to the need of realizing the strategic importance of logistics for disaster management. […] [S]ome humanitarian organisations still regard logistics services as an expense rather than a strategic management component."[22]

The more frequently and the more disruptive crises occur, the more important effective and efficient supply chain management becomes in conducting and coordinating humanitarian operations. As the number of disasters grows, so does the need for humanitarian assistance. While the number of humanitarian organisations providing assistance and conducting humanitarian operations has grown immensely over the last decade, dedicated research on the implied logistical and supply chain management tasks and challenges remains scarce. In fact, so far there is no dedicated international journal on humanitarian logistics and humanitarian supply chain management.[23] On the opposite extensive literature is available on all aspects of industrial logistics and supply chain management, especially with respect to process visualisation and optimisation and supply chain modelling and analysis. Likewise, a broad body of literature exists, which focuses on the political and sociological aspect of disaster relief and humanitarian operations. However, despite a growing interest in the academic community in the past few years, only a limited body of literature on supply chain management in the context of humanitarian operations can be found so far.[24]

In spite of the lack of academic research on humanitarian logistics issues, it cannot be denied that humanitarian logistics is a rapidly developing field and established research stream of logistics and supply chain management.[25] Based on a broad literature review of humanitarian operations and the issues associated with the implied logistical and supply chain tasks, several key challenges of humanitarian logistics can be identified.[26] Thomas and Kopczak (2005) see the lack of recognition of importance of supply chain management and logistics in humanitarian organisations as a challenge to efficient and effective logistics and supply chain management in the context of humanitarian opera-

[22] McGuire (2006), p. 7, partly based on Thomas (2003a) and Fenton (2003). McGuire (2006) goes on to draw the conclusion that "the central research problem is the lack of a coherent and comprehensive supply chain management strategy for humanitarian assistance in general and for health care goods in particular." He furthermore states that "humanitarian organisations have not realized the potential of systematically applying and adapting commercial supply chain management concepts to the very special context of humanitarian assistance.", p. 11.

[23] Cf. Beamon and Kotleba (2006). Some journals that do publish articles on humanitarian logistical issues include the European Journal of Operational Research, Forced Migration Review, IIE Solutions, International Journal of Logistics: Research and Applications, International Journal of Physical Distribution and Logistics Management, Journal of Business Logistics, Traffic World, Annals of Operations Research, Journal of Humanitarian Assistance, Logistics Today, Logistics Quarterly, Journal of the Operational Research Society, Logistics Management, Supply Management, among some others.

[24] A good and comprehensive summary of current literature from both academic and practitioners' sources can be found at Kovács and Spens (2007), who updated their work after the first dedicated European conference on humanitarian logistics took place in late 2007, cf. Kovács and Spens (2008).

[25] Cf. Kovács and Spens (2008), p. 218.

[26] Cf. for instance van Wassenhove (2006), Kovács and Spens (2007), Kovács and Spens (2008), Oloruntoba and Gray (2006), Thomas (2005), Thomas (2003a), Thomas (2003b).

tions. Furthermore, they recognize the lack of professional staff,[27] the inadequate use of technology, lack of institutional learning, and limited collaboration as the main issues that practitioners and academics need to tackle.[28]

In humanitarian operations three main phases are commonly distinguished: Preparation, immediate response and reconstruction/recovery.[29] The available literature which has been published in academic journals is presented in Table 1. It is apparent that the academic literature on supply chain management in the context of humanitarian operations mainly focuses on disaster logistics, i.e. the immediate response phase after the onset of a disaster. Some research is available for the reconstruction/recovery or post-emergency phase, i.e. the period which takes place subsequent to the immediate response phase and which begins approximately one year after the disaster impact.[30] However, there is a surprising lack of focus on the medium-term phase after a disaster has occurred, i.e. between the immediate response and reconstruction/recovery phases.

Table 1: Journal articles on humanitarian logistics issues[31]

Preparedness (Pre-emergency)	**Immediate Response (Emergency)**	**Recovery/ Reconstruction (Post-emergency)**
Beamon and Kotleba (2006), Kovács and Spens (2007), Kovács and Spens (2008), Chang et al. (2007), Perry (2007)	Beamon and Kotleba (2006), Kovács and Spens (2007), Kovács and Spens (2008), Chiu and Zheng (2007a), Perry (2007), Sheu (2007), Smirnov et al. (2007), Tzeng et al. (2007), Yi and Kumar (2007), Blecken et al. (2009b)	Kovács and Spens (2007), Kovács and Spens (2008), Perry (2007), Blecken et al. (2009b)

Due to the lack of academic knowledge of the research domain, an empirical survey, that mainly aimed at firmly anchoring the research topic as relevant in the application domain, was conducted. The process and results of the empirical survey are the subject of the following sections.

[27] In fact, some non-governmental organisations, that name consultancy and professionalisation of other humanitarian actors as their sole objectives in their mission statements, recently came into existence.
[28] Cf. Thomas and Kopczak (2005).
[29] Cf. Kovács and Spens (2008), p. 220.
[30] In the following, the terms “crisis” and “emergency” refer to events which effect either single people or communities; “disaster” and “catastrophe” refer to events which effect multiple communities or entire societies. Moreover, the terms “crisis” and “disaster” denote sudden-onset event, while “catastrophes” are used in conjunction with slow-onset or gradual events. Emergencies can be both sudden und slow-onset, cf. Ben Shneiderman (2008).
[31] Partly based on Kovács and Spens (2008), p. 231. Kovács and Spens (2008) additionally lists conference papers which have not been considered here due to the varying quality and frequently non-standard review processes of corresponding conferences.

2.2 Empirical Survey

An empirical survey was conducted during the course of the research in order to capture the present state of supply chain management in the context of humanitarian operations in practice and to identify possible research gaps and questions. The empirical survey pursued several objectives:

- To improve the understanding and knowledge of the humanitarian aid and humanitarian assistance sector
- To qualitatively identify the state of practice of humanitarian organisations in logistics management
- To quantify the state of practice of humanitarian organisations in logistics management
- To obtain input on framework, tasks, processes and responsibilities for a reference model for humanitarian organisations

The last of these objectives was added later as the research questions became clear and the objectives of the research had been formulated. It was already integrated at an early stage of the research process in order to take advantage of the established contacts with the logistics and supply chain management experts in the humanitarian organisations. Section 6.1 will further elaborate on the necessity of this part of the empirical survey.

2.2.1 Process

Basis for the empirical survey was a comprehensive search for humanitarian organisations (HO) with relevant logistics activities. A list of possibly relevant organisations was compiled using various sources: Internet searches, member lists of various associations of organisations such as VENRO[32], ICVA[33] and HLA[34] and other lists of charities

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[32] Association of non-governmental development organisations: "VENRO, the Association of German development non-governmental organisations, is [an] umbrella organisation of independent and church related NGOs working in the fields of development cooperation, emergency assistance, development education, and advocacy. Currently, the Association has 116 member organisations. In addition to the member organisations, local initiatives and small NGOs are represented in VENRO through NGO networks on regional level. Thus, as a network of about 2000, middle and small NGOs, VENRO represents a considerable part of German civil society." Source: http://www.venro.org/whoweare.html, accessed on May 18, 2009.

[33] International council of voluntary organisations: "The International Council of Voluntary Agencies (ICVA), […] is a global network that brings together humanitarian and human rights NGOs as an advocacy alliance for humanitarian action. Focusing on humanitarian and refugee policy issues, ICVA draws upon the work of its members at the field level and brings their experiences to international decision-making forums. ICVA provides a means for the collective body of its members to work together to effect change, and also assists members to improve their own work through access to initiatives and tools that help to increase quality and accountability." Source: http://www.icva.ch/about.html, accessed on May 18, 2009.

[34] Humanitarian Logistics Association: The Humanitarian Logistics Association (HLA) is an individual membership association for humanitarian logistics professionals which was created in the wake of the Humanitarian Logistics Conference 2005. During the conference, the participants signed a declaration thereby committing themselves to establish an association which would serve as a catalyst to enhance the professionalization of humanitarian logistics and the recognition of its strategic role in the effective

registered in Germany.[35] Especially the HLA allowed gathering information on supply chain structure and processes of the listed humanitarian organisation. This pre-study on humanitarian organisations resulted in a list of over 100 organisations.

For these organisations, a more detailed examination was conducted. As additional sources of information, the current annual report, financial reports and other publications were screened. Thus, fiscal and organisational data as well as breadth and depth of the humanitarian operations conducted by these organisations were obtained.

The humanitarian organisations were then classified according to a) their overall annual budget and b) their scope of logistics activities. Three classes were formed:

A: Humanitarian Organisations with both a high budget (> €1m) and a strong focus on logistics activities

B: Humanitarian Organisations with either a high budget (> €1m) or a strong focus on logistics activities

C: Humanitarian Organisations with a low budget (< €1m) and no dedicated focus on logistics activities

Among the 104 organisations contained in the pre-selected list, 29 reached class A, 33 organisations were categorised as B, and 42 organisations were classified as C. The complete list of selected and classified humanitarian organisations can be found in Appendix C: Selected Humanitarian Organisations.

Contact was then sought with all organisations contained in classes A and B (62 in total). In most cases a suitable contact person for logistics and supply chain management had already been identified during the pre-study. In the cases in which such a person had not yet been identified, the organisations were approached through a simple email or telephone call that aimed at establishing contact with such a person.

The contact person at the organisation was initially approached via email asking a limited number of guiding questions and enquiring about the possibility to conduct a telephone interview to further discuss the initial questions. The core questions asked in the initial email aimed at providing starting points for a more detailed discussion and were as follows:

- Are there written process descriptions for logistical processes and activities, e.g. in procurement, warehousing, distribution etc.?
- Do you distinguish between process descriptions of different types of operations, e.g. emergency vs. stable contexts?
- Which processes and activities are the most decisive for the successful logistical support of your projects?

delivery of relief during humanitarian crises. Source: http://www.humanitarianlogistics.org/about-hla/what-is-hla, accessed on May 18, 2009.

[35] Such as the “DZI-Spendenalmanach” which lists all NGOs which are rated to adequately use donated funds, especially with respect to little to moderate administration overhead.

- Do you measure the performance of the logistical processes (e.g. order lead time)?

At this point in time, the organisations had the option to either continue discussing the questions via email or to arrange for a telephone interview. The interviews conducted followed a semi-structured outline and evolved around the guiding questions already sent via email. Appendix E: Interview Guideline lists all questions asked during the semi-structured interviews.

A semi-structured approach was chosen in order to be able to flexibly adapt to the background and knowledge of the interviewee during the course of the interview. Out of the 62 organisations initially approached, 31 organisations took part in the survey. Overall response rate was thus 50%, which can be interpreted as a fortunately high response rate when compared to representative response rates for surveys in this domain. Of the 31 participating organisations, 6 chose to discuss those questions via continued email exchange, 25 organisations replied via email and an interview was conducted later on. In average the interviews took 1-2 hours.

The complete survey process is displayed in Figure 2. The empirical survey took place from May to December 2008.

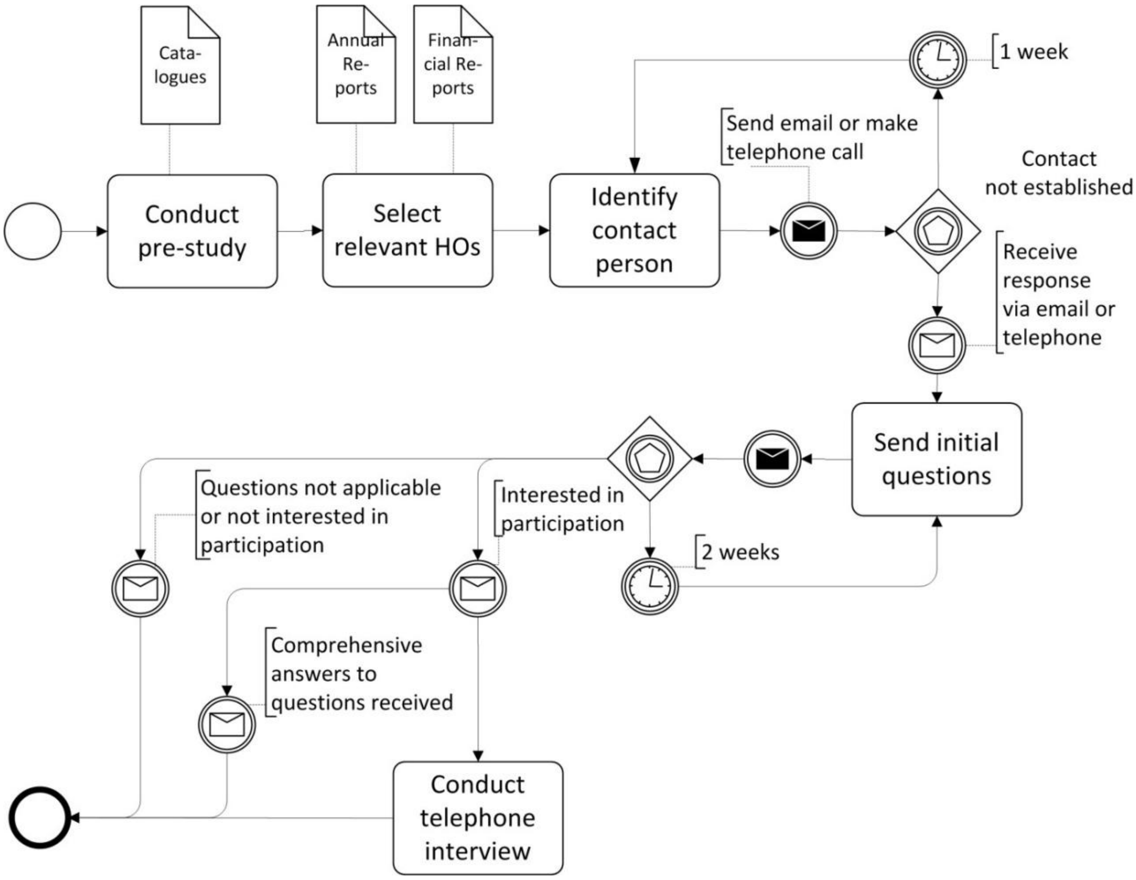

Figure 2: Empirical survey process

2.2.2 Outcomes

The main outcomes of the empirical survey among humanitarian organisations can be summarised as follows:

- There is a high degree of complexity involved in the logistics and supply chain management of humanitarian operations.
- There is a lack of supply chain process modelling, control and management and a lack of awareness of roles and responsibilities in the humanitarian supply chain.[36]
- Humanitarian organisations neither adequately measure the performance of their supply chains or the associated logistics activities, nor do they have the capability to do so.

These issues will be elaborated in more detail in the following: A number of characteristics of humanitarian supply chains lead to the conclusion that there is a high degree of complexity involved in the management of humanitarian operations and especially the logistics within.

The vast majority of the organisations contained in the survey claimed to transport goods across international borders on intercontinental transport routes. In many cases, the international transport includes only direct shipments from suppliers to the countries in which the operations themselves are run. Yet, 60% of all organisations also store goods at central warehouses, positioned mostly in the same country in which headquarters are located, i.e. a Western European or North American country (Figure 3). Moreover, a minority of organisations alternatively or even additionally pre-position goods in strategic locations world-wide in order to be able to respond to any medium-scale emergency within 48 hours. Some 70% of all organisations store goods decentrally, i.e. in the country of operations. All countries which generally operate warehouses within the country of operations were included in this category. Here, it was not further distinguished in regard to the number of echelons of warehouses within a country. Overall, it becomes clear that humanitarian organisations store goods both centrally and decentrally, with the two most common variations being decentral warehousing only and both central and decentral warehousing at the same time.

Another interesting aspect that increases the complexity in these supply chains concerns the sourcing and procurement strategy. Sourcing includes identification and selection of suitable suppliers for the necessary goods and equipment. The decision variables for organisations are here (among others) whether to source goods in the country of resi-

[36] The lack of process modelling, control and management as well as the lack of awareness of roles and responsibilities in supply chains of humanitarian organisations lead to an array of challenges. These challenges include coordination of humanitarian actors in large-scale humanitarian operations, training of staff, communication to staff, media, and other third parties, performance measurement and effectiveness and efficiency of operations themselves. The specific challenges faced by humanitarian organisations and strategies to overcome them will be presented in more detail in Section 3.6.

dence, i.e. the country where operations are run (domestically) or internationally. Procurement includes purchasing the sourced goods. The decision alternatives for humanitarian organisations here are to either purchase centrally in one location, i.e. through the headquarters or to purchase decentrally, i.e. in the country of operations.

The scope of purchasing does not need to coincide with the scope of sourcing. Centralised purchasing could source goods either domestically, i.e. in the residence country of headquarters, or internationally. Decentralised purchasing as well may source goods either domestically, i.e. in the country of operations, or internationally. In practice, it becomes obvious that procurement is done to a large extent both domestically and internationally by the organisations (Figure 4). In fact, the most common case is that organisations procure goods domestically or internationally depending on the type of item and respective quality requirements, required lead time, or total cost of ownership.

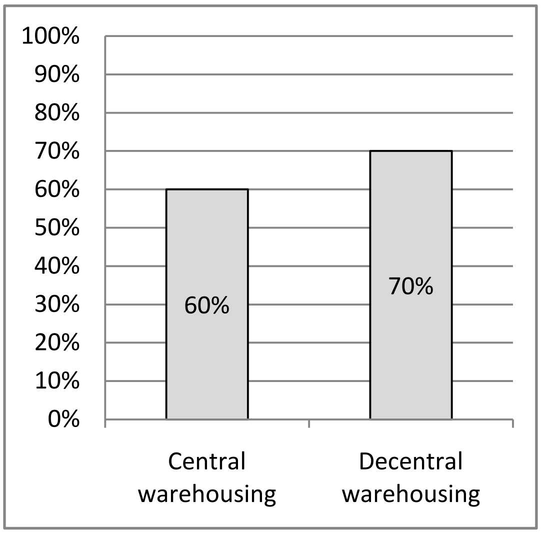

Figure 3: Storage strategy (multiple answers possible) (n=20)

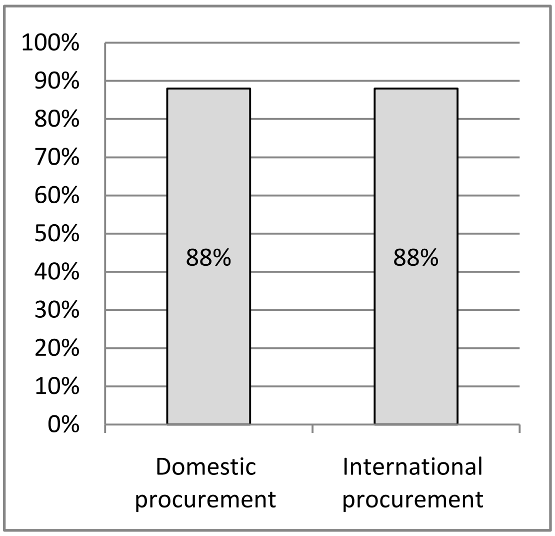

Figure 4: Procurement strategy (multiple answers possible) (n=16)

Another group of questions asked during the interviews aimed at obtaining information on the type of operations conducted. As will be seen in the following, humanitarian operations contain a vast array of activities, which differ not only in their functional breadth and depth, but also in their temporal advancement in the humanitarian operations life-cycle in the aftermath of a disaster.

It was found that 71% of all organisations generally distinguish between different types of operations, i.e. are not specialised on one particular phase of disaster relief such as preparation, immediate response or recovery and reconstruction (Figure 5). Most of the organisations which do distinguish between different types of operations stated that they separate emergency from standard operations. Some organisations even introduce more categories. The World Food Programme, for instance, uses five different categories of operations: “Protect, Recovery, and Relief Operations”, “Emergency Operations” “Development Projects”, “Special Operations”, and “Other Operations” including Trust Funds and Bilateral Services and Projects.

Also, the degree to which the distinction of different operational types is translated into differences regarding the setup, planning, and execution of the respective supply chains varies considerably. While IFRC, for instance, has laid out different process descriptions for each type of operation, most organisations foresee “urgent actions” or “priority actions” for emergency operations only. When questioned about different approaches to emergency operations as opposed to standard operations, most organisations stated that they did the same tasks but “faster” and with a “high priority”. Additionally, some internal control regulations were adapted in the emergency case in order to improve responsiveness.

For the humanitarian medical relief organisation Médecins sans Frontières (MSF) more detailed data was obtained, which is used as an illustrative example to further quantify the different types of operations. MSF considers itself as a classical humanitarian emergency relief organisation, i.e. with a strong focus on emergencies. Recovery and reconstruction or even development projects have not been in the operational focus of MSF. MSF distinguishes between projects in stable contexts, post-conflict contexts, internal conflicts and armed conflicts. Both stable and post-conflict contexts can be considered as non- or post-emergencies; internal and armed conflicts are typical emergency operations. Over the course of 2004-2008, consistently half or more than half of all projects were conducted in post-emergency settings. Emergency settings only contributed to 35-50% of all projects (Figure 6).

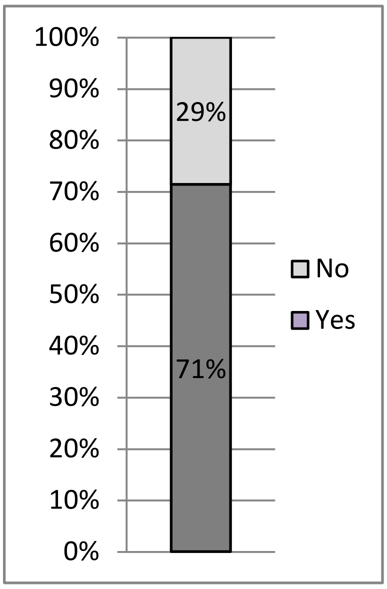

Figure 5: Distinction between types of operations (emergency and post-emergency operations)

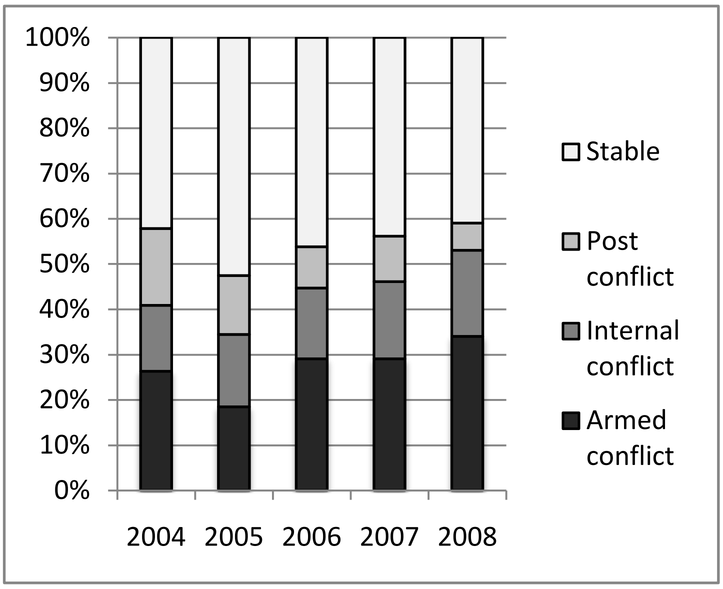

Figure 6: Typology of humanitarian operations[37]

While this example is only illustrative, it became clear during the interviews that a shift has taken place over the course of the last 10-15 years. Organisations which traditionally focussed on emergencies only, find themselves in contexts of complex or chronic

[37] Illustrative example; Here: Numbers from the humanitarian organisation MSF.

emergencies and post-emergencies and come to realise that their approaches to humanitarian operations need to reflect the changing nature of present conflicts and disasters.

As a side-step, the illustrative example obtained through the empirical survey coincides with other data: More and more emergencies develop from acute disasters to chronic emergencies, thereby necessitating organisations to stay active in these settings far longer than they had originally planned. At the same time, the necessity for humanitarian operations during the post-emergency phase or in chronic emergencies cannot be understated. It has been found in a study conducted in the Democratic Republic of Congo concentrating on the inflictions of warfare on public health, that crises undermine a civilian population's public health defences. The case study from the Democratic Republic of Congo showed that "an estimated 3.9 million more people died between 1998 and 2004 than would have been expected had the country not been in conflict."[38] It follows: "Yet fewer than 10 percent of the fatalities resulted from direct violence."[39] Fink (2007) continues and lists some of the causes for the many deaths, among which she sees mainly treatable and preventable diseases such as malaria, diarrhoea, respiratory tract infections, measles and malnutrition. Thus, humanitarian organisations may need a novel approach to their operations since short-term emergency operations are more and more evolving into longer-term humanitarian operations in post-emergency contexts.

Another crucial area subject of the interviews conducted during the empirical survey regarded issues of information management, including the employed information systems, methods for data retrieval and analysis and performance measurement. This, indeed, is a decisive area of supply chain management in the context of humanitarian operations, since it has been claimed that the "management of information during a crisis is the single greatest determinant of success"[40] for logistics of humanitarian operations.

One aspect of information management is the development, application and continuous improvement of performance measurement schemes. Performance measurement seeks to establish relationships between decision variables, i.e. parameters of the system that can more or less easily be changed, on the one hand and performance output on the other hand, leading to the creation and maintenance of high-performance systems.[41] This kind of performance measurement is deemed to be either "useful" or "very useful" by 83% of all practitioners, who were mostly senior logistics staff (Figure 7). Only a small fraction of 13% has a neutral position towards performance measurement and only 4% considers it "not really useful".

[38] Cf. Fink (2007), p. 77.
[39] Cf. Fink (2007), p. 77.
[40] Cf. Long and Wood (1995), p. 218.
[41] Cf. Beamon (2004), p. 3.

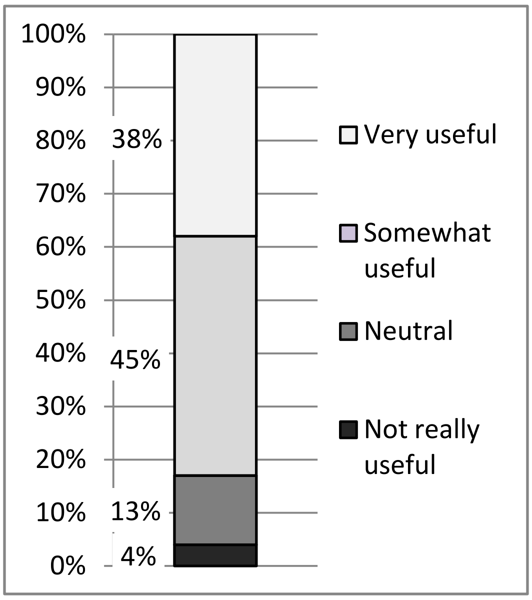

Figure 7: Perceived usefulness of performance indicators[42]

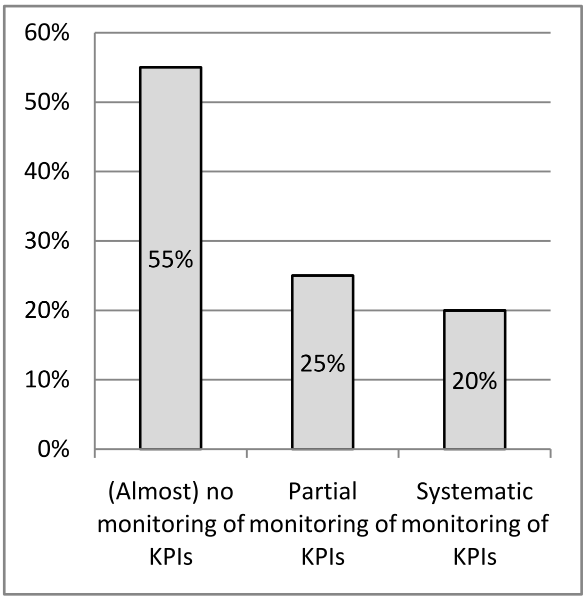

Figure 8: Logistics performance measurement (n=20)

This result is in contrast to the actual supply chain performance measurement found in practice. A vast majority of 55% of all organisations stated that they do not monitor any kind of performance indicators of their supply chains at all. Every fourth organisation claimed to monitor at least a few performance indicators. Only 20% of all humanitarian organisations consistently and thoroughly measure the performance of their supply chain operations (Figure 8).

As these results seem to be contradicting, this question was further elaborated on in order to gather more information on the reasons of this paradox. It was found that, among the various reasons for this situation, there is a lack of funding for investments in information technology and infrastructure.[43] Also, it became clear that logistics was traditionally perceived as a pure support function without strategic importance. Logisticians or supply chain managers have traditionally not been integrated in the planning of operations. Also, available IT systems are often perceived as inadequate for the requirements of humanitarian operations due to the fact that IT systems deployed in humanitarian operations need to be extremely robust and simple to operate. Moreover, as operations are usually carried out under great time pressure and with limited resources, logistics staff will only spend little time on monitoring and measuring operations.

It is obvious that a major opportunity to improve the performance of the supply chains of humanitarian operations lies in the information system and information technology infrastructure used by humanitarian organisations. Employees at all tiers of the humanitarian supply chain, most importantly in the country of operations, in the country of

[42] Cf. de Brito et al. (2007), van der Laan et al. (2009).

[43] Mentioned by almost all interviewees. Interestingly enough, some interviewees mentioned that donors have recently started to change their attitude towards investments in IT systems as they seem to have realised their strategic importance for effective and efficient supply chain operations.

headquarters, and possibly at the tiers in between, must have information about inventory and available storage and transport capacities in the supply chain in order to enable improved planning and execution of the supply chains. This gains special importance due to the fact that stakes in the humanitarian supply chain are extremely high, i.e. the strategic objective is not only to satisfy customer demand but to save lives and alleviate suffering.

As the last major part of the survey, the degree to which supply chain processes or logistics processes are documented and standardised within the humanitarian organisations was examined. Documentation of processes in humanitarian organisations commonly takes place in form of “Standard Operating Procedures”, which are a set of directive instructions, covering processes and procedures, which can suitably be defined or standardised without loss of effectiveness. “Guidelines”, which are also very common, have a less formal character and provide suggestions and best practices rather than a strict process to follow. Furthermore, many humanitarian organisations issue “field handbooks”, which cover selected areas of supply chain management in the country of operations and usually have a very pragmatic approach including checklists, advice from previous operations, lessons learnt etc. Lastly, some large organisations issue policies, special directives, and circulars governing selected issues of humanitarian logistics.

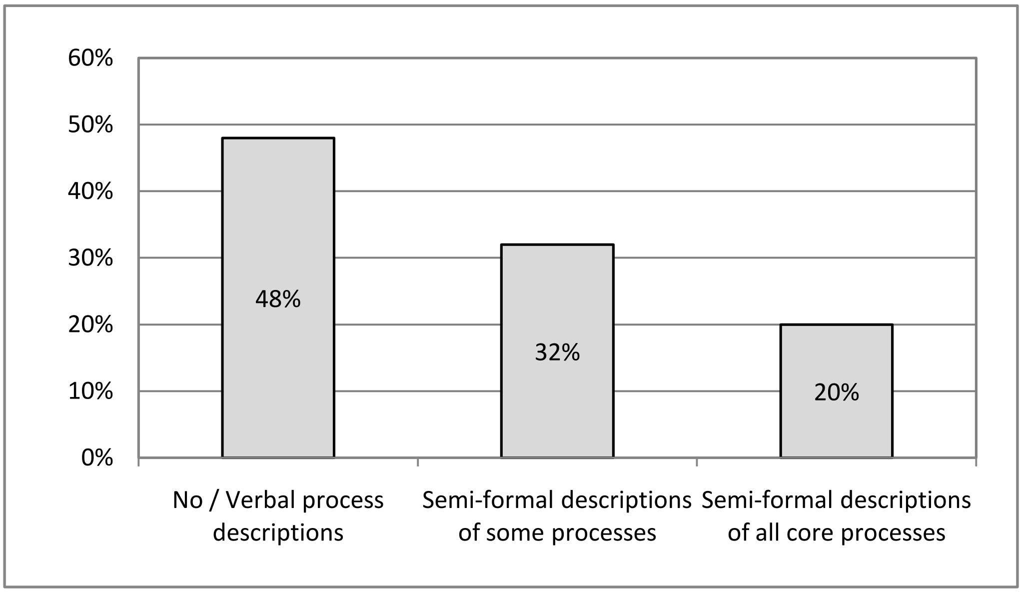

Figure 9: Documentation of supply chain processes (n=25)

Figure 9 conveys that about half of all organisations do not have any written documentation of their supply chain or logistics processes. About a third of the organisations have some sort of documented processes, while only every fifth organisation has comprehensively reviewed, documented and possibly standardised their processes. When documentation on supply chain processes is available, it mainly includes procurement and transport activities, to a lesser degree warehouse and storage issues, and even less financial management of operations. It also became clear that the size (in terms of employees or available budget) does not strongly correlate with the degree of formalisation or standardisation of processes. While a few smaller organisations were found to have SOPs for many of their processes, some large organisation did not have comprehensively documented processes.

Overall, this result is in contradiction with recent findings at a humanitarian logistics professionals conference, where practitioners have stated that an increasing transparency of the organisations' processes and a reduction of redundancies could help create synergies as well as enable economies of scale, and thus improve coordination and help to manage complexity of operations.[44] On the same line of argument is a comment received from the interviewee of a large humanitarian organisation: "In times of ever scarcer funds, safeguarding resources becomes a necessity. Documentation and standardisation of logistics processes can help to streamline supply chain operations and further improve our operational effectiveness and efficiency." Evidently, despite the apparent need, neither supply chain structure, nor supply chain processes, nor supply chain management have so far been in the focus of humanitarian organisations.

The findings of the empirical survey are used to formulate research objectives in the following section.

2.3 Research Objectives

It has been argued before that supply chain management in the context of humanitarian operations has neither been in the focus of humanitarian organisations themselves nor subject to academic research. Specifically, supply chain processes are currently not properly documented and IT systems, which could be used to accelerate, automate and measure these processes, have neither been comprehensively described nor assessed. Furthermore, supply chain management in the context of humanitarian operations is subject to unique challenges.[45] Hence, it is motivated to create a generically applicable reference model for emergency and post-emergency supply chain management tasks of humanitarian organisations.

On the basis of such a reference task model, it becomes possible to examine how these supply chains achieve their short-term responsiveness and flexibility in response to sudden-onset disasters but also secure cost-efficient and stable logistics support to operations in the medium term. Also, a reference task model can set the foundation for the analysis and evaluation of supply chain management IT systems for humanitarian operations.

In the following, the specific research objectives of this thesis are formulated:

- Systematic presentation and clear and concise documentation and **visualisation** of supply chain management and logistics tasks in the supply chains of hu-

[44] Cf. Tufinkgi (2006), p. 156.
[45] These challenges will be elaborated in Section 3.6.2 in more detail.

manitarian organisations taking into consideration the polarity of humanitarian operations between short-term disaster relief and medium-term humanitarian assistance, i.e. emergency and post-emergency logistics.

- Contribution to the **standardisation** of terms, definitions and activities in humanitarian supply chains in order to promote a sector-wide standardisation of core processes. This standardisation provides a starting point for the development of sector-specific IT solutions which could enable performance measurement, performance improvement and cost reduction.
- **Analysis** of cause-effect relationships in these supply chains and derivation of recommendations for improvement with respect to planning and control of logistics processes in humanitarian supply chains. Furthermore, an easily applicable method is to be developed which can be used for the effective process modelling and design in humanitarian supply chains and hence can contribute to a professionalization in the humanitarian sector.

The objectives visualisation, standardisation and analysis will be elaborated in more detail in the following sections.

2.3.1 Visualisation

Due to the striking lack of contributions from both the practitioners and the academic side, the first objective of this thesis is to review and visualise the current situation in the humanitarian domain with respect to logistics and supply chain management tasks and activities. This includes an assessment of the core processes necessary for effective humanitarian operations.[46] One goal is to categorise and visualise tasks in humanitarian supply chains under consideration of the different operational paradigms of emergency and post-emergency logistics, i.e. in the immediate response phase and the reconstruction/recovery phase of the humanitarian operations life-cycle. As seen before, humanitarian organisations frequently do not possess formal descriptions of their processes and neither do they deliver their assistance solely based on either one of these paradigms.

2.3.2 Standardisation

Building upon the objective of visualisation is the objective of standardisation. Lambert et al. (2005) have already noticed that “implementing business processes in the context of supply chain management”[47] is recommended by a number of authors “but there is not yet an ‘industry-standard’ on what these processes should be. The value of having standard business processes in place is that managers from organisations in the supply chain can use a common language and can link-up their firms’ processes with other members of the supply chain, as appropriate.”[48]

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[46] Cf. Staud (2006), p. 17.
[47] Lambert et al. (2005), p. 29.
[48] Lambert et al. (2005), p. 29.

So far, standardisation has been called for frequently in humanitarian organisations and progress has been made with respect to standardised item specifications,[49] needs assessment forms,[50] and in some other areas.[51] However, it has not yet been attempted to rigorously examine tasks in supply chains of humanitarian organisations and to construct reference processes from theses tasks.

While variability can certainly never be eliminated completely from any kind of operational process, standardisation is one means to reduce it. Standardisation of business processes becomes relevant when activities and processes exhibit a high degree of repetitiveness or structure. According to Schmelzer and Sesselmann (2008) it then becomes feasible to create an integrated and unified process landscape within an organisation and between the organisation and its suppliers and customers.

Standardisation of processes in a reference model[52] for humanitarian organisations could enable various benefits such as the promotion of best practices and the introduction of more efficient and more effective processes; it can help these organisations to easily and cost-effectively create their individual process models and information systems.[53] So far, processes in humanitarian organisations are frequently unstable and do not always lead to the desired results. Furthermore, a large number of different IT applications can frequently be found in any one organisation, which increases complexity, uncertainty and instability in business processes.[54] Here, process standardisation is a precondition for the harmonisation of IT infrastructure and applications and thus the reduction of associated costs.

Standardisation can constitute the lever to various other benefits such as the promotion of a common and unified process language in and across the organisation; the creation of process transparency;[55] the description of common roles and competence boundaries;

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[49] Cf. International Federation of Red Cross and Red Crescent Societies (2004); World Health Organization (2008).
[50] Cf. Grant (2007).
[51] Cf. van Wassenhove (2006), Kovács and Spens (2008), and especially Jahre and Heigh (2008), pp. 269-270: "In order to be responsive in highly volatile circumstances with a considerable number of variables, it is important to standardize as many processes and activities as possible. This standardisation cannot occur in the middle of an emergency and therefore must be carried out proactively. In general, this will take the form of permanent supply platforms, usually based in the regions to reduce lead times. These structures consist of the following key supply chain elements as described in the case above: (1) Infrastructure in the form of a set of offices and depots which hold pre-positioned stocks and coordinate procurement and framework contracts for resources and transport; (2) Process development where common roles, responsibilities and actions for supply chain response are designed and materials for training local and regional logisticians are produced; (3) Personnel comprised of management, technical and training positions, bolstered with specialist technical teams that can be deployed at very short notice and; (4) Systems used to initiate, track and replenish resources as well as provide information to make management decisions and reporting back to donors. This supply chain is generally predictable and stable, where demand figures can be used to plan resources."
[52] The term "reference model" will formally be introduced in Section 3.3.
[53] Cf. Grochla et al. (1971)
[54] One case example showing the immense cost of maintaining and operating IT systems includes the Siemens AG which invested approximately \$3-4bn in 2002 due to their complex and partly redundant IT applications (Source: Schmelzer and Sesselmann (2008), p. 228).
[55] The importance of transparent processes has been stressed in a number of recent studies on trends and strategies in the logistics sector, cf. Straube et al. (2005), p. 23.

the enabling and acceleration of business process introduction and improvement; and the creation of standardised interfaces with customers, suppliers, and partners.[56] Within these benefits, the promotion of a common terminology and the creation of transparency and process standardisation as an enabler of a harmonised IT infrastructure and common IT applications are among the most decisive advantages for humanitarian organisations. This is due to the frequent lack of coordination and collaboration, the high personnel turnover and high personnel relocation between projects and the commonly found mosaic IT landscape in these organisations and their supply chains.

Contrasting to these benefits, there is also a number of disadvantages or risks involved in (process) standardisation, including the loss of competitiveness or flexibility. Gaitanides (2007) claims that standardised solutions are rather not suitable to create competitive advantage since possibilities to consider organisation, customer or industry-specific characteristics are limited.[57] Moreover, Schmelzer and Sesselmann (2008) state that standardised business processes are more easily copied and imitated by competitors.[58] Schwegmann (1999) adds the risk of suffocating innovation and reduction of creativity and efforts for creating organisation-specific models by using reference models. He recommends the use of reference models only for those processes which are not decisive for the creation of competitive advantage.[59] Due to the non-profit nature of humanitarian organisations, there is less risk involved in processes being imitated by competitors. Likewise, the loss of flexibility is compensated for by the increase of process stability and decrease of process interruptions. Lastly, the cost incurred by the creation of a reference model needs to be balanced with the expected benefits. This can include costs for purchasing the reference model, costs for training personnel, cost for applying and adapting the reference model including possible extensions.

2.3.3 Analysis

The last objective of this thesis is the analysis of supply chains of humanitarian organisations and based upon this, the derivation of recommendations for these organisations. Building on the previous two objectives, the reference task model and reference processes will be used to gain further insight into the behaviour of humanitarian supply chains both in emergency and post-emergency contexts. If differences in emergency and post-emergency logistics are better understood by humanitarian organisations, the organisations will be able to improve the planning and design of their supply chain structures and processes. Naturally, the approaches to deliver humanitarian assistance are vast, so care is given to develop a reference model which is suitable for the application domain and can be adapted according to the needs of any specific humanitarian organisation. Recommendations for improvement with respect to planning and control of logistics processes in humanitarian supply chains need to be formulated. This also

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[56] Cf. Schmelzer and Sesselmann (2008), p. 229 and Feldmayer and Seidenschwarz (2008).
[57] Gaitanides (2007), p. 141
[58] Cf. Schmelzer and Sesselmann (2008), p. 229.
[59] Cf. Schwegmann (1999), p. 59.

includes demonstrating possibilities and benefits of integrated supply chain processes supported by appropriate supply chain management IT tools and derivating research gaps in existing tools through case examples. As Lambert et al. (2005) remarks: “Combining business process […] thinking with information and communication technology leads to cost reduction, time reduction, output quality (uniformity, variability, or no defects) […] The focus is not on automating the established business processes, but on redesigning businesses to improve outcomes for customers by making transactions more efficient and accurate.”[60]

2.4 Research Methodology

The research conducted in this thesis can be positioned scientifically within information systems (IS) research. Within IS research, two paradigms are distinguished: behavioural science and design science.[61] While behavioural science “seeks to develop and verify theories that explain or predict human or organisational behavior”[62], design science strives to broaden the boundaries of human and organisational capabilities by creating original and innovative artefacts, viz. intellectual and computational tools.[63] Design science has its roots of origin in engineering and the sciences of the artificial.[64] Within the design science paradigm, knowledge of a problem domain and its solution is enabled by the construction and application of designed artefacts. Design science “creates and evaluates IT artefacts intended to solve identified organisational problems”[65]. These problems are characterised by unstable requirements and constraints based upon ill-defined environmental contexts, complex interactions among subcomponents, and a critical dependence upon human cognitive abilities to produce effective solutions among others.[66] The artefacts created are “represented in a structured form that may vary from software, formal logic, and rigorous mathematics to informal natural language descriptions.”[67]

Benbasat and Zmud (1999) state that the relevance of IS research is directly related to its applicability in design, stating that the implications of empirical IS research should be “implementable, […] synthesize an existing body of research, […] [or] stimulate critical thinking” among IS practitioners.[68]

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[60] Lambert et al. (2005), p. 26.
[61] Cf. in the following Hevner et al. (2004); March and Smith (1995)
[62] Hevner et al. (2004), p. 75.
[63] Artefacts can be defined as follows: “Artefacts are innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, and use of information systems can be effectively and efficiently accomplished”, Hevner et al. (2004), p. 83; cf. also Denning (1997) and Tsichritzis (1998).
[64] Cf. for example Simon (1996), Dym (1994), Petroski (1996), or Pahl and Beitz (1996).
[65] Hevner et al. (2004), p. 77.
[66] Hevner et al. (2004), p. 81.
[67] Hevner et al. (2004), p. 77.
[68] Cf. Hevner et al. (2004), p. 76; Benbasat and Zmud (1999), p. 5. It is important to distinguish between routine design and system building from design research. Hevner et al. (2004) elaborate that the nature of the problems and solution is key to differentiating between the two: “[D]esign-science research addresses

The evaluation of new artefacts in a given organisational context allows the opportunity to apply both qualitative and empirical methods. The design science paradigm distinguishes between process (the research procedure) and product (the designed artefact). According to Hevner et al. (2004), the design process is “a sequence of expert activities that produces an innovative product”. The artefact is iteratively evaluated and the information retrieved leads to a better understanding of the problem, “in order to improve both the quality of the product and the design process.”[69] The two processes “build” and “evaluate” and the four artefacts “constructs”, “models”, “methods”, and “instantiations” can be distinguished.[70] In design science, computational and mathematical methods are predominant to assess the quality and effectiveness of artefacts, while empirical methods can also be used. The IS research framework according to Hevner et al. (2004) is presented in Figure 10.

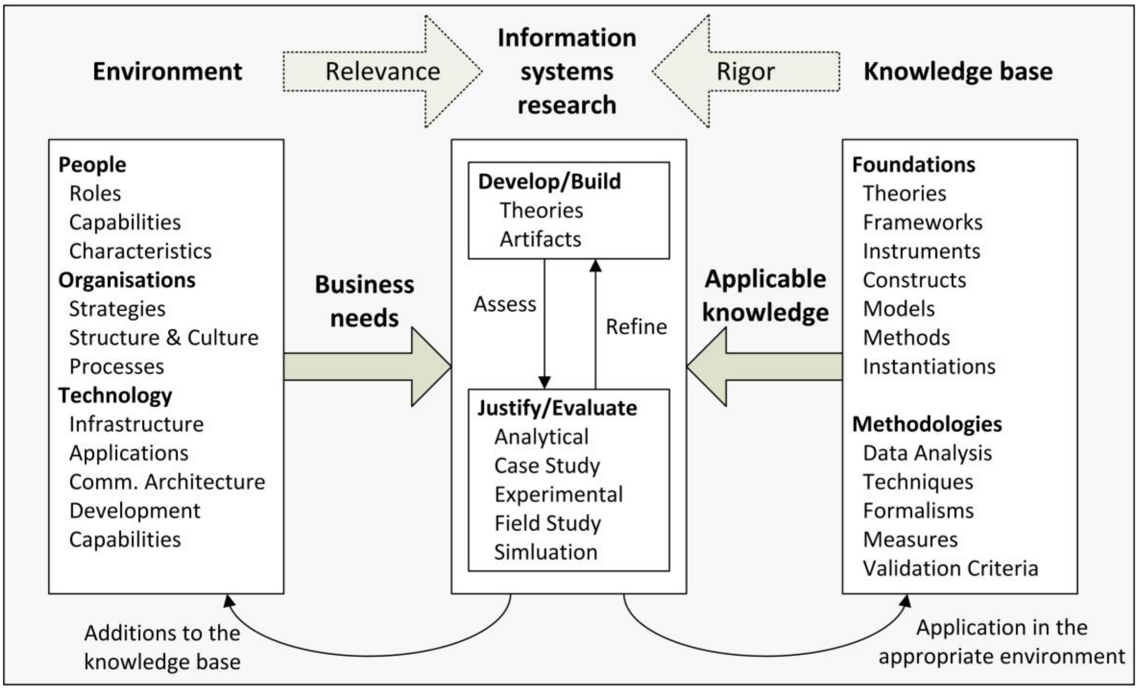

Figure 10: Information systems research framework[71]

The research conducted here follows the design science paradigm and implements the guidelines for design science in IS research as suggested by Hevner et al. (2004). The outcome needs to be assessed according to these guidelines. In Table 2 these guidelines are briefly described and it is indicated how and where contributions to the respective guideline can be found in this thesis.

important unsolved problems in unique or innovative ways or solved problems in more effective or efficient ways. The key differentiator between routine design and design research is the clear identification of a contribution to the archival knowledge base of foundations and methodologies”, p. 81.

[69] Hevner et al. (2004), p. 78.

[70] Cf. March and Smith (1995).

[71] Source: Hevner et al. (2004), p. 80.

Table 2: Design science research guidelines and implementation[72]

Guideline	Description	Contribution
Design as an artefact	Design-science research must produce a viable artefact in form of a construct, a model, a method, or an instantiation.	Reference Task Model for Supply Chain Processes; Sections 6.2, 6.3 and 7.2.
Problem relevance	The objective of design-science research is to develop technology-based solutions for important and relevant business problems.	Empirical Survey; Sections 2.1, 2.2, and 2.3.
Design evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.	Adaptability of RM; Validation of RM; Sections 6.4 and 6.6.
Research contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.	Sections 2.1 and 3.6, Chapter 5, Chapter 6.
Research rigor	Design-science research relies upon the application of rigorous methods in both the construction and the evaluation of the design artefact.	RM Construction Methodology; Sections 6.1 and 7.3.
Design as a search process	The search for an effective artefact requires utilizing available means to reach desired ends while adhering to laws in the problem environment.	Integration of existing approaches and best practices; Chapter 4.
Communication of research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.	Publication of results in international conferences and journals.[73]

Design science requires the creation of a purposeful and innovative artefact for a specified problem. The evaluation of the artefact is crucial to prove the purposefulness of the artefact. Innovation is achieved if a heretofore unsolved problem is solved or if a problem is solved in a more effective or efficient manner. The artefact itself must be rigorously defined, formally represented, coherent, and internally consistent. The construction of the artefact incorporates a systematic search process "whereby a problem space is constructed and a mechanism posed or enacted to find an effective solution". Eventu-

[72] Based on Hevner et al. (2004), p. 83.
[73] Cf. e.g. Blecken and Hellingrath (2007), Blecken et al. (2008b), Danne et al. (2008), Blecken et al. (2008a), Blecken et al. (2009b).

ally, the outcome of the design science research is communicated effectively to an audience composed of various groups with different backgrounds.[74]

The design science paradigm has been implemented in the research for this thesis in the following way (Figure 11): After a relevant research problem has been identified and the problem statement has been formulated, requirements regarding the research problem are devised. These requirements stem from both practice and research, thus reflecting organisational needs and theoretical knowledge. Existing approaches are then assessed and it is analysed if and to which extent legacy solutions can be employed. If existing solutions fully satisfy the requirements, a single approach or a combination of such can be used to address the research problem. If existing approaches do not fully satisfy the criteria, a new model can be constructed which meets all requirements. The model is then validated by evaluation in case studies.

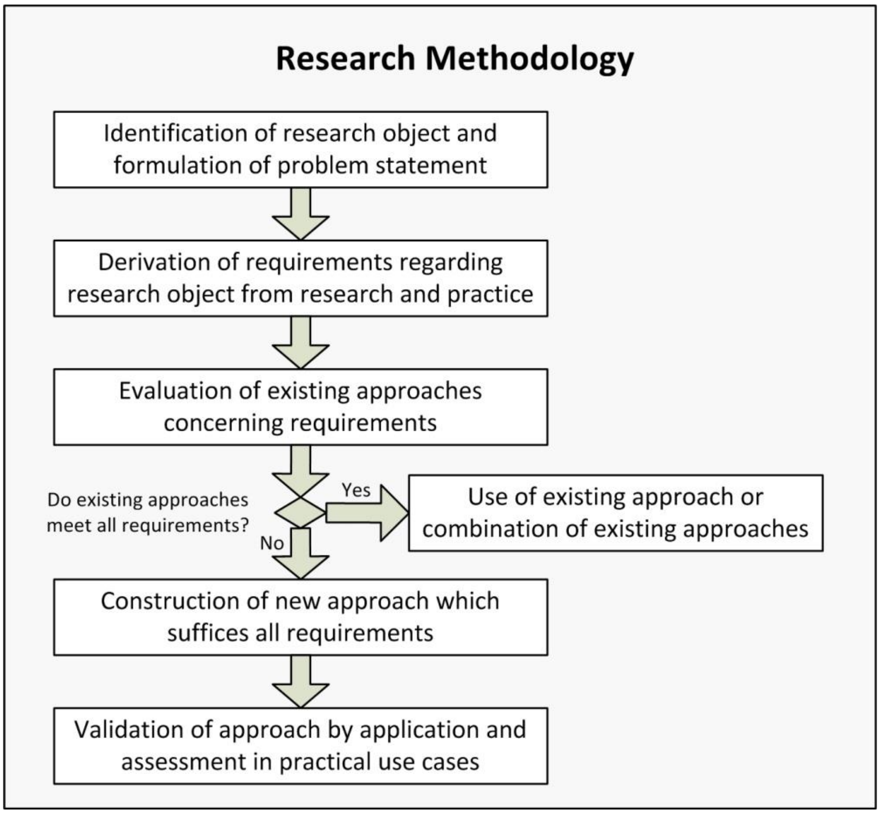

Figure 11: Research methodology

[74] Hevner et al. (2004), p. 82.

3 Logistics in the Context of Humanitarian Operations

The objective of this section is to introduce basic definitions and elaborating on the research domain. First, basic terms and definitions of system theory and system modelling are presented before processes and business processes are introduced. The field is further narrowed down by applying the notion of business processes to humanitarian operations and specifically humanitarian logistics. There, the characteristics and challenges of supply chain management in the context of humanitarian operations are elaborated and set the foundation for developing requirements for the desired solution.

3.1 System Theory

Organisations, communities and individuals are confronted with a volatile and irregularly changing environment during emergencies. A system-theoretic perspective eases the understanding of the dynamic and partly self-organising behaviour in these kinds of situations. System theory can further help to identify interdependencies between the constituents of the system and improve planning, execution and coordination of humanitarian operations.[75]

Disasters and crises can only be understood when all three constituting elements of a disaster are considered. These are the community, which is affected by the disaster, the disaster agent, which brings forth the disastrous event, and the environment and condition, in which the community is, at the point of impact of the disaster agent.[76] The behaviour, interactions and relationships between these constituents have a decisive influence on the severity of the disaster. Disaster management research has shown that the behaviour of and coordination between the community and organisations providing humanitarian assistance and between the organisations themselves has a significant impact on disaster recovery. However, activities of these entities including planning and execution of operations are frequently done independently from each other. In order to

[75] Cf. Tufinkgi (2006), p. 52.
[76] Cf. Tufinkgi (2006), pp. 36-43.

support the understanding of abstract systems, which are necessary to explain and analyse the reciprocal behaviour of organisations in both emergency and post-emergency settings, a short general introduction to system theory is given in the following.

A system[77] is a general model framework, in which the reality is projected under utilisation of a system perspective.[78] It consists of a set of elements with certain attributes interconnected by a set of relations.[79] Elements themselves can be subsystems of the super ordinate system. A system model is created through the projection of reality into the model framework. Frequently, the model itself is referred to as the system. Sometimes, the term “system” directly refers to the delimited section of reality.[80]

Open and closed systems can be distinguished: If a system is closed, the system is confined from its environment; in an open system, the system is constantly in reciprocation with its environment, i.e. there is a constant flux of material, information or energy between the system and its environment. Thus, an open system is not only characterised by relations between its elements but also by relations with its environment. Both open and closed systems are separated from their environments by system boundaries. The influence of a system on its environment is called output; the environment’s influence is called input. Both the system elements and relations between them serve to advance the system objective. The main task of a system is to transfer the inputs into outputs.[81] Due to the multiplicity of actors in the humanitarian supply chain, the vast array of activities carried out in humanitarian operations and their differing objectives, delineating the system appropriately such that it becomes observable is challenging.

System elements can be either abstract, e.g. numbers, matrices, values or ideas or concrete, e.g. cars, houses or people. These elements are considered atomic, i.e. their structure cannot be displayed in more detail or a finer granularity when modelling the system is not purposeful or sensible. The necessary granularity is determined mainly by the objective of the system examiner. Since there are relations between the elements of the system, the elements of the system are connected with each other either directly or indirectly. The relations between the system elements, between the elements, system and subsystems and the environment can be interpreted as energy, material or information flows. The behaviour of the system is influenced by the number and structure of these relations. The entirety of these relations under consideration of the system boundaries is defined as the system structure. The higher the number of relations proportional to the number of elements, the more complex a system is. Thus, the complexity of a system increases with increasing interconnectivity. Intrusion in and manipulation of complex systems can often lead to undesired and unanticipated outcomes.[82] Here, main system elements are tasks of actors in the humanitarian supply chain includ-

[77] Etymologically from Latin systēma, which in turn originated from Greek *σύστημα* (systēma).
[78] Cf. Wittmann et al. (1993), p. 4128.
[79] Cf. Arentzen et al. (1997), pp. 3693-3694; Wittmann et al. (1993), pp. 4127-4140.
[80] Cf. Wittmann et al. (1993), p. 4128 and Deutsches Institut für Normung (DIN) (1968).
[81] Cf. Mesarovic et al. (1970), pp. 34-36.
[82] Cf. Arentzen et al. (1997), p. 3694.

ing the attributes of these tasks such as roles and responsibilities. Through the interdependencies between these tasks, supply chain processes for humanitarian operations are created.

Complexity of a system can be reduced and managed by applying the principle of hierarchisation. Reduction of complexity is an essential prerequisite from a system theoretic perspective to enable theoretic and practical action.[83] The concept of hierarchy is one of the three fundamental system concepts necessary to understand systems. Next to concept of hierarchy[84], these concepts are the structural system concept and the functional system concept.[85] In the hierarchical system concept, elements themselves can represent subsystems of the system. The substitution of an element with a subsystem represents a concretisation or detailing. Abstraction denotes the substitution of subsystem(s) with a system. In the context of this research, hierarchisation is enabled by the introduction of a reference model framework, which further serves to help users navigate through the reference model.

So far, systems have been categorised according to their relationships towards the environment, their complexity and the concept of perspective. Systems can also be categorised in natural[86] and artificial systems. Artificial systems are made by humans and can be subcategorised in logical, mechanical, social and combined systems. One important type of combined system are socio-mechanical or socio-technical systems such as the organisation of a state. Enterprises or institutions are always socio-technical systems. These systems strive to fulfil a pre-defined purpose by coordination and cooperation of interactions between humans and things.

Further, systems can be either dynamic or static.[87] In a dynamic system, the system's elements or relations are time-variant, i.e. the parameters of these elements or relations can change over time. Otherwise, it is called static. In dynamic systems, it is interesting to examine whether a system is stable or instable or if a system reacts to disturbances either by becoming unstable or if a system is resilient, i.e. strives to regain a state of balance.[88] Obviously, the question of amplitude or duration of an interference, which can cause a system to leave a state of equilibrium, is an interesting research question especially with respect to disaster or crisis management.

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[83] Cf. Schütte (1998), p. 39.
[84] Cf. Ropohl (1979), pp. 54-57.
[85] Cf. also Schütte (1998), pp. 37-40; Gajewski (2004), pp. 5-7: The structural system concept focuses on the elements of the system and the relations between them. This perspective on systems is characterised by the assumption that the entirety of the system is more than the sum of its parts. Contrasting to this is the functional system concept which is concerned with the behaviour of the system. Thus, not the elements and relations themselves are object of this concept but rather the behaviour of the system and the processes in the system and between the system and the environment.
[86] Natural systems comprise the subcategories inorganic systems such as the planet system or atom system and organic systems such as biological families.
[87] Cf. Baetge (1977), pp. 510-511, who distinguishes a "Theory of static systems" and a "Theory of dynamic systems". Baetge (1977) is only concerned with the examination of dynamic systems since there are no static systems in the economic reality.
[88] The notion of system resilience has gained a recent upturn of research interest especially with respect to supply chain management, cf. e.g. Christopher and Peck (2004), Christopher and Rutherford (2004) and Hamel and Välikangas (2003).

3.2 Models

Stachowiak (1994) defines models[89] as 5-tuples: "X is a model of the original Y for the user k in the time span t with respect to an intention Z"[90]. Stachowiak claims that models should always satisfy the criteria of representation, abbreviation and pragmatism.[91] Transformation refers to the mapping of attributes of the original to attributes of the model (Figure 12). During this mapping, usually not all attributes of the original are mapped to attributes of the model following the principle of abbreviation. The principle of pragmatism establishes the reference to a subject, i.e. models are transformations of originals for a model user.

The term "model" compasses both a representative and a formative element. Models can serve to represent, map or reproduce a section of reality or formulate a design or ideal for a section of reality. In social sciences, two notions of models have developed: transformation-oriented and construction-oriented models. Transformation-oriented model definitions are supported by a number of authors, citing originally mostly Kosiol (1964) and Grochla (1974).[92] Kosiol understands a model as an "adequate representation of a considered reality"[93]. Statements regarding the content of the real system and regarding the objectives of the model development are, if present, frequently undifferentiated. Models can only serve as images or representations of reality if the transformation at least partly preserves the structure of the original.

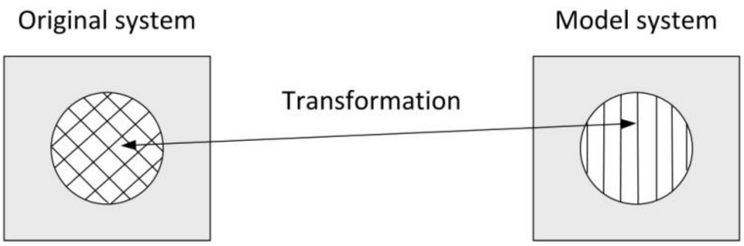

Figure 12: Transformation-oriented models[94]

In business economics, models always bear reference to reality. This is distinct from Stachowiak's model theory, in which the original does not necessarily have to be a section of reality. In business informatics, a discipline derived from business economics

[89] Etymologically from Italian modello, "paradigm", "archetype" and Latin modellus, diminutive form of modulus, "small measure", cf. Wermke and Scholze-Stubenrecht (1996). The term "model" is used in a variety of meanings and has different connotation depending on the branch of science within which it is employed.
[90] Stachowiak (1994), p. 219: "X ist Modell des Originals Y für den Verwender k in der Zeitspanne t bezüglich der Intention Z" (own translation).
[91] Cf. Klingebiel and Seidel (2007); Stachowiak (1973); Schütte (1998), pp. 41-45. The element of representation is always present in models due to the fact that Stachowiak requires the existence of an original which is transformed and represented in the model.
[92] Cf. Hars (1994), p. 11; Schütte (1998), pp. 46-47 who lists a number of authors who adopted a transformation-oriented model definition.
[93] Kosiol (1964), p. 321: "adäquates Abbild der betrachteten Wirklichkeit" (own translation).
[94] Source: Based on Stachowiak (1973), p. 157.

and computer science, the transformation-oriented perception of models is common.[95] Models are understood as representations of originals whose quality is measured by the degree of syntactical congruence with the original. Ferstl and Sinz (2006) define models as 3-tupels of object system, model system and transformation.[96] Rosemann (1996) claims that a homomorphous relation between an original and a model is required, in order to create structurally and behaviourally true representations of reality.[97] For the transformation-oriented perception of models, the following definition based on Buhr and Klaus (1975) can serve as a basis:

Definition 1: Model (transformation-oriented)[98]

> A model is a consciously created mapping of reality by use of a certain language at a given time, which, based on a structural, functional, or behavioural similarity to a respective original, is used by a subject to solve a specific task. This task cannot or not immediately be solved by conducting operations directly with the original since given restrictions render these operations impossible or inappropriate.[99]

In economics, models are interpreted as possible scenarios, interpretations of reality, such that the value of the model construction is that it can give guidance and orientation to actors.[100] Therein lies the criticism the transformation-oriented perception of models has been exposed to. Schütte (1998) summarises these into the criticism of indefiniteness, the criticism of implicity, the criticism from a cognitive science perspective and the criticism from the perspective of the model developer.[101]

These shortcomings of the transformation-oriented notion of models have been recognised in construction-oriented perceptions of models. First and foremost, the problem definition moves to the centre of the construction of models, i.e. modelling is no longer understood as a mere transformation and reproduction of a real system; rather, a model comes into existence only via the cognition of a subject. As Bretzke (1980) postulates, there are only problems which come into existence due to a subject-object-relationship and thus, there is no objective cognition of reality.[102] The homomorphous transformation is replaced with the construction of a problem. The model developer is central to this perception of models since the simple transformation of the original is replaced with a creative and independent design act. The difference between these two notions

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[95] Cf. Hars (1994), p. 11; Schütte (1998), pp. 52-53, especially footnote 83.
[96] Cf. Ferstl and Sinz (2006), pp. 12-18.
[97] Cf. Rosemann (1996), p. 18.
[98] In the following, all definitions will be given in indented paragraphs. If definitions are based on citations, these will always be set in quotation marks, even if a citation encompasses an entire paragraph.
[99] Based on Buhr and Klaus (1975): “Ein Modell ist ein bewusst konstruiertes Abbild der Wirklichkeit, das auf der Grundlage einer (Gegenstands-) Struktur-, Funktions- oder Verhaltensanalogie zu einem entsprechenden Original von einem Subjekt eingesetzt bzw. genutzt wird, um eine bestimmte Aufgabe lösen zu können, deren Durchführung mittels direkter Operation am Original zunächst oder überhaupt nicht möglich bzw. unter gegebenen Bedingungen zu aufwendig oder nicht zweckmäßig ist” (own translation).
[100] Cf. Schmidt and Schoor (1987), p. 26.
[101] Cf. Schütte (1998), pp. 55-58.
[102] Cf. Bretzke (1980), pp. 33-34.

has been characterised by Bretzke (1980): "Models of something (an original) and models for something (an objective)"[103]. The quality of these models will not be measured by the degree of the syntactical congruence with an original but rather their content-wise and formal contribution to a problem solution.[104]

Definition 2: Model (construction-oriented)

> A model is the outcome of the construction of a modeller who declares a representation of an original as relevant for model users at a given time in a given language.[105]

This definition involves the aspects of construction of models by modellers, model users, originals, time and language. The relationship between these elements are presented in Figure 13: The construction of the model developer leads to an internal model. The explicit model is the outcome of the modelling process. The model user is the person for whom the model is created. The model users employ the model to solve a specific task. Both model developer and model users are subjects, i.e. an individual but can also be groups of individuals. The original can represent any given problem, which needs to be modelled. Time is of crucial importance to indicate when the model was constructed and for how long it is intended to be valid. All models with a reference to the current situation will be of limited validity since environmental parameters will change over time. Finally, a language is needed for model construction. Artificial language systems serve to describe the model content.

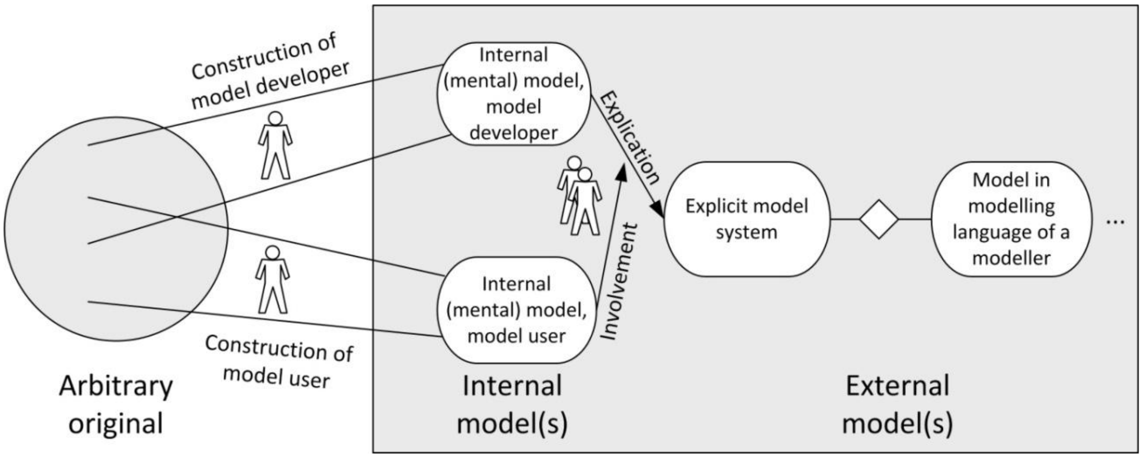

Figure 13: Construction-oriented models[106]

[103] Bretzke (1980), p. vii: "Modell von etwas (einem Original) und Modelle für etwas (einen Zweck)" (own translation).
[104] Cf. Hars (1994), p. 10.
[105] Following Schütte (1998), p. 59. The distinction between transformation-oriented and construction-oriented understandings of models has also been expressed in Krcmar (1996), p. 719, as an extension: "Models in the stricter sense are transformation rules according to which the reality is presented. […] Models in the broader sense incorporate models in the stricter sense and extend them by creator and user of models […], original […]." (own translation). This definition can also be found in Schütte and Rotthowe (1998), p. 243: A model is the "result of a construct done by a modeller, who examines the elements of a system for a specific purpose such as the redesign of an organisation or the development of an information system at a given point of time with a specific language" with reference to Bretzke (1980).

Although the transformation-oriented perception of models is still the most commonly used definition in business informatics, its definition of model is not adapted to the purposes of this thesis. In the transformation-oriented perspective, the creation of models can be seen as a passive-receptive act from observation. However, as frequently seen from modelling practice, a modeller A might achieve a different result from a modeller B depending on previous knowledge.[107] Thus, not the formal-descriptive act but the active cognitive act should be in the centre of the definition. This can be exemplified when looking at the process of hierarchisation. As Schütte and Rotthowe (1998) notes: "[in] an information systems modeling project the question of how to derive the hierarchical decomposition is not answered through observations but through constructional activities.[108] Schütte's construction-oriented definition of model is thus adopted here. This definition will provide the basis for the definition of reference information models in the succeeding section.

3.3 Reference Information Models

Within the realm of business informatics, models are mostly information models. These are a specific kind of model and focus on business systems. Information models are used for a variety of purposes in business informatics such as representation of ideas and causal links, which somehow leave the sphere of pure thought; explanation of phenomena; gathering of insight into the behaviour of a system by generation of hypotheses on system behaviour and verification by comparison of model and system; prediction of system behaviour by emulation of systems; software design and implementation; configuration of standard software; and optimisation of system structure, behaviour or function through system design and testing of system variants.[109] Following the construction-oriented definition of model in the previous section, information models can be defined as follows:

Definition 3: Information Model

> An information model is the outcome of the construction of a modeller who declares a representation of an original as relevant for application system or organisation developers to solve a specific task at a given time in a given language.[110]

Thus, the former definition has been specialised for application system or organisation developers, since these are the primary model users in business informatics. For more than 30 years, information models have been used to analyse, design, implement and

[106] Source: Adopted from Schütte (1998), p. 61; cf. also Delfmann (2006), p. 39 and Becker and Schütte (2004), p. 66.
[107] This has been shown empirically by Shanks (1997).
[108] Schütte and Rotthowe (1998), p. 243.
[109] Cf. Hellingrath (2008) and Thomas (2005), pp. 16-17.
[110] Cf. Schütte (1998), p. 63.

deploy information systems.[111] “Information systems are mediators between business frameworks and information technology and can be characterized using in-depth system-theoretical attributes”[112].

In order to enhance possibilities of reutilisation of information models, these models often need to abstract from organisation-specific characteristics. Hence, organisation-specific models and reference models can be distinguished. The attribute organisation-specific stresses the individuality of the model, while reference models constitute a point of reference for the development of specific models. The objectives of the development and application of reference models are to support the development and optimisation of organisation-specific models, to accelerate the speed of the development of organisation-specific models and to improve the quality of those models.[113] Reference models streamline the design of organisation-specific models by providing generic solutions. Reference models can be regarded as repositories of potentially relevant models, which are ideally “plug and play”, but often require customisation or configuration to be adjusted to organisation-specific requirements.[114]

Etymologically, the term “reference” has two meanings: Firstly, the word “reference” can be used in the sense of “bearing a relation to something, quoting something or alluding to something.”[115] Secondly, the term “reference” was used since the 19th century to denote a person or company who is able to testimony the trustworthiness of a business partner.[116] In business informatics a model, which is being consulted as a recommendation for the design or development of other models, is denoted a reference model.

However, the term “reference model” is not yet been clearly defined and neither is it obvious which models can be regarded as reference models. As Hars (1994) states, the term “reference model” “belongs to a class of terms used often but rarely defined clearly”[117]. This has somewhat changed in the last decade with a number of dedicated conferences on reference modelling[118]. The definition of reference information model has mainly been influenced by Nordsieck (1931); Jost (1993) who introduces the notion of universality; Kosiol (1964) who declares so-called ideal models as “prefabricated solutions or standard recipes for certain categories of decision problems in coping with practical problems”[119]; Forrester (1968) who discusses the characteristics abstraction and reusability); Grochla et al. (1971) and Grochla (1974) who introduce the term

[111] Cf. Fettke et al. (2005) and Grochla et al. (1971).
[112] Cf. Thomas (2005), p. 16.
[113] Cf. Schwegmann (1999), p. v. and Klingebiel and Seidel (2007), p. 6.
[114] Cf. originally Kosiol (1964) and in a more modern expression van der Aalst et al. (2005), p. 76.
[115] Thomas (2006), p. 18.
[116] Cf. Wermke and Scholze-Stubenrecht (1996), p. 1228, which lists three meaning of the term “reference”: 1. An assessment or judgement of a person give by a trusted and somehow related person; 2. Person or entity who is being referred to since it can give information about someone; 3. (Linguistics) Relation between symbols and their references.
[117] Hars (1994), p. 12.
[118] Such as the conference “Reference Modeling” at the University of Münster in the late 90s or the Third International Conference on Business Process Management in Nancy, France in 2005.
[119] Kosiol (1964), p. 758.

"reference information model"; Becker et al. (2002), Becker and Schütte (1997), Schütte (1998), Nonnenmacher (1994), and Thomas and Scheer (2002) who further develop the notion of reference information models; and Gersting et al. (1988), Peckham and Maryanski (1988), Scheer (1989), Scheer (1994), and Wollnik (1988). Scheer (1990) uses the term "reference model" in the sense of reference data models, which provide the point of origin for the construction of organisation-specific data models.[120] Schütte (1998) presents a comprehensive discussion in his seminal work on reference modelling. Building upon Schütte, the term "reference information model" is defined as follows:

Definition 4: Reference Information Model

> A reference information model is the outcome of the construction of a modeller who declares information about universal elements of a system relevant for application system or organisation developers to solve a specific task at a given time in a given language in such a way that a point of reference for an information system is created.[121]

Reference information models have become a medium for describing operational information systems.[122] Information systems themselves are implemented within organisations in order to improve the effectiveness and efficiency of that organisation by engaging new forms and structures.[123]

Reference models are often discussed in conjunction with meta models. The prefix meta can have several meanings such as "after", "behind", "higher" and "beyond", among others. Etymologically the word meta comes from Greek meta: "in the midst of, among, with, after"[124]. In conjunction with models, meta models are models of models, i.e. a meta model can be considered behind or beyond a model. A meta model contains information of the model and can serve to define the model structures.[125]

While meta models are concerned with and define the syntax of models, reference models are mainly concerned with the semantics of models and are syntactically on the

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[120] Cf. Scheer (1990), p. 519.

[121] Definition based on Schütte (1998), p. 69. A shorter definition, which can be seen as the core of the presented definition is given by Thomas (2006), p. 16: "A reference model – more explicitly a reference information model – is an information model that supports the construction of other models." (own translation). A comprehensive list of definitions of the term "reference model" can be found in Thomas (2006), pp. 21-26. One particularly interesting one is given by Klingebiel and Seidel (2007), p. 6: "A reference model depicts structures, attributes, relationships and behaviours of objects for a given domain. It is represented in a general, reusable and applicable form, so that specific application models can be created by adaptation and modification. It serves method-wise as well as content-wise as recommendation and framework for specified modelling and design tasks." Albeit containing a lot of the notions associated with the term "reference model" within this thesis, this definition is rejected since it links the definition of reference model to certain assertions which do not necessarily have be fulfilled by reference models. The construction-oriented perspective on modelling is not taken in this definition; moreover, the application method is already specified which should not be included in the definition.

[122] N.B.: Reference information models will also be denoted reference models (RM) in the following for reasons of brevity. These two terms will be used synonymous.

[123] Cf. Hevner et al. (2004), pp. 76, 78; Orlikowski (2000); Drucker (1988).

[124] Source: Etymonline (2008).

[125] Cf. Gajewski (2004), p. 16.

same level as the derived models. The internal models of both model developer and model user as displayed in Figure 13 can be considered meta models. Obviously, an implicit model always exists in the minds of model user or model developer; otherwise, the development of a model will not be possible.[126] The relationship between reference models and meta models is displayed in Figure 14.

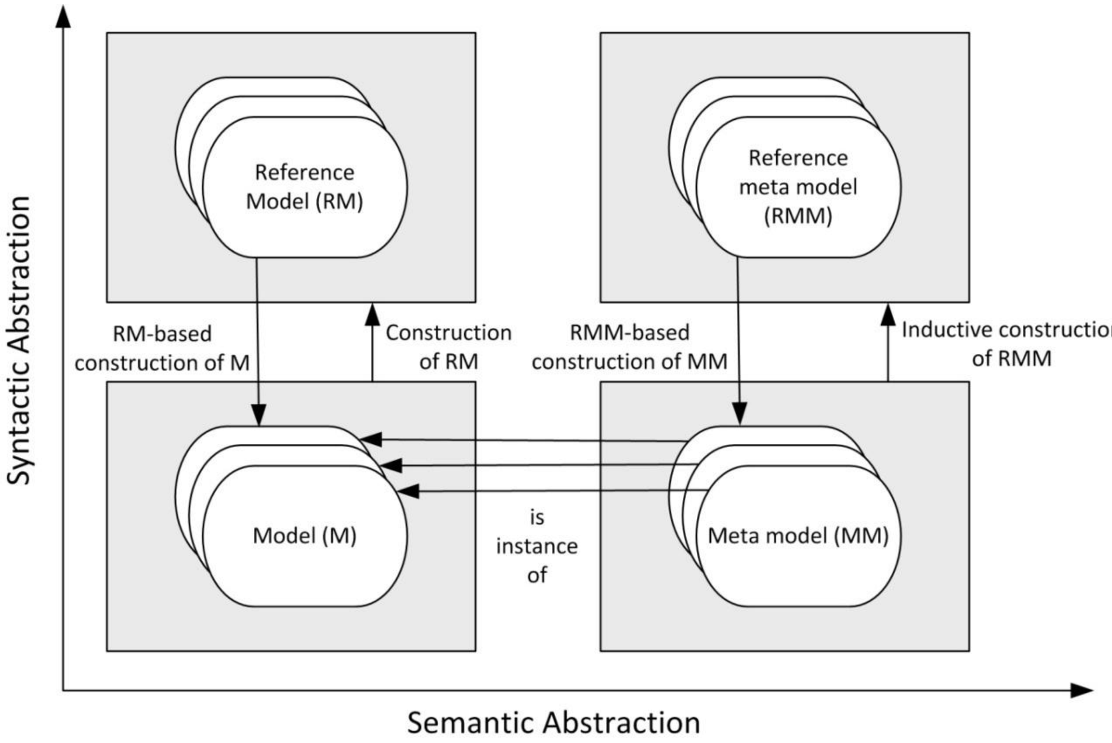

Figure 14: Reference models and meta models[127]

In order to be able to further limit the scope of the required reference model, the notion of "process" and "business process" need to be introduced. Thus, in the following section, these terms will be defined and the difference between them will be elaborated.

3.4 Business Processes and Process Models

Every organisation or company tries to deliver some sort of service or product in order to satisfy the needs of a customer. The creation of these products or the delivery of these services is achieved through processes. Klaus and Krieger (2004) provide a commonly accepted definition of process:

Definition 5: Process

> "A process is a sequence of at least two activities, operations or processing steps, which cannot be further distinguished given a specific analysis objective. Every activity is comprised of a measurable input (going into the proc-

[126] Cf. Sinz (1996), p. 126.
[127] Source: Based on Schütte (1998), p. 73.

ess), which is converted by a transformation into a measurable output (leaving the process)."[128]

Thus, a process consists of a number of activities, which transform a given input into a (desirable) output (cf. Figure 15). Within the context of creating products or delivering services, inputs can be any of the following: Energy, work equipment, auxiliary work equipment, working effort, material (raw, auxiliary, and operating) and information. Output types are either of the input types including the final products and services.

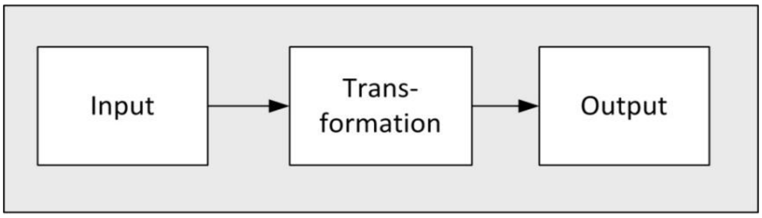

Figure 15: Process[129]

The definition by Klaus and Krieger (2004) suffers shortcomings when applied in the context of supply chain management, which necessitate an extension of the definition. Definition 5 does not specify to whom the process is directed or what the limitations of a process are; neither does it elaborate on its content or structure. As defined above, already the connection of two activities can be considered a process. However, in order to suitably describe processes, which are of relevance for a customer, it is necessary to connect and coordinate those activities which actually deliver service to the customer (cf. Figure 16).

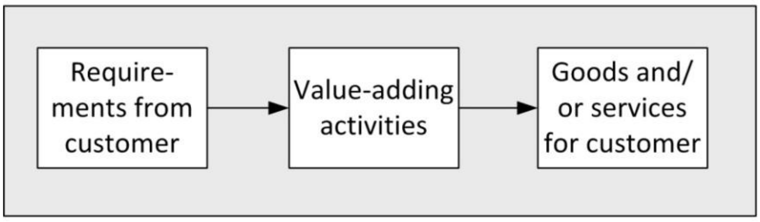

Figure 16: Business process[130]

When discussing processes, the focus is usually put on few connected activities. Business processes however put longer chains of connected activities with a possibly closed outcome into the centre of examination. Processes are centred on single activities and the process responsible, business processes on the other hand try to capture the entire

[128] Own translation based on Klaus and Krieger (2004), p. 423. Activities which cannot further be distinguished are also called elementary tasks, cf. Bullinger and Fähnrich (1997), p. 41. Elementary tasks can be combined to tasks which are defined as "functions with a measureable output conducted by humans or machines", cf. Österle and Winter (2003), and can further be aggregated up to a highest level, which are the organisation's objectives, e.g. "maximise profits" or "reduce mortality and morbidity". In the context of process modelling, tasks are closely related to functions and syntactically consist of two components: Verb (action) + Noun (object), e.g. "check inventory".
[129] Source: Based on Schmelzer and Sesselmann (2008), p. 64. ISO 9000:2000 defines process as a "set of interrelated or interconnected activities which transfer inputs into outputs", ISO 9000:2000, Section 3.4.1.
[130] Source: Based on Schmelzer and Sesselmann (2008), p. 65.

process disregarding the artificial organisational and responsibility boundaries. Evidently, this perspective on business processes is highly subjective, in the sense that it is due to the modelling and analysis objective which process is regarded as a business process, i.e. where a measurable benefit for the customer has been achieved.

The term "business process" is intensely discussed in literature. Here, the holistic and customer-oriented definition given by Schulte-Zurhausen (2005) and the definition by Gadatsch (2008) are adapted:

Definition 6: Business Process

> A business process is a chain of functionally connected activities using information and communication technologies, which lead to a closed outcome providing a measureable benefit for a customer.

There are many other definitions of the term "business process". The definition of Schulte-Zurhausen (2005) is adapted since it stresses the fact that business processes are geared towards the creation of customer value. Other definitions of business processes are given by Scheer and Zimmermann (1996), Hess (1996), Hammer et al. (2003) (emphasis on customer orientation), Osterloh and Frost (2006), and Porter (2008)[131] who distinguishes between core business processes and supportive business processes. Despite the variety of definitions, a set of common characteristics of business processes can be derived from the available definitions:[132]

- Business processes have one or several objectives, which are derived from the overall strategic objectives of the organisation.
- A business process can usually be partitioned in tasks. Tasks lie within the responsibility of task managers who are associated with organisational units.
- A business process usually crosses organisational boundaries, i.e. involves a number of departments.
- Business processes need information and other resources of the organisation of various kinds for their execution and the accomplishment of tasks.

Figure 17 portrays the components of business processes. Origin of business processes are not the process inputs themselves but some entities' requirements. This entity is usually a customer, but can also be a supplier, the general public, governance bodies or any other stakeholder. The business process bundles all tasks necessary to create the desired services or goods under the responsibility of a business process responsible who also monitors and manages the business process with the help of performance indicators. The business process can span several departmental or even inter-organisational boundaries and include tasks at suppliers, customers or other partners in the supply chain.

[131] Cf. originally Porter (1992).
[132] Cf. Staud (2006).

Business processes can be controlled by performance indicators, which usually involve efficiency and effectiveness metrics. Business processes are effective if they satisfy the stakeholders' requirements and contribute to reach the organisation's strategic objectives. Business processes are efficient if they are effective with as little as possible resource usage. Efficiency of business processes is often measured in terms of process time, quality and cost.[133] In case of deviation of either efficiency or effectiveness metrics, the business process responsible can decide to react and account for undesired effects.

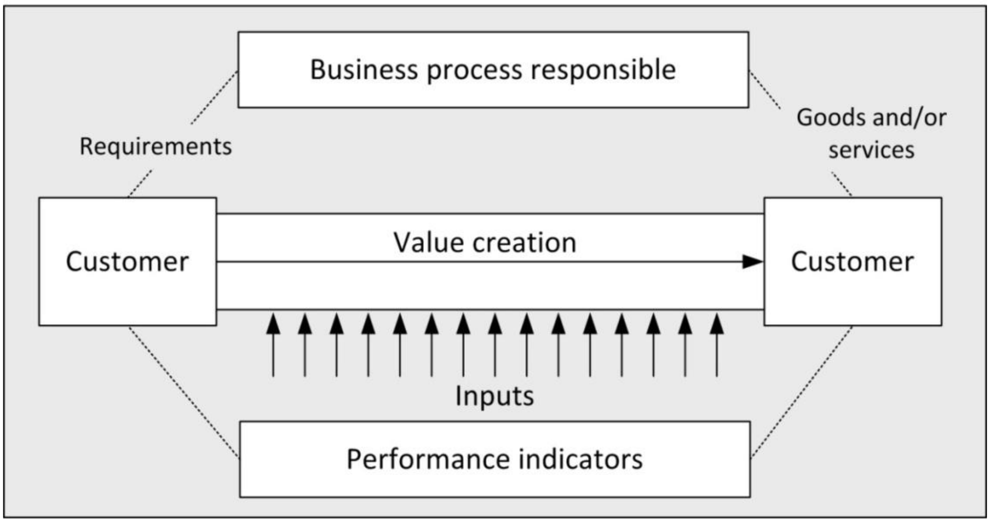

Figure 17: Components of business processes[134]

A major benefit of the business process perspective is that it supports a holistic view on an organisation and how it delivers its products and services. The traditional fragmentation of processes, which is due to organisational structures, can be overcome and the business processes can be aligned to customer requirements.

Based on the definitions delivered in this and the preceding sections, the term "process model" can be introduced. Process models have traditionally been used in software engineering, but these models become more frequently used for pure organisational purposes like process reorganisation, certification, Activity-based Costing, or human resource planning.[135] A process model represents dynamic aspects of an organisation, e.g. activity sequences, control-flow between activities, or particular dependency constraints etc.[136] Process models can serve as communication platforms in system planning and development.

Process models offer several benefits to any organisation as they

- serve to strengthen the institutional capacities in order to manage growth

[133] Cf. Schmelzer and Sesselmann (2008), p. 67.
[134] Source: Based on Schmelzer and Sesselmann (2008), p. 65.
[135] Becker et al. (2000), p. 31.
[136] Cf. Fettke et al. (2005), p. 1.

- improve transparency and accountability requirements towards stakeholders, especially beneficiaries, private donors and institutional donors
- offer the establishment and measurement of indicators and steering tools for the organisation
- support the harmonisation of relations between departments and
- strengthen the decisional autonomy

Bringing together the notions of business processes and reference models allows the introduction of process reference models. Process reference models are a specific kind of object-oriented reference information model focusing on the behavioural aspects of an organisation through the analysis of its business processes. They are not primarily intended to verify or validate specific assertions or to identify or explain hypotheses or facts, but rather to extend the scope of possible decision situations and thus serve as solution schemes or generic recipes for certain classes of decision problems for the accomplishment of practical tasks.[137] Process reference models can serve as bases for the selection and adaptation of reference processes according to the purposes of specific organisations. Here, benefits can be reaped in terms of reusability, benchmarking, improvement of transparency, collaboration and cooperation, process control, as well as process optimisation, amongst others.[138]

Reference models can be developed based on practical use cases or following theory-based approaches. When reference models are based on practical use cases, a best practice approach is usually followed. Process reference models are "documentations of process knowledge"[139], which can be used when business processes need to be modelled. They can provide the basis for organisations or companies for the design of their processes in giving guidance on model content or detail. Thereby, reference models are adapted to fulfil the specific requirements of an organisation and a reference model becomes an organisation-specific model.[140]

In the following two sections, the notion of business processes will be transferred to the application domain, i.e. it will be examined what business processes in supply chain management in the context of humanitarian operations are.

3.5 Humanitarian Operations

Humanitarian operations are grounded on the belief that those affected by crises have a right to life with dignity and therefore a right to assistance. This right to life with dignity has been formulated by The Sphere Project (2004), in which over 400 organisations

[137] Cf. Kosiol (1964).
[138] The importance of process optimisation cannot be stressed enough. In a recent study on trends in the logistics sector 75% of all companies included attributed process optimisation enabled by logistics a "high" or "very high" value, cf. Straube et al. (2005), p. 39.
[139] Scheer (1998b), p. 61.
[140] One of the main advantages of reference models is that they can help to reduce cost by up and increase speed of model construction by up to 30%, cf. Schütte (1998), p. 61.

from 80 different countries have contributed to formulating common ideas, concepts and minimum standards for humanitarian operations.[141] In The Sphere Project (2004) the right to life with dignity is formulated as follows:

> "This right is reflected in the legal measures concerning the right to life, to an adequate standard of living and to freedom from cruel, inhuman or degrading treatment or punishment. We understand an individual's right to life to entail the right to have steps taken to preserve life where it is threatened, and a corresponding duty on others to take such steps. Implicit in this is the duty not to withhold or frustrate the provision of life-saving assistance. In addition, international humanitarian law makes specific provision for assistance to civilian populations during conflict, obliging states and other parties to agree to the provision of humanitarian and impartial assistance when the civilian population lacks essential supplies."[142]

The preservation of life when it is threatened and the undertaking steps to reduce suffering are core ideas in this characterisation of humanitarian operations. Médecins Sans Frontières (MSF), a large humanitarian organisation with focus on emergency medical assistance, formulates the objective to reduce suffering for populations in distress and also incorporate the humanitarian principles neutrality, impartiality and independence:

> "Médecins Sans Frontières provides assistance to populations in distress, to victims of natural or man-made disasters and to victims of armed conflict. They do so irrespective of race, religion, creed or political convictions. Médecins Sans Frontières observes neutrality and impartiality in the name of universal medical ethics and the right to humanitarian assistance and claims full and unhindered freedom in the exercise of its functions."[143]

These statements are based on a number of international conventions such as the Geneva Conventions, International Human Rights Law, Refugee Law and International Humanitarian Law and common agreements such as the Code of Conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organisations in Disaster Relief.[144]

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[141] The standards developed in the Sphere Project are mostly not genuinely new. However, since the Sphere Project consulted a vast number of practitioners when it developed its recommendations, the fact that a consensus was reached across a broad spectrum of humanitarian organisations can be regarded as an achievement. The Sphere Project's recommendations have become a de-facto standard for humanitarian operations.

[142] The Sphere Project (2004), p. 17, based on the following original sources: Articles 3 and 5 of the Universal Declaration of Human Rights 1948; Articles 6 and 7 of the International Covenant on Civil and Political Rights 1966; common Article 3 of the four Geneva Conventions of 1949; Articles 23, 55 and 59 of the Fourth Geneva Convention; Articles 69 to 71 of Additional Protocol I of 1977; Article 18 of Additional Protocol II of 1977 as well as other relevant rules of international humanitarian law; Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment 1984; Articles 10, 11 and 12 of the International Covenant on Economic, Social, and Cultural Rights 1966; Articles 6, 37 and 24 of the Convention on the Rights of the Child, 1989; and elsewhere in international law.

[143] Médecins sans Frontières (2008a), cover page; cf. also Médecins sans Frontières (2008b).

[144] Cf. International Federation of Red Cross and Red Crescent Societies and International Committee of the Red Cross (2004).

A disaster can be defined as an “event which causes widespread human suffering, […] an event responsible for a breakdown in the normal functioning of a community that also overwhelms local response capability.”[145] Guha-Sapir et al. (2004) from the Centre for Research on the Epidemiology of Disasters[146] define disaster as a “situation or event which overwhelms local capacity, necessitating a request to the national or international level for external assistance, or is recognized as such by a multilateral agency or by at least two sources, such as national, regional or international assistance groups and the media.”[147] The United Nations Department of Humanitarian Affairs (UNDHA) further characterises a disaster as an “unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins. Wars and civil disturbances that destroy homelands and displace people are included among the causes of disasters. Other causes can be: building collapse, blizzard, drought, epidemic, earthquake, explosion, fire, flood, hazardous material or transportation incident (such as a chemical spill), hurricane, nuclear incident, tornado, or volcano.”[148] In reality, this can mean instability of population, large-scale displacement of people, water and food shortage as well as deprivation of housing, disruption of services and damage or destruction of infrastructure to name just a few examples.[149] One important aspect within this definition is the notion that an affected community’s ability to cope with an ongoing or past crisis is overwhelmed and outside assistance is needed.[150]

Since local capabilities are overwhelmed by these crises, the international community normally responds to disasters in an effort to help the community restore its original situation by providing goods and services to the most basic and life-saving needs. Among these are search and rescue, water, food, (temporary) shelter and blankets, electricity, medical needs (primary and secondary health care and epidemiological surveillance as well as vaccination), and sanitation (garbage, sanitary sewer) with changing priorities depending on the context.[151] Each of these goods and services may require a combination of personnel, equipment and supplies.

Definition 7: Humanitarian operations

> Humanitarian operations aim to preserve life and reduce suffering of members of communities in crises. They comprise the provision of material and technical aid as well as the delivery of essential services in response to situations of crises when a community’s ability to cope has been severely

[145] Cf. Pan American Health Organization (Regional Office of the World Health Organization) (2001). This definition is also close to a definition commonly used by UN agencies: “A serious disruption of the functioning of the society, causing widespread human, material, or environmental losses which exceed the ability of affected society to cope using only its own resources.”
[146] Cf. http://www.em-dat.net.
[147] Guha-Sapir et al. (2004), p. 16.
[148] United Nations Department of Humanitarian Affairs (1992).
[149] Cf. Pettit and Beresford (2005), p. 313.
[150] Concerning the fact that a community’s ability to cope with the crisis is overwhelmed, cf. especially Tufinkgi (2006).
[151] Cf. Rodman (2004), p. 6 and Table 3, p. 39.

> impeded. It is given to people in need without distinction as to race, ethnicity, creed, nationality, sex, age, physical or mental disability or political affiliation. Humanitarian operations are not motivated by making profits; however, they are based on basic human rights as formulated in International Humanitarian Law and the Geneva Conventions. Humanitarian operations are temporary in nature and aim to re-establish self-sufficiency of the affected community.[152]

Humanitarian operations, humanitarian assistance, humanitarian aid and humanitarian intervention are terms often used interchangeably in literature. These will also be used synonymously here, although "humanitarian operations" is the preferred term.[153] Humanitarian operations are launched in response to both natural and man-made crises and executed normally over a short to medium-term time horizon. As soon as the political and security situation permits, these operations are replaced by rehabilitation and reconstruction programmes, which in turn are followed by development aid.[154] The boundaries between these different phases are sometimes blurred, the phases can be overlapping and initiatives exist to integrate these phases in Linking Relief, Rehabilitation and Development (LRRD) programmes.

Considering their chronological advancement, humanitarian operations can be broadly categorised into three different phases. These are preparation, emergency humanitarian operations or immediate response, and post-emergency humanitarian operations or reconstruction/recovery (Figure 18). The preparation phase ends when a disaster occurs and humanitarian operations geared towards a specific community begin. The preparation phase sets the framework and foundation for the humanitarian operations. It is also in this phase that design and planning decisions with effect on the humanitarian supply chain are taken. The more time is spent in the planning phase of the supply chain, the more consistent and predictable the flow of material will be later on throughout the supply chain, from the supplier to the beneficiary.[155] After the preparation phase, emergency humanitarian operations with the objective to alleviate suffering and safe lives of members of the affected community follow. While this phase is characterized by a high degree of uncertainty and frequently volatile environments, this slowly calms down towards the end of the immediate response phase. The last phase in the humanitarian operations life-cycle starts when the environment has become more stable and reconstruction and recovery projects begin. This is also the time when humanitarian organisations' efforts begin to focus on handing over the relevant operations either to local organisations or development agencies.

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[152] Source: Own definition with input from McGuire (2006), p. 4; OECD (1999), p. 10; EC 1257/96; and Médecins sans Frontières (2008a).
[153] One exception is the term "humanitarian intervention", which is a term frequently used when reference is made to military-humanitarian interventions. Since the concept of military-humanitarian interventions is highly debated, the term "humanitarian intervention" is avoided in the following.
[154] N.B.: Naturally, not the political or security situation themselves are the original basis for phasing out humanitarian assistance, but rather the needs of the affected community.
[155] Cf. Davidson (2006), p. 46.

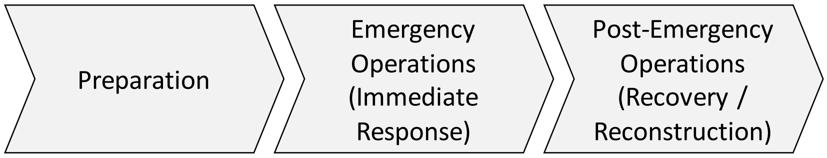

Figure 18: Humanitarian operations life-cycle

Contemporary humanitarian operations comprise a wide variety of activities, e.g. the delivery of goods and essential services that aim to support a community in its survival or reduce suffering when the ability to cope with a specific crisis is overwhelmed. The large variety of humanitarian operations is due to the range of different contexts and causes, which provide the setting for these crises and which result in a broad range of needs and humanitarian responses. It is important to note that needs change during the course of a crisis and thus, operational priorities and focus and scope of operations change. Humanitarian operations can include a wide variety of actions, the most important of which are portrayed in Table 3 together with an array of further types of humanitarian operations.

The Sphere Project (2004) distinguishes 4 main and 14 sub categories of humanitarian operations. The four main categories are as follows: Water Supply, Sanitation and Hygiene Promotion; Food Security, Nutrition and Food Aid; Shelter, Settlement and Non-Food Items; and Health Services. However, The Sphere Project (2004) does not attempt to cover all possible forms of humanitarian assistance. Yet, the categories introduced by The Sphere Project (2004) cover the majority of humanitarian operations. These four categories will be considered in the following when the task model for supply chain processes of humanitarian organisations is developed.

Table 3: Areas of humanitarian operations

Water supply, sanitation and hygiene promotion	Procurement, storage, processing and distribution of potable water. Installation of mobile water bladders or tanks. Further hygiene promotion, excreta disposal, vector control, solid waste management and drainage.
Food security, nutrition and food aid	Provision of suitable food during famines. Setting up and running of therapeutic as well as supplementary feeding centres. Distribution also includes basic food processing equipment such as simple stoves, utensils, and fuel.
Shelter, settlement and non-food items	Support of communities with basic amenities to provide protection against harsh environmental conditions: Distribution of sheets, tents and blankets, clothes, bedding and bed sheets, etc.
Medical care and health services	Basic health care against most infectious diseases, respiratory infections, malaria, cholera, meningitis among others. Secondary health care including life-saving operations as well as immunizations and vaccination campaigns. Preventive health care as well as

	curative health care. Epidemiological screening.
Humanitarian access	Negotiation of humanitarian access or negotiation of an agreement to be able to transport goods and deliver services to a community affected by a crisis. Usually, representatives of the group holding the power over a region are involved as well as representatives of humanitarian organisation. This includes establishing a set of "ground rules", which regulate access to affected communities.
Protection of individuals	All efforts aimed at obtaining full respect for the rights of non-combatants. Monitoring of adherence to Geneva Conventions and International Humanitarian Law. Efforts geared towards prevention and ending of violence and human suffering. Establishing of safe areas for refugees and internally displaced persons.
Repatriation and reunification	Restoration of family links, Re-Establishment of contact between members of families split up during crisis situations, Collection of information about people who detained or deceased, Family reunifications and repatriations, Tracing of persons unaccounted for, Issuing of travel documents and certificates of detention.
Evacuation	Evacuation of certain groups of the population, such as children or other especially vulnerable people from conflict, disaster or crisis zones.
HIV/Aids treatment	This is included as an area distinct from medical care since it has become a very large individual task for many humanitarian organisations. Included are (voluntary) counselling and HIV testing as well as treatment of Aids.
Psycho-social assistance	Psycho-social assistance to victims of violence, internally displaced persons, refugees, victims of sexual violence, treatment of psycho-social traumata.
Basic facilities	Reconstruction, rehabilitation or set up of medical facilities, refugee camps, food and water distribution points, schools, hygiene facilities such as latrines and waste treatment zones, wells, and other institutions.
Basic support systems	Reconstruction, rehabilitation or set up of basic survival support systems, such as water lines, sewers, food storage facilities, power supply stations, etc.
Mine action	Removal of mines and other explosive remnants of war, which can block access to basic needs and hinder reconciliation; demarcation of mine zones.

Training	Training has also become a major part of humanitarian operations. This includes training of local logistics and medical personnel among others.

The core objective of all of these types of operations is to support affected communities in their survival, to save and protect lives and to prevent and alleviate suffering while respecting the dignity of the recipients.[156] The ultimate recipients of humanitarian assistance are usually individuals, who are commonly called beneficiaries.

Humanitarian operations are carried out by non-profit organisations (NPO). Badelt (2007) observes that "[c]ommercial and non-profit organisations have much in common, among others their orientation towards serving customers"[157] but also recognises their differences. "While commercial organisations are motivated mainly by financial profits, non-profit organisations have mainly social objectives"[158]. Thus, market prices for products are replaced with collective fees such as donations, taxes or other contributions. NPOs seek to provide goods or services delivering various benefits to people. Jaschinski et al. (1997) remark that these organisations have a natural tendency to rigid structures and to couple decisions to political circumstances since the driving force of the market is lacking.[159] There is a wide variety of non-profit organisations, which can be categorised in governmental and non-governmental non-profit organisations. For humanitarian operations, the special case of intergovernmental non-profit organisations exists.[160] Governmental NPOs offer public services for citizens and usually become active first when responding to humanitarian crises. Private NPOs can be subdivided into economic NPOs, socio-cultural NPOs, political NPOs and charitable NPOs.[161] In the following, humanitarian organisations will refer to those non-profit organisations, which are involved in conducting humanitarian operations.

Supply chain operations in for-profit supply chains originate at the customer who is driven by his needs, wishes and desires and who is, or ought to be, the origin of all activities within the supply chain. This notion can partially be transferred to humanitarian supply chains, too, where the beneficiary is in need of certain services and goods. However, although an assessment of the beneficiaries' needs is often the origin of activities within the humanitarian supply chain, the beneficiaries cannot be considered the real driving forces behind the supply chain. Rather, these are the donors who finance all activities within the supply chain. Humanitarian organisations must sometimes first answer to their sponsor before they can serve the beneficiaries. While the aims of the sponsor and the needs of the beneficiary should coincide, the humanitarian organisation

[156] Cf. The Sphere Project (2004), p. 227.
[157] Badelt (2007), p. 97.
[158] Badelt (2007), p. 136.
[159] Cf. Jaschinski et al. (1997), p. 8.
[160] All UN entities and the International Federation of Red Cross and Red Crescent Societies (IFRC) as well as the International Committee of the Red Cross (ICRC) are intergovernmental non-profit-organisations conducting humanitarian operations.
[161] Cf. Jaschinski et al. (1997), pp. 8-9.

will have difficulties serving both parties should this not be the case.[162] This difference can also quite figuratively be seen as the difference between the pursuit to improve customer retention in the commercial case whereas quite the opposite is true for the humanitarian case. Beneficiaries are “customers” who hopefully do not seek to return. Therefore, the objectives are different: While the objective of commercial supply chains is the maximization of profits, the humanitarian supply chain is driven by alleviating the suffering of people in crisis.[163]

In contrast to commercial organisations, the beneficiary is not the beginning and end of all processes since the recipient of the organisation’s services is not the enabler of the organisation’s services. In commercial organisations, both recipient and enabler are the customers who enter the financial resources into the supply chain. In humanitarian organisations, the beneficiary does not compensate the organisation for the received goods and services which are funded by various donors.[164] Thus, originators of processes in humanitarian organisations can be both beneficiaries and donors. Donors provide (mainly financial) resources, which are sourced, channelled and managed by the funding process. The funding process feeds into the operations planning process, which has the beneficiaries’ needs, donors’ requirements and product and programme proposals from the innovation process as further inputs. The operations planning process can be considered as one of the central business processes of humanitarian organisations: It feeds into the operations processes, which deal with all processes from order reception to final delivery. The operations processes incorporate order management, procurement, possibly assembly and production, provision and distribution, installation and billing processes. The operations processes are key enabling processes in supply chain management.[165]

3.6 Humanitarian Logistics

In supply chain management research, the supply chain processes of humanitarian organisations have received little attention. Logistics in the context of humanitarian operations suffers from various shortcomings due to the nature of how humanitarian organisations finance their operations but also due to the structure of these organisations.

[162] Cf. Long and Wood (1995), p. 226.
[163] Cf. Médecins sans Frontières (2007), Kovács and Spens (2007), p. 107, and Thomas and Kopczak (2005).
[164] The relations between the humanitarian organisation and the various donor entities is usually very complex. For the complex financial flows between donor entities, humanitarian organisations and beneficiaries and the various kinds of humanitarian organisations which conduct humanitarian operations, cf. Thomas and Kopczak (2005) and Danne et al. (2008).
[165] Cf. Schmelzer and Sesselmann (2008), pp. 212-213.

3.6.1 Definitions

All humanitarian operations crucially rely on logistics support and effective supply chain management, which enables the prompt delivery of the required goods and services. Yet, it is hard to find a definition of logistics in the context of humanitarian operations. The same is true for the commercial domain as there is no commonly accepted definition of supply chain management. The term "Supply Chain Management" is frequently used in a variety of senses.[166] In the industrial context, SCM can be understood as the integrated process-oriented planning and control of material, information and financial flows along the entire value chain from the customer to the raw material producer with various objectives such as improvement of customer orientation, synchronisation of supply and demand, and reduction of inventory along the value chain.[167] Here, the definition given by the Council of Supply Chain Management Professionals (CSCMP), an association for individuals involved in supply chain management with more than 9000 members, will be adopted:

Definition 8: Supply Chain Management

> "Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers […]."[168]

Simchi-Levi et al. (2000) elaborate that SCM is "a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements". While supply chain management is concerned with network-wide optimisation of material, information and financial flows in supply chains, logistics management is mainly concerned with operational activities such as transportation and storage.[169] In their definition, the CSCMP distinguishes between "Supply Chain Management" and "Logistics Management". Logistics Management is defined as:

Definition 9: Logistics Management

> "Logistics management […] plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements."[170]

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[166] For a comprehensive discussion and review of definitions of the term "Supply Chain Management", cf. Hieber (2002), pp. 32-35. Ehrmann (2003), p. 25 and Stabenau (2004), p. 141-146, provide a discussion on the term "logistics" and compare several schools promoting different definitions.
[167] Cf. Kuhn and Hellingrath (2002), p. 10.
[168] Council on Supply Chain Management Professionals (CSCMP) (2008).
[169] Cf. Waters (2003), p. 29.
[170] Council on Supply Chain Management Professionals (CSCMP) (2008).

The definition of logistics management as a part of supply chain management is convenient since it focuses on the more tactical and operational activities, which are relevant for effective and efficient logistics processes. In the following, the previous definitions will be used in order to define the term “Humanitarian Logistics”.

The term “Humanitarian Logistics”[171] is often used as an umbrella term comprising a vast array of activities. Practitioners of humanitarian logistics frequently have a loose definition of the term “Humanitarian Logistics”, which incorporates many notions, tasks and activities. “Because logistics functions are so poorly defined, there is a tendency for organisations to use it as a repository for functions that do not fit elsewhere.”[172] The ICRC write in their profile for logistic specialists: “They are responsible for procurement, ensure warehouse maintenance, deal with customs formalities, monitor stock levels, draw up budgets with the delegation administrator, analyze costs, and train and supervise local personnel.”[173] In the humanitarian organisation *Médecins sans Frontières*, logisticians are responsible for the transport of material and medication, well-maintained communication equipment, for accommodation and even food provisions. They procure material and goods, and ensure transport, customs clearance and stock management. The logisticians’ tasks also include maintenance of all technical apparatus and vehicles, route planning and vehicle scheduling, conducting job interviews with and supervision of national staff, reporting on security and safety issues and responsibility for security.[174]

Kovács and Spens (2007) denote humanitarian logistics as a “mixed array of operations” including disaster relief as well as enduring support for developing regions, i.e. as a response to various catastrophes. They see the commonality in all these operations that their objective is to aid people in their survival.[175] They include the “design [of] the transportation” of all kinds of material and personnel “from supply points to a large number of destination nodes” as well as the “transfer of people affected by the disaster to the health care centers.”[176]

Thomas and Kopczak (2005) base their definition of humanitarian logistics on a survey among humanitarian logisticians from headquarters of humanitarian organisations and projects conducted by the Fritz Institute[177]. They summarise their findings with the following definition: “Humanitarian Logistics is defined as the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people. The function

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[171] “Humanitarian Logistics” is understood here as an artificial short term for “Logistics in the context of humanitarian operations”.
[172] Fritz Institute (2004).
[173] International Committee of the Red Cross (2008).
[174] Adopted from http://www.aerzte-ohne-grenzen.de/mitarbeiten/berufsgruppen/logistiker/index.html, accessed June 10, 2009.
[175] Cf. Kovács and Spens (2007), p. 101.
[176] Kovács and Spens (2007), p. 101.
[177] http://www.fritzinstitute.org, accessed June 10, 2009.

encompasses a range of activities, including preparedness, planning, procurement, transport, warehousing, tracking and tracing, and customs clearance."[178] Bearing similarity to the CSCMP definition of logistics management, this definition extends it considerably.

Long and Wood (1995) attribute the following areas to the scope of humanitarian logistics: Demand forecasting to allow the establishment of an efficient pull system in the supply chain; local as well as international sourcing with special attention to as little disruption to the local economy as possible; packaging of items taking into account handling issues, survivability of supplies, and transportation requirements; inventory management with respect to the fact that the time value of goods is much greater than their inventory carrying costs; local distribution strategies that strike a balance between efficient central distribution and optimal decentralised distribution; warehousing and storage considering the possibly unreliable transport environment; documentation; parts and service supports for maintenance activities; and eventually control mechanisms for coordinating the different organisations with their different terminologies, technologies, and objectives.

Long and Wood (1995) elaborate how the humanitarian supply chain operates between push and pull in different crisis scenarios. "Initially supplies are 'pushed.' Once relief personnel are in the disaster area, they re-assess the situation, and try to correct the mistakes. Once better assessments have been made, and communicated to the origin of supplies, a 'pull' system is put into effect and the process becomes much more effective.[179] Although the authors apply their research on famine relief operations, this holds true for any kind of humanitarian supply chain between sudden-onset or slow-onset disasters (emergencies) and chronic emergencies and development aid (post-emergencies).

Lee and Zbinden (2003) stress that the primary tasks for humanitarian logistics are the procurement and tracking of food, non-food and other goods "from appeal through to delivery while simultaneously monitoring the commodity and financial information along the relief pipeline"[180].

Beamon (2004) focuses on the material flow in humanitarian operations and contrasts the business supply chain with the humanitarian supply chain. Beamon sees the specific characteristics of humanitarian supply chains to include extremely short lead times bordering zero that dramatically affect inventory availability, procurement and distribution, the high stakes, and unreliable and incomplete demand and transportation information. Beamon (2004) points out that demand in the humanitarian supply chain does not only comprise supplies, but also people.[181] She also stresses that the primary success indicators of humanitarian supply chains are "output performance measures, such as the

[178] Thomas and Kopczak (2005), p. 2.
[179] Long and Wood (1995), p. 218.
[180] Lee and Zbinden (2003), p. 34.
[181] Cf. Beamon (2004), p. 3; cf. also Beamon and Balcik (2008).

time required to respond to a disaster […] or the ability to meet the needs of the disaster"[182].

Van Wassenhove (2006) provides a definition, which is evidently based on the definition of logistics management by the CSCMP, in which the customer has been replaced with the beneficiary. Through this slight adaptation, the definition becomes applicable to the context of humanitarian operations:

Definition 10: Humanitarian Logistics

> Humanitarian logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods, materials and equipment as well as related information, from point of origin to point of consumption for the purpose of meeting the beneficiary's requirements.[183]

3.6.2 Challenges

Anisya Thomas, executive director of the Fritz Institute, makes the case for academic contributions to supply chain management in the context of humanitarian operations, when she states: "Humanitarian logistics has much in common with corporate logistics, yet the best practices from the corporate world […] have not crossed over. It is paradoxical that a sector, which has such extreme requirements in terms of timeliness, affordability and oversight, is so underdeveloped."[184]

Humanitarian operations with their ultimate stake of saving lives frequently take place in highly unstable and volatile environments, under great time pressure, working on poor infrastructure and generally exhausting working conditions. Humanitarian supply chains, which deliver goods and services in response to sudden and slow-onset disasters as well as chronic emergencies and which strive to provide humanitarian assistance both rapidly and efficiently, are subject to specific challenges. Humanitarian supply chains suffer from frequent breakdowns and interruptions in the material and information flow, which is in strong contrast to the extremely short lead times required. Due to the particular nature of funding their activities and the perception of logistics as a necessary expense rather than an integrated function which necessitates high management attention, humanitarian organisations traditionally have not invested much in research on supply chain issues. This gives rise to the possibility that humanitarian supply chain professionals can learn and benefit from the lessons learnt from commercial supply chain management.[185]

[182] Cf. Beamon (2004), p. 3.
[183] Own definition based on van Wassenhove (2006), p. 476; cf. also Thomas and Mizushima (2005), p. 60 and Kotzab et al. (2008), p. 298.
[184] Thomas (2003a), p. 2.
[185] Cf. Thomas and Kopczak (2005), pp. 5-6.

In the following, some of the characteristics and challenges of humanitarian supply chains, which set them apart from commercial supply chains are presented.[186]

Uncertainty: These supply chains need to operate in highly volatile environments as well as provide assistance in both the short and medium-term time horizons, i.e. in both emergency and more stable contexts. Uncertainty in humanitarian supply chains refers to uncertainty of demand, supply, personnel, and equipment as well as lead time, process instabilities, other actors in the supply chain, and financial resources. Demand patterns are highly irregular and the environment puts unique constraints on the operations.[187] Especially in disasters relief operations, uncertainty also includes the number of people affected, the infrastructure that is still intact, and information uncertainty. Uncertainty is thus inherent to any type of humanitarian operation. However, the areas shift while the humanitarian operation develops from the emergency to the post-emergency phase.

Earmarking of funds: Due to the nature of how these supply chains are funded, investments in research and infrastructure are severely restricted. As has been stated before, the main stakeholder in humanitarian supply chains is not the beneficiary (who should be in the focus of humanitarian operations) but rather the donor.[188] Thus, the donors have significant influence over where and how humanitarian operations take place and the beneficiary or the affected community has little to say in this manner. However, funding for improvement of processes, installation of state-of-the-art information and communication infrastructure, operations' support with a long-term focus, and organisational learning are often not in the focus of donors. There is consistent underinvestment in these areas which have the potential to improve the efficiency and responsiveness of humanitarian supply chains.

Infrastructure: This includes poor communication and transportation infrastructure. With respect to transportation infrastructure as well as communication infrastructure, it can be observed that disasters tend to happen in areas where the local infrastructure is already in a poor state.[189] This situation can be dramatically deteriorated during and after a disaster when possibly few remaining roads cannot take the number of refugees and disaster management vehicles that pour into and out of these areas or few remaining communication posts are destroyed. Even in more stable settings, these issues remain valid. Poor communication infrastructure prevents efficient information management and increases uncertainty. Transportation remains vulnerable to disruptions and needs to take into account the possibility of using multiple modes.

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[186] Cf. Oloruntoba and Gray (2006), Tufinkgi (2006), p. 204, Thomas and Kopczak (2005), Thomas (2003b), Kovács and Spens (2007), van Wassenhove (2006), Blecken et al. (2008b), Kovács and Spens (2008), Schulz (2009), Rodman (2004), pp. 8-18.
[187] Cf. Beamon and Kotleba (2006), p. 1.
[188] It needs to be remarked that speaking of "the donor" is somewhat misleading. While there are some exceptions, the donor base of most humanitarian organisation is rather broad, i.e. a multitude of donors appear as stakeholders of a specific humanitarian organisation.
[189] Cf. International Federation of Red Cross and Red Crescent Societies (2009), pp. 162-190.

Human Resources: Humanitarian logistics is affected by the lack of training in logistics personnel. Logistics personnel are in the midst of numerous requirements posed by local governments and officials, donors, the media, beneficiaries, and their own headquarters. Professional logisticians are rare and thus, employee reliability is hampered. Mostly, standardised processes do not exist and the use of (untrained) personnel does not support the standardisation of work processes. Retention of personnel is extremely difficult considering the aforementioned challenges and requirements to logisticians. Staff turnover rates are high.

Others: While business supply chain management incorporates the areas of procurement, production, and distribution equally, humanitarian supply chains focus mainly on either the procurement or the distribution side. Production can be involved in humanitarian operations but is certainly not of major concern. Demand in the humanitarian supply chain is not only the demand for goods and services, but also the demand for personnel. The supply chains are thus involved with mass movement of goods and people. While commercial supply chains focus on the optimisation of the different flows within the network, the challenges in the humanitarian supply chain lie more in the area of establishing and maintaining a (possibly highly vulnerable) supply chain. Some humanitarian organisations may be issue-related and therefore exist only temporarily. Thus, for each operation, a new supply chain may need to be established. Humanitarian operations frequently take place in emergency environments, thus, supply chain activities are highly non-routine in the sense that actors in the supply chain need to be redefined anew in each context. Further challenges are posed to the humanitarian supply chain in terms of complex documentation requirements, corruption, theft, special packaging requirements, and extreme time pressure to carry out the activities. Lastly, it can be observed that communication barriers exist that can sometimes hardly be overcome and that these supply chains are frequently positioned in an early stage in the supply chain life-cycle. Although stakes in these supply chains are extremely high, aspects such as output and flexibility but also cost need to be considered in all phases of humanitarian operations.

There are other factors which refer more to issues of coordination and cooperation of organisations involved in humanitarian operations. However, since these issues can have substantial influence on the humanitarian supply chain as well, they will be presented here. These include:

Mandate: Differing mandates and interests of humanitarian organisations, operational objectives and therefore different agendas, target communities and goals. This also includes humanitarian values such as neutrality and impartiality.

Structure: The organisational structures of humanitarian organisations can be incompatible and even incomparable. This makes the application and comparability of supply chain management principles difficult.[190]

[190] Cf. Tufinkgi (2006), p. 123 and auf der Heide (2007).

Information: Missing or wrong information concerning programmes and resources of other organisations such as stock levels and items, transport routes and schedules, already carried out assessments as well as missing reports on similar events, lack of institutional learning, missing and inadequate documentation, especially quantitative documentation.[191]

Information and Communication Technology: This issue has been partly addressed above but also has severe consequences on the operational field level. This includes differing frequencies and licences, missing communication technology, outdated and unreliable IT equipment, incompatible software systems etc.

Competition: Governmental as well as non-governmental organisations perceive themselves to be competitors of scarce financial resources. This attitude makes cooperation difficult despite being in the best interest of the beneficiaries. On a supply chain level, this problem might not be as relevant since logistics usually performs support functions in humanitarian operations and is therefore not as donor-visible as direct operations.

This chapter has served to map the research objectives onto the research domain. The research domain has further been explained by introducing basic definitions and elaborating on the specific challenges that supply chain management in the context of humanitarian operations has to face. This has set the foundation for developing requirements for the desired solution. In combination with the previous chapter, existing solutions with respect to process modelling, supply chain management frameworks and reference models can now be examined for their applicability to the current research problem.

[191] Cf. auf der Heide (2007), Chapter 1 and Barton (1969).

4 Foundations of Reference Modelling

In this chapter current approaches to model and analyse supply chain tasks and processes are investigated and recent developments in reference modelling and the construction of reference models are reflected upon. In Section 4.1 the guidelines of modelling are presented, which need to be respected in any modelling project. In Section 4.2 various state-of-the-art modelling techniques are discussed and their usefulness in this application domain is assessed. It is the objective of Sections 4.3 and 4.4 to identify the degree to which existing solutions can be used to solve the problem at hand. Hence, supply chain management frameworks are analysed first before existing reference models are presented and assessed.

In recent years, efforts in supply chain management concentrated on reaching a better understanding of the behaviour of supply and distribution networks but also searched for better control and planning of these networks. Through these efforts, various approaches of modelling these networks have been followed. Among these, descriptive approaches have the objective to provide a description of the supply chain with its resources and structures. Most relevant for the scope of this work are descriptive reference models, which encompass the majority of reference models presented in Section 4.4.

4.1 Guidelines of Modelling

The guidelines of modelling (GoM)[192] have been developed in the late 1990s on the basis of theories of critical realism by Albert (1968) and Popper (1972) and the fact that the relationship between modeller and model could no longer be ignored. Since the subjectivity of modelling can never be eliminated, rules should guideline the modelling process. Thus, the GoM present "a framework of principles that improve the quality of information models by reducing the subjectivism in the information modelling process."[193]

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[192] The guidelines of modelling are also sometimes denoted as Generally Accepted Modelling Principles in reference to the Generally Accepted Accounting Principles (GAAP). In German, the GAAP correspond to the "Grundsätze ordnungsmäßiger Buchführung", GoB.
[193] Schütte and Rotthowe (1998), p. 240.

The GoM draw from various previous sets of rules for modelling and have become state-of-the-art. They should be adhered to during any modelling process and due to the claim of generality especially during the process of constructing reference models. The GoM consist of two sets of principles, a set of mandatory and a set of supplementary principles. The mandatory principles are the principles of construction adequacy, language adequacy, and economic efficiency; the supplementary principles are clarity, systematic design, and comparability. The principles of the Guidelines of Modelling are presented in Table 4.[194]

Table 4: Guidelines of Modelling: Mandatory and Supplementary Principles

Principle of construction adequacy	The principle of construction adequacy is the most important criterion for assessing models and is sometimes also denoted as the principle of reality adequacy. From the perspective of the reference model user, e.g. the designer of an information system, the principle of construction adequacy requires that a consensus is found with respect to the represented problem. The same is true from the perspective of the model user, but with respect to the model itself. Thus, the principle of construction adequacy refers both to the original and to the reference model: "Besides the consensus about the problem to be constructed, a consensus about the type of construction needs to be defined, i. e. an agreement about the model representation needs to be settled."[195] A consensus between analysts and model users needs to be reached. The guideline of construction adequacy is sometimes also called the guideline of correctness and two facets are distinguished: Syntactic and semantic correctness: "A model is syntactically correct, if it is consistent and complete against the [corresponding] meta model […] Semantic correctness postulates that the structure and the behaviour of the model is consistent with the real world."[196]
Principle of language adequacy	Models are constructed by using artificial languages. The principle of language adequacy focuses on the relation between the model system and the used language and can be distinguished in language suitability and language correctness. Language suitability includes the "problem-related selection of modelling techniques" and the selection of relevant model elements. Since information models often lead to the implementation of application systems, semi-formal languages are used in information modelling. Language correctness includes the correct application of the language syntax.

[194] In the following, cf. Schütte and Rotthowe (1998), pp. 244-254 and Schütte (1998), pp. 111-176.
[195] Schütte and Rotthowe (1998), p. 245.
[196] Cf. Becker et al. (2000), p. 32. The claim for semantic correctness is challenged by the criticism from critical realism that there is no objective reality.

Principle of economic efficiency	Every activity in economic organisations is subject to economic efficiency. Thus, the "produced cost of the design process needs at least to be covered by the proposed utilization of cost cuttings and revenue increases."[197] The principle of economic efficiency limits the modelling effort and is thus in contradiction to the other principles. In process reference models it is tried to incorporate the principle of economic efficiency by creating models, which are robust and adaptive towards changing environmental factors. Robustness is achieved by a high level of abstraction; adaptivity is achieved if the necessity for modifications and adaptations can easily be identified and implemented when building organisation-specific models.
Principle of clarity	The principle of clarity includes the explicitness and comprehensibility of a (reference) model. Addressee-oriented hierarchical decomposition[198], layout design and filtering of information are means to achieve the principle of clarity. According to Schütte, "[c]riteria for the development of decomposition need to be defined, such as organisational or information technology focus, structural or behavioral analysis, concentration on material or information flow, etc."[199] Rules for layout design, i.e. the graphical arrangement of information objects, have long been formulated and are included in the principle of clarity.[200] By limiting the number of different information objects, complicatedness of the model is restricted and comprehensibility is improved. A balance needs to be struck between a detailed and powerful set of elements, which suits the model designer when detailed information of the system needs to be modelled, and the counter-effect that a powerful set of elements might hamper the comprehensibility of the model. Comprehensibility of process models is especially important since the number and variety of model users and model designers has increased considerably, none of which need necessarily be modelling experts.[201] The principle of clarity is restricted to model user groups only, which can sometimes justify the use of synonyms and redundancies.[202]

[197] Schütte and Rotthowe (1998), p. 247.
[198] Hierarchical decomposition of models has been discussed before in the context of managing complexity of models.
[199] Schütte and Rotthowe (1998), p. 248.
[200] Cf. Tamassia et al. (1988) or Batini et al. (1985) for instance; Layout design has been identified as a specific challenge in process models, cf. Becker et al. (2000), p. 31.
[201] Cf. Becker et al. (2000), p. 30.
[202] Cf. Rosemann and Schütte (1997), pp. 22-23.

Principle of systematic design	"The principle of systematic design concentrates on the well accepted differentiation between diverse views within modelling. Information models describe the logical composition of structure and behaviour of information systems."[203] Thus, the principle of systematic design aims to concretise the demand for inter-model consistency between structural and behavioural models. One consequence of this principle is the existence of the same information objects in both the structural and the behavioural model.
Principle of comparability	The principle of comparability has the objective to enable comparison of two models regarding their congruence and similarity. The comparison of reference models and organisation-specific models enables the identification of weaknesses and differences between to-be and as-is models.[204] The principle of comparability is supported by all other guidelines of modelling.

Sometimes, the principle of relevance is included within these sets of principles. The principle of relevance postulates to select a relevant object system, to take a relevant modelling technique or to configure an existing meta model adequately, and to develop a minimal model system.[205] This principle is not included here since it will be an integral part of the construction-method for the reference task model and will be appropriately reflected there. All principles can be distinguished for organisation-specific models and reference models. However, the structure of the general guidelines is independent from this distinction, making all six principles applicable to both modelling objectives.

An overview of the guidelines is presented in Figure 19. Not all of these principles are equally important in every modelling project. As Schütte points out: "Since the guidelines aim to serve the evaluation of models, first one needs to select the perspectives on the problem area in order to derive the objectives of the model construction. Therefore, differing concentrations of the six guidelines can be carried out in a specific modelling project."[206]

[203] Schütte and Rotthowe (1998), p. 248.
[204] Cf. Schütte (1998), p. 134.
[205] Becker et al. (2000), p. 32. A minimal model system is a system in which the necessary information is presented with the least number of elements and thus, information redundancy is minimised.
[206] Schütte and Rotthowe (1998), p. 251.

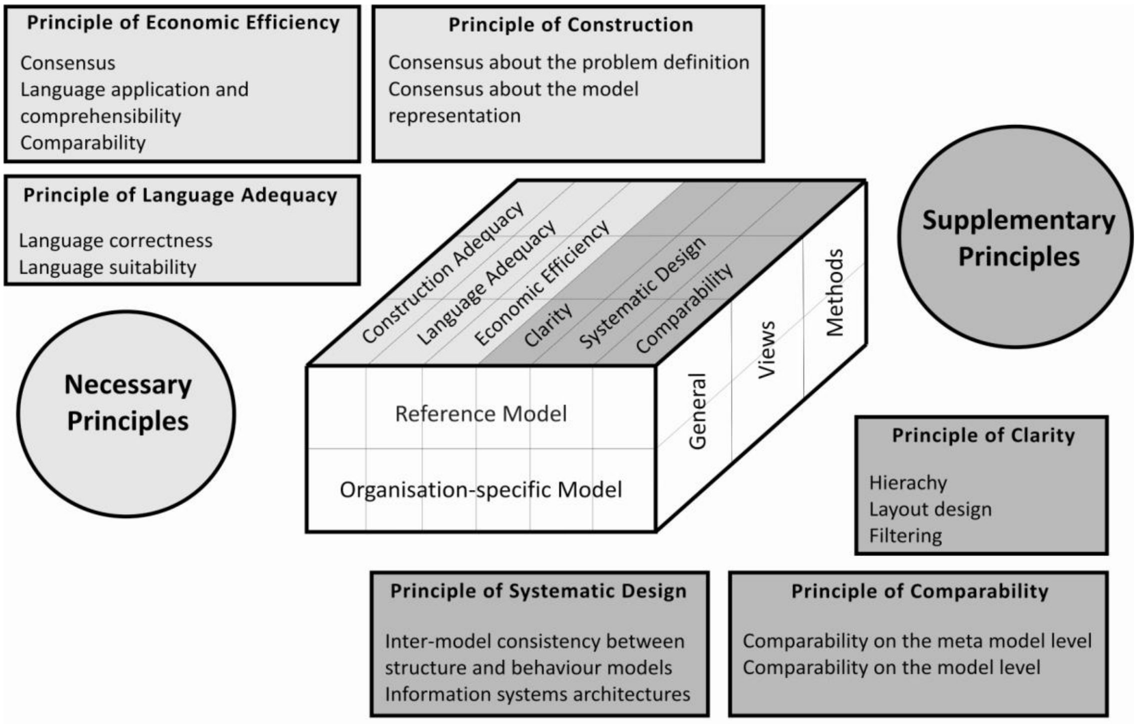

Figure 19: Guidelines of modelling[207]

4.2 Modelling Techniques

Modelling has always been at the core of both organisational design and information systems development.[208] Furthermore, process-oriented modelling of organisations has found an intensive echo in the academic discussion.[209]

Modelling languages[210] are artificial constructs consisting of a set of elements and rules describing their relation to each other, thus setting the foundation for a syntax. In this section, some commonly used techniques for modelling processes are presented in order to evaluate their suitability for the construction of the reference model. There exists a large number of modelling languages with focus on process representation and analysis. In order to be able to choose the most appropriate modelling technique, the following languages will be analysed in the subsequent sections: Flowcharting, Integrated Definition Languages, Petri Nets, OMEGA, Process Chain Modelling, Event-driven Process Chains, the Unified Modelling Language and the Business Process Modelling Notation.

There are two main features that a business process modelling technique should generally incorporate: Firstly, it should provide the opportunity to model several layers of abstraction, in such a way that issues on different levels can be addressed. Hence, it

[207] Source: Adapted from Schütte and Rotthowe (1998), p. 251.
[208] Giaglis (2001), p. 209.
[209] Cf. Kuhn and Hellingrath (2002), Kuhn (1995), Supply-Chain Council (2005), Werner (2002).
[210] Modelling languages are also sometimes denoted as modelling techniques, cf. Giaglis (2001), p. 211: "Techniques are taken to refer to diagrammatic or other notations for studying and analyzing modelled systems." In this context, the terms modelling language and modelling technique are used interchangeably.

becomes possible to handle the complexity of large models. Secondly, it should lower the barriers between process representation and process analysis and optimisation by enabling automated methods of process management.[211] Further requirements for a suitable modelling technique for the development of reference models and especially a reference task model for supply chain processes of humanitarian organisations include comprehensibility, communicability, the ability to model process components, reusability, comparability, and the support of technology selection.[212] Modelling techniques differ in the extent to which their elements and relations suffice the aforementioned requirements.

4.2.1 Flowcharting

Flowcharting has been among the first graphical modelling techniques, dating back to the 1960s. Its main advantages include the possibility to graphically model the overall structure of a system and to display the information and product flow with key decision and change of responsibility points and to present the physical media on which data are entered, processed and stored.

Although flowcharts are easily generated and understood, they are not predominant in industry any longer and rather used as a "graphic means of communication, intended to support narrative descriptions of processes when the latter become complicated and difficult to follow."[213] Yet, in humanitarian organisations, flowcharting is still frequently used.[214] Flowcharting does not strongly support hierarchisation. Overall, flowcharting is considered as a legacy solution not suited to the application context.

4.2.2 Integrated Definition Languages

The Integrated Definition (IDEF) modelling techniques are a family of notational formalisms intended to represent and model process and data structures in an integrated fashion.[215] The IDEF family consists of a variety of independent languages, out of which IDEF0 and IDEF3 are the most relevant for business process and reference modelling.

IDEF0 is a technique, which allows the modelling of decisions, actions, and activities of an organisation or any other system. It is thus a technique that promotes the functional perspective of models. IDEF0 supports hierarchical modelling by progressively decomposing higher-level ICOMs (input-control-output-mechanisms) into more detailed

[211] Cf. Lin et al. (2002), p. 19.
[212] Cf. Giaglis (2001) who presents requirements for modelling techniques based on the respective modelling goals and objectives. Giaglis (2001) sees five different modelling goals, viz. Support human understanding and communication; Support process improvement; Support process management; Support process development; and Support process execution.
[213] Giaglis (2001), pp. 214-215. For a tutorial on how to model business processes using flowcharts cf. Chapin (1970).
[214] Cf. Blecken and Hellingrath (2007).
[215] Giaglis (2001), p. 215.

models. According to Giaglis (2001), the main strength of IDEF0 lies in its simplicity as it uses only one notational construct, the ICOM. On the other hand, IDEF0 models are static diagrams without any representation of time. Thus, while the functional perspective can be covered with IDEF0 diagrams, these diagrams cannot cover behavioural perspectives.

IDEF3 was developed to mend some of the limitations of IDEF0. IDEF3 illustrates processes as ordered sequences of activities and thus provides a structured method to model how processes in a particular system or organisation work. Sequence and causality of processes can be captured and thus, both functional and behavioural modelling perspectives are covered. IDEF3 facilitates modelling with multiple levels of abstraction and enables top-down and bottom-up methods. IDEF3 supports both process-centred and object-centred analyses and incorporates temporal and logical relationships.[216]

4.2.3 Petri Nets

Petri nets originated from systems modelling and are therefore not a business process modelling technique in the strict sense. They are bipartite directional graphs consisting of nodes and edges denoting conditions and events. Petri nets permit representing static system behaviour through cause-and-effect relationships. Basic Petri nets have been suggested for business process modelling since they provide a means to graphically model a system and its behaviour. Especially synchronous and interacting processes can be conveniently modelled using Petri nets. Basic Petri nets, however, are not suited for modelling high-level business processes. Extensions have been developed, which are referred to as high-level Petri nets such as coloured Petri nets.[217] A main advantage of Petri nets lies in the wide range of possible applications. However, Petri nets easily grow very complex, which impedes comprehensibility and performance. Representation of data structures is equally difficult with Petri nets. Furthermore, the strength of Petri nets lies in their formal syntax and not in the representation of semantics. Since the semantics of the reference tasks are key to the reference processes, Petri nets are not a suitable modelling technique here.

4.2.4 OMEGA

The object-oriented method OMEGA has been developed to support business process reengineering. It is a method for business process mapping, analysis and optimisation and consists of two main parts: A process modelling language and a procedure for developing process models.[218] In the modelling procedure it is foreseen to construct three different models, viz. a model for the organisational structure, a model for the process structure and a business process model. The model for the process structure

[216] Cf. Lin et al. (2002), p. 22.
[217] Originally introduced by Petri (1962), Petri nets have been further developed and used in a broad range of applications, cf. Salimifard and Wright (2001) and van der Aalst et al. (2000).
[218] Cf. Fahrwinkel (1995), p. 65.

describes the interaction of all business processes inconsiderate of the responsible business unit. The business process model connects both other models to provide a comprehensive overview.

The modelling language exhibits three main characteristics: an object-oriented approach, the categorisation in model types and a 3D visualisation. Every business process is considered an object which transforms input objects to output objects using further objects such as technical resources. Graphical 3D symbols are used in this modelling language, which enables a higher information density of the models. In the graphical diagrams, the abscissa represents time while the ordinate is used to order parallel processes. There is also a third axis, which represents varying degrees of abstraction of a business process, thus enabling hierarchical modelling.[219] Three groups of symbols are used in OMEGA for business process modelling: external objects, processing objects, and technical resources. External objects are entities outside the considered system and represent people, groups of people, institutions or other organisations. These can send and receive processing objects and initiate business processes. The entire material and information flow is handled via processing objects among which the following five types exist: oral information, information groups, IT objects, paper objects and material objects. A paper object, for instance, can represent an input or output object of a business process. The technical resources support the business process by supplying or storing material or information objects. All elements of the modelling language OMEGA are depicted in Figure 20.

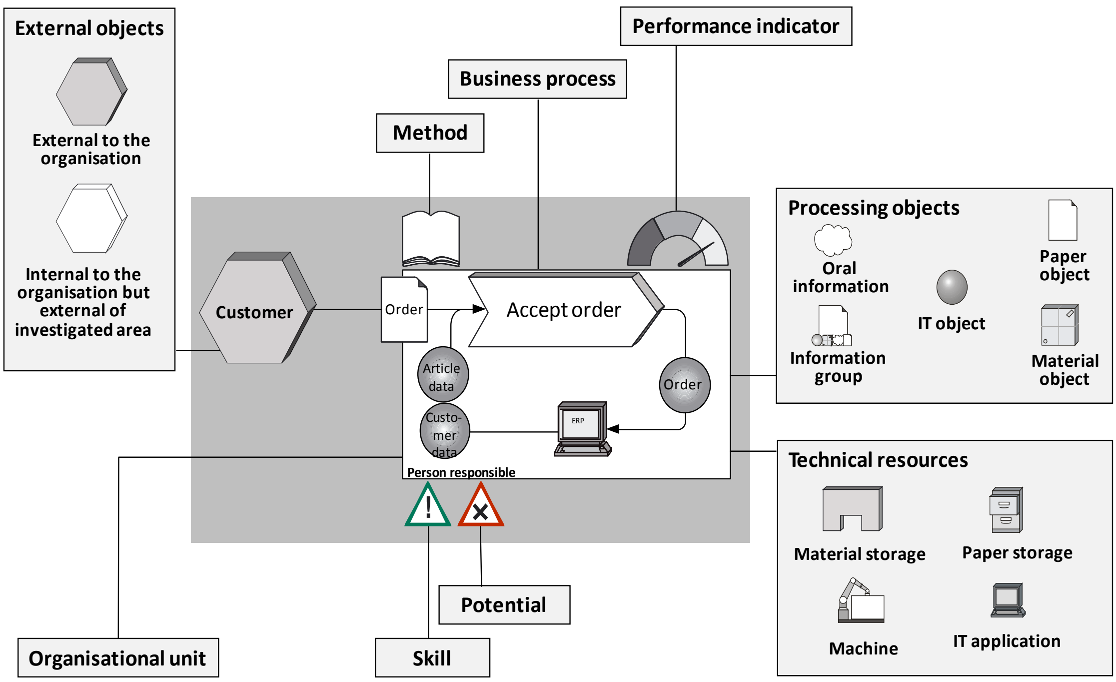

Figure 20: Symbols of the modelling language OMEGA[220]

[219] Cf. Fahrwinkel (1995), p. 68.
[220] Source: Based on a presentation on OMEGA, ©UNITY AG, 2008.

OMEGA offers a variety of possibilities to model business processes. Especially the diversity of symbols available to model the material and information flow is a benefit of this method. Tool support is available through standard software. However, there are also drawbacks to this modelling language: Users need to invest in training in order to be able to use the language appropriately. There is a variety of symbols available in the language, which makes it hard for the novice user to understand OMEGA diagrams. Textual annotations are written underneath the process diagrams, which impedes comprehensibility. The language is standardised but is not widely used in industry. Overall, OMEGA is judged as a suitable candidate to be used in the development of a reference model for supply chain processes.

4.2.5 Process Chain Modelling

Process chains are a model-based method to analyse and design logistics networks. They can be used to describe enterprises, which in turn allows an effective communication and discussion of business processes with partners. Process chains also allow a time-oriented view combined with a compact representation of the most important parameters of a business process. Process chain modelling is based on Porter's notion of value chains.[221] The value chain concept has been extended by Klöpper (1989), Pielok (1993), and Kuhn (1995) to process chains.

The process chain toolbox enables the modelling of enterprises or business units following a top-bottom approach, which is made possible by the self-similarity paradigm of process chains. This means that the parameters of process chains are the same on all levels of abstraction and are mapped onto each other when changing the level of abstraction. With this notion of self-similarity, it is possible to handle complex problems without losing focus on the most significant issues[222] and to create deployable solutions, which are integrated over the entire business.[223]

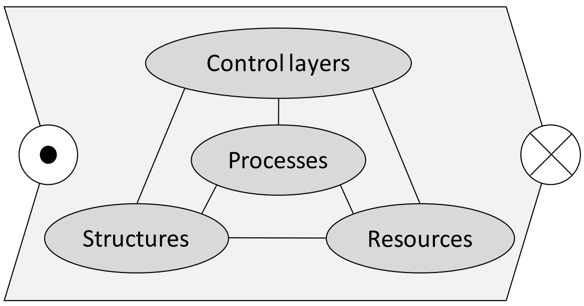

Figure 21: Process chain element[224]

Every process chain element as depicted in Figure 21 can be viewed as a system composed of the parameters sources and sinks, processes, resources, structures, and control

[221] Cf. Porter (1985).
[222] Cf. Stracke (2000).
[223] Cf. Schmidt (1989).
[224] Source: Adopted from Käppner et al. (2002), p. 14.

layers. The parameters can be used to specify and alter the process flow through the element according to the desired performance measures.

Sources create objects that flow through the system's boundaries into the processes of the system. Main measure for sources is the number of objects per time unit. There are two types of sources: active and passive. Active sources push objects into the process, whereas passive sources are sources, which wait for the process to pull objects out of them. Through sinks the transformed objects are delivered to the system's environment. Logistical flow objects can be all kinds of materials or information such as transportation units, a representative article, an order, or an invoice.[225]

The parameter processes contains a description of all detailed processes, their structure, connectivity as well as distribution amongst the organisational units. The design of processes is known to be of crucial importance for the overall performance of the system.[226] Processes are linked with resources to enable the modelling of resource and time usage.

The main task of a process element is to transform objects, which requires the use of personnel, technical, or informational resources. For a given system load, the use of resources defines the cost incurred by a process element. Resources contained within the process chain methodology are: personnel, information, operating supplies, auxiliary supplies, financial services, services, organisational tools, surfaces, and stocks. Stocks are the sum of all stored goods in an inventory[227] and primarily serve to overcome the spatial and temporal distances between provision and consumption of products or material as well as to secure the uninterrupted flow of production and distribution processes.[228] Stocks influence performance measures since they are directly related to capacities, cycle time, and service levels but also to cost. Stocks can be classified into a large number of categories: Hopp (2003) identifies the five most common as working stock, congestion stock, cycle stock, safety stock, and anticipation stock. The resource information describes an effort caused by the necessity to gather, provide, and maintain data needed to execute the process.

Every process chain element is embedded in the structure of an organisation. Parts of the structure are the topology, the technical communication structure and the setup structure. These different types of structures are interdependent and need to be coordinated to enable a process-oriented order execution.[229] The setup structure focuses on the hierarchical and the communication layers.[230] Objective of the setup structure is to align corporate goals and organisational forms with the processes contained therein. The setup structure allows looking further into problems such as time delays, indirect communication, and changes of responsibility or logistical base unit.

[225] Cf. Käppner et al. (2002), p. 11.
[226] Cf. Käppner et al. (2002), p. 15.
[227] Cf. Bichler et al. (2005), p. 60.
[228] Cf. Gudehus (2005), p. 355.
[229] Cf. Kuhn (1995).
[230] Cf. Käppner et al. (2002), p. 16.

Lastly, the control layer encompasses the control, regulation and supervision processes that ensure the overall functionality of the system. Kuhn (1995) describes five distinct layers: normative, administration, disposition, network, and process layer.

The use of process chains enables the user to choose a level of detail (or abstraction) suitable for his purpose; thus, hierarchisation is supported. Process chain representations can be understood by people who are not familiar with or directly involved in the activities, but who are somewhat familiar with the formal language. The process chain methodology has been successfully applied to a number of different modelling domains including supply chain process modelling.[231] The process chain modelling technique does recognise the need to model resources and the language offers possibilities to model resources of various kinds, which yet remain limited. Process chains are standardised but cannot be considered an industry-wide standard.

4.2.6 Event-driven Process Chains

Event-driven process chains (EPCs) are a graphical business process description language. The EPC language was developed at the University of Saarland in collaboration with SAP AG and has first been presented in Keller et al. (1992). EPCs also became the core modelling language in ARIS[232]. EPCs are one of the most widely used process modelling languages and have already been proposed and employed as a language for reference models.[233] While some basic knowledge of the elements and their function is required, EPC diagrams can be understood by users who do not possess in-depth modelling knowledge.

EPCs consist of events, functions, and connectors, which are coupled by defined rules.[234] A function represents an activity, i.e. task or process step, which needs to be executed. Events describe the situation before or after a function is executed and constitute triggers or post conditions that signal the termination of a function. Functions are coupled with events through connectors. There are three types of connectors: AND, OR and XOR. AND splits and joints can be used to model parallel processes. XOR splits and joints are used to model the selection of specific branches. Finally, OR splits and joints may denote a mixture of parallel and conditional routing.[235] Since functions and events are only coupled through connectors, EPC diagrams are always bipartite graphs.

EPCs which are extended by objects such as data and resources and other features needed for business process modelling such as notions of time and probabilities, are called extended EPCs (eEPCs). Extended EPCs add information to the processes by

[231] For process chain modelling cf. Käppner et al. (2002), Bause et al. (2000) and Kuhn (1995); for the ProC/B approach cf. Bause et al. (2002). Furthermore, the process chain models have been further developed into the ProC/B approach which allows the application of analytical methods as well as a simulator.
[232] Cf. Section 4.4.3.1.
[233] Cf. e.g. van der Aalst et al. (2005), Recker et al. (2005).
[234] For a formal presentation of the EPC syntax, cf. Delfmann (2006), pp. 84-93.
[235] Cf. van der Aalst et al. (2005), p. 80.

integrating objects and providing data, information and organisational views on the process. Thus it becomes possible to represent data processing in functions, associate employees/attach responsibilities to certain functions, associate the employees with organisational units and have functions generate and process services.

One of the main drawbacks of EPCs is that they do not support reference modelling through configuration or customisation at run-time. EPC models may need to be translated into executable process specifications, e.g. for a workflow management system that that executes, manages, and controls business processes based on these models. This drawback was somewhat alleviated with configurable EPCs (C-EPCs), “a generic-monolithic approach for constructing re-usable models”[236]. C-EPCs offer the possibility to be translated (=configured) into regular EPCs at run-time by selection or hiding of elements, while covering the entire range of reference scenarios at built-time.

4.2.7 Unified Modelling Language

The Unified Modelling Language (UML) is a modelling language, which can be used for a variety of purposes. UML was developed by Booch, Jacobsen and Rumbaugh and is a formal language for specifying, constructing, and documenting object-oriented systems, with a focus on software engineering. UML is standardised and further developed by the Object Management Group. The current release of the specification is UML 2.2 from February 2009.[237]

UML offers a variety of different diagrams, which can be used to model different perspectives on a system. In total there are 13 diagrams in UML divided into the three categories structure, behaviour, and interaction diagrams. These are: Class diagram, component diagram, composite structure diagram, deployment diagram, object diagram, package diagram (structure diagrams); activity diagram, state diagram, use case diagram (behaviour diagrams); and communication diagram, interaction overview diagram, sequence diagram, and timing diagram (interaction diagrams). UML diagrams can capture both a static and a dynamic view on the system. The static view emphasises the structure of the system using objects, attributes, operations, and relationships. The dynamic view focuses on behavioural aspects of the system and is used to show collaboration among objects and changes to the internal states of objects. Interaction diagrams are a subset of behaviour diagrams and emphasise the flow of control and data among objects.

Although business process modelling is not among the primary modelling goals of UML, some of these diagrams can be employed for process modelling purposes. Relevant for business process modelling are class, activity, and use case diagrams. Class diagrams are generally used to model data structures and to describe the structure of a system by presenting the system’s classes, their attributes, and the relationships among the classes. Use case diagrams are used to show concrete use cases of a (software)

[236] Van der Aalst et al. (2005), p. 77.
[237] Cf. http://www.omg.org/technology/documents/formal/uml.htm, accessed on July 31, 2009.

system. Thus, the functionality provided by a system in terms of actors and their goals or roles are presented. Use cases are employed to define the requirements for a system. Activity diagrams represent the step-by-step tasks or sequence of tasks and events in a system. An activity diagram can display sequential and parallel as well as alternative branches in the flow of control.[238]

UML is a formalised language widely used in software engineering and various other domains. The language is standardised and continuously developed further. Although activity and use case diagrams have been suggested for business process modelling, this use is only possible to a limited extent.[239] UML has certain weaknesses, which render its use difficult for process modelling purposes: The modelling of business processes in two distinct diagrams (use case diagrams and activity diagrams) may be feasible for a single information system but is not suited for system-independent or system-overlapping perspectives.[240] Furthermore, it gives rise to redundancies in the constructed models. Class diagrams are not sufficiently suited to be used for modelling of organisational structures. Readily comprehensible visualisation of processes is weakened by the usage of a variety of different line styles, which can have different meanings in different diagram types. Moreover, no adaptation or configuration technique which could enable reference modelling has yet been proposed for UML. It can be concluded that object-oriented modelling of business processes suffers shortcomings with respect to hierarchical modelling of functions and in terms of the elements they offer to present sequence of events. Although UML is overall a strong language, which has already been successfully used for process and reference modelling, it is not selected here as process modelling language.

4.2.8 Business Process Modelling Notation

The "primary goal of BPMN is to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes."[241] One key objective during the development of BPMN was to create a simple yet powerful mechanism that allows handling complex business processes. The BPMN standard integrates the most useful ideas from other notations including certain UML diagrams (activity diagrams, class diagrams), IDEF, ebXML BPSS, Activity-Decision Flow Diagrams, and EPCs into a language that is geared towards the modelling of business processes in such a way that both presentation and

[238] UML activity diagrams are similar to EPC diagrams, albeit some aspects such as the modelling of documents used outside the (software) system are missing in UML. Moreover, the modelling of organisational structure aspects with EPCs is possible in an integrated fashion while modelling these with UML requires the use of class diagrams for that purpose.

[239] Cf. Krallmann et al. (2007), p. 111 and in opposition to this position Oestereich et al. (2003) who address some of the aforementioned issues.

[240] Cf. Allweyer (2007), pp. 205-206.

[241] Object Management Group (January 2008), p. 1.

communication of the processes is supported and a guidelines for implementation of these processes is given.[242]

An advantage of BPMN is its close link to the business process execution language BPEL4WS. BPEL4WS provides a formal mechanism for the definition of workflow processes. These kinds of languages are built to optimise the operations and inter-operation of business process management systems. Inter-operation of business processes at the level of the physical model user, e.g. the employee of an organisation, is enhanced by the standardisation of BPMN. BPMN also offers a mapping to BPEL4WS and thus, provides a standard visualisation mechanism for business processes defined in an execution optimised business process language.

There are four basic categories of elements, viz. Flow Objects, Connecting Objects, Swim Lanes, and Artefacts. Flow Objects are used to specify the behaviour of a process. Flow Objects comprise Events, Activities, and Gateways. Flow Objects are connected by Connecting objects, which include Sequence Flows, Message Flows and Associations. These elements can be grouped using Swim Lanes, i.e. Pools or Lanes. Artefacts are used to provide additional information. The modeller is free to extend the set of Artefacts, but can also restrict the use to the three standardised Artefacts, viz. Data Objects, Groups, and Annotations. In Figure 22, some of the most commonly used elements of BPMN are displayed. They will be briefly elaborated in the following:

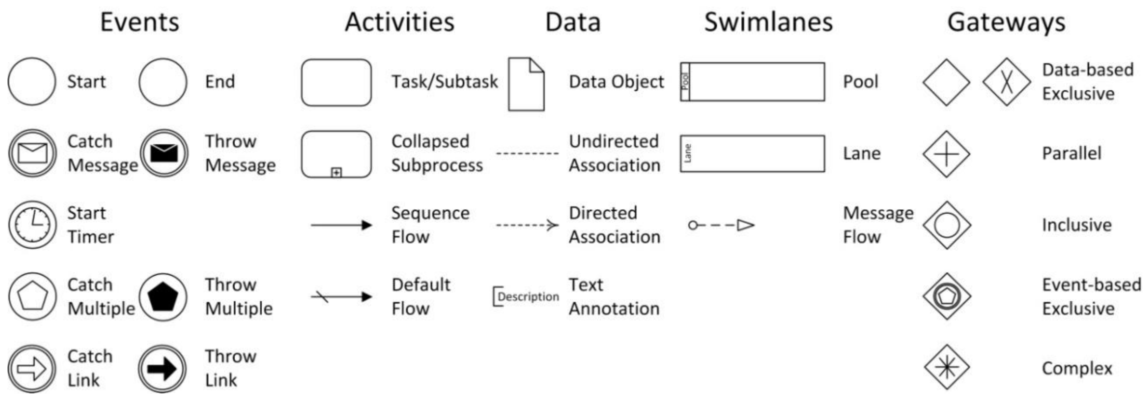

Figure 22: Basic BPMN elements[243]

Events:

- Start/End: These are Events without specific type and show where the process starts or ends.
- Catch/Throw Message: These Events are used to receive and send messages.
- Start Timer: Cyclic timer events, points in time, time spans or timeouts.
- Catch/Throw Multiple: Catching or throwing one out of a set of events.

[242] Cf. Briol (2008), p. 17 and Krallmann et al. (2007), p. 114.
[243] The symbols displayed are based on BPMN 1.1 specifications. Only the most commonly used symbols of BPMN 1.1 are displayed here. For a complete description of all BPMN symbols, cf. Object Management Group (January 2008).

- Catch/Throw Link: These are off-page connectors. Two corresponding link events are identical to modelling a sequence flow.

Activities:

- Task/Subtask: A Task is an atomic activity that is included within a process. A Sub-Process is a compound activity that is included within a process.
- Collapsed Sub process: The details of a collapsed Sub process are not visible in the diagram. A Sub process is a decomposable activity.
- Sequence Flow: A Sequence Flow is used to show the order in which the activities will be performed.
- Default Flow: Default Flow is the default branch to be chosen if all other conditions evaluate to false.

Data:

- Data Object: Data Objects do not have any direct effect on the Sequence Flow or Message Flow, but they provide information about what activities require to be performed and/or what they produce. Data Objects can be business documents, e-mails or letters.
- Undirected Association: An Undirected Association is issued to attach a data object to a sequence flow and indicates handover between the activities involved.
- Directed Association: A Directed Association indicates information flow.
- Text Annotation: Text Annotations are a means for modellers to provide additional information for the reader of a BPMN diagram.

Swim Lanes:

- Pool: A Pool represents a participant in a process. Participants can be organisations, roles, or a system.
- Lane: A Lane is a hierarchic sub-partition within a Pool and will extend the entire length of the Pool.
- Message Flow: A Message Flow is used to show the flow of messages between two pools.

Gateways:

- Data-based Exclusive: This gateway routes the sequence flow to exactly one of the outgoing branches based on conditions. When merging, it awaits one incoming branch to complete before triggering the outgoing flow.
- Parallel: When splitting, all outgoing branches are activated simultaneously. When merging, it waits for all incoming branches to complete before triggering the outgoing flow.

- Inclusive: When splitting, one or more branches are activated based on branching conditions. When merging, it awaits all active incoming branches to complete.
- Event-based Exclusive: This gateway has to be followed by catching events or receive tasks. Sequence flow is routed to the subsequent event/task which happens first.
- Complex: This gateway triggers one or more branches based on complex conditions or verbal descriptions.

BPMN is a standardised and widely used modelling technique for business process modelling. So far, no reference models have been modelled using BPMN. The model supports hierarchisation, is easily understood by a variety of model users and offers a variety of elements necessary to model complex business processes. However, BPMN also has some known shortcomings: The specifications are not precise; interpretation of inclusive gateways is ambiguous and it remains unclear when data objects come to life or when they cease to exist. In order to address some of these shortcomings, BPMN needs to be further formalised in order for it to become suitably applicable. Overall, BPMN is assessed as the most suitable modelling technique for the present application context and for achieving the research objectives. The remaining shortcomings will be addressed within the development of the reference task model.

4.3 Supply Chain Management Frameworks

Reference models need to present a possibly vast number of elements in a concise and consistent manner. A way has to be found to handle inherent challenges of complexity. The users need to be able to effectively navigate through the model. This can be achieved through applying the principle of hierarchisation which in turn is supported by the introduction of a framework. In particular, most suited here are existing frameworks for supply chain management.

Supply chain management frameworks for humanitarian operations need to satisfy a number of criteria. These criteria will be used to assess existing frameworks and to evaluate whether existing framework can be used or suitably altered to serve as framework for the reference task model developed in Chapter 6 and the requirements profile described in Chapter 7:

- The framework should provide a structure for the presentation of tasks and activities present in humanitarian supply chains in a way that supports the standardisation of these tasks.
- The framework should support the creation of best practices and organisation-specific processes in a way that is easily understood by practitioners.
- Due to the changing nature of humanitarian operations and humanitarian organisations, the framework should grant a certain degree of flexibility in order to accommodate for future additions or alterations.

- The framework should have a reference to IT systems for supply chain management and thus provide the basis for an assessment of SCM IT systems for humanitarian organisations.

4.3.1 Cooper et al. (1997)

Cooper et al. (1997) were among the first to suggest a comprehensive framework for supply chain management. At the time of publication, supply chain management had only recently been distinguished from logistics and recognized as having a scope that goes beyond the classical understanding of logistics. The authors stress that coordination of activities and processes within and between organisations in the supply chain is a key characteristic of supply chain management. Cooper et al. (1997) suggest a three-part framework, which integrates the potential structures of supply chains, the business processes, and the key components for management attention. The framework is implemented employing these three main components.

The supply chain structure describes the configurations of partners within the supply chain. Business processes are the activities that produce a specific output of value to the customer. The management components are the components by which the business processes are structured and managed.[244]

Seven business processes are contained within the framework: Customer Relationship Management, Customer Service Management, Demand Management, Order Fulfilment, Manufacturing Flow Management, Procurement, Product Development and Commercialization, and as well as Returns Management. All of these processes focus on meeting the customer's requirements and thus providing value for to the customer. Likewise, all of these processes are cross-functional and span multiple companies. The business processes are partitioned into a sequence of strategic and operational sub-processes. The sequence of operational sub-processes specifies the process and describes a set of activities.[245]

The supply chain management components are common to and support all business processes. The framework includes the following management components: planning and control, work structure, organisation structure, product flow facility structure, information flow, management methods, power and leadership structure, risk and reward structure, as well as culture and attitude. The business processes determine how the business processes, and thus the supply chain, are managed and structured. In Figure 23 a high-level perspective of the supply chain is given. The business processes cut through the functions within the organisation and also across different actors in the supply chain. Every actor in the supply chain has its own set of functional silos that must be related to each core supply chain process.[246]

[244] Cooper et al. (1997), p. 5.
[245] Cf. Lambert et al. (2005), p. 28.
[246] Cooper et al. (1997), p. 9.

The framework of Cooper et al. (1997) is one of the most widely known and referenced frameworks of supply chain management. It has been adopted, refined, and expanded by many other authors, e.g. Croxton et al. (2001) who provide strategic and operational descriptions of each of the eight supply chain processes and examples of how processes can be implemented within the organisations. Their framework supports the standardisation of business processes across the entire value chain. Yet, some of the business processes suggested are not directly relevant for humanitarian organisations: Customer Service Management is not key due to the non-profit character of humanitarian supply chains. Manufacturing flow management is irrelevant since no manufacturing companies are direct stakeholders in the humanitarian supply chain. Product Development and especially Commercialization only play minor roles in the humanitarian supply chain. The framework is fairly simple, although presented in a rather and seemingly unnecessary complicated way. Flexibility of the framework is limited. There is little reference possible to IT systems for supply chain management.

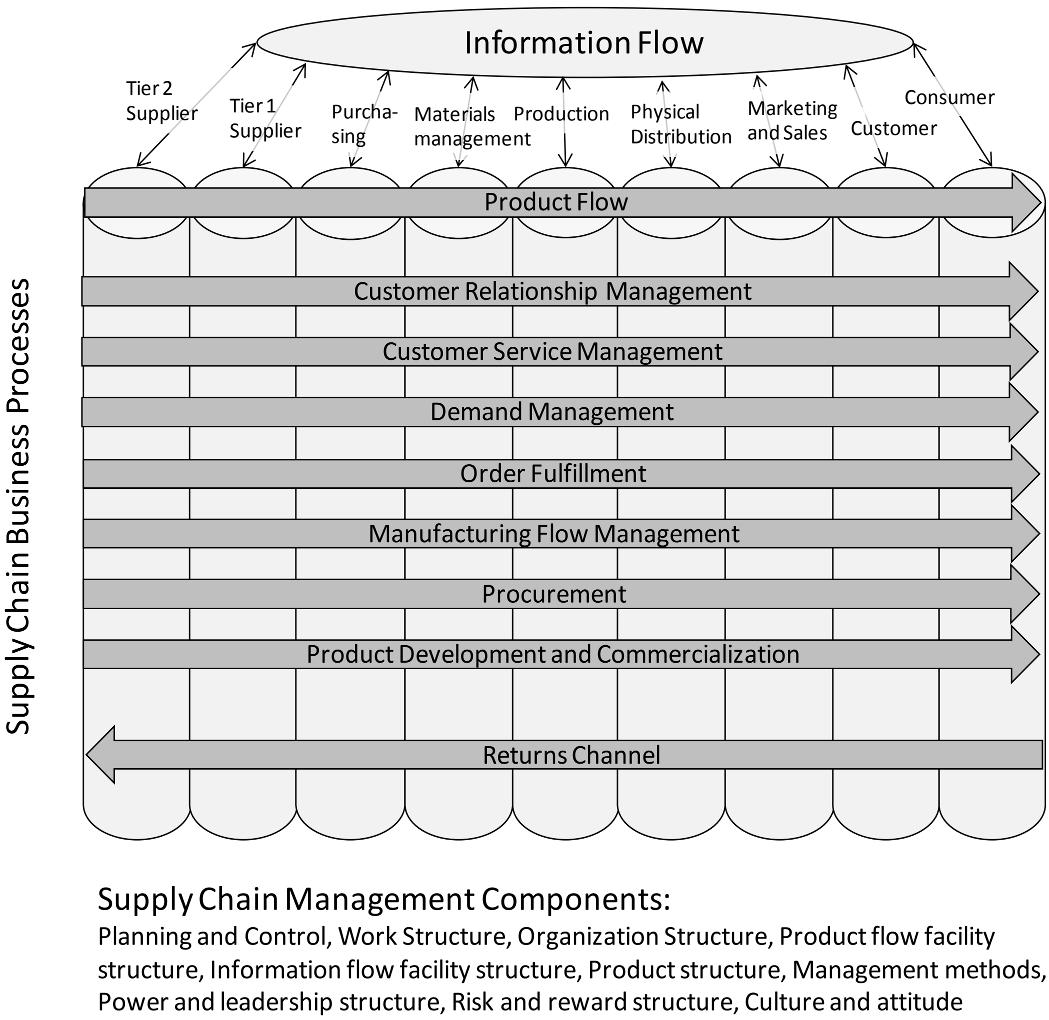

Figure 23: Cooper et al. (1997): Framework of Supply Chain Management[247]

[247] Source: Adopted from Cooper et al. (1997), p. 10.

4.3.2 Bowersox et al. (1999)

The 21st Century Logistics framework was developed building upon more than 15 years of research exploring leading logistics practices.[248] In the 21st Century Logistics framework (Figure 24) six competencies critical for logistics and supply chain management are identified. Each of these competencies is composed of a number of constituting capabilities that guide processes to complete logistics and supply chain activities. In Figure 24 the three competencies are depicted, which Bowersox et al. (1999) claim to lead to high supply chain performance: The operational process, the planning and control process, as well as the behavioural process.

Within these three different processes a number of competencies lead to excellence: Within the operational process, these are customer integration, internal integration, as well as material and service supplier integration. Within the planning and control process, these are technology and planning integration as well as measurement integration. Technology integration denotes the capability of information systems to support a variety of operational configurations needed to serve different markets. Within the behavioural process, relationship integration is the notion of developing and sharing a mutual mental framework between the actors in the supply chain. The processes and competencies are embraced by the flows, which span between the resource base and the end customer, viz. the product-service value flow, the market accommodation flow, the information flow, and the cash flow.

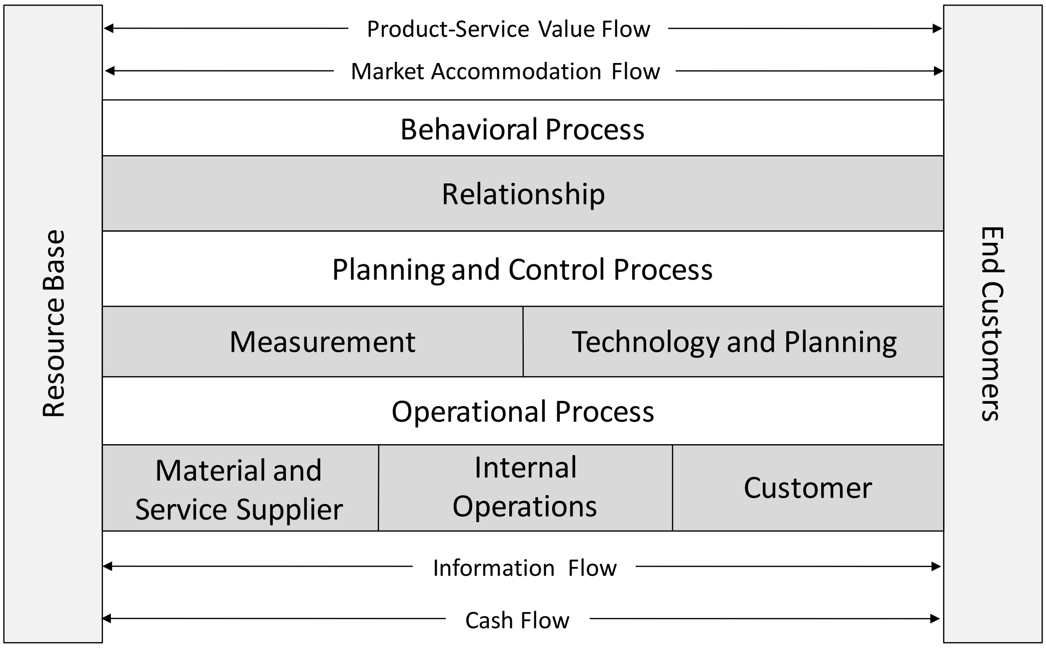

Figure 24: Bowersox et al. (1999): The 21st Century Logistics Framework[249]

[248] Cf. Closs and Mollenkopf (2004), p. 37.
[249] Source: Adopted from Closs and Mollenkopf (2004), p. 38.

This framework was further developed to include eight business processes, viz. plan, acquire, make, deliver, product design/redesign, capacity management, process design/redesign, and measurement.[250]

The 21st Century Logistics Framework is geared towards implementation since its authors claim that it “allows managers to identify and implement the competencies and capabilities characteristic of leading logistics and supply chain organizations.”[251] The 21st Century Logistics Framework was originally constructed on US-American data and interviews only. This shortcoming has been somewhat alleviated by its application in international environments and subsequent expansion and modification.

The 21st Century Logistics Framework incorporates a wide range of aspects of supply chain management. This variety of issues does not seem to suit the application context of humanitarian logistics, in which the objective is to come up with an easy-to-use and readily understandable task model, which focuses on the material and information flow in humanitarian supply chains. It focuses strongly on the integration aspect of supply chain management. While this is certainly an important aspect, it does not seem at this point to be decisive for supply chain management in the humanitarian context. The 21st Century Logistics Framework is fairly simple but its presentation does not clearly distinguish between flows, processes, and capabilities. The 21st Century Logistics Framework seems to be flexible and could potentially be adapted. Lastly, there is only little reference to IT systems beyond the technology and planning integration capability.

4.3.3 Kaufmann (2002)

Kaufmann (2002) defines supply management as “all processes of supplying the company with direct and indirect materials, services, rights, and machinery and equipment from sources external to the organization, aimed at contributing to the achievement of sustainable competitive advantage”[252] and includes strategic and operational activities. Clearly, this definition is process-oriented, which carries over to the supply management framework Kaufmann develops. Kaufmann perceives logistics and supply management rather similar since he claims that the “basic difference between supply and logistics management is that the latter transcends the whole company, and only inbound logistics represents an overlap of both sets activities.”[253] Supply management encompasses inter-company tasks of supply, materials and logistics management involving the source of raw materials up to the final customer. Moreover, disposal and renewal of material including reverse logistics are included in supply management.

Kaufmann’s framework for supply management is evidently based on Porter’s original definition of value chain, which is enhanced and adopted to supply chain management (Figure 25). Two interrelated categories of supply management processes are distin-

[250] Melnyk et al. (2000)
[251] Closs and Mollenkopf (2004), p. 37.
[252] Kaufmann (2002), p. 12.
[253] Kaufmann (2002), p. 12.

guished: In the first category, seven enabling/support processes are identified, viz. Clarifying supply management's role in achieving Sustainable Competitive Advantage, Designing Sourcing Strategies, Organizing Supply Management, Crafting Information and Communication Systems, Cost Management and Cash Management, Managing Human Resources, Managing Risk. These processes are strategic in nature and enable or support a comprehensive range of supply transactions.

The second category consists of the transaction-specific processes, which constitute the activities necessary for every single supply transaction: Pre-negotiation activities, Negotiations and Implementing the Agreement. This group consists of mainly operational activities. According to Kaufmann, Pre-negotiation activities include Identify/Anticipate Purchase Requirements, Establish Sourcing Team, Make SWOT Analysis, Set Objectives, Select Potential Sourcing Regions, Send Requests for Quotation, and Develop Negotiation Strategies and Tactics. Negotiations include Clarify Issues, Agree on Process, Set Agenda Points, Narrow Differences/Make Concessions/Update Goals, Conduct Electronic Reverse Auction, and Reach Agreement. Implementing the Agreement includes Identify Purchase Need, Receiving and Incoming Goods Inspection, Storage and/or Delivery, Check Invoice, Payment, Performance Feedback, and Learning/adaptation.

Enable/Support processes and transaction-specific processes are linked in such a way that the support processes create the supply management system of an organisation and the transaction-specific processes employ this system.

Kaufmann's framework for the supply management value chain is a general framework for supply chain management tasks, which can be adapted to a number of different contexts, including humanitarian logistics. It is not focused on a specific industry. The processes are comprehensive in a sense that they cover a range of supply chain management activities and are in line with commonly accepted standard supply chain business processes. The model is fairly simple and could be rapidly understood by practitioners.

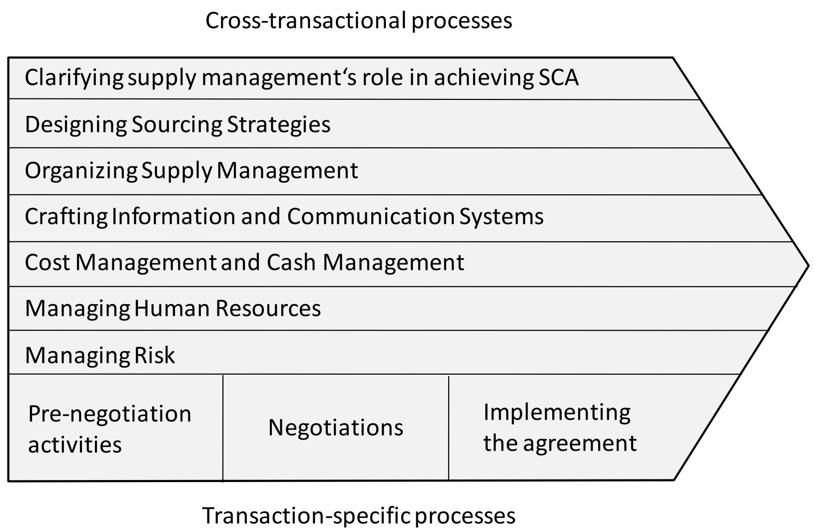

Figure 25: Kaufmann (2002): Supply Management Value Chain

Kaufmann’s model distinguishes both strategic and operational supply chain management processes. However, while Kaufmann elaborates in a detailed fashion on the strategic processes, the transactional processes remain on a rather abstract level. However, supply chain transactions are essential for a task model for supply chain management in the context of humanitarian operations. Moreover, while the strategic activities are generally applicable to most supply chain management contexts, the transactional activities focus on sourcing, purchasing as well as procurement processes and neglect issues related to transport and warehouse management.

Possibly the biggest disadvantage of Kaufmann’s framework is that – apart from the process “Crafting information and communication systems” – it is not IT-based, i.e. it neither supports nor guides the development or assessment of supply chain management systems. Overall, although the framework is an interesting, flexible, comprehensive, and generic approach to supply chain management, it is not suited for the adoption for a supply chain management framework in the context of humanitarian operations.

4.3.4 Gunasekaran and Ngai (2004)

Gunasekaran and Ngai (2004) develop a framework for studying the applications of information technology in supply chain management (Figure 26). They base their framework on a comprehensive literature review, which had the objective of bringing out pertinent factors and useful insights into the role and implications of IT in SCM. The selected references on IT in SCM are classified based on the nature of IT and IT applications, major areas of decision making and major enabling strategies and technologies.

The authors develop a classification scheme, which is based on the major components of IT-enabled SCM. There are six main categories, each of which has a number of subcategories: Strategic planning of IT in SCM (Marketing reasons of IT in SCM, Economic reasons, Organizational, Technological), Virtual enterprise in SCM (Partnership, Virtual reality and supply chain, Virtual enterprise and IT), E-commerce and SCM (Purchasing, B2B e-commerce and supply chain, Logistics), Infrastructure for IT in SCM (Organisational, Technological), Knowledge and IT management in SCM (Technology Management, Education and Training), Implementation of IT in SCM (Organizational, Methodological, Human resource).

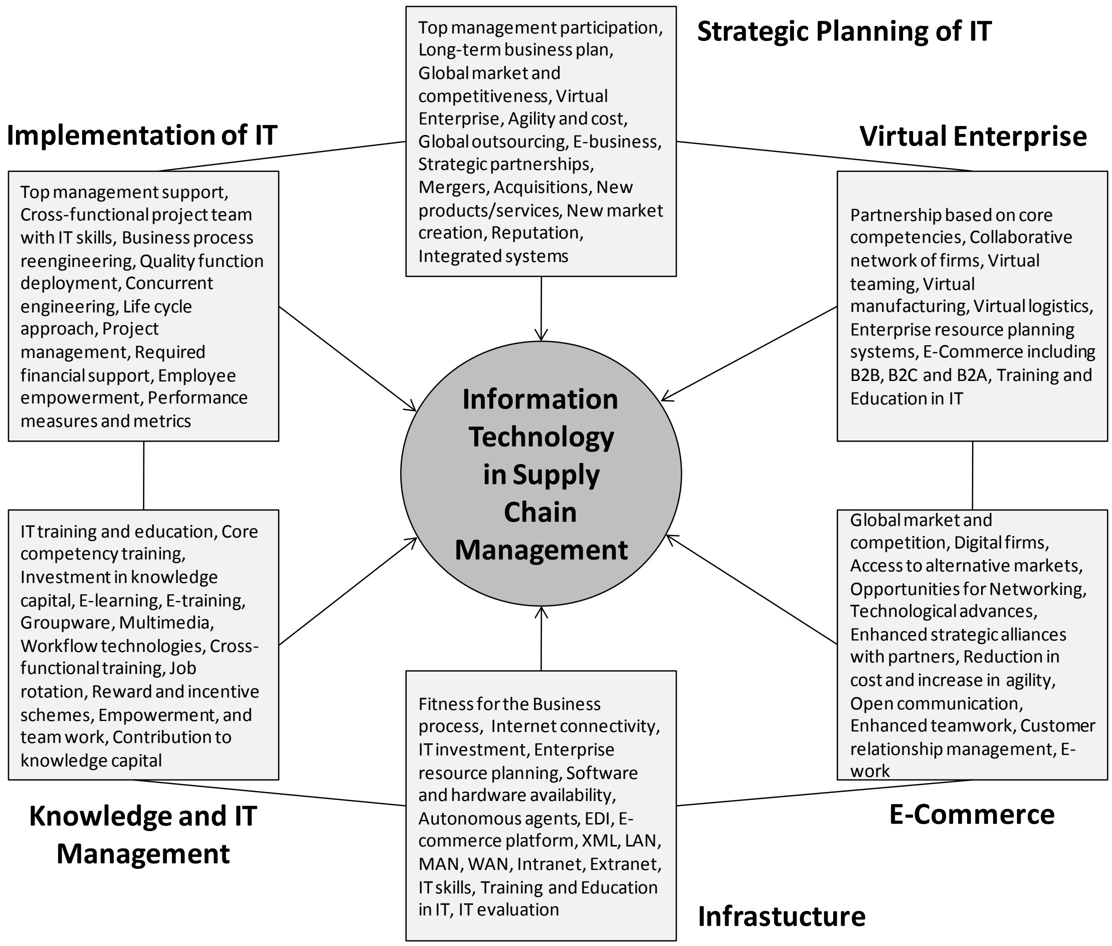

Figure 26: Gunasekaran and Ngai (2004): Framework for IT systems for SCM

The framework developed by Gunasekaran and Ngai supports the standardisation of IT in supply chain integration and attempts to enhance its role. It focuses on the integration of supply chain activities. It is applicable in the context of humanitarian operations, but limited to the IT domain. Logistics and supply chain management processes are not subject of the framework. The framework is simple to use and can be easily understood by practitioners. One of the main requirements of a framework for reference models is that it ought to give guidance to model users and provide a frame, which makes the reference model comprehensible and accessible for users. The lack of hierarchy in the model of Gunasekaran and Ngai and the limited scope, which excludes for example a perspective on processes or specific SCM tasks and activities, render it unsuitable for application in the context of a reference task model for supply chain processes of humanitarian organisations.

4.3.5 Fleischmann et al. (2005)

Fleischmann et al. (2005) introduce a planning matrix for supply chain management.[254] In the context of the model of Fleischmann et al. planning is defined as supporting

[254] The Supply Chain Planning Matrix was originally introduced by Rohde et al. (2000). In the first version, the supply chain planning matrix was a tool to assess advanced planning systems only. It has

"decision-making by identifying alternatives of future activities and selecting some good ones or even the best one."[255] As such, planning comprises the recognition and analysis of a problem, the definition of objectives, the forecasting of future developments, the identification and evaluation of feasible activities and eventually the selection of good solutions.

The Supply Chain Planning Matrix (Figure 27) distinguishes between the two dimensions "planning horizon" and "supply chain process". Four types of supply chain processes are identified: Procurement, production, distribution, and sales. In the planning horizon, long-term, medium-term and short-term planning is separated. Long-term planning involves strategic decisions, which create prerequisites for creating supply chains in the future. Decisions in this domain have long-term effects (several years) and aim at the design and structure of a supply chain. Medium-term planning has the objective to outline regular operations, particularly the rough quantities and times for the flows and resources in the pre-determined supply chain. The time horizon in this domain is 6 to 25 months; seasonal considerations are enabled. Lastly, short-term planning defines all activities as detailed instructions for immediate execution and control. Decisions within this domain are restricted by the decisions taken on the super ordinate levels. According to Fleischmann et al. (2005), decisions taken here are nonetheless

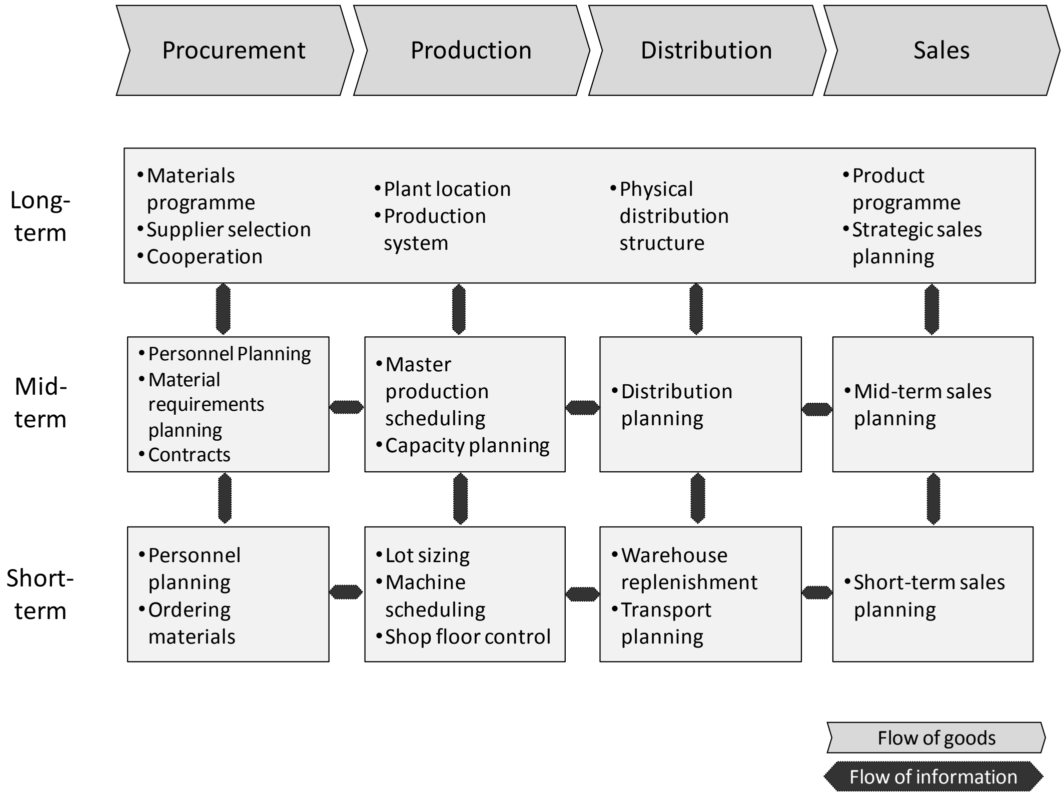

Figure 27: Fleischmann et al. (2005): The Supply Chain Planning Matrix[256]

been expanded by Fleischmann et al. (2005) in such a way that it has become a framework for categorizing supply chain management planning tasks.

[255] Fleischmann et al. (2005), p. 91.

[256] Source: Adopted from Fleischmann et al. (2005).

important for the performance of the supply chain. The planning horizon is between a few days and 3 months.

Figure 27 shows the Supply Chain Planning Matrix together with typical tasks, which occur in most supply chain types. These tasks cover both intra-organisational and inter-organisational tasks. Fleischmann et al. (2005) identify Product Programme and Strategic Sales Planning, Physical Distribution Structure, Plant Location and Production System, Materials Programme and Supplier Selection, as well as Cooperations as typical long-term planning tasks; Medium-term Sales Planning, Distribution Planning, Master Production Scheduling and Capacity Planning, Personnel Planning, Material Requirements Planning, and Contracts as typical medium-term planning tasks; and Short-term Sales Planning, Warehouse Replenishment, Transport Planning, Lot-sizing and Machine Scheduling, Shop Floor Control, Short-term Personnel Planning, and Ordering Materials as typical short-term planning tasks in supply chains. Most notably, these tasks are not fixed; the Supply Chain Planning Matrix rather provides a framework, which can be adapted to the supply chain type at hand.

The supply chain planning tasks are connected by the material and information flows, which have the objective to integrate and coordinate the planning tasks. Horizontal and vertical information flows are distinguished: The horizontal information flow consists mainly of customer orders, sales forecasts, internal orders for warehouse replenishment as well as purchasing orders to suppliers. The vertical information flow has the objective to coordinate subordinate plans by transmitted information such as aggregate quantities, allocated to production sites, departments, or processes.

The matrix suggested by Fleischmann et al. (2005) supports both the standardisation and categorisation of tasks of supply chain management. The matrix is fairly simple and can flexibly be adapted since the tasks are not fixed. Moreover, further processes could be inserted or deleted, e.g. production could be omitted since it is not decisive in the humanitarian context. The Supply Chain Planning Matrix is geared towards SCM systems since it can be used to position the software modules of many supply chain management and advanced planning systems. Altogether this framework is suited for the application context. An adaption of Fleischmann et al.'s model will be used in the following to serve as a framework for the reference task model supply chain processes of humanitarian organisations.

4.3.6 Hellingrath and ten Hompel (2007)

The framework for IT tasks in logistics and supply chain management was first presented by Hellingrath et al. (1999) and further detailed by Hellingrath et al. (2003) and Hellingrath and ten Hompel (2007). It was developed in order to provide an overview of all logistics tasks, which are to be supported by IT systems for logistics and supply chain management both within companies and across the supply chain. The task model was created taking into account a number of change drivers of logistics such as the need for collaborative planning and control processes, the need to create transparency and reactiveness to increasing uncertainties, the need to be able to cope with the dynamics of ever-shorter order cycles and lead times, and the production and delivery of customer-specific products.

Hellingrath's task model distinguishes three layers of supply chain management tasks (Figure 28). The strategic layer aims at the cost-efficient design of the entire supply network together with its supply chain management systems aligned to the overall supply chain strategy and its objectives. Planning decisions taken on this level can be regarded more or less independently from the underlying operative tasks.[257] Main objective of the strategic network design is the evaluation of investment decisions, especially concerning decisions on number and location of production facilities, warehouses, distribution centres and supplies. Following the strategic network and system design is the tactical planning layer, which is mainly concerned with optimal resource planning. Production and logistics capacities are planned in such a way that current and anticipated customer orders can be fulfilled. Aspects of the supply chain become more and more detailed and tasks are concerned with shorter time horizons. For instance, demand planning for product groups or market regions is conducted here. Decisions taken on the tactical layer such as transport or production planning are dependent on the structures defined in the super ordinate strategic layer. The objective of this layer is to draw up coordinated plans, which take into account interdependencies, capacity restrictions, and target dates. Lastly, the supply chain execution layer builds the foundation of the supply chain management task framework. Objective of this layer is to optimise process execution within the boundaries set by the tactical planning player. This layer combines all activities which enable inter- and intra-company control of logistics processes and which serve the operative process execution and records management. All components in this layer have the objective to flexibly react to the current operational environment and provide decision support for short-term time horizon decisions.

Furthermore, tasks are arranged in a manner to reflect customer-facing and supplier-facing activities. The task model shows that the tasks of designing, planning and executing supply chains are interconnected and necessarily need to be examined together. These different areas, i.e. supply chain design, planning, and execution or operation have to be considered together with their respective time horizon, which can stretch from minutes and hours for some supply chain transactions from the execution area to several years for decisions taken in the strategic task area.

The task model for information technology in logistics by Hellingrath and ten Hompel provides a comprehensive supply chain management framework for IT systems. The model can be generally applied to a variety of different SCM systems. Since it consists of different modules, it is flexible enough to be adapted to the context of humanitarian operations. Although a large number of modules is currently contained within the model, these could be suitably reduced in order to make it simple enough to be understood and employed by practitioners. The task model has a concrete reference to logis-

[257] Cf. Hellingrath and ten Hompel (2007).

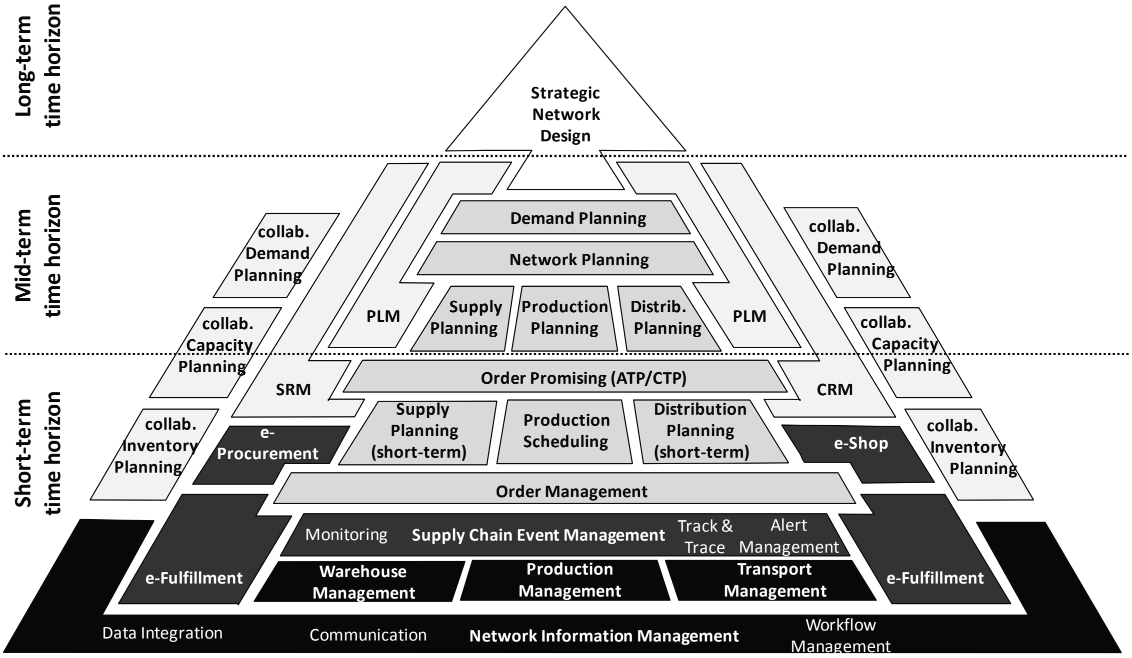

Figure 28: Hellingrath and ten Hompel (2007): Supply chain management task framework for IT

tics IT and even SCM systems and can thus be used for the development and assessment of SCM systems for humanitarian organisations. Overall, the framework developed by Hellingrath and ten Hompel is a suitable candidate for adaptation to become a framework for a requirements profile necessary to analyse and assess IT systems for SCM and logistics in humanitarian supply chains.

4.3.7 Supply-Chain Council (2008)

The Supply Chain Council recently introduced the Supply Chain Operations Reference model (SCOR) in version 9.0. Since the SCOR model and its framework are tightly interwoven, they will be discussed and evaluated together as reference model and framework rather than a pure supply chain management framework (cf. 4.4.3.4).

4.3.8 Kannegiesser (2008)

Kannegiesser (2008) develops a value chain planning model that integrates volume and value decisions within the value chain. The planning model primarily addresses the chemical industry but takes into account the challenges involved in managing the flow of commodities in a supply network. Kannegiesser considers value chain planning as part of value chain management, which has the objective to integrate strategy, planning, and operational decisions across the entire supply or value chain.

Specifically, Kannegiesser formulates a global value chain planning model for the intra-company commodity value chain network. The global scope of the model incurs additional requirements such as handling exchange rates, consideration of multi-period transportation time and transit inventories between continents. The global value chain planning model is structured in parts and is depicted in Figure 29. Each model part is composed of various model elements such as objective functions, constraints or decision variables. All model parts share the same planning basis. The main parts of the model are the value planning (i.e. profit planning consistent with profit & loss statement and future inventory value planning), sales planning (i.e. contract and spot sales planning), distribution planning (i.e. global material flow planning, multi-period transport and transit inventory planning, static and dynamic inventory planning), production planning (i.e. variable production processes, input and output planning), and procurement planning (i.e. spot and contract procurement planning).[258]

Kannegiesser's model offers a novel approach for a supply chain management framework. Since the approach is new, it remains unclear whether it supports standardisation of tasks in a supply chain management framework. However, since the case study presented in Kannegiesser et al. (2009) is rather quantitative, the possibility for adoption in the context of a supply chain management task framework built to construct supply chain processes seems limited. Kannegiesser's global value chain model focuses on the intra-company value chain network, which is analogous to humanitarian organisations, which take over responsibility for large parts of their supply chains. His model is focussed on the chemical industry, which is a process-industry offering products produced in repetitive production processes carrying out specific physical and chemical reactions and is thus not directly comparable to humanitarian supply chains, where commodities are moved and processed.[259] Yet, Kannegiesser himself claims that his model also applies to commodities since his specifically addresses chemical commodities, i.e. standard products of defined quality, for which price is a key purchase criterion. Relevance for IT implementation and assessment remains limited.

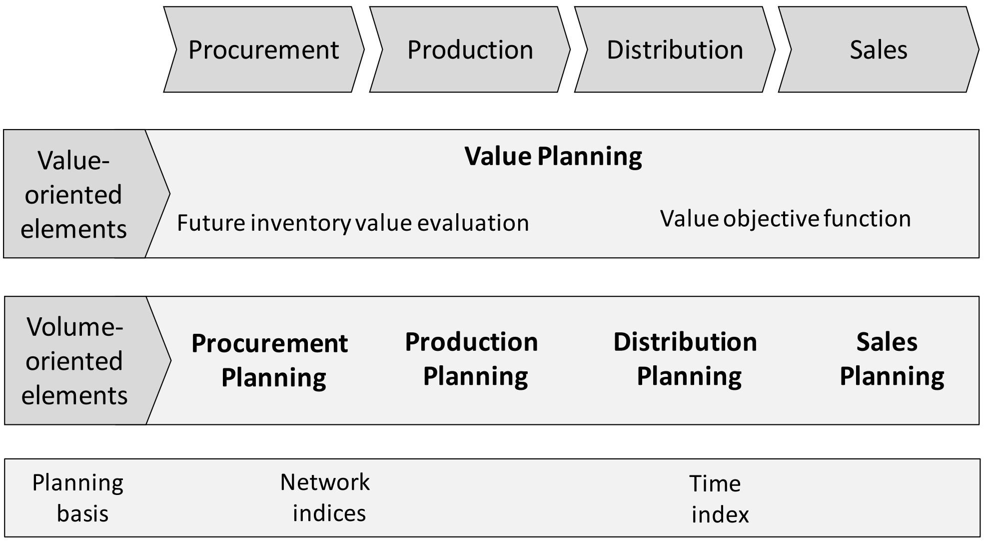

Figure 29: Kannegiesser (2008): Global value chain planning model[260]

[258] Cf. Kannegiesser (2008), pp. 123-125.
[259] Cf. Kannegiesser (2008), p. 1.
[260] Source: Adopted with changes from Kannegiesser (2008).

4.4 Reference Models

The number and variety of reference models has grown immensely over the last decade. Reference models have successfully been employed to improve both the quality and the speed of development of organisation-specific models, to reduce cost and improve profit by optimisation of organisation structures and to improve communication within supply chains by providing standardised terminology.[261]

4.4.1 Reference Model Typology

Typologies of reference models have been presented by Schütte (1998), Fettke and Loos (2004), Fettke et al. (2005), Thomas (2006), Thomas (2005), Vom Brocke (2003), and Schwegmann (1999), pp. 53-80. In order to reflect on and characterise existing reference models, classification criteria for reference models in general and process reference models in particular are required. Here, the classification scheme suggested by Fettke et al. (2005) and Fettke and Loos (2004) is partially adapted.[262] As Fettke et al. (2005) elaborate, "[b]eside universal characteristics, suitable for the complete spread of reference models, the description and classification of process reference models requires particular consideration of process-related criteria."[263] The criteria used to characterise state-of-the-art reference models are as follows:

General information:

- **Source:** Primary and secondary sources used for classifying the reference model or features of the reference model are listed here.
- **Name:** Identifies the reference model using a unique name. The name is also used as an indicator for the responsible person or entity that created the reference model.
- **Origin:** Distinguishes whether the reference model was created in the realm of science or practice.

Construction:

- **Method:** Elaborates the construction method of the reference model.
- **Modelling Language(s):** Lists the modelling language(s) used to describe the reference model. With respect to reference models, the specific diagram types and modelling languages used to represent the process models are specified.
- **Modelling Framework:** Distinguishes whether a modelling framework is used in the reference model or not. Frameworks can be helpful to provide an over-

[261] Cf. Schwegmann (1999), pp. 57-59, Supply-Chain Council (2006), and Becker et al. (1997).
[262] Cf. Fettke et al. (2005) and Fettke and Loos (2004). The authors claim that their framework for the classification of reference models is work in progress. A number of criteria are listed that do not seem decisive for a brief categorisation and thus are omitted here.
[263] Fettke et al. (2005), p. 2.

view over all elements and relations used in the reference model. They are also a means to reduce and handle complexity.

- **Size:** Appropriate size metrics for reference models do not exist yet. Thus, the number of diagrams as well as the number of views have been suggested as possible size attributes. Both depth and length of processes can serve as a measure to gauge the size of process reference models. Estimations are used for larger reference models. Reference models can grow large and complex and consist of hundreds or thousand of different modelling objects.[264]

Application:

- **Domain:** Describes the intended domain for the application of the reference model from the perspective of the developing person or institution. Within this criterion, several approaches for differentiation have been suggested. Differentiation is possible according to the institutional characteristics of the intended business system, functional characteristics, object-driven differentiation, which in the case of process reference models can for instance be use cases, and enterprise type-driven differentiation. Finally, some reference models exist that defy categorisation into any of these domains.
- **Users:** Addressees of reference models can either be application system or organisation developers. Thus, reference application system models and reference organisation models are distinguished. The third category comprises reference procedure models, which are sometimes regarded as a subcategory of either of the former two. They are introduced here due to their wide-spread use as a self-contained type of reference model and their importance in both practice and theory. Reference organisation models are used for a variety of purposes such as business process management, ISO certification, benchmarking, and knowledge management. Reference application system models are used for the selection of standard software, reference model-based customising, software development, workflow management, and simulation. Reference application system models are, for instance, the SAP R/3 business process model or the Oracle reference model. Examples for reference organisation models include the reference model for retail or the reference model for industry by Scheer. Reference procedure models include, for example, the Waterfall model, the Prototyping Model for developing software or Schütte’s model for developing construction-oriented reference models. Procedure models provide a pattern or paradigm method for efficiently reaching a pre-determined goal and are mostly used in Software Engineering and Business Process Reengineering.
- **Reuse and Customisation:** Using this criterion, concepts concerning the reuse and customisation of model elements in the process of the model’s application are assessed.

[264] Cf. Scheer (1998b), p.61.

- **Tool Support:** Describes whether the reference model can be used automatically by a software tool or whether the reference model is only available in a hard or soft copy.

4.4.2 Overview of Reference Models

A comprehensive literature review was undertaken in order to identify current reference models. The literature review included a thorough search within online databases, search engines, conferences and journals. Moreover, available collections of reference models were screened for potential reference models. The selection of reference models to be included in this overview was based on two questions:

- Is the reference model indeed a reference model according to Definition 4 (Reference Information Model)?
- Does the reference model address either tasks or activities of supply chain management and logistics or does the reference model have a dedicated focus on business processes?

All reference models which fulfilled these two criteria were integrated in the overview and subject to a closer investigation.[265] A complete list of all examined reference models with their respective assessment can be found in Table 5.

[265] Obviously, there is a whole range of further reference models with various scopes and foci. Resources which contain comprehensive lists and descriptions of available reference model include Fettke and Loos (2004), Gajewski (2004), pp. 43-78, p. 255, and Fettke and Loos (2006).

Table 5: Overview of reference models

General information				Construction			Application			
Source	**Name**	**Origin**	**Size**	**Method**	**Language**	**Framework**	**Domain**	**Users**	**Reuse/ Customisation**	**Tool Support**
Becker and Schütte (1996, 1997, 2004), and others	Retail information systems: Retail "H"	Science	~700	No formal method	EPC, ERM, Others	Own framework: Retail "H"	Retail	OD	Organisation-specific variants	None identified
Buchwalter (2001)	Electronic tenders in procurement	Science	~100	No formal method	Flow diagrams	None identified	Procurement	ASD	No method identified	Various tools
Erzen (2001)	PRO-NET	Science	~900	Formal procedure	Flow diagrams, Others	Hierarchical	Textile Industry	ASD	No method identified	None identified
Gajewski (2004), Dangelmaier et al. (2004)	Reference Model of After-Sales-Services	Research	~40	No formal method	UML	Hierarchical	Service Industry	ASD	No method identified	None identified
GWU mbH (2005)	Reference Model for Resource Cost Calculation	Practice	~290	No formal method	Flow diagrams	None identified	N/A	OD	No method identified	None identified
Hamm (1997)	Process-oriented design of industrial procurement	Science	~50	No formal method	Flow diagrams, Others	None identified	Procurement	OD	Modularisation, Customisation	None identified
Curran and Keller (1999), Keller and Teufel (1998)	R/3 Reference Model	Practice	~1000	Empirical	EPC	Business Scenarios	Cross-industry	ASD	Customisation	Yes
Knothe (2000), Mertins et al. (2008)	Reference model for ordering processes	Research	~30	No formal method	Flow diagrams, Others	Hierarchical	Services, Administration	ASD	Modularisation	None identified

General information				Construction			Application			
Source	**Name**	**Origin**	**Size**	**Method**	**Language**	**Framework**	**Domain**	**Users**	**Reuse/ Customisation**	**Tool Support**
Kruse (1996)	MR-based business process management	Science	~70	No formal method	EPC, ERM, Others	Meta model	Distribution, Warehousing	OD	Modularisation, Customisation	None identified
Lang (1997)	Lang's Generic RP Building Block Library	Science	~350	Procedure-model	EPC, Others	None identified	N/A	ASD, OD	Customisation	None identified
Heiderich et al. (1998), Schotten et al. (1998), Luczak (1998)	The Aachen PPC Model	Science	~100	No formal method	Others	None identified	Manu-facturing industries	OD	Modularisation, Customisation	None identified
McGuire (2006)	SCM framework for health care goods provided as humanitar-ian assistance	Research	~50	No formal method	N/A	Extension of Thorn's framework	HO	OD	Supported through use of context-depen-dent strategies	None identified
Meise (2001)	Framework for process-oriented organisation design	Research	N/A	Procedure-model	Others	None identified	N/A	OD	Reference Procedure Model	None identified
Nonnenmacher (1994)	RM-based modelling of information	Research	N/A	Sequential modelling	Others	None identified	N/A	OSD	No method identified	None identified
Otto (2002)	Automation of cross-enterprise procurement processes	Science	~160	No formal method	EPC, UML, Others	None identified	Cross-industry	ASD	No method identified	None identified
Pan American Health Organization (Regional Office of the World Health Organization) (2001)	Humanitarian Supply Management and Logis-tics in the Health Sector	Practice	N/A	No formal method	Verbal	Functional division	HO	OD	Best practice approach	None identified

General information				Construction			Application			
Source	**Name**	**Origin**	**Size**	**Method**	**Language**	**Framework**	**Domain**	**Users**	**Reuse/ Customisation**	**Tool Support**
Remme (1997)	Construction of RP with generic process particles	Science	~50	No formal method	EPC, ERM, Others	None identified	N/A	OD	Placeholder, Specialisation	None identified
Remmert (2001)	Reference modelling for retail logistics	Science	~40	No formal method	EPC, Others	None identified	Retail	OD	No method identified	None identified
Scheer (1991) and others	Architecture of Integrated Information Systems (ARIS)	Science	N/A	Procedure-model	EPC, ERM, Others	ARIS House of Business Engineering	N/A	OD, ASD	Perspectives	Yes
Schütte (1998)	Construction of configuration- and adaptation-oriented RM	Science	N/A	No formal method	EPC, ERM, Others	None identified	N/A	ASD, OD	Reference Procedure Model	None identified
Schwegmann (1999)	Object-oriented reference modelling: Theoretical Foundations and Application	Science	~80	No formal method	EPC, UML	None identified	N/A	ASD, OD	Model Specialisation; Build-Time Operators	None identified
The Sphere Project (2004)	Minimum Standards in Disaster Response	Practice	N/A	Empirical	N/A	Functional division	HO	OD	No method identified	None identified
Supply-Chain Council (2008)	Supply Chain Operations Reference model - Version 9.0	Practice	~200	Empirical	Verbal, graphical	Own framework	Cross-industry	OD	Supported through modular design	None identified
Tufinkgi (2006)	Development of a logsitics reference model for disasters	Research	~40	No formal method	Process chains	Hierarchical processes	HO	OD	Supported through modular design	None identified
Zabel (2004)	Reference model of interaction processes of procurement applications	Research	N/A	Unified Modeling Methodology	UML, Use Cases	None identified	Cross-industry	OD	No method identified	None identified

4.4.3 Reference Models on Supply Chain Management and Logistics

Based on the initial overview of reference models obtained in the preceding section, a further selection can be made in order to choose those reference models which could most beneficially contribute to the research objectives. The reference models selected for a closer investigation share the following characteristics:

- The reference model addresses tasks and activities of supply chain management and logistics
- The reference model provides some guidance with respect to business processes of supply chain management and logistics
- The size and level of detail of the reference model are sufficient to provide concrete recommendations for organisations
- The reference model has been evaluated through the application in practice or in case studies
- The reference model employs a standardised (semi-) formal language

4.4.3.1 Scheer (1991): ARIS and R/3

ARIS[266] was developed by Scheer based on KIM[267] and Scheer (1990). ARIS provides a framework for the development, improvement, and implementation of integrated information and communication systems and aims to align enterprise information systems with all external and internal requirements. ARIS thus provides a framework which partitions the description of the model into perspectives and layers each with their own sets of modelling elements and languages.

ARIS provides several perspectives on an organisation, viz. the organisational view, data view, function view, control view, and output view.[268] These perspectives are used as a means to reduce complexity of the overall system. Moreover, the redundant use of objects in the model is circumvented. The different perspectives can make use of different modelling techniques and languages. The organisational view denotes the class of organisational units and thus the organisational structure. Within the organisational structure, several task bearers are distinguished. The data view comprises all environmental data and messages which can trigger functions or which are created by the execution of functions. The function perspective illustrates all processes which transform input objects into output objects. Here, the notions of function, activity and proc-

[266] Architektur integrierter Informationssysteme (Architecture of integrated information systems). ARIS is widely discussed in both academic and practical works, cf. Scheer (1992), Scheer (1994), Scheer (1997), Scheer (1998b), Scheer (1998a), Mattheis and Jost (1998), Scheer (1999), Scheer (2001), Scheer and Jost (2002).

[267] KIM (Kölner Integrationmodell, Cologne Integration Model) has been developed in the 1960s and is an approach to model all activities and information related to organisation-specific processes. The objective of KIM is to create a framework for the develpment of information and communication technologies for enterprises. KIM has provided the foundation for many modelling techniques and languages, most prominently ARIS.

[268] Cf. Scheer (1998b), pp. 33-37.

ess are used indiscriminately. Objectives of the organisation are also attributed to the function perspective since functions serve to pursue and are controlled by these objectives. The output view contains all material and immaterial input and output services including the financial flow. Lastly, the control or process view integrates all the latter perspectives and creates the framework for the systematic analysis of the bilateral relationships between the perspectives. The control view serves to model the control flow of the model, i.e. the temporal-logical sequence of the business process. While the first four perspectives describe the structure of the model, the latter process perspective portrays the dynamic, behavioural aspects of the business process flow.

ARIS foresees to model the perspectives described before in a sequential and iterative process. The process models the three layers (functional) concept, data processing and implementation layer for each of the perspectives.[269] The objective is to transform process-oriented models into information systems. In a first step, the functional concept is described independently of the applied information systems (requirements specification). Here, languages are chosen which are comprehensible from a business perspective but also formal enough that they can serve as the basis for an IT implementation. The data processing layer follows, in which it is defined how the contents of the functional concept layer can be implemented with information systems. Here, the requirements for the interfaces of implementation tools such as data base systems or programming languages on the functional concepts are aligned (design specification). Lastly, the implementation layer is concerned with the construction of programming code and executable software. The entire ARIS concept is displayed in Figure 30.

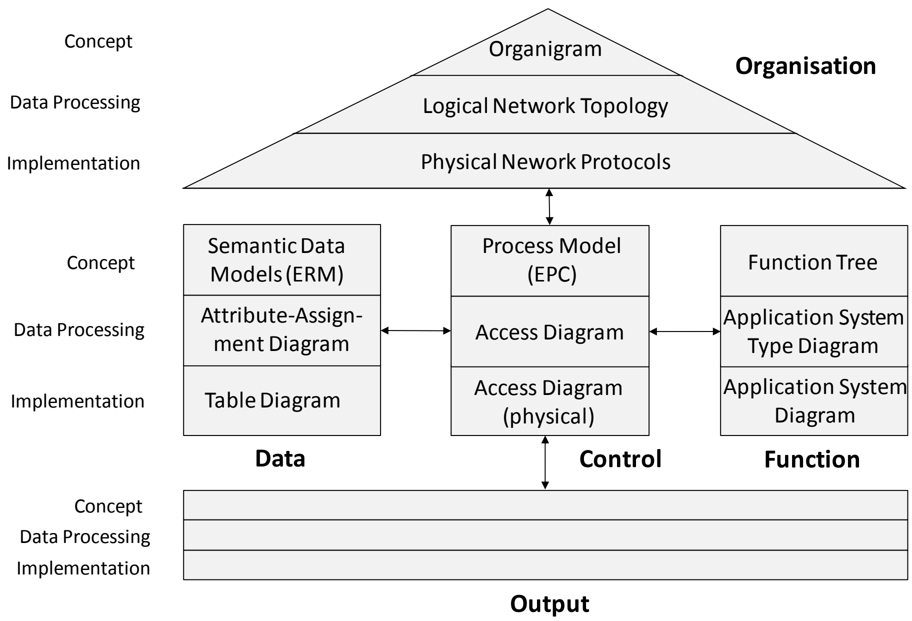

Figure 30: ARIS concept[270]

[269] Cf. in the following Allweyer (2007), pp. 146-152.
[270] Source: Based on Scheer (1997), p. 17; Scheer (1998b), p. 41; Gajewski (2004), p. 46, Keller et al. (1992), p. 5.

ARIS has been used as a framework for the development of several industry-specific reference models. The SAP R/3 Reference Model is possibly the most prominent example.[271] The R/3 Reference Model is a comprehensive business process model that contains more than 4000 entity types in the data model and more than 1000 business processes and over 100 inter-organisational business scenarios in the process reference models.[272] SAP's reference processes were developed in a joint project with IDS Scheer AG in 1990-1992 and are modelled using EPCs. SAP R/3 is the market leader in the field of Enterprise Resource Planning systems.[273]

SAP has created a business blueprint which is a description of the R/3 Reference Model. The R/3 Reference Model provides a comprehensive view of the main processes and business solutions available in the R/3 system. It was developed based on SAP's empirical know-how of best practices in business processes of various industries. It is a tool that supports configuration of organisation-specific business processes. The business blueprint has the objective to clarify what processes are decisive for supporting the organisations' activities and how these are linked. The R/3 Reference Model employs EPCs to provide templates for many different situations from "asset accounting" to "procurement" and "treasury".[274] Five views are provided by the R/3 Reference Model: A Process view which displays the network event-driven process chains; a Function view which presents a summary of the business functions required for R/3; an Information flow-view which models the information flow between event-driven process chains; a Data view which clusters data structures required for the business processes; and an Organization view illustrating the relationships between the organizational units of the enterprise.[275]

The R/3 Business Blueprint can be viewed and analysed with the R/3 Business Engineer. The Business Engineer is a set of integrated tools for the configuration of R/3 and can be used directly from the R/3 Repository to graphically display the Business Blueprint. The R/3 Repository contains all data definitions and structures necessary for ABAP/4 programmes. The Business Engineer also comprises customizing components which enable the user to configure the system according to the requirements.[276]

4.4.3.2 Becker and Schütte (2004): Retail-H

Retail is important to both manufacturing companies and ultimate customers since retail companies ensure that the consumers are supplied with the required goods. Hence, retail companies are the intermediaries of manufacturing companies and end consumers. They are characterised by a both temporal and spatial bridging function.[277] Moreover, since

[271] Cf. Scheer (1998b), pp. 61-63. ARIS has also been used for the design of many SAP-independent reference models, e.g. the ARIS-based reference model for Siebel CRM or industry models for banking, retail, insurance, telecommunication, etc., cf. van der Aalst et al. (2005), p. 77.
[272] Cf. Curran and Keller (1999), van der Aalst et al. (2005), p. 77.
[273] Cf. van Dongen and Jansen-Vullers (2000), p. 465.
[274] van Dongen and Jansen-Vullers (2000), p. 466.
[275] Cf. Ryerson Polytechic University (10.02.2000), Curran and Keller (1999).
[276] Curran and Keller (1999), p. 28.
[277] Cf. Becker (1996), p. 3.

retail companies do not manufacture products themselves but rather focus on optimal procurement, storage and distribution of goods, this industry bears some similarity to humanitarian organisations. The Retail-H is a common and frequently implemented industry-specific reference model and is thus discussed here.[278]

Retail information systems are information systems which cover “not only merchandise tasks but also business administrative tasks as well as general controlling and company planning tasks.”[279] Retail information systems traditionally displayed certain weaknesses in terms of intra- and inter-company communication and coordination and legacy software architecture. The Retail-H was developed to address these shortcomings. The Retail-H summarises the tasks of a retail company. The different views function, data, and process are distinguished similarly to the ARIS architecture. The function view lists all elementary functions of procurement, warehousing, distribution, administration, and strategic and tactical planning. The data view depicts the static structures in the form of ERMs. The process view determines the temporal-logical sequence of activities and combines functions and data together with the temporal aspect.[280]

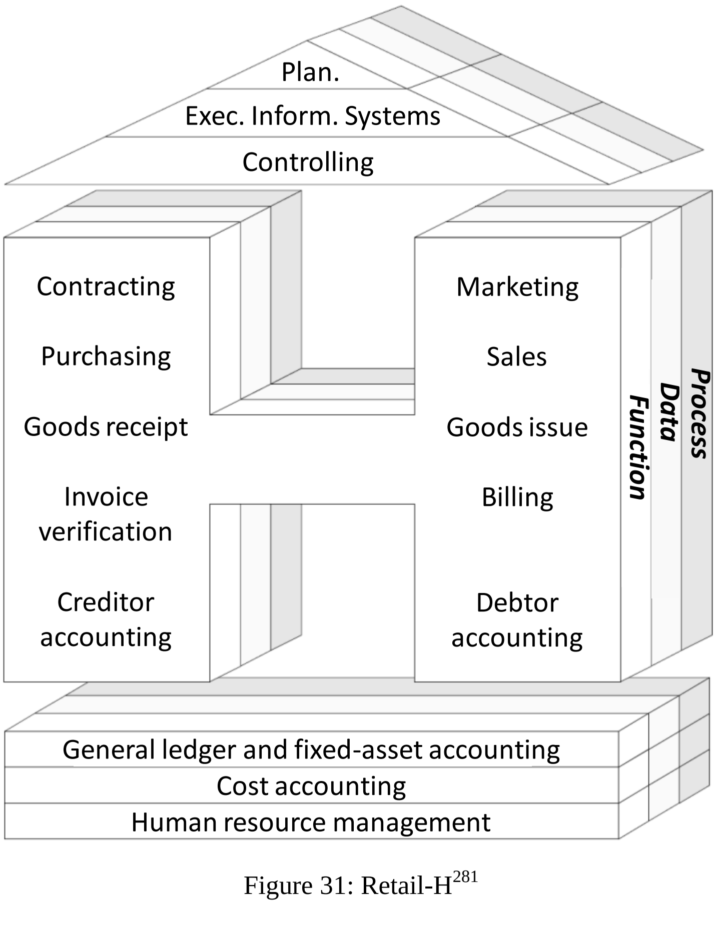

Figure 31: Retail-H[281]

[278] Cf. in the following Becker and Schütte (1996), Becker and Schütte (1997), Becker (1999), Becker et al. (2001), and Becker and Schütte (2004).
[279] Becker et al. (2001), p. 13.
[280] Cf. Becker (1999), p. 160.
[281] Source: Based on Becker (1996) and Becker et al. (2001).

On the left side of the Retail-H, the area of procurement is shown; the right side is composed of distribution and sales tasks. Warehousing is located in between these two and thus interconnects procurement and distribution. Procurement consists of contracting, purchasing, goods receipt, invoice verification, and creditor accounting. Distribution is comprised of marketing, sales, goods issue, billing and debtor accounting. The foundation of the model is composed of the functional areas general ledger and fixed-asset accounting, cost accounting and human resource management. Overarching the Retail-H are organisational tasks, viz. company planning, executive information systems and controlling. The information systems in the "roof" of the Retail-H aggregate data from the underlying layers to significant performance indicators which provide the basis for executive management decisions.

Several variants of the Retail-H exist, e.g. for wholesalers and stationary retail stores. In fact, the Retail-H covers a superset of tasks of different retailing companies and can thus be applied to a range of different retail business scenarios such as third-party business, pooled payment business, promotion business and service business.[282]

4.4.3.3 Schuh and Gierth (2006): Aachen PPC Model

The Aachen Production Planning and Control Model (Aachen PPC Model) takes a holistic perspective on the production system. A company's and furthermore its suppliers' resources and processes need to be geared to create added-value and have to be aligned with the customers' requirements.[283] The main objective is the optimisation of the production system. Thereby, a production system encompasses the entire production organisation including all concepts, methods, and tools. The interaction of these elements characterise the effectiveness and efficiency of the entire production flow.[284] The Aachen PPC Model has been developed to enable the implementation of projects focusing on the reorganisation of PPC as well as development, selection, and implementation of PPC concepts and systems.[285]

Furthermore, the Aachen PPC Model has the objective to describe production planning and control from different perspectives. Hence, reference views are created among which are the task view, process view, function view, and data view. There are a number of additional views such as the object-oriented view, the goal view, and others which are not elaborated here. The tasks view specifies and details the tasks of PPC in a hierarchical abstraction for the manufacturing company and its suppliers.[286] Inter-company network tasks, intra-company core tasks and cross-sectional tasks are distinguished. The core tasks define the requirements for PPC from the manufacturing organisation. In the process view these tasks are extended by a temporal-logical sequence.[287] Interfaces to other processes and external partners are defined. Several

[282] Cf. Becker et al. (2001), pp. 16-20.
[283] Schuh and Gierth (2006), p. 11.
[284] Schuh and Gierth (2006), p. 11.
[285] Cf. Schotten (1998), p. 10.
[286] Schuh and Garg (2007), p. 417.
[287] Schuh and Garg (2007), p. 417.

manufacturing-type dependent processes are available here which can be customised to the organisation at build-time. The function view serves to describe the requirements for IT systems for production planning and control. Reference functions are described in a flat hierarchy and are structured analogously to the task view in order to support rapid identification of functions necessary to support certain tasks. Finally, the data view delivers the required data. All data necessary to execute PPC systems are contained.

The Aachen PPC Model is one of the most widely used reference models for the construction of production planning and control. Similar to ARIS, a number of perspectives are used to enable the holistic modelling of a PPC system. Furthermore, detailed process descriptions, function catalogues and data structures are delivered with the model. While the model excels both in depth and application breadth, it remains strongly focused on manufacturing tasks and does not address distribution and procurement tasks in a detailed manner.

4.4.3.4 Supply-Chain Council (2008): SCOR 9.0

One of the most important reference models of supply chain management is the industry-driven Supply Chain Operations Reference model (SCOR), which provides means to visualise supply chain structures and processes.[288] The current version of SCOR is 9.0 and has been released in 2008. SCOR has become a de facto standard tool for commercial supply chain management.

The SCOR model was developed by the Supply Chain Council in order to facilitate an industry-wide discussion and advancement of state-of-the-art supply chain management practices. The SCOR model provides a framework that links business processes, metrics, best practices and technology features into a unified structure to support communication and collaboration among supply chain partners.[289] The model focuses on one enterprise at a time and spans from its supplier's supplier to its customer's customer. The SCOR model breaks down each management process at various organisational levels and establishes metrics at each of these levels. It deals with all customer interactions as well as all product interactions including equipment, supplies, spare parts, bulk products etc. The SCOR model enables users to address and communicate supply chain management practices within and in between supply chain partners. It provides three levels of process detail, each detailing the respective super ordinate level. Thus, it follows a top-bottom approach, which is necessary in order to handle complex problems. The top level view of the SCOR 9.0 processes is shown in Figure 32.

[288] Cf. Supply-Chain Council (2005), Supply-Chain Council (2008).
[289] Cf. Stewart (1997), Huan et al. (2004).

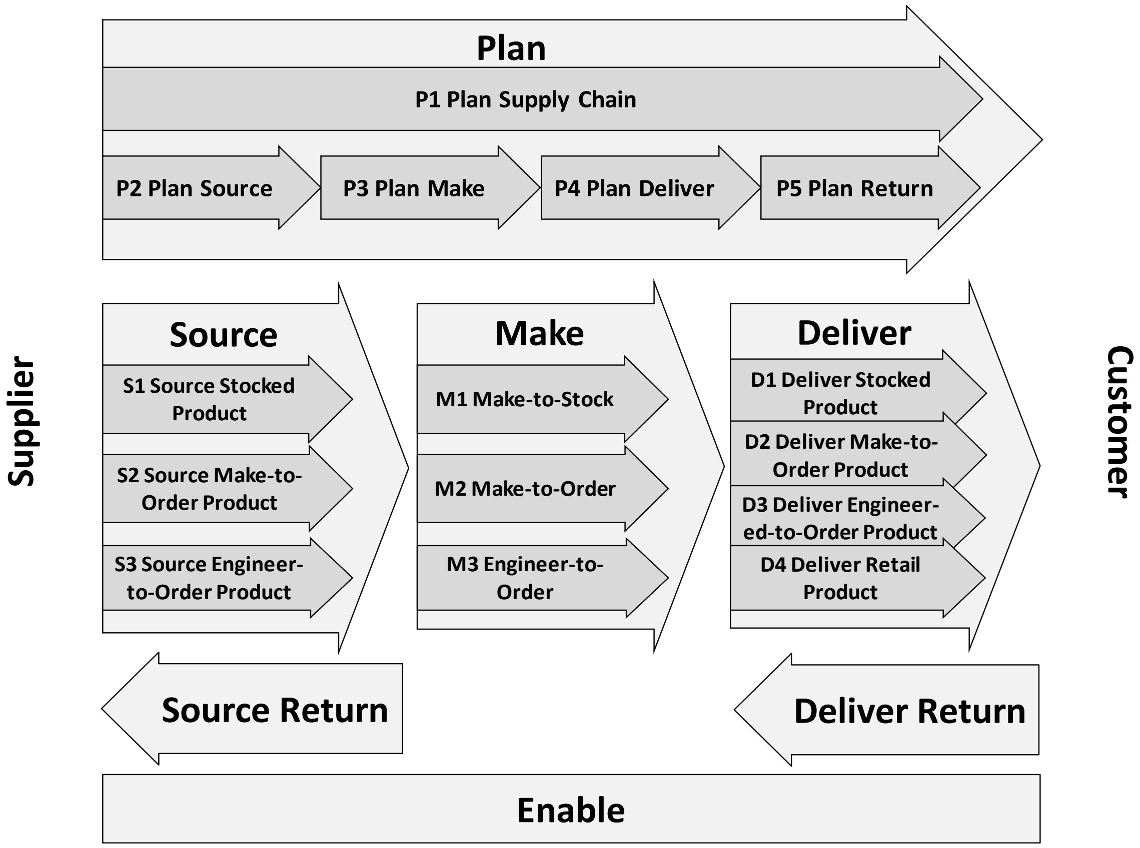

Figure 32: Supply-Chain Council (2008): SCOR 9.0

The model is composed of three components: Process Modelling, Performance Measurement and Best Practices. Within the process modelling framework five distinct management processes are considered: Plan, Source, Make, Deliver, and Return. “Plan” refers to processes that balance aggregate demand and supply to develop a course of action which best meets sourcing, production, and delivery requirements; “Source” processes are those by which goods and services are procured in order to meet planned or actual demand; “Make” processes transform goods or products to a finished state to meet planned or actual demand; “Deliver” processes provide finished goods, products, and services by spatial and temporal transformation. Order, transportation, and distribution management is contained within this process category; finally “Return” processes are associated with returning or receiving returned products as well as post-delivery customer support.[290]

[290] An interesting aspect of SCOR is its application of metrics and key performance indicators. As mentioned before, SCOR defines metrics at each of its levels; these metrics are aggregated into key performance indicators at the highest level, viz. Perfect Order Fulfilment, Order Fulfilment Cycle Time, Upside Supply Chain Flexibility, Upside Supply Chain Adaptability, Downside Supply Chain Adaptability, Supply Chain Management Cost, Cost of Goods Sold, Cash-to-Cash Cycle Time, and Return on Supply Chain Fixed Assets. Adaptability of performance measurement for differing supply chains is achieved by SCOR through the combination of pre-defined standard processes which can be assessed on the basis of performance indicators which are defined for these processes. As side benefit, this also enables the comparability of performance indicators between different organisations. SCOR is suitable for both company-internal as well as supply chain wide performance assessment and supports the user with a multitude of different and precisely defined performance indicators. However, due to the tight boundaries

4.4.3.5 Erzen (2001): PRO-NET

Erzen (2001) develops the reference model PRO-NET for textile supply chains focussing on improving the cooperation in these supply chains with respect to order planning and production control. In order to achieve this, Erzen combines elements of process and coordination management. The model can thus be integrated in an inter-organisational concept which includes design, planning and implementation of cooperation in textile supply chains.[291]

Erzen's reference model can be classified as an organisational object model describing the behaviour of a system. It is intended for business process management and describes tasks and processes within its application domain. The focus is on the information flow rather than on the material flow.[292] The reference model for order processing is complemented with a methodology for organisations to compare their processes to the reference processes and if needed adjust their processes according to the reference model and thus realise potentials for improvement.[293] Object of the model is the description of cooperative customer-supplier relations with respect to order processing on the basis of framework orders, such as those typically found in textile supply chains. External and internal production as well as suppliers and customers are within the scope of the model.

When developing the reference model, Erzen strictly follows the methodology presented by Schütte (1998). Moreover, Erzen uses prototypes or templates on which he draws when building his model. These templates are mainly Aachen's PPC model[294], SCOR and the reference models by Scheer (1999) and Schönsleben[295]. Erzen extends and completes these templates with empirical data. The reference model also includes best practices which are mainly derived from Supply-Chain Council (2005) and expert interviews from the RAPTIL project.[296]

Erzen presents his reference model with hierarchical flowcharts which capture all activities involved in order processing of textile supply chains. The model incorporates roles and responsibilities as well as objectives of supply chain partners and distinguishes between strategic, tactical and operational layers. Colours are used to point out

of pre-determined definitions, flexibility and adaptability of the performance measurements system suffers. As Davidson (2006) writes: "While this model provides enough detail and choices of metrics that it may be adaptable to the humanitarian supply chain, it is not the best choice of metric system mainly because its complexity could hinder its ability to be implemented in a humanitarian organisation. The SCOR model would also have to be analyzed on a "per disaster" basis in order to be implemented." Davidson (2006) continues arguing along the lines of Beamon (2004): "[…] businesses operate in a static world where supply chains and distribution networks are pre-defined and planned before demand from the consumer occurs. Humanitarian organisations may have some pre-defined distribution networks and agreements with vendors in place before disaster strikes, but nearly all operations contain some kind of "ad-hoc" elements to the supply chain, given the unpredictability of operation timing, location, needs, etc."

[291] Cf. Erzen (2001), p. 114.
[292] Cf. Erzen (2001), p. 50.
[293] Cf. Erzen (2001), p. 113.
[294] Cf. Schotten (1998).
[295] Cf. Schönsleben (1994), Schönsleben (1998).
[296] Cf. Erzen (2001), p. 54.

to which layer activities are attributed. However, Erzen's reference model also suffers certain shortcomings: The lack of a formal language limits the modelling options and the possibility to extend the reference model and adapt it to order processing in other supply chains. Furthermore, the lack of a formal language also hampers the use of the model to support the implementation of IT systems or IT-supported workflow management. The reference model does not include data or function models which are needed when implementing IT systems to support order processing. Finally, the reference model does not support adaptation by use of build-time and run-time operators and thus the reusability of the model is reduced.

4.4.4 Reference Models on Humanitarian and Disaster Logistics

This section is dedicated to reference models with specific focus on humanitarian logistics, disaster logistics or supply chain management in the context of humanitarian operations. As presented in the previous sections, a breadth of reference models for commercial and industrial supply chains exists. This does not carry over into the humanitarian domain – neither in breadth nor in depth of existing reference models. Here, reference models remain scarce and if available only portray certain sections of humanitarian supply chains or certain application contexts such as health care and have a specific focus on either disaster logistics or long-term development. Nonetheless, the need for a common representation and standardisation of various aspects of the humanitarian supply chain has been recognised.[297]

4.4.4.1 Tufinkgi (2006)

Tufinkgi (2006) provides the first comprehensive and structured description of activities associated with disaster logistics. He focuses on designing a reference model for disaster logistics and distinguishes between two main phases of logistics management. In the phase Generic Disaster Logistics Management (GDLM) all activities are included that take place before a crisis situation comes into existence.[298] This phase has a rather long-term, strategic character and comprises strategic and generic measures. Four different phases are identified within the GDLM phase: Regional clustering and risk analysis, Pre-Assessment for each cluster, Planning and implementation of network structures for each cluster, and Generic contingency supply management. All of these activities are not geared towards a specific disaster. Based on information and experience collected in the past as well as forecasted future developments, concrete estimations are made towards the occurrence of specific types of disasters and the required resources are planned accordingly.[299] Figure 33 presents the top-level view of the Generic Disaster Logistics Management.

[297] Cf. Kovács and Spens (2008).
[298] Cf. Tufinkgi (2006), pp. 206-215.
[299] Cf. Tufinkgi (2006), p. 207.

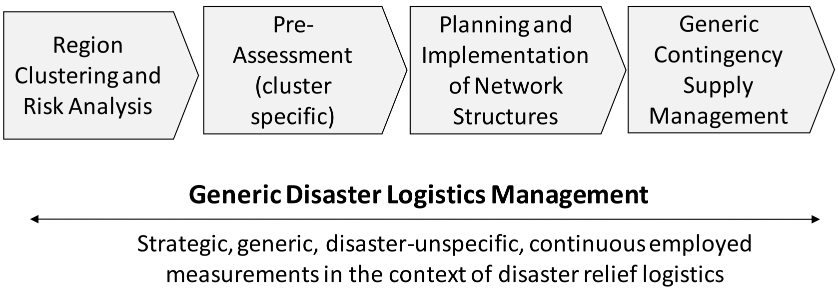

Figure 33: Tufinkgi (2006): Generic Disaster Logistics Management[300]

The onset of a specific disaster signifies the boundary of the GDLM phase and the beginning of the Specific Disaster Logistics Management (SDLM). The SDLM phase consists of three main layers: The Operations Support process chain, the Disaster-Specific Supply process chain, and the Integrated Project Planning and Control process chain.[301] The main focus of the Operations Support process chain is the provision of basic infrastructure needed for the execution of logistical measures. The Integrated Project Planning and Control Process chain serves as an integration platform during the project and helps implementing the strategic objectives which were determined in the assessment and pre-assessment phases. Most interesting for the scope of this work is the Disaster-Specific Supply process chain which describes activities related to providing the project or beneficiaries with suitable resources and goods. This process chain is coupled with the Operations Support process chain, since the measures taken within the operations support domain are the basis for the implementation and execution of the disaster-specific supply chain. It consists of the distinct phases Standardized Ad-Hoc Partial Mobilization of Supplies, Mobilization and Procurement of Supplies, Transport, Storage, and Distribution. Specific Disaster Logistics Management is rather focused on short-term, project-oriented activities. Figure 34 presents the top-level view of the Specific Disaster Logistics Management.

Tufingki's reference model gives a broad description of the entire logistics domain in disaster management. Tufinkgi also points out how more efficient and effective network structure configurations could improve identified weaknesses of the current system. However, Tufinkgi does not distinguish between different humanitarian actors since he argues that the International Disaster Relief System in its entirety is responsible for the disaster management. There is no distinction between the material and information flows in the network. Furthermore, although the model captures all activities in disaster logistics, it does not structure them in a process-oriented sense that promotes IT-supported execution of processes. Furthermore, the model is focused on disaster logistics. While Tufinkgi succeeds in aptly displaying all supply chain processes involved in immediate disaster response activities, his scope does not include the longer term, rather reconstructive and supportive humanitarian operations.

[300] Source: Adopted from Tufinkgi (2006).
[301] Cf. Tufinkgi (2006), p. 205.

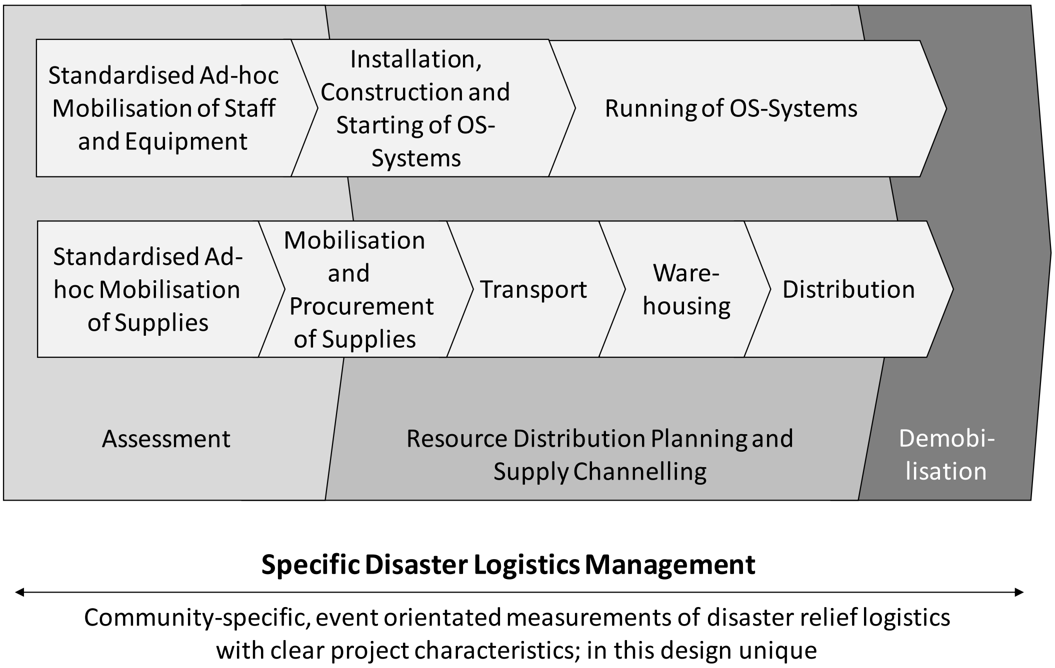

Figure 34: Tufinkgi (2006): Specific Disaster Logistics Management[302]

4.4.4.2 McGuire (2006)

McGuire (2006) presents a supply chain management framework with a dedicated focus on humanitarian logistics. McGuire develops a supply chain management framework for health care goods provided as humanitarian assistance in complex political emergencies which intends to enable humanitarian organisations to improve the effectiveness and efficiency of their operations. McGuire’s analysis of humanitarian assistance identifies and structures a multitude of objectives towards different groups which are relevant for logistics and supply chain management. Based on this analysis, McGuire postulates ten logistics and supply chain management objectives which are summarised into cost, risk, and reduction of suffering in order to further elaborate on the trade-offs between them. In order to answer questions about how humanitarian organisations can manage the supply chain for health care goods in complex political emergencies, McGuire’s research is placed in Thorn’s hierarchical planning framework (cf. Figure 35).[303] Thorn’s framework is extended by the aspects of time, distance and criticality. The time aspect of McGuire’s framework covers emergency, rehabilitation and reconstruction as well as the development phase. The distance from the conflict areas determines the level of safety and security risks. Criticality refers to items and their importance and associated detrimental consequences of shortages and stock outs. The resulting framework establishes a basis for developing strategies at all management levels and for each echelon in the humanitarian supply chain within the aspects of time, distance and criticality.

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302 Source: Adopted from Tufinkgi (2006).

303 Cf. Thorn (2002) and McGuire (2006), p. 14, pp. 70-71. Thorn’s process production has been removed “as humanitarian organizations generally are not concerned with manufacturing and production”. Furthermore, the “process of distribution is differentiated into storage and transport, which may be carried out a several tiers of the supply network, and the process of providing customer service is maintained”.

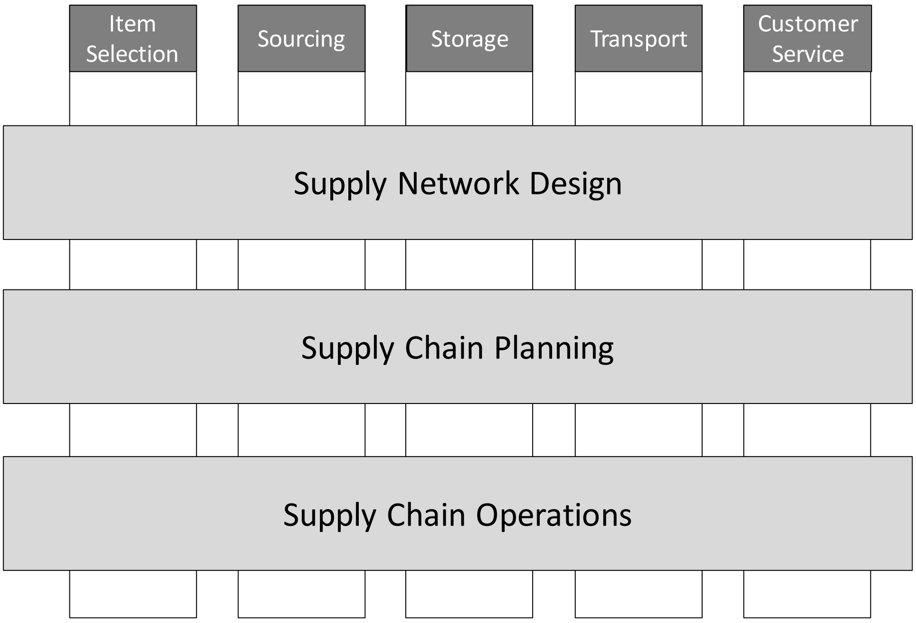

Figure 35: McGuire (2006): SCM framework for health care goods

McGuire (2006) focuses on strategic issues and commercial procedures of humanitarian health care logistics in complex political emergencies. The framework provided by McGuire focuses on supply chain design and planning of health care goods delivered as humanitarian assistance. It does not reflect on the operational tasks and processes necessary to carry out general humanitarian operations. While his framework covers a considerable range of strategies for designing and planning the humanitarian supply chain through transfer of principles and methods of commercial supply chain management by heuristics and reasoning, it lacks a dedicated focus on logistics processes, especially operational processes. On the level of supply chain operations, McGuire only discusses selected issues which are of particular importance for supply chain operations of health care goods in humanitarian assistance. Moreover, the framework is solely based on a literature analysis and thus lacks direct insight from humanitarian organisations.

4.4.4.3 The Sphere Project (2004)

The Sphere Project "Humanitarian Charter and Minimum Standards in Disaster Response" was launched in 1997 to develop a set of universal minimum standards in core areas of humanitarian assistance. The aim of The Sphere Project is to improve the quality of assistance provided to people affected by disasters, and to enhance the accountability of the humanitarian system in disaster response. The guidelines, indicators and best practices developed in The Sphere Project are the product of the collective experience of a large number of experts from different agencies.[304]

The Sphere Project defines best practices and indicators for the following five sectors: water supply and sanitation, nutrition, food aid, shelter and site planning, and health

[304] The Sphere Project (2004), p. 2.

services. Each chapter in The Sphere Project (2004) provides indicators, guidance notes and contextual information which are necessary to interpret and apply the standards. Each chapter also contains a brief introduction highlighting the major issues relevant to that sector. The standards are based on the humanitarian principles and are intended for universal application, i.e. in any kind of humanitarian operation. The key indicators are of qualitative and quantitative nature.

The following areas are addressed within the five sectors:

- Minimum standards in water supply, sanitation and hygiene promotion: Hygiene Promotion, Water Supply, Excreta Disposal, Vector Control, Solid Waste Management, and Drainage.
- Minimum standards in food security, nutrition and food aid: Food Security and Nutrition Assessment and Analysis standards, Food Security standards, Nutrition standards, and Food Aid standards.
- Minimum standards in shelter, settlement and non-food items: Shelter and Settlement, and Non-Food Items: Clothing, Bedding and Household Items.
- Minimum standards in health services: Health Systems and Infrastructure, Control of Communicable Diseases, and Control of Non-Communicable Diseases.

The Sphere Project also addresses some transversal issues which are relevant to each of the preceding technical aspects. Namely, these are participation, initial assessment, response, targeting, monitoring, evaluation, aid worker competencies and responsibilities, and supervision, management and support of personnel.

The Sphere Project recognizes that "there are different approaches among humanitarian agencies as to how to carry out relief activities, based on differences in identities, mandates and capabilities. These differences point to the concept of complementarity, which means that humanitarian agencies use different modes of action or techniques in fulfilling their responsibility to provide assistance. In all contexts, disaster response should support and/or complement existing government services in terms of structure, design and long-term sustainability."[305]

The Sphere standards and indicators were developed using a large number of experts, mainly practitioners, in each of the sectors. The standards and indicators as such are not new but rather an attempt to consolidate and adapt existing knowledge. The Sphere Project (2004) suggests a variety of indicators and structures the various domains of humanitarian operations. Although issues of supply chain management are included, it does not focus specifically on humanitarian logistics or supply chain management issues. It mainly elaborates outcomes and performance indicators of humanitarian operations but does not detail the processes and tasks necessary to plan and implement these operations.

[305] The Sphere Project (2004), p. 7.

4.4.4.4 Model Fragments

This section presents some recent modelling approaches for humanitarian supply chains. While these approaches remain fragmented, they point out important aspects with respect to the development of an overall task model for humanitarian supply chain processes.[306]

Pettit and Beresford (2005) remark that humanitarian operations can have vastly differing scopes and objectives. Under humanitarian operations disaster, emergency and crisis situations are comprised as well as long-term relief, famine and resettlement activities, as well as rehabilitation and development programmes. Two observations can be made with respect to this variety of operational foci: Firstly, logistics tasks are not restricted to emergency relief but become a long-term need. Secondly, despite this variety and the fact that each crisis is unique in its detail, most humanitarian operations exhibit at least some similarities in the logistical response.[307]

Oloruntoba and Gray (2006) present a very simple model of a typical humanitarian supply chain (Figure 36). They display a direct flow from a government donor via international agencies, international NGOs, local NGOs, and community-based organisations to the aid recipients. Oloruntoba and Gray (2006) observe that there is no single form of a humanitarian supply chain. Yet, the authors identify common characteristics of the humanitarian supply chain such as the instability of demand, frequent breakdowns at the receiving end as well as instabilities at the origin due to political blocks and the competitive nature of fundraising.[308] Oloruntoba and Gray (2006) do not elaborate which flow they are portraying (most likely the material flow); furthermore, informational aspects or the variety of possible supply chain structures are not adequately reflected in their model.

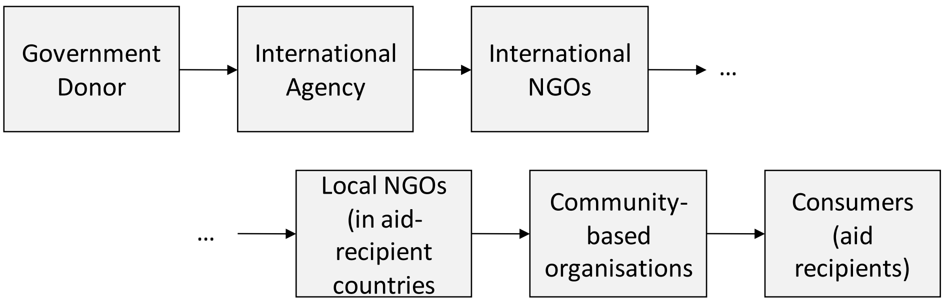

Figure 36: Oloruntoba and Gray (2006): Humanitarian supply chains[309]

Thomas (2003a) has a more process and task oriented point of view which has had influence on several other authors.[310] Thomas does not specifically distinguish between

[306] A good overview over academic contributions to humanitarian logistics with a focus on categorising contributions according to the perspective they take on the supply chain is given by Kovács and Spens (2008).
[307] Cf. Pettit and Beresford (2005), p. 316, p. 325.
[308] Cf. Oloruntoba and Gray (2006), p. 115.
[309] Source: Adopted from Oloruntoba and Gray (2006).
[310] Cf. also Thomas (2003b).

the different flows in the humanitarian supply chain but rather separates the different categories of activities associated with humanitarian logistics. These categories are shown in Figure 37: Preparedness, Assessment/Appeal, Resource Mobilization, Procurement, Transportation Execution, Tracking & Tracing, Stock/Asset Management, Extended Point of Delivery, and Performance Evaluation. While not specifically designed to portray the material flow in the humanitarian supply chain, the material flow is actually quite well-represented in this model. Starting with the procurement phase (or sometimes even the production phase), goods are transported via international and local distributors. Tracking & Tracing as well as stock management accompany these activities. Local distribution to the projects and eventually to the beneficiaries is the sink of the material flow. Thomas (2003a) does not give details on the tasks comprised within these categories and remains on a very abstract level with her description of the humanitarian supply chain. Furthermore, the model is not specifically designed to describe the supply chain processes of humanitarian operations.

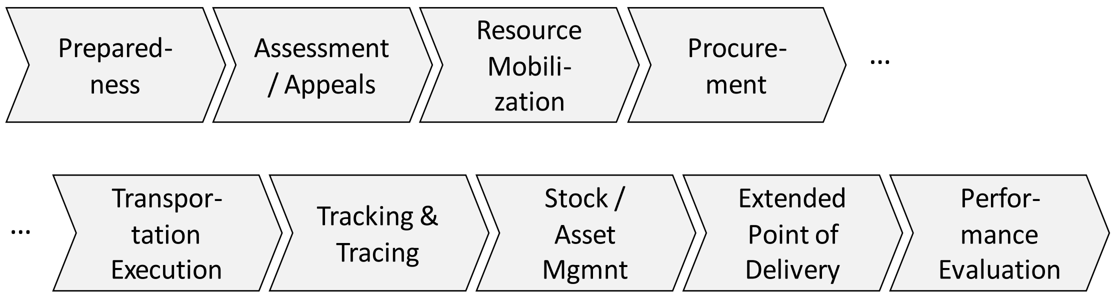

Figure 37: Thomas (2003a): Supply chain activities during humanitarian relief

Thomas and Kopczak (2005) show the complex funding flows in the humanitarian supply chain and include some aspects of the material flow without explicitly displaying them.

Kovács and Spens (2007) have a different focus when describing their logistics framework for disaster relief. Their super ordinate model separates between three phases: Preparation, Response, and Reconstruction. In detail, they focus on the difference between a regional perspective and an extra-regional perspective. The authors point out how different actions are taken on different levels and how these actions correspond to each other. Their depiction can help in supporting collaboration in the planning, response and reconstruction phases but does not deliver an overview over the material, information or financial flows in the supply chain.

Kovács and Spens (2008) still distinguish the three phases of humanitarian relief, i.e. Preparation, Response and Recovery. They extend their original model with additional actors in the humanitarian supply chain and present the most recent advances in general research on humanitarian logistics issues. In Kovács and Spens (2008) it is clearly shown that research on the humanitarian supply chain remains fragmented. The distinction of the phases is not always possible due to the emergence of complex crises that combine elements of reconstruction and immediate response.[311]

Research on humanitarian logistics issues also includes organisation-internal issues such as the training of humanitarian logisticians, particular logistics activities such as purchasing, specific processes such as needs assessment, the concept of leanness or the construction of frameworks for humanitarian logistics. Yet, while Tomasini and van Wassenhove (2004) and van Wassenhove (2006) present frameworks for humanitarian logistics, there is a lack of detailed models or descriptions of processes in the humanitarian supply chain.

Table 6 displays a synthesis of current contributions with a dedicated focus on humanitarian supply chains. Only the two phases immediate response and recovery/reconstruction are distinguished here instead of the traditional three phases distinguished in humanitarian operations. Listed contributions either present models on humanitarian logistics or humanitarian supply chains or deliver starting points for the construction of a comprehensive reference model for supply chain tasks in humanitarian operations. Beyond the contributions listed below, there is a large number of case studies which have been excluded from the literature analysis due to their lack of independence from specific organisations or specific types of humanitarian operations.

Table 6: Humanitarian logistics models / reference model fragments

Immediate Response	Recovery/Reconstruction
Blecken et al. (2009b), Tufinkgi (2006), McGuire (2006), Oloruntoba and Gray (2006), Thomas (2003a), Thomas and Kopczak (2005), Kovács and Spens (2007), Kovács and Spens (2008), van Wassenhove (2006), Tomasini and van Wassenhove (2004), Beamon (2004), Beamon and Kotleba (2006), Grant (2007), Gustavsson (2003), Jahre et al. (2007), Long (1997), Tatham and Kovács (2007), Pettit and Beresford (2005)	Blecken et al. (2009b), McGuire (2006), Oloruntoba and Gray (2006), Kovács and Spens (2007), Kovács and Spens (2008), van Wassenhove (2006), Jahre et al. (2007), Pettit and Taylor (2007), Pettit and Beresford (2005)

4.5 Summary and Conclusions

In this chapter state-of-the-art solutions with relevance to the research problem and the research objectives have been examined for their applicability and transferability to the research problem at hand.

[311] Cf. Kovács and Spens (2008), p. 222.

The Guidelines of Modelling give general guidance on the construction of models and specifically reference models. A number of modelling techniques were assessed for their suitability to the creation of process reference models. While there were a number of suitable candidates, BPMN proved to be the most promising among these. BPMN was created specifically to suffice the requirements from process modelling projects, is an inter-sectoral standard which is widely used and the specification is further developed by the Object Management Group, an organisation experienced with standard developments.

Supply chain management frameworks have been presented and evaluated. Among these, the framework by Fleischmann et al. (2005) is assessed to provide the best basis for the development of a framework for a reference task model for supply chain processes of humanitarian organisations. Further input directly from the application domain with respect to the framework can be drawn mainly from the SCM framework for health care goods by McGuire (2006) and partially from the disaster logistics management framework by Tufinkgi (2006).

A broad review of general reference models and reference models with a specific focus on either supply chain tasks and processes or the humanitarian domain has been carried out. From the examined reference models, input for a reference task model for supply chain processes of humanitarian organisations can mainly be retrieved from the SCOR model which sets an industry-overarching standard when it comes to supply chain operations.

The separation between generic disaster logistics management and specific disaster logistics management, i.e. the separation of disaster management phases with strategic, generic and continuously conducted measures unspecific to a disaster on the one hand and measures triggered by a concrete disaster with directed focus on an affected community on the other hand can be adopted from Tufinkgi (2006). Therefore, the reference task model will employ a classification or type scheme which indicates whether a task is of a “generic” or “specific” type.

Furthermore, through the empirical survey, the contact with many humanitarian organisations and the interviews conducted (cf. Section 2.2), a large body of expert knowledge and technical supply chain management documents were retrieved. These documents were screened for best practices and contents of these documents and interviews implicitly influenced the development of the reference task model.

5 Work Packages

Caminante no hay camino,
se hace camino al andar.

Antonio Machado

The analysis of the current state-of-the-art of research on humanitarian logistics and supply chain management issues (Chapters 2 and 3) and the corresponding mapping to available solutions (Chapter 4) reveals gaps, which are addressed in this thesis. A supply chain task model needs to be developed, which can serve as reference model for the construction of supply chain processes in of humanitarian organisations. The task model can then serve as the basis for evaluating existing SCM systems for humanitarian operations and for identification of research and development needs of these systems. The specific work packages that need to be carried out in order to achieve the research objectives are presented in the following.

5.1 Reference Task Model for Humanitarian Operations

None of the examined reference models prove to fully suffice the research objectives. Thus, a reference task model describing the tasks and activities in the humanitarian supply chain needs to be constructed. Besides adhering to the general Guidelines of Modelling as presented in Section 4.1, the reference task model has to fulfil certain other requirements, which will be elaborated in the following.

Generality: The reference model for supply chain processes will not accommodate for all possible requirements of all individual users. In order to reduce complexity, only those processes will be incorporated in the reference model, which have general validity for an entire class of application contexts, i.e. which are generally part of the humanitarian supply chain. Since reference models are intended to have universal validity – or at least universal validity for a limited and clearly defined scope with respect to content and time – and taking into account their possibly vast application by a number of application system or organisation developers, it is necessary to clearly define standards concerning names, classifiers, process steps, and other model elements.

Obviously, reference models should exhibit a high degree of generality in order to accommodate for a large number of possible users. Generality can mainly be achieved through the manipulation of two parameters: Abstraction and variant coverage range. If the level of abstraction is chosen to be high, i.e. the level of detail is severely restricted, the reference model will be usable by a large number of users. On the other hand, by limiting the level of detail, the possible usages of the reference model will be impeded up to the point where no specific advice can be generated from the model. Another parameter influencing the generality of a reference model is linked to the number and coverage range of variants. Variants in reference information models are characterised by alternative structures or processes[312] and are essential to reflect the divergent requirements by model users. Examples of such divergent requirements include procurement type (consumption-driven or demand-driven), production type (flow production, job shop production) and various others.[313] Variant coverage range denotes how many potential variants of a specific field of observation can be covered by a reference model. A wide range of covered variants improves the generality and applicability of the reference model, but also increases its complexity and (construction) cost.

Reusability: Reusability is a central requirement for any reference model. Reference models are reusable if the quality of the reference model is sufficient, both in terms of content and modelling technique from the perspective of the model users. Both of these requirements are captured in the Guidelines of Modelling: A reference model is of high quality in terms of content if it suffices the principles of construction adequacy and/or the principle of relevance. A model is of high quality in terms of modelling technique if intra-consistency of the model is guaranteed, if the principle of minimalism is respected and the principles of clarity and systematic-design as well as the principle of language-adequacy are preserved.

Modularity: Modularity is a term originating from software engineering. There, a module denotes a closed software block, which offers services via clearly defined interfaces.[314] In reference modelling, the requirement of modularity is fulfilled if a model consists of modules describing closed issues, which can be connected via predetermined interfaces. If a reference model fulfils the requirement of modularity, reusability is also supported since the reuse of one module for an organisation-specific model is evidently easier than the reuse of the entire model. Modularity also supports comprehensibility of the model due to distinctions of fields of observations and thus enabling the user to grasp the model in small and separated pieces. As Klingebiel and Seidel (2007) put this: "To allow for the adaptation and reuse in as many as possible

[312] Cf. Jacobson et al. (1997), pp. 124-130.
[313] Cf. Schwegmann (1999), p. 68.
[314] Cf. Balzert (2001).

cases, it is useful to represent the reference model in a modular structure. This serves more than just the purpose of easily generating application models. Reference models always represent subjective know-how of the application domain. Therefore, if a reference model is used by an individual outside the group of creators it may be necessary to expand or modify the reference model."[315] Concisely defined tasks, clearly defined boundaries, and a high degree of cohesion support the modularity of reference models.

Adaptability: Humanitarian operations range from short-term relief in response to sudden and slow-onset disasters (emergencies) to sustained efforts in complex and chronic crises (post-emergencies). Jahre and Heigh (2008) distinguish a third type of operational focus in humanitarian logistics, viz. the project supply chain: "Usually set up in the recovery phase of a disaster or to develop some resources in preparation for a possible event, the project supply chain is essentially a locally managed set of resources that provide a service similar to that of a commercial service provider, against which costs are recovered. This supply chain is generally predictable and stable, but requires local presence and market understanding of the integrating company."[316] Evidently, the range of possible supply chain structures and logistics processes varies considerably. Thus, the adaptability of the reference model or more specifically the organisation-specific models derived from the reference model becomes crucial for enabling efficient and effective modifications. A high degree of adaptability is guaranteed if the structure of the model and the modelling language have been chosen such that these modifications are supported. Adaptability is coupled with modularity: Modular reference models are more easily adapted than monolithic models, since parts of the model can be altered, deleted, replaced, expanded or modified without inflicting changes on the remainder of the model. Finally, adaptability is also a contributor to reusability.[317]

Another overarching requirement for any reference model is simplicity. The challenge here is to strike a balance between the principle of economic efficiency, the principle of construction adequacy, and the principle of clarity. The objective is to construct a model that is sufficient to reach the goals of reference models, but is not too detailed and thus counters the design goals generality, modularity, and comprehensibility.[318]

5.2 Formalisation of BPMN

In the previous chapter, a range of modelling techniques for business process and reference modelling was examined. While some of the modelling techniques present well-balanced, flexible and effective means for building process models, none of these suffice all requirements completely. The Business Process Modelling Notation was evaluated as both the most advanced and most suited modelling technique for achieving the research objectives. However, BPMN also suffers some shortcomings, which need

[315] Klingebiel and Seidel (2007), p. 6.
[316] Jahre and Heigh (2008), p. 270.
[317] Biggerstaff and Richter (1989), p. 7.
[318] Cf. also Oestereich et al. (2003), p. vii.

to be overcome. Although BPMN is standardised and specifications exist, these are not always precise. For instance, the interpretation of inclusive gateways is ambiguous and it remains unclear when data objects come to life or when they cease to exist. When building BPMN models, the modeller has a number of options for modelling alternatives. Thus, models using BPMN are generally not biunique. In order to support the objective of visualisation and standardisation, this issue needs to be addressed. During the construction of the reference task model, an algebraic specification for BPMN is developed, which allows refining a core set of BPMN elements into a biunique language. Although this is not a mandatory requirement for process models, biuniqueness becomes obligatory when constructing reference models. The reference model can thus be implemented in an information system and the generation of organisation-specific models is supported. The algebraic specification will be supported by a meta model for BPMN, which describes the syntactic relationships between the core elements of the language.

5.3 SCM Systems for Humanitarian Organisations

The reference task model for supply chain processes of humanitarian organisations serves to visualise logistics and supply chain management tasks of the different actors in the supply chains of humanitarian organisations. A focus is laid on operational and transactional activities in order to be able to construct reference supply chain processes in a formal language. The created reference model can be applied to model organisation-specific processes in humanitarian supply chains. It has been stated before that process models in general serve to improve transparency and accountability requirements towards an organisation's stakeholders and offers opportunities for monitoring performance indicators. These benefits are enabled by the implementation of SCM IT systems. Simon (2001) remarks that the "wedding of information technology and logistics is key to the effective management of a dynamic supply chain" such as disaster relief and humanitarian supply chains.[319] Due to the nature of humanitarian operations and the specific challenges of humanitarian logistics, the requirements for SCM and logistics systems to support humanitarian operations are unique. A requirements profile will need to be developed, which can be used as an assessment tool for existing SCM systems. Based on the requirements profile and the assessment of available systems, gaps can be identified to guide future development of SCM systems to support humanitarian operations.

[319] Simon (2001), p. 66.

6 Construction of a Reference Task Model

Table 7: Two examples of humanitarian supply chain management

In 1998 Hurricane Mitch hit a number of Central American Countries. The International Federation of the Red Cross launched a humanitarian assistance mission. *"During that emergency, it [the IFRC] had failed to coordinate the relief contributions of the donating National Societies; its technical staff and relief delegates had arrived on the disaster scene far too late; its specialised equipment was only deployed at the eleventh hour; and basic supplies took weeks to mobilise and distribute to the population."*[320]	In January 2001, an earthquake of magnitude 7.9 on the Richter scale hit the area of Gujarat in western India and eastern Pakistan. *"The arrival of a Field Assessment Coordination Team 48 hours after the disaster helped gauge relief requirements and develop plans for resource mobilisation. The quick deployment of the Emergency Response Units allowed relief activities to be swiftly kicked off. […] [T]he commodity tracking system helped mobilise, organise and coordinate the arrival of relief supplies. […] [F]inally the frame agreements with key suppliers ensured the quality of relief items and their prompt delivery at competitive prices. Three days after the Gujarat earthquake, IFRC's response plan was already in full swing."*[321]

The objective of this chapter is to develop a reference task model which can be used to construct supply chain processes of humanitarian organisations. This reference model is developed according to a formalised construction methodology (6.1). A framework for the reference task model which separates a strategic, tactical and operational level is presented (6.2). The reference model addresses tasks in these levels and further distinguishes the tasks according to their function. While all levels are addressed, emphasis is put on supply chain operations and transactions. The reference task model incorporates both tasks in emergency and post-emergency settings and enables the visualisation and

[320] Bernhard Chomilier, Director of the Logistics and Resource Mobilisation Department at IFRC in Chomilier et al. (2003), p. 18.
[321] Bernhard Chomilier, Director of the Logistics and Resource Mobilisation Department at IFRC in Chomilier et al. (2003), p. 18.

analysis of supply chain processes and their interdependencies. Thus, it contributes to a standardisation and better communication of roles and responsibilities of organisations involved in humanitarian operations. The task model is presented (6.3) and subsequently employed to construct various processes in humanitarian supply chains in a formalised business process modelling language (6.5 and 6.6). An outlook on military supply chains concludes this chapter (6.7).

6.1 Methodology of Reference Model Construction

Reference models are always constructed both inductively from existing models and practical experience and deductively from theoretical insight.[322] Since the term "reference" etymologically implies a recommendation, reference models in business computing have been used to formulate recommendations for the design or development of other models. Thus, the reference model constructed here will present the basis for the development of organisation-specific to-be models for humanitarian organisations. Case examples will be used in order to show the applicability of the model.

The development of the reference model follows the procedure model for the construction of reference models presented by Schütte (1998) and further elaborated by Becker et al. (1997) and Becker et al. (1999). Some authors claim that the quality of the construction process of the reference model is in fact more important than the model quality itself.[323] Further additions to Schütte's model by Knackstedt (2006) and Delfmann (2006) have been integrated here where the additions improved the quality of the construction process.

The construction of a reference model according to Schütte and hence, the reference model developed here, includes five phases: Problem definition, construction of reference model framework, construction of reference model structure, completion of reference model and application of reference model (cf. Figure 38). All phases are characterised by a continuous monitoring and validation of the modelling outcomes, such that corrections can be incorporated through feedback loops.[324] In Figure 38, the arrows represent the phases of the reference model construction while the boxes contain the outcomes of the specific phases. In the following, it will be elaborated how and where the different phases in the construction process by Schütte have been tackled here.

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[322] Cf. Rosemann and Schütte (1997), pp. 16-17.
[323] Cf. Schütte (1998), p. 184; de Molière (1984), pp. 71-72.
[324] Cf. Schütte (1998), p. 187.

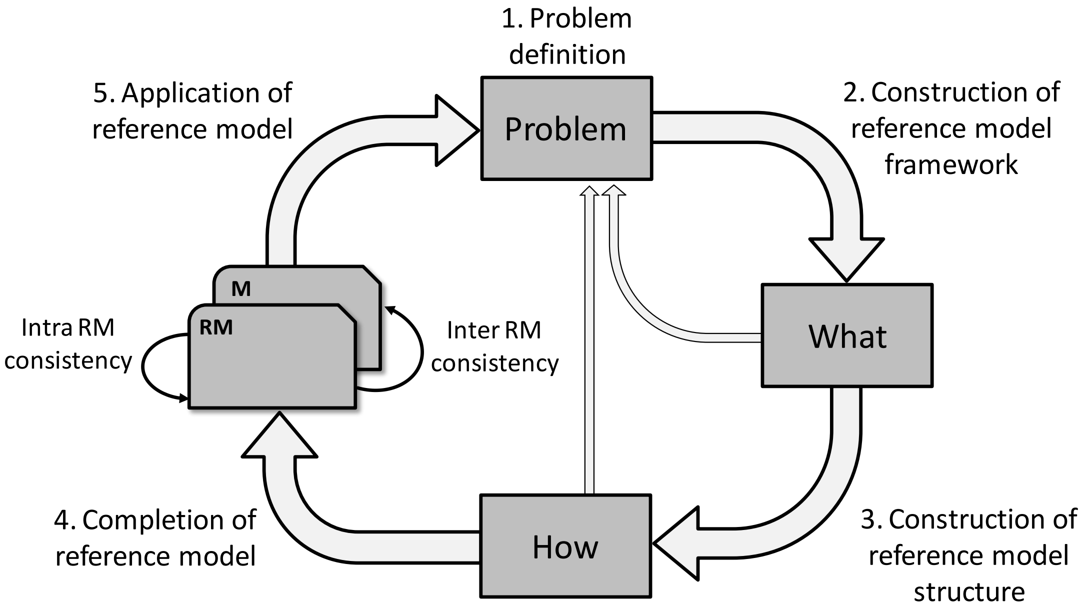

Figure 38: Construction of reference models[325]

In the first step, the problem statement has the objective to clearly define the problem tackled, i.e. the problem for which recommendations or solutions are to be derived, in order to mitigate the design of a model which offers a solution for a problem which is irrelevant from the point of view of the potential model user. It needs to be concisely stated which problems of the application domain the reference model is geared towards. Schütte (1998) suggests that surveys amongst potential model users can help to verify that the problem tackled does exist in practice.[326] Hence, experts on the subject and empirical data have been integrated in the modelling process. The problem definition should also include a description of the application domain. Reference models claim to offer decision support and solution patterns for entire classes of problems. These classes of problems frequently translate into specific industries, viz. in the case at hand to supply chain processes of humanitarian organisations. This phase has been addressed in Chapters 2 and Sections 3.5 and 3.6 and especially through the integration of the survey results and the integration of expert knowledge and supply chain management documentation of specific humanitarian organisations.

Based on the problem definition, a top-down approach is recommended, i.e. a rough overall model has to be drafted and successively detailed. The overall model is usually constructed deductively based on existing knowledge from related scientific disciplines and the detailed knowledge of the modeller.[327] Thus, Delfmann (2006) recommends that existing reference models should be checked whether they suffice the semantical requirements and thus if they can be partially reused.[328] This recommendation is also in line with the principle of economic efficiency. For the development of the reference

[325] Source: Based on Schütte (1998), p. 185.
[326] Cf. Schütte (1998), pp. 184-187.
[327] Cf. Erzen (2001), p. 46.
[328] Cf. Delfmann (2006), p. 212.

model at hand, existing reference models have been analysed extensively in Sections 4.3 and 4.4 and opportunities for reuse have been detailed there and in Section 4.5.

Becker et al. (1997) recommend that the model is checked and inductively refined parallel to its construction. This has been addressed in the construction of this reference model by continuously publishing partial results of the model and presentation of those results at academic and practitioner conferences.[329] The advantage of this approach was that a framework has been created within which the details of the reference model could be embedded.

In the second phase of the reference model construction, a framework ought to be created. The framework has the objective to ensure that the reference model is comprehensible on a high level of abstraction for all possible user groups. The framework also ought to serve as the basic building block for further modelling; the levels of detail are to be defined. The framework ought to give guidance to reference model users for navigation in the model and among the various reference model layers. The reference model framework can be considered a partial reference model for an entire class of problems. Schütte (1998) suggests process object selection matrices as an outcome of this phase. Delfmann (2006) on the other hand suggests using generic frameworks such as the reference design proposed by Meise (2001). While the generic framework by Meise (2001) is in principle applicable here, it is situated on a level too abstract to provide appropriate insight. Potential frameworks have been analysed in Section 4.3 and opportunities for reuse and transfer have been discussed in the respective subsections and in Section 4.5. A suitable framework for the reference task model for supply chain processes of humanitarian organisations will be developed in Section 6.2.

The third phase according to Schütte (1998) is the creation of the reference model structure. The reference model structure contains the choice of a suitable layer of abstraction, the identification of structural analogies, the modelling of the internal process object structure and the construction of a reference data model. During this phase, process reference models and data reference models are created and the relations between them are defined. The presentation of process reference models and data reference models is achieved through the use of a formal language. The third phase of the reference model construction according to Schütte (1998) has been partially omitted during the construction of the reference task model.[330] The basis for the layer of abstraction has been set in the reference model framework and is further detailed in the following phase. Structural analogies are already incorporated in the framework. Since a data model is not contained within the scope of development of the reference task model, the other objectives of this phase do not apply.

The fourth phase, reference model completion, completes the modelling process. External (inter-reference model) and internal (intra-reference model) relations are defined and

[329] Cf. Blecken and Hellingrath (2007), Blecken et al. (2008a), Blecken et al. (2009b), Blecken (2009).

[330] This phase is also not included in the construction procedure of reference models according to Delfmann (2006) who combines the phases of construction of reference model framework and structure into one phase.

consistency needs to be assured. Specific care must be given when formulating the inter-object relations. Criteria and parameters, which can ultimately be used to configure the reference model, are formulated in a formal language. Schütte (1998) also suggests completing the reference model by adding quantitative information which can be used as a reference point for benchmarking. Alternatives and concrete recommendations can be formulated here. The parallel check and continuous verification of the results ensures the acceptance of the reference model and should be carried out by potential model users. During the fourth phase, the design of the reference model is completed. This phase of Schütte's procedure model will be tackled in Section 6.3 in which the tasks of the reference model are described. The outcomes of this phase are presented in detail in Appendix F and Appendix G.

The fifth phase is the application of the reference model. In literature, the model design phase is attributed more importance than the model application. However, as regards generally applicable models, the application phase is crucial in order to ensure that these models deliver efficient solutions to problems of the application domain. Construction phases and application phase of reference models ought to integrate seamlessly in such a way that case examples can be used to further detail and possibly extend the model.[331] Therefore, the reference task model is applied in Sections 6.5 to create exemplary reference processes and in Section 6.6 in a case example of a humanitarian organisation which conducts humanitarian operations in an immediate disaster-relief setting.

6.2 Reference Model Framework

The reference model framework serves to guide the navigation through the reference model and supports comprehensibility and applicability of the model. The framework distinguishes two dimensions, viz. hierarchical decomposition and structural decomposition, which will be introduced in the following. The hierarchical decomposition distinguishes a strategic, tactical, and operational level. The structural decomposition consists of assessment, procurement, warehousing, and transport. Next to these main functions of humanitarian organisations, a vertical and a horizontal support function is identified in the form of reporting and operations support (Figure 39). The reference model framework also includes actors in the humanitarian supply chain which are required in order to assign roles to each task. The framework will be elaborated in the following sections.

[331] Cf. Schütte (1998), p. 188.

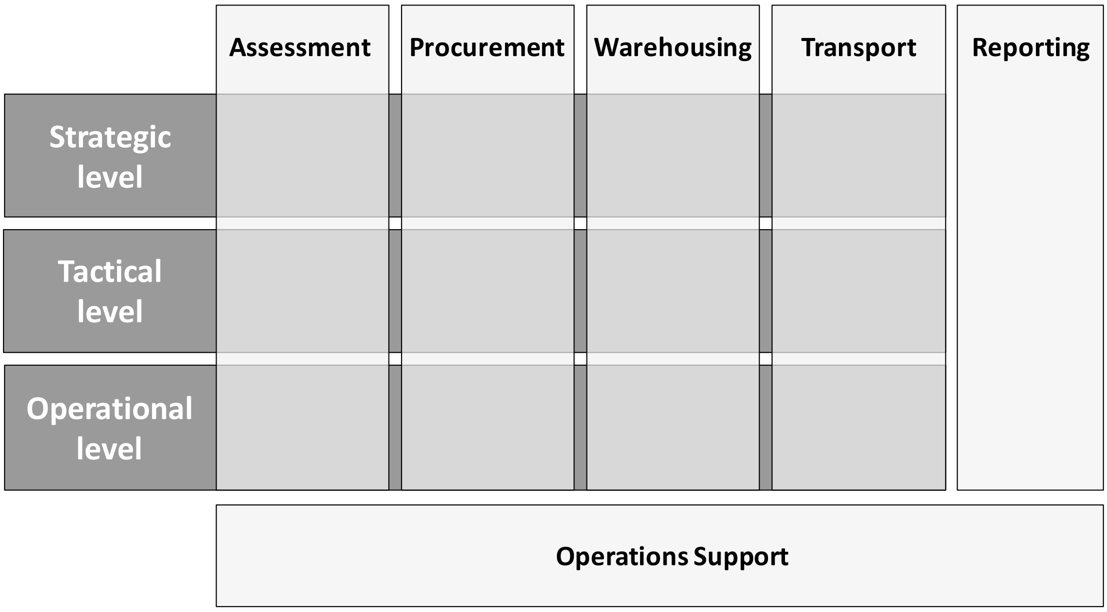

Figure 39: Reference model framework

6.2.1 Supply Chain Management Tasks (Planning Horizon)

6.2.1.1 Strategic Level

Strategic tasks in supply chain management mainly involve tasks associated with supply chain design. Supply chain design covers a strategic time horizon (beyond 2 years) and includes decisions on the structure of the supply chain over the coming years;[332] here it is decided what the supply chain configuration will look like, how resources will be allocated and what processes each tier in the supply chain will perform. Also, decisions regarding the dimension of facilities and transport relations on the basis of forecasted demand are taken. It is decided which products are to be manufactured at which facilities as well as the structure and technology of information systems to be used in the supply chain. In this phase it is important that organisations align the supply chain configuration with their strategic objectives. Decisions made in this phase must take the strategic time horizon into account and cannot, or only at a high cost, be altered during a short time frame.

6.2.1.2 Tactical Level

The tactical level covers a tactical time horizon (between 6 months and 2 years[333]) and comprises all tasks which are necessary in order to optimise an organisation or the entire supply chain. The configuration of the supply chain has already been fixed and

[332] All time horizons for supply chain management defined in the following are dependent on the specific sector. Time horizons as denoted here mirror average figures which can be found frequently. While the strategic and tactical time horizons of supply chain management in the context of humanitarian operations coincides with these, the operational time horizon can be considerably shorter here. Time horizons for operational decisions with respect to supply chain management can be as short as hours or days and would only infrequently extend to the commonly suggested upper boundary of six months.
[333] Cf. Footnote 332.

constraints and restrictions which are derived from the strategic level need to be incorporated into the tactical planning. Thus, the restrictions within which the supply chain will have to operate over a specified period of time are established here. Tactical supply chain planning is normally done in the following sequence: Identification and analysis of the decision problem, definition of objectives, forecast of future developments, identification and evaluation of solution alternatives, and selection of the most suitable solution.[334] Supply chain planning decisions include forecasting demand in different markets, which markets will be supplied from which locations, which inventory policies will be followed, and the timing and size of marketing promotions.[335] One of the results of the tactical planning phase is the definition of operating policies that govern short-term operations.

6.2.1.3 Operational Level

The main objective of decisions taken and tasks executed on the operational level is to optimise the use of resources allocated by decisions taken on the super ordinate tactical and strategic levels. The operational level covers an operational time horizon (up to 6 months[336]) and mainly comprises tasks of the supply chain execution phase in which supply chain configuration as well as planning decisions are assumed to be fixed. The objective of supply chain execution is now to optimise customer response by handling a customer request in the best possible manner. Decisions during the execution phase include allocation of inventory to an individual customer order, timely order fulfilment, delivery and production scheduling, and placing replenishment orders. A clear distinction between the operational and tactical planning levels is not always possible and activities can sometimes be associated with either planning or execution. One interesting way to visualise the difference between operational and tactical planning is given by Zäpfel and Piekarz (1996) who paraphrase planning with “decision-making” and execution with “decision implementation”[337].

6.2.2 Supply Chain Management Tasks (Functional Division)

6.2.2.1 Assessment

Assessment[338] has the objective to both quickly and accurately ascertain the needs of an affected community, i.e. the beneficiaries, including quantitative information on crisis area and population, and derive the logistical implications for the planned or currently executed humanitarian operation. It is the objective of the assessment phase to deliver a decision basis, i.e. the information necessary to decide whether or not a humanitarian operation is begun, i.e. whether it is necessary and feasible to start, continue or close an operation, to define the priorities of an operation, to plan the implementation of these

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[334] Cf. Hellingrath (2008), Hellingrath and ten Hompel (2007).
[335] Cf. Chopra and Meindl (2004), p. 7.
[336] Cf. Footnote 332.
[337] Cf. Zäpfel and Piekarz (1996), p. 27.
[338] Alternative terms used are “Needs assessment” or “Field assessment”.

priorities, and to pass on information to the international community, donors and other actors present in the crisis. Assessment is not done uniquely at the beginning of an operation but rather conducted continuously during the entire life-cycle of the operation.

In the emergency phase, an assessment team with expertise amongst others in logistics and supply chain management carries out the needs assessment. In the post-emergency phase, this is done by field logisticians. A case example for a typical field assessment is presented in the following:

Table 8: Case example "Field Assessment"[339]

Case example "Field Assessment"	The initial relief effort was chaotic. Too many aid workers showed up in some areas, while other places remained underserved. But when I arrived a month later […] the aid effort had already become more organized – in part because of the use of technology. […] There [in the UNOCHA office] I collected GIS maps that depicted the disaster zone at different scales, from the regional down to the village level. The maps were accompanied by various spreadsheets that compiled the number of displaced, injured, dead and missing persons; coverage areas for various aid groups; the location of hospitals, clinics and pharmacies; and the most common potential disease outbreaks in each area.

According to The Sphere Project (2004) needs assessments "provide an understanding of the disaster situation and a clear analysis of threats to life, dignity, health and livelihoods to determine, in consultation with the relevant authorities, whether an external response is required and, if so, the nature of the response."[340] Thus, the tasks of supply chain management during the needs assessment are to enhance supply chain responsiveness in the emergency phase and cost-efficiency in the post-emergency phase through effective and efficient information technology integration and appropriate mechanisms at the local and regional level. The objective of the continuous needs assessment during the post-emergency phase is to be able to adapt swiftly to possibly changing beneficiaries' needs.

Field assessment includes a status quo analysis of the situation and a comparison to a desired situation given certain indicators such as morbidity and mortality. The initial assessment usually has to be carried out under high time pressure and with a nearly zero lead time requirement. The quality of the initial assessment in the emergency phase already has to meet certain quality thresholds due to the behavioural characteristics of non-linear dynamic systems. Field assessment also needs to deliver information on actors present in the crisis, their specific agendas, resources, capacities and relations. The requirements for the information quality are high even during an early emergency phase but increase still in the post-emergency phase.

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[339] Source: Fink (2007), p. 74.
[340] The Sphere Project (2004), p. 29.

Ongoing field assessments are carried out during the post-emergency phase. Before the assessment is carried out, certain decisions need to be taken concerning the assessment frequency, and whether an independent assessment or an assessment which is coordinated with other actors is carried out. The forecasting during the ongoing assessment will be done based on pre-assessments and historical demand data. The initial assessment will be adapted and priorities are likely to shift depending on the development of the crisis.

Further activities include but are not limited to: Analysis of deficits in local capacities and definition of minimum requirements for the humanitarian operation including establishment of a pre-crisis baseline; deduction of gross and net needs; and prioritisation of operational activities and development of scenarios for future development.

6.2.2.2 Procurement

The objective of procurement is to ensure that the humanitarian organisation has the material resources necessary to meet operational requirements and operational support requirements. Thereby, goods of sufficient quality are required while costs need to remain limited. To support the economies of disaster-affected areas, if possible preference is given to procurement of goods manufactured in the area of operation and supplies or services readily available locally in the quality required at competitive prices.

It is the objective of procurement to identify the right goods, equipment and services required for the implementation of operations; to identify this need operationally at the right time for a specific operation, in the correct quantity which matches the needs and of the right quality which meets minimum specification that satisfy criteria for specific conditions of the operation and at the best price available taking into account cost, lead time, and quality as well as reasonable transport, transport insurance and import-related costs.

Procurement includes definition of requirements, requesting and sourcing of goods, evaluation of offers, purchasing contracts and further construction and technical contracts. Furthermore, tasks related to delivery and payment procedures, donor regulations, code of conduct, procurement procedures, vendor relations, purchase orders, and documentation fall within this category. Procurement tasks also include identifying, qualifying and selecting suitable suppliers, planning and reservation of capacities and stocks to ensure availability; initiation and execution of purchasing activities; and cooperation with suppliers and customers.

6.2.2.3 Warehousing

The objective of storing goods in warehouses is to protect goods from deterioration, damage and theft and to store goods before they are further transported towards the area of operations. Warehousing is also a means to buffer against varying lead times and demand volatility. Thus, except for pre-positioning of stocks and emergency preparedness plans, storage of goods is usually suboptimal since it involves the use of scarce financial, logistical and personnel resources. These costs, however, need to be balanced with economies of scale in long-haul transportation of goods. The provision of storage space or warehouses also requires providing personnel and (auxiliary) equipment.

The main tasks associated with warehousing or storage of goods are receipt, inspection, storage, quality control, picking, packing, marking and labelling, and consolidation of goods and transports.[341] Warehousing includes both management of warehouses and stocking points on an international, regional or local level. Warehouse management activities such as stock content and placement decisions are considered, as well as inventory control and supervision and reorder policies.

6.2.2.4 Transport

Humanitarian supply chains usually include multi-echelon transportation of goods. From globally distributed warehouses with pre-positioned goods to be deployed in acute emergencies, goods flow through the stages of the humanitarian supply chain. Regional warehouses serve as consolidation points for distribution to certain regions such as East Africa or Central America. Local warehouses are usually located within the boundaries of an affected country, thus goods have already been customs cleared. From a central local warehouse, goods are transported on a last leg to the final point of distribution.

Transport comprises all deliveries within the network of the humanitarian organisation including the last leg of the transport ("last-mile distribution"). Thus, transport tasks also include in-country transportation. The last leg of the transport of goods to an affected community can be viewed as a demultiplexing, i.e. deconsolidation of the material flow and further delivery to the area of operations. Transport also includes inter-warehouse transport (transshipments).

Transport includes both national and international, single mode and multi-modal transport. In which way goods are transported through the humanitarian supply chain is mainly dependent on the priority of the goods, the quantity in volume and weight and the destination of the goods, required capacities in warehousing and auxiliary equipment, special transportation requirements, e.g. for hazardous or fragile goods or goods with importation restrictions such as drugs, and security issues.

6.2.2.5 Reporting

The ability to regularly generate accurate information concerning the status of assets, goods, and equipment in the humanitarian supply chain including data on location, condition, and prices is decisive for humanitarian operations to be able to plan and implement operations. Reporting refers to all activities associated with creating internal and external reports for a variety of purposes. Reports serve as a means to acquire funding necessary to implement operations, to coordinate humanitarian operations and as a means to monitor the efficiency and effectiveness after operations have started, during the operations and after operations have been terminated or handed over to other actors. Reporting is done towards the media to demonstrate effective action, and thereby

[341] Cf. Stock and Lambert (1993), p. 276.

increase pledge contributions.[342] Reporting towards donors is done to enable them to inform their constituencies about the funded activities. Financial reports are further used for internal controlling purposes. In order to secure funding of operations, timely and accurate reports are crucial. However, considering the lack of use of appropriate IT systems to support reporting, this is frequently difficult to achieve.

A prerequisite for timely and accurate reporting is the implementation of a hard-copy or electronic “paper trail” of all supply chain transactions. These transactions take place between any two actors in the humanitarian supply chain, such as suppliers, in-kind donors or other external actors as well as within a humanitarian organisation, e.g. between a warehouse manager and a driver. All extraordinary or unusual transactions should be accompanied by an explanatory note. This “paper trail” ensures accountability and is the baseline for any tracking or tracing of goods in the supply chain.

6.2.2.6 Operations Support

The primary objective of operations support is to enable humanitarian operations by planning, implementing and operating the required basic infrastructure. Operations support enables the effective and efficient flow of material, information and personnel in the humanitarian supply chain. The implementation of suitable control and supervision of effective and efficient use of resources is also part of operations support.

Operations support mainly consists of two kinds of categories: Human resources on the one hand and services and equipment on the other hand. Human resources as part of operations support consist of specifically trained staff able to assist in humanitarian crises. Staff can be supply chain managers or experts for various kinds of infrastructure such as telecommunications, transport, warehousing, IT, security, energy, water and sanitation. Equipment comprises all kinds of technical machinery necessary to enable the material and information flow in the supply chain. Equipment can include transport vessels, communication systems, IT systems, generators, water pumps, shelter, auxiliary equipment, and other types of equipment.

6.2.3 Actors and Organisational Units

In this section the main actors involved in the material flow within the humanitarian supply chain will be presented, together with their roles and responsibilities. Figure 40 shows a reference structure of a humanitarian supply chain and the involved actors.

Material flow in the network can be diverse: The most common case is that goods flowing through the supply chain consist of pre-positioned stocks in warehouses, supplies procured from suppliers (possibly at any tier of the supply chain), and in-kind donations. Goods are shipped from various locations to a regional warehouse, which is located at a geo-strategic location and which is well-connected to long-haul transport routes (usually near a sea port or airport). The regional warehouse offers integrated

[342] Thomas (2003a).

logistics services for the operations such as technical support, management of customer orders, calls for tenders and purchases of material, quality control, warehousing and shipment of goods up to the port of entry in the country of operations. Goods are shipped to a domestic warehouse typically located in the capital city of the country in which operations are run. Here, goods are stored, sorted and transferred to stocks located directly at the operational sites. In the following subsections the various actors will be presented in more detail.

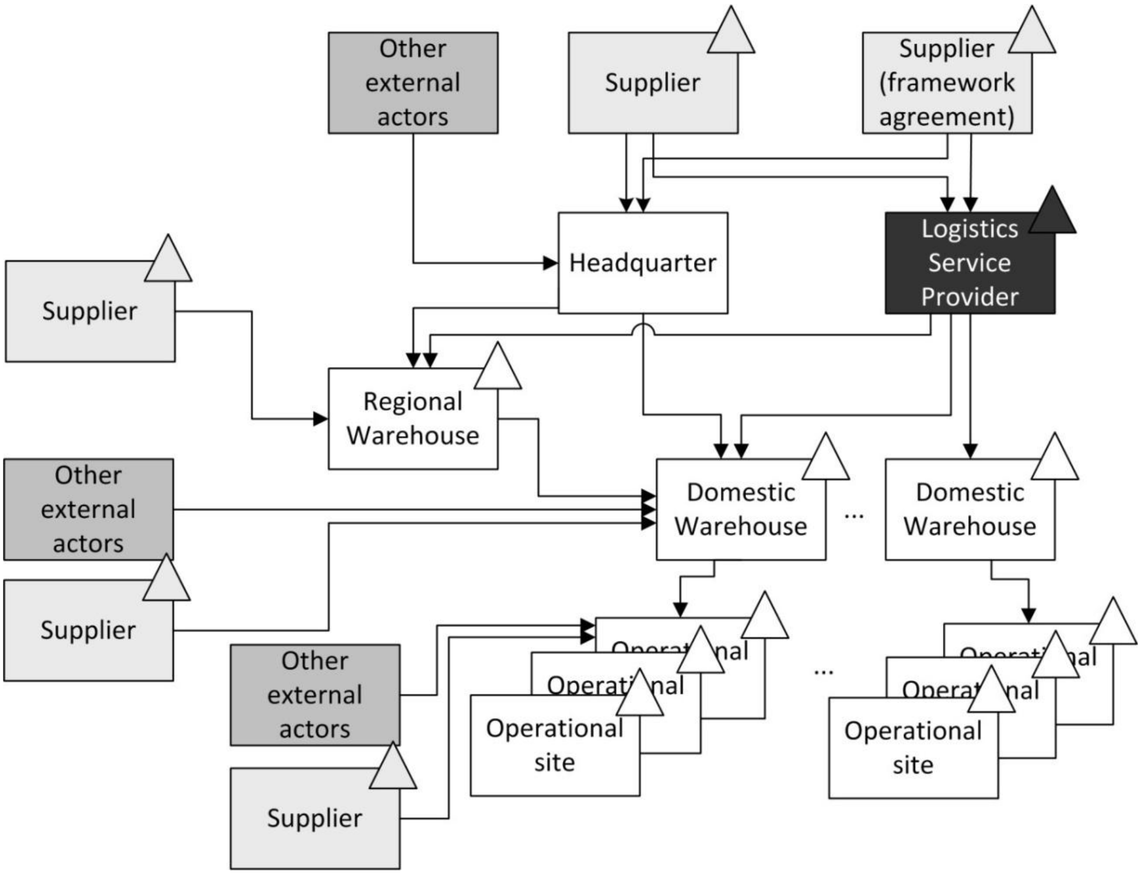

Figure 40: Reference configurations of humanitarian supply chains[343]

6.2.3.1 Humanitarian Organisation

The humanitarian organisation is the key stakeholder in the humanitarian supply chain. The humanitarian organisation is accountable for humanitarian operations conducted and is thus the driving and coordinating force in the supply chain. The humanitarian organisation operates on several hierarchical levels, including (international) headquarters, regional (international) and domestic warehouses (located mostly in the capital city) as well as operational sites. A reference organisational chart of the humanitarian organisation is given in Figure 41.

[343] Only material flows are displayed in the figure. Information and financial flows are omitted for purposes of clarity. Triangles denote that stocks may be held by the respective entity.

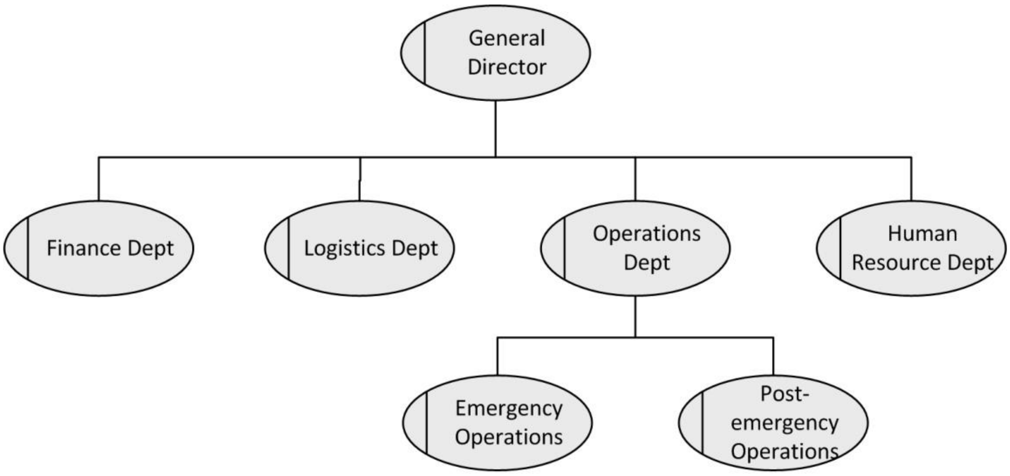

Figure 41: Reference organisational chart of headquarters / regional centre

The **general director** (management) of the organisation has a senior executive function and usually is the official spokesperson of the humanitarian organisation. The general director bears overall executive responsibility and ensures that the organisation continues to develop and enforces the operational mission according to the mission statement. Since contexts of humanitarian operations are changing both rapidly in the short-term and potentially gradually in the long-term, the general director is responsible for organisational development and change management within the humanitarian organisation. The general director is the line manager of the various heads of departments and is responsible for the development and implementation of a long-term vision, strategy, and policies for the organisation and its operations. The general director ensures the effective generation and utilisation of resources and promotes accountability and transparency of use of resources to the relevant stakeholders.

The **finance department** supports the organisation to conduct operations in an effective, efficient, ethical, and accountable manner. Thus, the department plans, organises, and directs strategies, activities, and staff members engaged in the humanitarian organisation's budgetary, financial, and accounting practices. The objectives of the finance department are to develop and implement financial processes abiding to domestic legislation and regulations and to organise and further develop the organisation-internal administrative structure. The head of the finance department is responsible for the strategic financial management and follows up financial issues including funding of international operations and the overall management of the internal administration of the humanitarian organisation. The head of department participates in developing collective decisions, setting priorities for the organisation given resource constraints, and approving internal policies. Officers in the financial department are trusted with tasks of bookkeeping, i.e. maintaining the financial records and assisting in financial reporting of operations, budget holding, i.e. managing the operation and approving its finances, and programme management, i.e. making sure that the operations meet the reporting and management requirements of the donors.

The **operations department** is headed by the operational director who is responsible for the line management of all humanitarian operations. These can include operations of varying sizes and scopes, i.e. horizontal as well as vertical operations. The objective of the operations department is to review ongoing operational issues and to consider the opening and closing of operations. The operations department realises responsive and effective field operations as well as matches the required resources for these operations on the basis of the overall operational strategy. Functional support for operations is delivered by the various departments (e.g. human resources, finances), of which the respective head of department is the line manager of the operational advisors. Alongside the line management, the officers of the operational department are also key interlocutors with the various other departments to ensure that the operational needs are linked with the development of inter-departmental issues and specialisations. Within the operations department, two distinct teams exists for emergency operations and regular or post-emergency operations. Within those teams, operations are clustered in portfolios according to regions or types of operations. Within these portfolios, the operations department has the responsibility for quality and implementation of humanitarian operations, assessments, policy and strategy, security as well as of initiative, response, observation, closure, monitoring, and evaluation of operations.

The **human resources department** is responsible for designing and implementing a human resources strategy which is in line with the overall operational policy. The human resources strategy involves recruitment, briefing, and further development of personnel, evaluation, remuneration, and employment of staff for all levels within the humanitarian organisation. Much like the other departments, the human resources department has to ascertain that the operational needs in terms of qualified and motivated personnel are continuously monitored and fulfilled. Human resources are crucial for the success of operations. This is amplified by a frequently high turnover of personnel both near to operational sites and in headquarters.

The **logistics department** is responsible for assisting operations by planning, implementing and executing processes related to procurement, transport, and storage of goods, equipment, and assets necessary to run operations. The head of the logistics department is accountable for the efficiency, transparency, and quality of the supply chain policies and work processes of the department. The main tasks of the logistics department are to promote the formulation of the overall logistics capacity and strategy, to devise and implement supply chain policies and standard procedures at HQ and in the field operations, and to provide quality logistic and technical support to operations. Services provided by the logistics department include the provision of supplier contacts, support with tender procedures and monitoring of procurement processes. The logistics department also handles the procurement of assets, equipment and MRO parts that are not available directly in the operational area or for which local sourcing is not suitable. The logistics department is further responsible for issuing written guidelines and formats regarding procurement, transport, and storage matters and keeping them in line with evolving donor requirements. Other services of the logistics department include advice in all technical and logistical matters, and troubleshooting in case of technical problems, monitoring of the supply chain during emergency operations, and assistance with specific questions related to procurement such as custom or transport issues.

Within the logistics department, various roles exist for which reference descriptions are suggested in the following.[344] These roles primarily apply to positions near to the operational sites. Roles within the headquarters logistics department are not further detailed here since these roles are sufficiently similar to roles within logistics departments of for-profit organisations:

The role of the **head of the logistics centre** (HeadLog) is to manage the logistics centre activities as a service provider with efficiency (purchase, warehousing, dispatch, fleet and air transport and operations) and to respond to the expressed needs from the field operations (or headquarters) with effectiveness and in accordance to the overall logistics policy. The head of the logistics centre supervises all employees of the logistics centre including purchase officers, warehouse managers etc.

The role of the **logistics coordinator** (LogCo) is to provide logistics support to large-sized operations in accordance with logistics standards. The LogCo manages the logistics team in providing technical and operational support in the areas of purchasing, warehousing, stock management, maintenance and fleet management in order that relief supplies arrive at the final distribution point at the agreed time and in good condition. The LogCo is a key member of the country coordination team and thus in the overall decision-making process.

The role of the **(senior) logistician** (SenLog/Log) is to provide logistics support to small-/medium-/large-sized operations in accordance with logistics standards. The SenLog/Log provides technical and operational support in the areas of purchasing, warehousing, stock management, maintenance, and fleet management in order that assistance arrives at the final distribution point at the agreed time and in good condition.

6.2.3.2 Suppliers

Suppliers in humanitarian supply chains serve by and large the same function as they do in purely commercial or for-profit supply chains. Suppliers are the origin of the material flow in the humanitarian supply chain as considered within the scope of this reference task model and they are one sink of the financial flow. Suppliers provide the goods, equipment, and value-adding services needed for a specific humanitarian operation. Yet, there are a number of differences that separate the role of the supplier in the humanitarian supply chain from the role of suppliers in other supply chains which will be briefly elaborated in the following.

Suppliers in the humanitarian supply chain are mainly commercial companies which provide goods, equipment, and services for the humanitarian operation. However, donors, governments, and logistics service providers can also act as suppliers and their

[344] Partly based on International Committee of the Red Cross (2006), pp. II-95-106.

roles (cf. also the following section) can be multi-faceted. According to Kovács and Spens (2008), suppliers can have "different motivations for participating; [for] some, humanitarian aid is another 'industry' they provide their products to, others see it as part of their corporate social responsibility."[345] While organisations in purely commercial supply chains usually deal with a predetermined set of suppliers and more or less fairly stable demand, these are features unknown in the humanitarian supply chain. In the humanitarian supply chain, suppliers often cannot be predetermined and the choice of suppliers is frequently limited (especially in conflict areas), up to the extent that sometimes even unwanted suppliers participate in the supply chain.

In humanitarian supply chains, suppliers situated close to the operational site are frequently preferred, especially in emergencies when timely delivery of the goods is the life-saving factor. Local suppliers are also preferred since local sourcing supports the local economy. However, it needs to be carefully checked whether local suppliers meet quality requirements and all procurement objectives can be fulfilled. The successful, cost and time efficient local procurement depends on the thorough assessment of locally available goods, their cost, available quantities, and quality.

Other sources of goods needed in humanitarian operations are private or corporate donations in-kind.[346] Humanitarian organisations need a clear position concerning the acceptance of donations of (types of) goods in their supply chains. In any case, suppliers have to comply with various requirements set by donors and the humanitarian organisation itself. These requirements include quality assurance policies, requirements for the goods themselves as laid out in the standard item catalogue, possibility to reserve stock, and/or capacity in case of priority demand for emergency operations etc. Especially for those items which are critical for the success of operations, suppliers will have to ensure availability of stocks or capacity or their ability to provide suitable substitutes in case of stock outs within a limited and pre-determined timeframe. Key performance indicators of suppliers in the humanitarian supply chain are absolute order cycle time, variability of lead times, and various service levels.[347] These indicators influence the safety stock levels humanitarian organisations will have to maintain and the respective service levels provided by the humanitarian organisations themselves.

6.2.3.3 Other External Actors

While minor or small-scale emergencies can be handled by local organisations alone or in conjunction with a single humanitarian organisation, larger crises require coordinated operations conducted by a number of different actors. These other actors are summarised as other external actors and include:[348]

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345 Kovács and Spens (2008), p. 224.

346 Cf. Pan American Health Organization (Regional Office of the World Health Organization) (2001), p. 147.

347 Cf. McGuire (2006), p. 144.

348 Based on Pan American Health Organization (Regional Office of the World Health Organization) (2001) and Davis and Lambert (2002), pp. 13-24.

The local population and neighbouring communities: The residents of the affected area are the first to provide humanitarian assistance including search and rescue operations. Frequently, neighbouring communities or even countries respond quickly with financial or material donations.

Multilateral organisations: These are organisations such as the United Nations agencies, whose mandate covers humanitarian assistance. Generally, their support focuses on technical assistance related to their own field of expertise, sending consultants and experts, or supporting the allocation of resources to help the affected country in rehabilitation and reconstruction efforts.

Governmental organisations: A crisis usually prompts the intervention by national as well as foreign governmental organisations. Foreign governmental organisations intervene on the basis of bilateral agreements. This assistance, which occurs between the two governments, may include financial and in-kind donations, the financing of rehabilitation and reconstruction projects, or the sending of consultants and experts.

NGOs: National and international, religious or social non-governmental organisations offer a wide range of capabilities, experience and resources. Some international NGOs specialize in emergency management, and their skills and resources are tailored to humanitarian operations.

The private sector: National or transnational private for-profit organisations can get involved at different levels, from donations to providing specialised services in areas such as transportation, warehouse rentals, or the sale or in-kind donation of equipment, food and drugs. The role of private organisations in humanitarian operations is currently changing as new roles and responsibilities of these organisations are identified.

Specialised institutions: These can provide highly valuable technical assistance in areas such as vulnerability assessments and risk reduction, needs assessment, and more concrete efforts such as water purification or medical supply management.

Military institutions: A country’s military institutions can be deployed in humanitarian operations for logistical support. They have their own means of transport, including sophisticated means of transport such as helicopters, highly flexible human resources, and essential skills in fields such as rapid road repair and bridge construction. The involvement of military institutions in humanitarian operations also has adverse effects which will be reviewed in Section 6.7.

6.2.4 Limitations

In order to restrict complexity and appropriately limit the scope of the reference model, some trade-offs had to be made during the construction of the task model. Thus, a number of issues are only peripherally touched or omitted altogether. These issues include:

Asset management: Although having been identified as key to efficient humanitarian operations, tasks and processes of asset management have been almost completely excluded from the reference model.

Return: Standard logistics reference models such as SCOR usually include return processes. In the humanitarian supply chain, return processes can take place when operations end with high excess stock and/or in order to avoid mass expiry of goods. Frequently goods are destroyed instead of being returned due to impossibility of returns or prohibitively high cost. Return processes in humanitarian supply chains are not decisive for efficient and effective operations and have thus been excluded from the scope of the model. Moreover, return processes in humanitarian supply chains often take place manually, i.e. returning expatriates hand-carry returned goods to headquarters. Thus, these processes are infrequent and defy standardisation.

Distribution: Final or last-mile distribution of goods is not considered in the reference model. Distribution tasks differ from transport tasks since they focus on handing over the goods or providing humanitarian services to an affected community. Although frequently cited as an issue of humanitarian logistics, these tasks are primarily concerned with deriving and implementing strategies and policies which assure that goods and services are delivered effectively. Thus, this final step in delivering goods to an affected community is not considered a core logistical or supply chain issue.

Human Resource Management: While the reference organisational model developed before contains the human resource department of the organisation, human resource management has explicitly been excluded from the reference task model. Although these processes are of high overall importance in order to conduct successful humanitarian operations, they are not core logistics processes.

Funding/Donors: Humanitarian organisations are non-profit organisations funded not by the end users of the goods and services but by donations from third party organisations. Usually, before humanitarian operations can be implemented, the required funding needs to be obtained from donor entities, i.e. individuals or organisations.[349] The financial flows in the humanitarian supply chain have largely been excluded from the analysis. While the reference organisational model developed before contains the finance department of the organisation, the attempt to accurately model the intricate financial flows would have overburdened the model with complexity and would have impeded the design goals of the model. The financial flows in humanitarian supply chains do not originate at the end consumer, i.e. the beneficiary of the goods and services of the humanitarian operation, but at the donors of the humanitarian organisation. The resulting financial flows involved a number of different actors and the flows can be quite complex. Financial flows in humanitarian supply chains have been analysed by Danne et al. (2008) and Thomas and Kopczak (2005). Thus, donors are also not included in the description of the actors in the humanitarian supply chain. Donors who

[349] One option to avoid this is to acquire non-earmarked funding which can be utilised at will for any operation including operations in response to sudden-onset emergencies.

enter in-kind donations in the supply chain can be regarded as non-commercial suppliers.

Coordination: Coordination and collaboration of humanitarian organisations has frequently been mentioned as a key issue in humanitarian supply chains. In fact, effective coordination of humanitarian organisation can be key to efficient humanitarian interventions. Moreover, collaborative issues have recently been added to the standard supply chain management task model.[350] Collaborative features are implemented in recent releases of standard supply chain management software. Collaboration and coordination of humanitarian organisations has so far only been explored from a political perspective; contributions with a dedicated focus on issues of supply chain management remain scarce.[351] Thus, in practice, coordination of humanitarian organisations is either insufficient or takes place in an ad-hoc fashion. Due to the number of different actors involved, the variety of mission statements and the numerous ways in which humanitarian organisations could cooperate, this issue has been excluded from the task model in order to guarantee generality and in order to restrict complexity.

Operations Support: Operations Support processes are only peripherally touched in the reference task model. Operations Support is an enabler for the material and information flow in the humanitarian supply chain but is in itself not a core process. However, due to their importance as enabler of logistics processes, some key issues have been included.[352]

Maintenance, Repair and Overhaul: The reference task model only reflects those activities which are performed regularly and periodically and which are suitable for standardisation and implementation in an information system. Thus, MRO processes have not been included in the task model. Furthermore, no irregular activities reacting to unexpected events, such as machine failure or vehicle breakdown or infrequent activities, e.g. rare transport modes such as air-drops are considered.

Others: Various other aspects have been explicitly excluded from task model: Very little focus is laid on communications processes. Exit and mission end strategies and demobilisation measures and plans are not included. The task model does not assess the urgency or criticality of the tasks. Special measures with respect to security management are crucial in order to guarantee the safeguarding of the organisations' staff, assets, equipment, and goods but have not been included in the task model as they are not considered to fall within the logistics boundaries.

[350] Cf. Hellingrath et al. (2003).
[351] For a counter example, cf. Schulz (2009). Schulz examines horizontal cooperation in humanitarian supply chains and presents potential benefits of and impediments to such cooperation.
[352] For a comprehensive discussion of operations support processes in disaster relief, cf. Tufinkgi (2006).

6.3 Reference Tasks

The tasks developed for the reference model are presented in this section. Here, the presentation is limited to a plain list of all tasks included in the reference task model (Table 9). Furthermore, one example of a reference task is given in detail (Table 10)

The complete task model is subject of Appendix G: Reference Task Model: Task Descriptions. Each of the listed tasks is described; alternatives of parameters of the task are indicated when applicable. Comments are made regarding possible successors and predecessors. For each task the type "generic" or "specific" is indicated, i.e. whether they are unspecific and not geared towards a concrete disaster or whether they belong to the immediate response and recovery phase, i.e. are disaster-triggered and geared directly towards an affected community. In practice, the tasks will not solely be carried out sequentially but rather both sequentially and parallel with complex interdependencies. The allocation of roles and responsibilities of the tasks to the actors in the humanitarian supply chain is presented in Appendix F.

Table 9: List of reference tasks

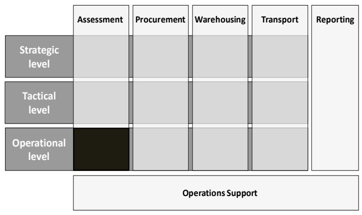
Strategic / Assessment	Create Mission Statement Plan Emergency Preparedness Plan Programme Strategy
Strategic / Procurement	Negotiate Framework Agreement Plan Emergency Supply Strategy Plan Kits Plan Standard Item Catalogue Plan Supply Strategy
Strategic / Warehousing	Plan Warehouse Capacities Plan Warehouse Network
Strategic / Transport	Plan Transport Capacities Plan Transport Network Plan Transport Strategy
Tactical / Assessment	Plan Demand Plan Emergency Team Plan Project Activities Plan Standard Item List Select Project Sites
Tactical / Procurement	Plan Programme Item List Plan Purchasing Methods Plan Sourcing Methods Plan Supply of Operations (regional)

	Plan Supply of Operations (local) Plan Tender Procedures Pre-Qualify Suppliers
Tactical / Warehousing	Plan Emergency Stock Positioning Plan Quality Assurance Plan Warehouse Layout Set Inventory Control Policy
Tactical / Transport	Plan Consolidation Policy Plan Transport of Special Goods Plan Transport Modes Plan Transport Routes
Operational / Assessment	Assess Local Capacities Assess Local Resources Assess Local Sources of Supply Deploy Emergency Team Deploy Exploratory Team Forecast Demand Identify Needs and Number of Beneficiaries Identify Type and Magnitude of Disaster Initiate Needs Assessment Initiate Search and Rescue Order Goods Prioritise Needs Request Goods
Operational / Procurement	Acknowledge Order Analyse Comparative Bids Consolidate Orders Execute Justification Procedure Execute Tender Procedure Mobilise Supplies (ad-hoc) Monitor Pipeline Obtain Quotations Purchase Goods Qualify Suppliers Record Order and Shipment Information Select Supplier Set Order Priority Status

	Source Goods (external) Source Goods (internal) Specify Special Goods Specify Standard Goods Validate Order (Non-Standard) Validate Order (Standard)
Operational / Warehousing	Assemble Kits Assure Quality Check Incoming Goods Check Quality Consign Goods Count Stock Create Packing List Create Waybill Dispose Goods Issue Replenishment Order Mark and Label Goods Monitor Stocks Pick and Pack Goods Prepare Shipping Documents Prepare Special Certificates Prepare Stock Transfer Receive Goods Receive Goods (unsolicited) Return Goods Store Goods Transport Goods to/from Stock Update Inventory Verify Shipment Information
Operational / Transport	Consolidate Transport Export Goods Handover Goods Import Goods and Clear Customs Load Goods Obtain Signature Offload Goods Prepare Customs Documents

	Schedule Deliveries Schedule Transport Select INCOTERMS Mode Select Transport Mode Select Transport Route Send Advance Shipping Notice Track and Trace Shipment
Reporting	Create Asset Report Create Donor Report Create Inventory Report Create Damage/Loss Report Create Needs Assessment Report Create Outstanding Order Report
Operations Support	Implement Basic Infrastructure Mobilise Auxiliary Equipment Mobilise Equipment Mobilise Personnel Operate OS Systems Prioritise and Allocate OS Resources

Table 10: Reference task (example)

Operational / Assessment	
Identify Needs and Number of Beneficiaries	This task has the objective to generate qualitative and quantitative information on the target population of a possible humanitarian operation. Qualitative information on the affected population can be drawn from observations, interviews with key informants and focus group discussions. Sample surveys can be used to obtain basic demand information. Basic information required to derive the needs of the affected population includes sources of water supply, with information regarding its quantity and quality and, if displacement of groups of people has taken place, their conditions must be evaluated. The needs will also be dependent on various key data about the affected population such as demography (total population, age, sex); ethnic background, clan structures etc.; socio-cultural characteristics

	(religion etc.) and identification of vulnerable groups (children, elderly, pregnant women etc.). In order to identify the number of beneficiaries, a variety of methods can be used: Aerial or satellite photographs, census (to estimate the total number of people in an affected area) or sample or cluster surveys. Needs are also dependent on locally available goods, in terms of water, food, shelter and other non-food items, and health services. The assessment of the health status of an affected population includes information on rates and causes of mortality, diseases with epidemic potential, prevalence of acute malnutrition, data on vaccine coverage and morbidity data on the most common diseases. The results of this task need to feed into the task "Forecast Demand".
	Type: *Specific*

6.4 Formalisation of BPMN

Before the supply chain tasks developed in the previous section can be employed to create reference supply chain processes, some amendments to the selected business process modelling language BPMN need to be made. In this section, a structured formalization of the syntax is laid down. The first step in constructing a formal arrangement involves developing a meta model of the syntax, as described in the following subsection. The objective of this exercise is to further develop BPMN to a level which supports the construction of adaptive reference models. The formal algebraic specification of the relationships between the elements enables automatic syntax checks of adapted, i.e. organisation-specific models.

BPMN 1.1 has some known shortcomings: The specifications are not precise; interpretation of inclusive gateways is ambiguous and it remains unclear when data objects come to life or when they cease to exist. In order to address some of these shortcomings, especially the precision of the specifications, a formal syntax for BMPN is formulated in the following. This syntax is partly based on Object Management Group (January 2008); however, since the specifications are not entirely clear and focus much more on semantics rather than syntax, modifications had to be made.

Through its syntax and semantics, the modelling language is able to determine the correct application of the elements in a model as well as its correct composition. The syntax of a language serves to determine certain rules governing which elements can be combined with which others, without thereby imputing any unintended meaning to those elements. The latter is the task of semantics.[353] The syntax and semantics of the BPMN notation are delineated in the BPMN specification which forms the basis for the formal presentation of the syntax provided in this section. In the official BPMN specifi-

[353] Cf. Delfmann (2006), pp. 33-34.

cation, the syntax and semantics are presented in an informal manner. In this way, ample room is created for individual interpretations and discussion.[354]

6.4.1 Meta Model of the BPMN Syntax

The meta model depicts the main elements of the BPMN notation as well as their relationship to each other. For the sake of clarity, not all elements of the extended set of BPMN elements are presented in the meta model. The development of the meta model is based on the BPMN 1.1 specification and incorporates initial suggestions for a BPMN meta model by Korherr and List (2007) and Becker et al. (2008). Modifications and amendments are justified in the following section. Figure 42 presents the meta model in the form of a UML class diagram.

Business Process Diagrams (BPD) show business processes consisting of one or more pools, the processes of which are connected across the borders of the individual pools through message flows. Since business process modelling is the core of BPMN, the term "Business Process Diagram" is used interchangeably with the term "business process" in the meta model. Each pool contains a process which is either visible or invisible in the BPD. Annotations are included in the meta model since they will be further detailed in the algebraic specification. The same holds true for the given cardinalities. However, a few cardinalities which are easily understood should be briefly elucidated at this stage.

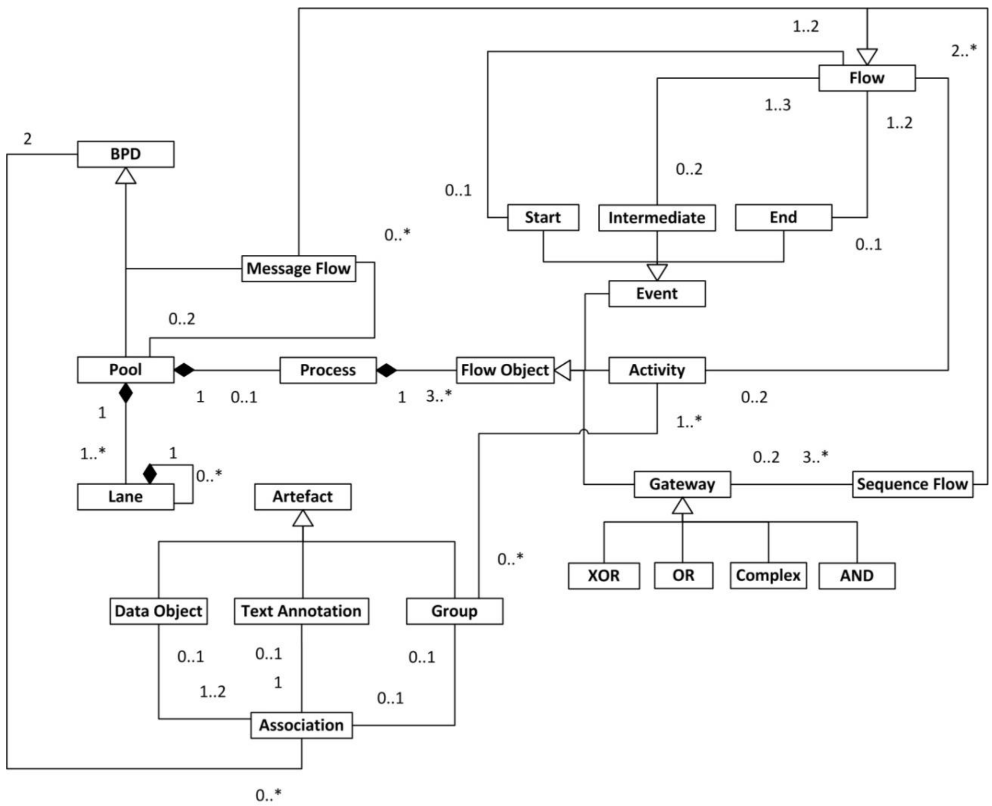


Figure 42: BPMN meta model

[354] Cf. Fensel (1994), p. 3.

A process contains at least three flow objects, which at a minimum consist of a start and an end event and one activity. This indicates that when a process is present it will be visible in the pool and consequently will imply the presence of flow objects. The case where no process is present or visible in the pool is reflected by the fact that cardinality indicates that a pool can contain no process or a maximum of one process. Moreover, activities consist of at least two flows made up of exactly two sequence flows and, where necessary, of several message flows. Gateways consist of at least three sequence flows because they serve as points of divergence or merge and must necessarily have edges on every side. These restrictions have been put in place because it is not permitted to begin or end a process with an activity or a gateway.

6.4.2 Algebraic Specification of the BPMN Syntax

In the previous section the syntactic rules for selected elements of BPMN were presented in a meta model. Since an attempt at describing all of the elements as well as their predecessor-successor relationships would result in an unmanageable model, the meta model outlined above will now be supplemented and expanded upon through an algebraic specification. This type of specification also make it possible to state explicitly any predecessor-successor restrictions that are of transitory nature; that is, where an element can exert restrictions on another element through a flow.[355]

The following algebraic specification follows BPMN 1.1.[356] The algebraic specification adopts the following symbols as constituent elements:

BPD	The finite, non-empty set of BPD elements
Po	The finite, non-empty set of specific pools Po_n
M	The finite set of message flows
F	The finite, non-empty set of flow objects
C	The finite, non-empty set of connecting objects
A	The finite set of artefacts
FE	The finite, non-empty set of events
FA	The finite, non-empty set of activities
FG	The finite set of gateways
CS	The finite, non-empty set of directional sequence flows
CA	The finite set of associations
AD	The finite set of data objects
AA	The finite set of annotations
FE_{Start}	The finite, non-empty set of start events
FE_{Inter}	The finite set of intermediate events

[355] Cf. Delfmann (2006), p. 88.
[356] Object Management Group (January 2008)

FE_{End}	The finite, non-empty set of end events
FE_S	The finite set of start events without start message events
FE_E	The finite set of end events without end message events
FEM_{Start}	The finite set of start message events
FEM_{InterC}	The finite set of intermediate catching message events
FEM_{InterT}	The finite set of intermediate throwing message events
FEM_{End}	The finite set of end message events
FET_{InterC}	The finite set of intermediate catching timer events
FEE_{InterC}	The finite set of intermediate catching error events
FEC_{InterC}	The finite set of intermediate catching conditional events
FEL_{InterC}	The finite set of intermediate catching link events
FEL_{InterT}	The finite set of intermediate throwing link events
FES_{InterC}	The finite set of intermediate catching signal events
$FEMu_{InterC}$	The finite set of intermediate catching multiple events

There are further types of start, intermediate and end events, but only those which experience specific restrictions in the later development are listed here. The remaining elements are defined in relation to the respective start events, intermediate events and end events detailed above.

FG	The finite set of gateways
$FG_{XOR\ (Data)}$	The finite set of data-based exclusive gateways
$FG_{XOR\ (Event)}$	The finite set of event-based exclusive gateways
FG_{AND}	The finite set of parallel gateways
FG_{IOR}	The finite set of inclusive gateways
$FG_{Complex}$	The finite set of complex gateways

$\circ f = \{g: (g, f) \in CS\}$ denotes the set of predecessor nodes of a flow object f with $f, g \in F$

$f \circ = \{g: (f, g) \in CS\}$ denotes the set of successor nodes of a flow object f with $f, g \in F$

$\|f\|$ denotes the cardinal number of the set f.

$FG_Z = \{g \in FG: \|\circ g\| \geq 2 \land \|g \circ\| = 1\}$ corresponds to the set of merging gates
$FG_V = \{g \in FG: \|\circ g\| = 1 \land \|g \circ\| \geq 2\}$ corresponds to the set of diverging gates

In the following step, the relationships of the sets on the BPD level and then on the pool level are formalised:

With respect to pools, two cases are to be distinguished: If $Po_n = \emptyset$ holds, then a finite set of pool process elements are alluded to and Po_n designates the set of pool process elements; if $Po_n = \emptyset$ holds, then a standalone irreducible element is present.

$Po \subseteq BPD, M \subset BPD$: The set of specific pools is a subset and the set of message flows is a true subset of the set of BPD elements. Moreover, it holds that the set of BPD elements contains at least one specific pool.

$BPD = Po \cup M$: The set union arising from the set of specific pools and message flows equals the set of BPD elements.

$Po \cap M = \emptyset$: The sets of specific pools and message flows are disjunct.

$Po_1 \subseteq Po,\ Po_2 \subseteq Po, \dots,\ Po_i \subseteq Po$ if $Po_n \neq \emptyset$: The sets of pool process elements are each subsets of the set of specific pools.

$Po = Po_1 \cup\ Po_2 \cup \dots \cup Po_i$: The set union arising from the respective pool process elements equals the set of specific pools.

In the following, the syntax within a specific pool will be examined. In order to represent the syntax within a pool, only a pool $Po_k$with the pool process elements flow object, connecting object and artefacts are considered. It is assumed that $Po_k \neq \emptyset$ holds.

$F \subset Po_k,\ C \subset Po_k,\ A \subset Po_k,$ where $\|A\| \geq 0$: The quantities of specialized pool process elements are true subsets of the respective sets of pool process elements. Moreover, it holds that the set of pool process elements can comprise no or several artefacts.[357]

$Po_k = F \cup C \cup A$: The set union arising from the sets of specialized pool process model elements equals the sets of pool process model elements.

$F \cap C = \emptyset,\ F \cap C = \emptyset,\ F \cap C = \emptyset$: The sets of specialized pool process model elements are pair-wise disjunct.

Relationships in the set of flow objects:

$FE \subset F,\ FA \subset F,\ FG \subset F,$ where $\|FA\| \geq 1$ and $\|FG\| \geq 0$: The sets of specialized flow objects are true subsets of the set of flow objects. The sets of specialized flow objects are each true subsets of the sets of flow objects. There can be no gateway[358], but there must be at least one activity in the set of flow objects.

$F = FE \cup FA \cup FG$: The set union arising from the sets of specialized flow objects corresponds to the set of flow objects.

$FE \cap FA = \emptyset,\ FE \cap FG = \emptyset,\ FA \cap FG = \emptyset$: The sets of specialized flow objects are pair-wise disjunct.

Relationships in the set of events:

$FE_{Start} \subset FE, FE_{Inter} \subset FE, FE_{End} \subset FE,$ where $\|FE_{Start}\| \geq 1,\ \|FE_{Inter}\| \geq 1,\ \|FE_{End}\| \geq 1$: The sets of specialized events are each true subsets of the set of events. The set of events must contain at least one start event and one end event.

$FE = FE_{Start} \cup FE_{Inter} \cup FE_{End}$: The set union of the sets of specialized events

[357] Cf. Object Management Group (January 2008), p. 92.
[358] Cf. Object Management Group (January 2008), p. 70.

corresponds to the set of events.

$FE_{Start} \cap FE_{Inter} = \emptyset,\ FE_{Start} \cap FE_{End} = \emptyset,\ FE_{Inter} \cap FE_{End} = \emptyset$: The sets of specialized events are pair-wise disjunct.

$FE_S \subseteq FE_{Start},\ FEM_{Start} \subseteq FE_{Start}$: The sets of specialized start events are each subsets of the sets of start events.

$FE_{Start} = FE_S \cup FEM_{Start}$: The set union of the sets of specialized start events corresponds to the set of start events.

$FE_S \cap FEM_{Start} = \emptyset$: The sets of specialized start events are disjunct.

$FE_E \subseteq FE_{End},\ FEM_{End} \subseteq FE_{End}$: The sets of specialized end events are each subsets of the set of end events.

$FE_{End} = FE_E \cup FEM_{End}$: The set union of the sets of specialized end events corresponds to the set of end events.

$FE_E \cap FEM_{End} = \emptyset$: The sets of specialized end events and end events are disjunct.

$H = \{FEM_{InterC}, FET_{InterC}, FEC_{InterC}, FES_{InterC}, FEMu_{InterC}\}$: The set Hincorporates the specialized intermediate events cited above. The sets of specialized Helements are pair wise disjunct.

$FE_I = FE_{Inter}/(FEL \cup FEE_{InterC} \cup H)$: FE_I is the set of intermediate events without the sets of link events, the catching error events and the set H.

$FE_I \subseteq FE_{Inter},\ FEM_{InterC} \subset FE_{Inter},\ FEL_{InterT} \subset FE_{Inter},\ FEE_{InterC} \subseteq FE_{Inter},\ FEM_{InterT} \subseteq FE_{Inter},\ H \subseteq FE_{Inter}$: The sets of specialized intermediate events are each subsets of the set of intermediate events. The set of catching link events and the set of throwing link events are each true subsets of the set of intermediate events.

$FE_{Inter} = FE_I \cup FE_{InterC} \cup FE_{InterT} \cup FEE_{InterC} \cup FEM_{InterT} \cup H$: The set union of the sets of specialized intermediate events corresponds to the set of intermediate events.

The sets of the specialized intermediate events are pair-wise disjunct.

Relationships in the set of gateways:

$FG_{XOR\,(Data)} \subseteq FG,\ FG_{XOR\,(Event)} \subseteq FG,\ FG_{AND} \subseteq FG,\ FG_{IOR} \subseteq FG,\ FG_{Complex} \subseteq FG$: The sets of the specialized gateways are each subsets of the set of gateways. A subset can correspond to the total set if, for example, the set of gateways is empty or a model exists which contains gateways of just one type.

$FG = FG_{XOR\,(Data)} \cup FG_{XOR\,(Event)} \cup FG_{AND} \cup FG_{IOR} \cup FG_{Complex}$: The set union of the sets of specialized gateways corresponds to the set of gateways. The sets of specialized gateways are pair-wise disjunct.

$FG_Z \cap FG_V = \emptyset$: The sets of the merging and diverging gateways are disjunct. Every gateway $g \in FG$ is therefore either merging or diverging.

$FG = FG_Z \cup FG_V$: The set union of the merging and diverging gateways yields the total set of gateways. Thus, gateways which neither diverge nor merge are excluded. Furthermore, gateways which have no inbound or outbound edge are also excluded.

$FG_{XOR\,(Event)} \cap FG_Z = \emptyset$: An event-based XOR-Gateway cannot be a merging gateway.[359]

Relationships in the set of artefacts:

$AD \subseteq A,\ AA \subseteq A$: The sets of specialized artefacts are each subsets of the set of artefacts.

$A = AD \cup AA$: The set union of the sets of specialized artefacts corresponds to the set of artefacts.

$AD \cap AA = \emptyset$: The sets of the specialized artefacts are disjunct.

Relationships in the set of connecting objects:

$CS \subseteq C,\ CA \subseteq C$: The set of sequence flows is a subset and the set of associations is a true subset of the set of connecting objects.

$C = CS \cup CA$: The set union of the sets of specialized connecting objects corresponds to the set of connecting objects.

$CS \cap CA = \emptyset$: The sets of the specialized connecting objects are disjunct.

Restrictions on the permissible predecessor-successor relationships within a specific pool Po_k are determined through the following algebraic operations on the defined sets and set elements:

$CS \subseteq (FE_{Start} \times FA) \cup (FE_{Start} \times FG) \cup (FE_{Start} \times FE_{Inter}) \cup (FE_{Inter} \times FA) \cup (FA \times FE_{Inter}) \cup (FE_{Inter} \times FG) \cup (FG \times FE_{Inter}) \cup (FA \times FA) \cup (FE_{Inter} \times FE_{Inter}) \cup (FG \times FG) \cup (FA \times FG) \cup (FG \times FA) \cup (FG \times FE_{End}) \cup (FE_{Inter} \times FE_{End}) \cup (FA \times FE_{End}) \cup \left(FG_{XOR\,(Event)} \times FEM_{InterC}\right) \cup \left(FG_{XOR\,(Event)} \times FET_{InterC}\right) \cup \left(FG_{XOR\,(Event)} \times FGS_{InterC}\right)$: This restriction ensures that from a start event no start event and from an end event no end event can follow. It also ensures that a start event cannot occur at the end, and an end event cannot occur at the beginning of a process. Moreover, the restriction demands that after an event-based XOR-Gateway only the intermediate events message, timer and signals (each catching) may follow.[360]

$CA \subseteq (FA \times AD) \cup (AD \times FA) \cup (AD \times CS) \cup (AD \times M) \cup (AA \times BPD)$: Data objects are connected through associations with activities, sequence flows or

[359] Cf. Object Management Group (January 2008), p. 78.
[360] Cf. Object Management Group (January 2008), p. 80.

message flows. Text annotations can be connected through associations with any element of a BPD.[361]

$\forall e_S \in FE_{Start}$: $\|\circ\, e_S\| = 0 \ \land\ \|e_S \circ\| = 1$: Each start event has no predecessor node and exactly one successor node.

$\forall e_S \in FE_{End}$: $\|\circ\, e_S\| = 1 \ \land\ \|e_S \circ\| = 0$: For every end event it holds that there is exactly one predecessor node and no successor node.

$\forall e_I \in FE_I$: $\|\circ\, e_I\| = 1 \ \land\ \|e_I \circ\| = 1$: For every intermediate event in the set FE_I (exclusive of the sets H, FEL und FEE_{InterC}) it holds that each event has one predecessor node and one successor node.[362]

$\forall e_{LinkC} \in FEL_{InterC}$: $\|\circ\, e_{LinkC}\| = 0 \ \land\ \|e_{LinkC} \circ\| = 1$: Each intermediate catching link event has no predecessor node and exactly one successor node.[363]

$\forall e_{LinkT} \in FEL_{InterT}$: $\|\circ\, e_{LinkT}\| = 1 \ \land\ \|e_{LinkT} \circ\| = 0$: Each intermediate throwing link event has exactly one predecessor node and no successor node.[364]

$\forall e_{ErrorC} \in FEE_{InterC}$: $\|\circ\, e_{ErrorC}\| = 0 \ \land\ \|e_{ErrorC} \circ\| = 1$: For every intermediate catching error event it holds that there is no predecessor node and exactly one successor node.[365]

$\forall h \in H$: $\|\circ\, h\| = 1 \ \land\ \|h \circ\| = 1$: Each intermediate catching event in the set H has at most one predecessor node and exactly one successor node.[366]

$\forall a \in FA$: $\|\circ\, a\| = 1 \ \land\ \|a \circ\| = 1$: For each activity it holds that there is exactly one predecessor node and one successor node.

$\forall n \in AA$: $\|\circ\, n\| = 0 \ \land\ \|n \circ\| = 1$: A text annotation has no predecessor node and exactly one successor node. [367]

Restrictions over a pathway: In the BPMN specification a process is defined as a graph mapping flow objects consisting of a set of activities the flow of which is determined through sequence flows. However, the flow can also contain jumps, above all when there are exception flows present. These complicate the formalization of restrictions over a directed path. As such, a process Pr shall be determined as follows:

Let
Pr be a pathway from a flow object f_{i-k} to a flow object f_i, then it holds that:
$Pr = \langle f_{i-k}, f_{i-k+1}, \dots, f_i \rangle$ with $\langle f_j, f_{j+1} \rangle \in (CS \dot\vee \emptyset)$ and $i - k \le j \le i$ as well as $f_{i-k} \in FE_{Start}, f_i \in F, f_i \in FE_{End}$

Let w be a directed path from a flow object f_1 to a merging inclusive gateway

[361] Cf. Object Management Group (January 2008), pp. 93-94.
[362] Cf. Object Management Group (January 2008), pp. 47-48.
[363] Cf. Object Management Group (January 2008), pp. 47-48.
[364] Cf. Object Management Group (January 2008), pp. 47-48.
[365] Cf. Object Management Group (January 2008), pp. 47-48.
[366] Cf. Object Management Group (January 2008), pp. 47-48.
[367] Cf. Object Management Group (January 2008), pp. 94-95.

f_{i-1}, then it holds $w = \langle f_1, f_2, \ldots, f_{i-1}, f_i \rangle$ with $\langle f_j, f_{j+1} \rangle \in CS$ and $1 \leq j \leq i-1$ as well as $f_j \in F$ and $f_{i-1} \in FG_{IOR} \cap FG_Z$

$\exists f \in V: \{f: f \in FG_{IOR} \cap FG_V\}$: Let moreover the set V be defined as the set of the predecessor nodes in front of the merging inclusive gateway $V = \langle f_1, f_2, \ldots, f_{i-2} \rangle$ and let V be the subset of the set of flow objects $V \subset F$, then it holds that there is at least one predecessor node in the set V that is a diverging inclusive gateway.

Up to now, only the relationships and restrictions within a pool were observed. The scope is now widened to the BPD and the relationships within a BPD.

$Po = Po_1 \cup Po_2$: The example considered here will consist of just two pools. Any expansion to a greater number of pools would follow analogously.

$FA_1 \subseteq Po_1 \ \wedge \ FA_2 \subseteq Po_2$ if $Po_k \neq \emptyset$ with $1 \leq k \leq 2$: Each set of activities is a subset of the corresponding specific pool.

$FEM_k = \{FEM_{kStart}, FEM_{kEnd}, FEM_{kInterC}, FEM_{kInterT},\}$ with $1 \leq k \leq 2$: The set FEM_k consists of the set of the respective message events of Po_k.

$FEM_1 \subset Po_1 \ \wedge \ FEM_2 \subset Po_2$: The particular set of message events is a subset of its specific pools.

$M \subseteq (Po_k \times FEM_{1Start}) \cup (Po_k \times Po_1) \cup (Po_k \times FA_1) \cup (Po_k \times FEM_{1InterC}) \cup (FA_k \times FEM_{1Start}) \cup (FA_k \times Po_1) \cup (FA_k \times FA_1) \cup (FA_k \times FA_{1InterC}) \cup (FEM_{kInterT} \times FEM_{1Start}) \cup (FEM_{kInterT} \times Po_1) \cup (FEM_{kInterT} \times FA_1) \cup (FEM_{kInterT} \times FEM_{1InterC}) \cup (FEM_{kEnd} \times FEM_{1Start}) \cup (FEM_{kEnd} \times Po_1) \cup (FEM_{kEnd} \times FA_1) \cup (FEM_{kEnd} \times FEM_{1InterC})$, where $k \in \{1; 2\}$; $l \in \{1; 2\}$; $k \neq l$: This restriction shows which elements may be connected to one another through message flows.[368] It must be emphasized that elements within a given pool Po_k may not stand in a relationship to one another; rather elements from different pools may do so only.

The following predecessor-successor relationships pertain to the elements which can be connected to one another through message flows:

Let $\circ p = \{q: (q, p) \in M\}$ be the set of predecessor nodes of a specific pool p with $p, q \in Po$. If $Po_k = \emptyset$ holds, then it holds for the specific pool itself as an element; if $Po_k \neq \emptyset$ holds, then the condition holds for the pool process elements.

Let $p \circ = \{q: (p, q) \in M\}$ be the set of successor nodes of a specific pool p with $p, q \in Po$. If $Po_k = \emptyset$ holds, then it holds for the specific pool itself as an element; if $Po_k \neq \emptyset$ holds, then the condition holds for the pool process elements.

[368] Cf. Object Management Group (January 2008), p. 31.

If $\|Po\| > 1 \wedge Po_n = \emptyset$, then it holds that $\forall p \in Po_n$: $\|\circ p\| + \|p \circ\| \geq 1$: If the set of a specific pool consists of more than one pool then every pool p must have at least one predecessor node or one successor node.[369]

$\forall fem_{kStart} \in FEM_{kStart}$: $\|\circ fem_{kStart}\| \leq 1 \wedge \|fem_{kStart} \circ\| = 0$: Each start message event of a pool has no or exactly one predecessor node, but no successor node, whereby the predecessor node must be an element from another pool Po_n.[370]

$\forall fem_{kEnd} \in FEM_{kEnd}$: $\|\circ fem_{kEnd}\| = 0 \wedge \|fem_{kEnd} \circ\| \leq 1$: Each end message event of a pool has no predecessor node and no or exactly one successor node, whereby the successor node must be an element from another pool Po_n.[371]

$\forall fem_{kInterC} \in FEM_{kInterC}$: $\|\circ fem_{kInterC}\| \leq 1 \wedge \|fem_{kInterC} \circ\| = 0$: Each intermediate catching message event of a pool has no or exactly one predecessor node, but no successor node, whereby the predecessor node must be an element from another pool Po_n.[372]

$\forall fem_{kInterT} \in FEM_{kInterT}$: $\|\circ fem_{kInterT}\| = 0 \wedge \|fem_{kInterT} \circ\| \leq 1$: Each intermediate throwing message event of a pool has no predecessor node and no or exactly one successor node, whereby the successor node must be an element from another pool Po_n.[373]

6.4.3 Limitations and Changes

Since it is not possible to depict all elements or their syntactic relationships even with the foregoing formalisation, some changes to the BPMN specification had to be carried out. In addition, further changes were introduced in order to derive a simplified, clear and transparent formalisation of BPMN. The following changes or omissions were carried out in relation to the BPMN specification:

1. **Groups:** No lanes or groups were incorporated in the algebraic specification as it is difficult to allocate them to specific sets. Groups have a purely visual function and can contain various sets or elements. The algebraic concretisation of groups is therefore infeasible.[374]
2. **Expanded Sub Processes:** Only tasks and collapsed sub processes were included as activities, as these demonstrate equivalent behaviour.[375] Expanded sub processes are not incorporated as they would result in a further process level[376] and this would lead to less transparency and greater complexity in the formalisation.

[369] Cf. Object Management Group (January 2008), p. 99.
[370] Cf. Object Management Group (January 2008), p. 40.
[371] Cf. Object Management Group (January 2008), p. 43.
[372] Cf. Object Management Group (January 2008), pp. 48-49.
[373] Cf. Object Management Group (January 2008), pp. 48-49.
[374] Cf. Object Management Group (January 2008), p. 90.
[375] Cf. Object Management Group (January 2008), p. 63; p. 69.
[376] Cf. Object Management Group (January 2008), p. 56.

3. **Special Activities:** Similarly, the symbols ~, ↺, ‖, ◄◄ were not used because they serve only to identify the behaviour of an activity and are not elements of the BPD in their own right. If these are used to further specify a task, a maximum of two may be used, or in the case of a sub process a maximum of three, given that ↺ and ‖ cannot be used together.[377]
4. **Compensation:** Compensation and respective compensation events have been excluded in order to restrict complexity and minimise exceptions to the algebraic specification.[378]
5. **Transaction/Cancel:** The same is true for transactions which had to be omitted due to the fact that expanded sub-processes and compensation elements had already been excluded. The cancel event, which can only be used with a transaction element, has also been excluded.[379]
6. **Event-based Exclusive Gateway:** Activities can be connected beyond pools with message flows. This should be retained, but receiving tasks, which can contain messages, should not be allowed after an event-based exclusive gateway due to reasons of uniformity. An equivalent depiction is possible using an intermediate catching message event.[380]
7. **Start/End Events:** Start Events and end events are optional according to the BPMN specification. In order to retain a clear and unambiguous syntax, the use of start events and end events in a non-empty pool are made obligatory.[381]
8. **Gateways:** Similarly, for the sake of a clear and transparent formalisation, the possibility that start and end events or activities could possess multiple inbound or outbound sequence flows, or that gateways could serve both to merge and to diverge flows simultaneously, is not considered. An equivalent behaviour arises with corresponding gateway compositions.[382]
9. **Flows:** For the sake of transparency and reduced complexity, only the three essential connecting objects namely sequence flows, message flows and associations were incorporated in the formalisation. The conditional flow and the default flow are not taken into account. Conditional flows can be depicted identically through inclusive gateways.[383] Default flows are also optional in the BPMN specification. Due to the omission of this flow, the modeller must ensure that at least one edge provides for the continuation of the flow following a diverting exclusive data-based gateway or inclusive gateway.[384]

[377] Cf. Object Management Group (January 2008), p. 64.
[378] Cf. Object Management Group (January 2008), p. 129.
[379] Cf. Object Management Group (January 2008), p. 62-63.
[380] Cf. Object Management Group (January 2008), p. 78.
[381] Cf. Object Management Group (January 2008), p. 37, p. 41.
[382] Cf. Object Management Group (January 2008), p. 71.
[383] Cf. Object Management Group (January 2008), p. 113.
[384] Cf. Object Management Group (January 2008), p. 75; p. 98.

6.5 Reference Processes

The reference task model developed above needs to be suitably applied in order to achieve usable and detailed organisation-specific variants of supply chain processes. This adaptation is done exemplarily in case examples in the following, distinguishing emergency and post-emergency operational contexts and standard as well as non-standard items. Rather than trying to achieve completeness, the construction of the exemplary reference processes has the objective to show the flexible application of the reference task model. The examples include some of the most commonly found processes in humanitarian supply chains.

6.5.1 Operational Scenarios

In the following, three different scenarios will be distinguished: Emergency operations are distinguished from post-emergency operations due to the different supply chain processes taking place in either of these two phases. Secondly, processes will further be discriminated by standard and non-standard goods. The case of emergency operations and handling non-standard goods is excluded since this case should be avoided by organisations and only occurs infrequently in practice (Figure 43).

While the distinction between emergency and post-emergency operations is decisive for the logistics processes, it has been shown that the distinction of the logistics response according to the nature or type of disaster is largely irrelevant.[385]

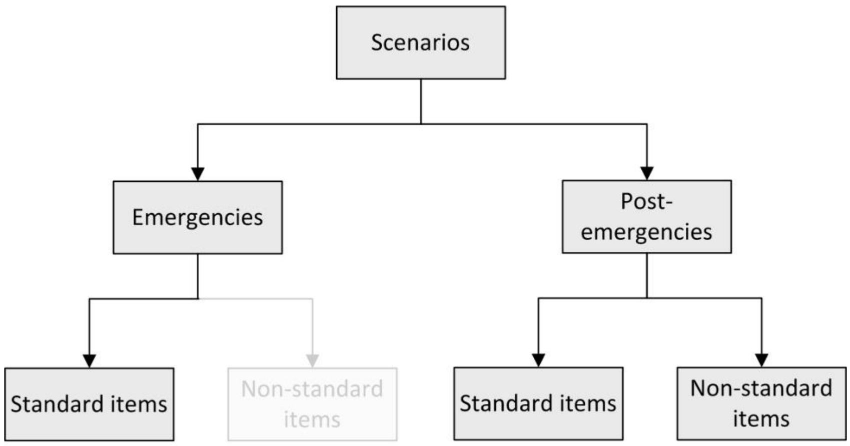


Figure 43: Scenarios for reference processes

6.5.1.1 Emergency and Post-emergency Logistics

Humanitarian operations go beyond the initial disaster response and often experience a period of more or less steady operations in relatively stable environments. Thus, humanitarian supply chains need to operate following two distinct paradigms. While in the immediate aftermath of a disaster, humanitarian organisations need to provide assistance rapidly and responsively, the importance of this paradigm shifts to more effi-

[385] Cf. Schillemans (2007), p. 2.

ciency and process reliability in the later phases of the humanitarian operation. Thus, humanitarian supply chains need to both deliver their goods and services in a turbulent and often chaotic environment and also plan and deliver assistance in a stable way over a medium-term time horizon.

Emergency operations are characterised by a high degree of uncertainty and frequently volatile and chaotic environments; this slowly calms down towards the end of the emergency humanitarian operations phase, which is when the post-emergency phase begins. Towards the end of this phase, humanitarian organisations' efforts begin to focus on handing over the relevant operations either to local organisations or development agencies. Supply chain processes within theses phases can be different both in terms of chronological order and content: In the case of emergency operations, for instance, pre-positioning of stocks can lead to a reduction or even omission of procurement processes; distribution processes can be multi-staged in target areas; warehousing can be duplicated both in central warehouses on possibly more than one continent as well as within a target area.

The (acute) emergency phase usually lasts from the initial onset of a disaster for roughly 4-6 weeks. Sometimes the acute emergency phase can be shorter, e.g. in effective Ebola emergency interventions; on the other extreme, emergency phases can also be considerably longer, e.g. in complex political emergencies, civil war and some post-conflict settings. During this phase the basic needs of the affected community are not covered: Health systems have broken down, basic infrastructure such as transport, water, electricity and telecommunications are not functional or severely damaged. There is usually a high risk of epidemics and high insecurity. The crude mortality rate is above 1/10.000 persons per day; risk of malnutrition is high. The overall objective of humanitarian operations during this phase is to meet the immediate needs of the affected community and to reduce the crude mortality rate. Table 11 shows a summary of the characteristics of emergency situations.

Table 11: Characteristics of the emergency phase

Time period	**0 – 2 months**
Situation	Basic needs are not covered Mortality rate >1/10.000 persons per day High risk of epidemics Usually high risk of insecurity Lack of coordination
Objectives	To meet the basic and immediate needs of the population rapidly and effectively and thus reduce the mortality rate

In the emergency phase the humanitarian supply chain is characterised by a fast main haul, yet slow distribution. Pre-positioning of stocks can lead to a reduction or even omission of procurement processes; distribution processes can be multi-staged in target areas; warehousing can be duplicated both in central warehouses on possibly more than one continent as well as within a target area. Inconsistent packaging and the need for loading and unloading devices further drives transportation complexity. Suggestions have been made concerning better labelling and the organisation of a multi-layered transport network as well as the reduction of bottlenecks.[386] In the emergency phase it may be necessary to hire local personnel to support the operations, i.e. for warehousing, loading and unloading of vehicles and distribution of items and delivery of services.[387] Especially in the early stage of the emergency response, tracking and accounting for the items distributed is problematic.

The erratic and volatile demand which is present during the emergency phase slowly calms down towards the end of this phase, which is when the post-emergency phase begins. During this phase, the most urgent and life-saving needs of the affected community are covered, and basic infrastructure such as water, transport, electricity, and telecommunication services have become functional again. Public health care facilities offer health services to the affected population. Basic indicators such as mortality and morbidity return to their pre-disaster levels. Mortality has fallen to less than 1/10.000 per day. The threat of epidemics has declined and security threats might no longer be present. During this phase, the objective of humanitarian operations is to further reduce mortality and morbidity, to reduce the expatriate staff present in the projects, and to focus efforts on deriving and implementing preparedness plans. Programmes tend to become rather vertical, i.e. specialise on treatment of tuberculosis, HIV, mental health, mother-child-health care etc. Table 12 shows a summary of the characteristics of post-emergency situations.

Table 12: Characteristics of the post-emergency phase

Time period	**2 – 6 months**
Situation	Basic needs are covered Mortality rate <1/10.000 persons per day Reduced risk of epidemics Usually reduced risk of insecurity Coordinated humanitarian operations
Objectives	To further reduce the mortality rate of the affected population while reducing presence of expatriate staff; preparation of preparedness plans and exit strategies.

6.5.1.2 Standard and Non-standard Items

Humanitarian organisations employ pre-defined standard item catalogues and programme standard item lists to support both their responsiveness in the emergency phase

[386] Cf. Tufinkgi (2006).
[387] Cf. CARE (2008), p. 4.

as well as the cost-efficiency in the post-emergency contexts. The objective behind distinguishing standard and non-standard items is to reduce lead-times for the most essential products (standard items) by making a distinction between products which can be routinely procured and supplied and other non-standard articles. This distinction is made in various processes and especially at an early stage of the ordering process in order to guide the ordering process accordingly and give the field an indication of probable lead times. The distinction between these two scenarios will enable organisations to focus on improving the standard assortment and thus will make supply more efficient and help to decrease lead times because non-standard items are not blocking the regular ordering process. Having a standardised assortment facilitates the supply process and also facilitates framework agreements with suppliers.

While standard items are routed through the procurement department of the humanitarian organisation, non-standard items are not. Thus, competencies are clearly separated and an efficient flow is ensured for standard items, which are the most frequently requested items and the only item class which can be ordered in emergencies. The number of non-standard items should be minimised as much as possible since sourcing and purchasing these kinds of items will inevitably lead to delays in the ordering process. The typical number of standard items for a humanitarian organisation will be around 1000-3000 products. The number of non-standard items can vary extensively and amount between 1000-7000 products.[388] It is suggested to keep a database with standard items. Thus, all items not contained in this database are by definition non-standard items.

6.5.2 Identify Demand

New operational demand, i.e. demand which is not based on previous consumption data in regular operational programmes, is determined – on a high level – through two fundamentally different ways. Usually, a high degree of decision autonomy is delegated to the regional operational centres and most decisions within the scope of assessment are taken at these regional centres. After the decision has been taken that a needs assessment will take place, i.e. after some indication of possible uncovered needs that fall within the operational policy and programme strategy of the organisation has been received and after a pre-analysis of possibly available budget has been considered, two different processes may apply depending on the location of the possible operational site.

In post-emergency contexts regular assessments are conducted in order to ascertain that the programmes are always adapted to the needs. The default process to identify new demand is thus the deployment of an exploratory team to the area where new demand is suspected. Basic information concerning the regular programme and demand, the vulnerability of the community, already covered needs, local resources and capacities

[388] Cf. the item catalogues published by the humanitarian organisation Médecins sans Frontières or the publicly available item catalogue from the International Committee of the Red Cross and Red Crescent Societies (ICRC).

etc. are already known. The exploratory team normally consists of regular staff with possibly one specialist from headquarters. The exploratory team tries to identify the needs and number of beneficiaries which are not yet covered in the regular programmes.

In case the operational demand is not yet known, i.e. there are no operational sites nearby or previous demand data available, an emergency team is deployed to that area. Here, little or no operationally important information on the area or the affected community is available. The emergency team comprises of experts on the assessment procedure as well as technical experts based on the expected needs of the community. The emergency team carries out several tasks in parallel, including the identification of needs and number of beneficiaries but also an assessment on the type and magnitude of the disaster that has taken place or is taking place in the area. Further information needs to be gathered, depending on the amount of information that is already available. This information can include an assessment of the local capacities, local resources and local sources of supply.

Once these assessments have been completed, the resulting net needs of the community have to be prioritised according to the organisation's programme strategy within that operational area and available budget. Goods need to be requested and the sourcing of these goods follows. At this point, the reference task model is not detailed enough to be able to capture the process details. Thus, further details of the sourcing process will be developed in the following section. The entire process "Identify Demand" is depicted in Figure 44.

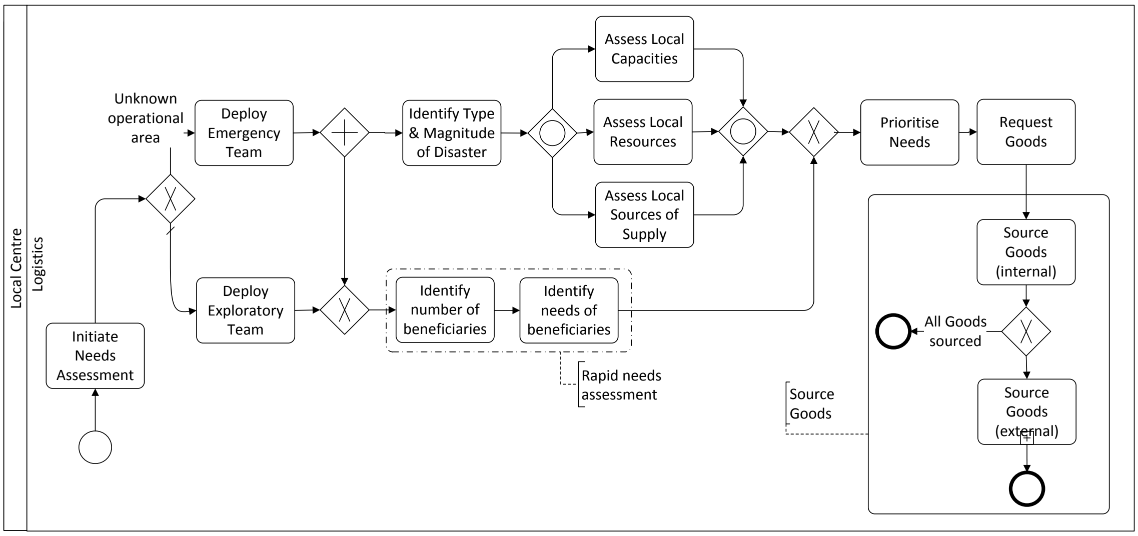


Figure 44: Process "Identify Demand"

6.5.3 Rapid Needs Assessment

The rapid needs assessment process is comprised of a number of tasks. These tasks are elaborated here in more detail since needs assessment is a core competence of humanitarian organisations conduction operations in emergency contexts.

Rapid needs assessments provide an understanding of the emergency situation and an analysis of existing threats to life, health and livelihoods of members of the affected community in order to assess whether an external response is required and, if so, the nature of the humanitarian operation necessary.[389] Although comprehensive assessments consider all technical sectors, i.e. water and sanitation, nutrition, food, shelter and NFI, and health care, together with the physical, political and security environment together, the process has been restricted here in such a way that those activities relevant for logistics and supply chain management are covered.

The need for standardisation of the rapid needs assessment process is apparent since humanitarian organisations have to be able to react rapidly and effectively in acute emergency contexts. The initial assessment in an emergency situation should be completed within days after the situation has been triggered. The format and content of the assessment should allow stakeholders to identify priorities, net needs of the affected community and take operational decisions. During the assessment process, a mix of quantitative and qualitative methods which are appropriate in the context are selected to be used.

The number of affected people requiring assistance will determine all other estimates and calculations, and therefore, needs to be established as precisely as possible. Total population should be included and disaggregated by age and gender. Estimates of population numbers should be cross-checked with a variety of sources in order to achieve a higher validity of the outcome.

In general, a multi-sectoral assessment is carried out which takes into account the needs of the affected community in the following areas: Water, sanitation and hygiene promotion; food aid and nutrition; shelter and NFIs; and health care. Key questions which need to be addressed when assessing these areas will be elaborated in the following.[390]

Identify water and sanitation needs: Current and possibly future water- and sanitation-related diseases; Current water sources and users; Availability of water per person per day; Sufficiency of water for both short-term and long-term needs of the affected community; Necessity of type and quantity of water treatment including disinfection and decontamination; Identification of key hygiene issues; Identification of vector-borne disease risks and assessment of these risks; Current defecation practice; Expected further development of current needs.

Identify shelter and NFI needs: Number of people in a typical household; Separation of groups within the affected community which have different shelter/NFI needs such as unaccompanied children or minority groups; Number of households without adequate shelter; Number of people without adequate shelter; Short-term and medium-term risk of lack of shelter or inadequate shelter with respect to lives, health, and security; Suitable designs of both initial and medium-term shelter solution based on existing materials; Typical building practices in the present context; Assessment of alternative design

[389] Cf. The Sphere Project (2004), p. 29.
[390] Cf. The Sphere Project (2004).

and material solutions; Current material, financial and human resources of the affected households and community; Expected further development of current needs.

Identify nutritional needs: Effect of crisis on sources of foods and income for each of the identified different groups within the affected community; Seasonal patterns of food security; Access to markets; Market availability and prices of essential items; Coping strategies of the affected community including short-term and medium-term effect of these strategies on health or other risks; Nutritional Survey; Risk of malnutrition related to poor public health, inadequate care, or inadequate food access; Needs of clothing, blankets and bedding; Short-term and medium-term risk of lack of adequate clothing, blankets or bedding; Needs of essential items of personal hygiene; Needs of cooking and eating utensils; Needs of basic tools for construction, maintenance or repair; Expected further development of current needs.

Identify health care needs: Determine total number of people in the affected community and proportion of children under five years old; Determine age and sex breakdown of the population; Identify groups at increased risk, e.g. (pregnant) women, children, elderly, disabled people, injured people or members of certain ethnic, social or other minority groups; Determine average household size; Identify pre-existing health problems prior to the emergency; Identify existing risks of epidemics; Calculation of crude mortality rate; Calculation of cause-specific and group-specific mortality rates; Determine group-specific mortality rates; Expected further development of current needs.

During the assessment of all of the above areas, various sources of information are tapped. The first source of information should be primary sources including direct observation and interviews and conversations with representatives of the affected community. Moreover, representatives from local authorities, health staff, teachers, traders and other relevant actors should be considered. Lastly, secondary sources such as existing literature and reports as well as relevant historical material and pre-emergency data are needed to complete the assessment report.

Identified gross needs have to be balanced with local resources and capacities before net needs can be deducted. In all of the technical areas discussed above, it is important to compare the prevailing situation with the pre-emergency data which can serve as a baseline. The objective of the humanitarian operation is to re-enable self-sufficiency of the affected community on pre-emergency level.

The rapid needs assessment also takes into account the responsibility of relevant local actors to protect and assist the affected community. Furthermore, national law, standards and guidelines applicable need to be considered when calculating gross needs.

The assessment also includes an analysis of the operational environment which aims at both deducting net needs of the affected community and needs for operational support resources and equipment.

Findings of the rapid needs assessment are shared with other stakeholders internal and external to the affected community. This includes other sectors, national and local authorities, other governmental and non-governmental organisations and representatives of the affected community.

Outcome of the rapid needs assessment process are the deducted but unprioritised net needs of the affected community. Recommendations are given concerning the need for external assistance, and on appropriate humanitarian operations. These recommendations should already include possible exit strategies, i.e. take into account the entire humanitarian operations life-cycle. This information provides the basis for deciding on launching any immediate humanitarian operation and its scope. Furthermore, areas are identified on which a more detailed assessment should be carried out. The rapid assessment must not be seen as a singular event but rather as a first step in a continuous process of reviewing and updating beneficiaries' needs. This is crucial especially at the beginning of sudden-onset disasters or if there are critical events such as the movement of large populations or at the onset of an epidemic.

Rapid needs assessments are frequently carried out in highly insecure environments and under high time pressure. Hence, not all sectors or local stakeholders can always be appropriately involved in the process. This fact should be clearly noted in the findings and be followed-up upon at a later stage.

The overall rapid needs assessment process is displayed in Figure 45.

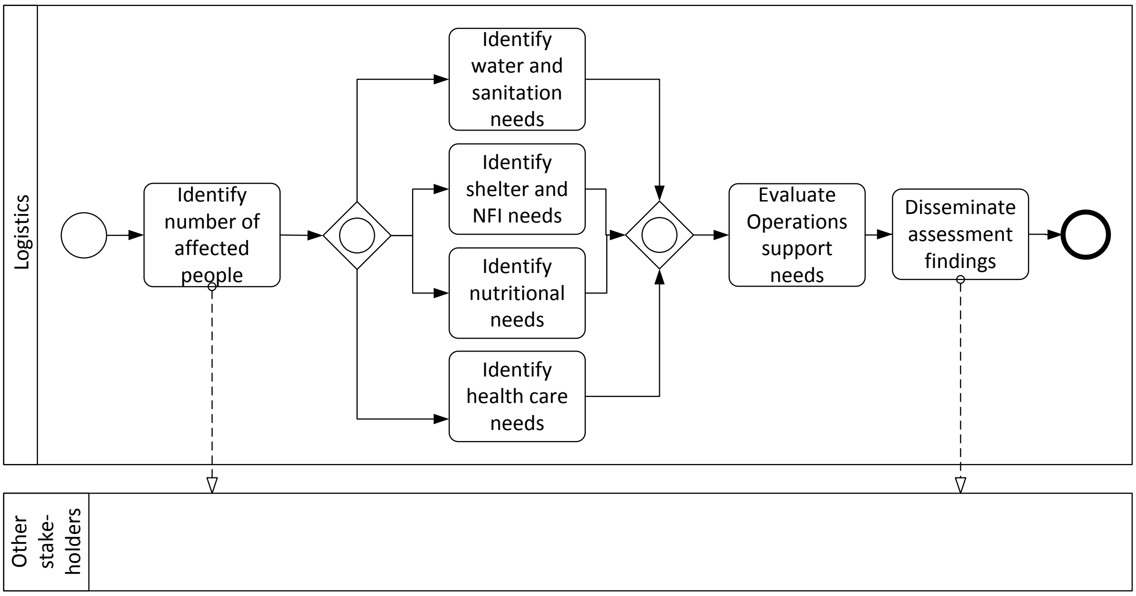


Figure 45: Process "Rapid Needs Assessment"

6.5.4 Source Goods

Most humanitarian operations are conducted in remote places with poor infrastructure. Thus, many logistical processes are paper-based if suitable IT systems have not yet been implemented. Employees of humanitarian organisations frequently do not use the appropriate standard forms when ordering goods. Moreover, employees are often unclear about their competencies, especially with respect to the order line value they are empowered to purchase locally. Thus, the sourcing process will be developed in more detail in the following, beyond the level of detail delivered by the reference task model. Moreover, links to all reference documents necessary in the process will be displayed.

Goods are requested by using order request forms. These forms are transmitted via email or paper-based to the super ordinate level in the supply chain. Once the order request has been received by dedicated logistical staff at the upstream supply chain tier, it is checked for accuracy, completeness and consistency. Specifically, order header and footer information is checked for administrative purposes, i.e. consecutive order numbers, date, possibly budget reference numbers etc. If any information is missing, open questions remain and data on the order request form seems dubious, further information is requested at the field level. In order to minimise these time consuming iterations which cause a lot of delay in the ordering process, care should be given when completing the order request form. Once all the information in the order request form has been provided and checked, every order line is compared with the item database or Standard Item Catalogue. Within this catalogue, all items for which standard specifications, prices, and in some cases pre-qualified suppliers exist, are listed.

The type of item, i.e. whether the item is included in the Standard Item Catalogue or not, determines the further process. Non-standard items or items which require specification, e.g. drugs, specialised technical equipment, or items for which import restrictions exist, have to pass the justification procedure (not shown in detail here) using a special justification form. If justification fails, the downstream tier in the supply chain is informed and the ordering process cannot be completed successfully. If justification is successful, the ordering process continues directly with the initiation of an international purchase procedure. This international purchase procedure requires the documents order request and international purchase order (IPO). International purchase is directly routed to headquarters and is handled by the logistics department (not shown in detail here).

If the item does not need justification and is included in the Standard Item Catalogue, an altogether different kind of routing is followed. The following procedure is reiterated for each order line. Local availability is checked. This can include availability in the local warehouse but also availability at local suppliers or other organisations. If the item is not available locally, a purchase order is issued based on the order request. If the item is available locally, the availability in the local warehouse is checked further. If the item is available in the local warehouse, a simple stock request form is issued and the item can be sourced from the local warehouse. If the item is not available in the local warehouse, but may be purchased locally and has an order line value less than the set threshold of 250€[391], a purchase order is also issued and the item can be purchased locally. It needs then to also be set on a stock request in order to ensure consumption data integrity at the warehouse.

[391] The values for the thresholds are set arbitrarily but reflect common values in medium-sized humanitarian organisations.

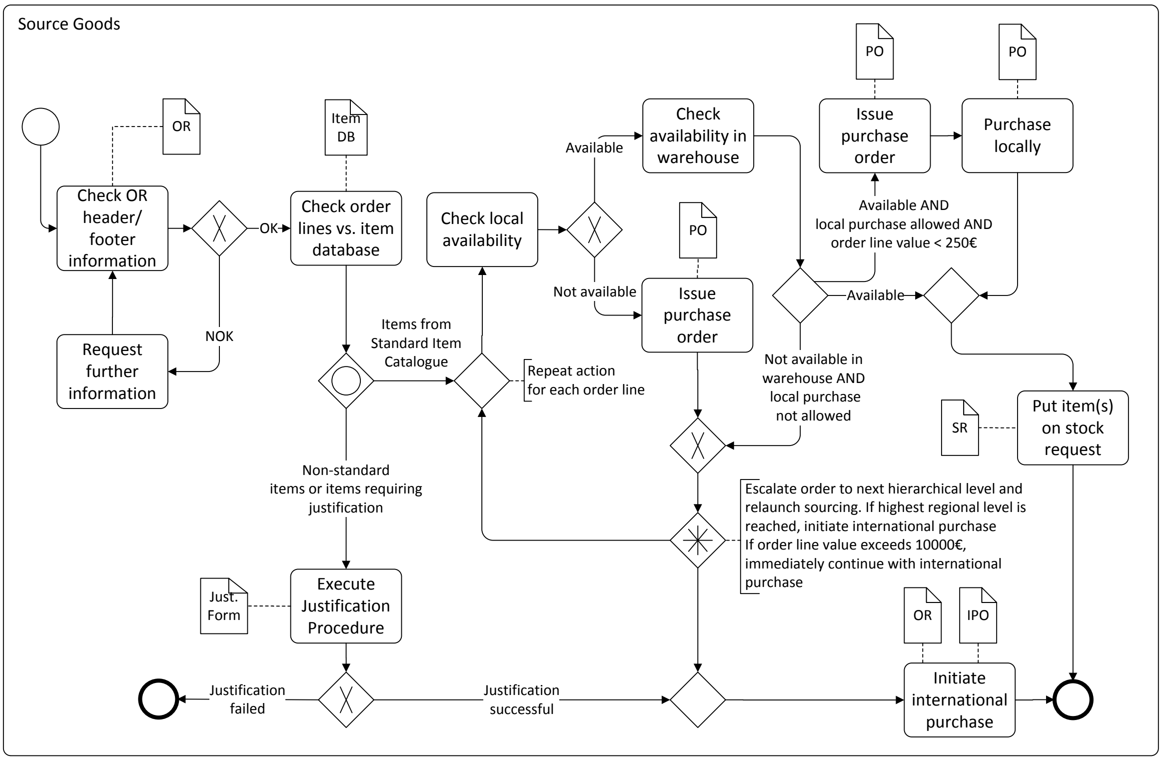


Figure 46: Process “Source Goods”

If the item is not available locally, local purchase is not allowed[392], or the order line value exceeds the set threshold of 250€, the item is escalated to the upstream tier in the supply chain and the sourcing process is relaunched. When the highest tier of the supply chain below the organisation’s headquarters is reached or order line value exceeds the set threshold of 10.000€, international purchase is initiated and the international purchasing process is continued at headquarters level.

The entire process for sourcing goods is displayed in Figure 46.

6.5.5 Order Goods

Most of the goods humanitarian organisations provide are not available directly where they are needed but rather require regional or even international purchasing as has been elaborated in the previous section. Although operations are geared towards the beneficiaries, the beneficiaries themselves do not have direct influence on the design of the supply chain structure and processes, since they do not pay for the goods and services they receive. Thus, ordering is also not directly triggered by the beneficiary but by local employees of the organisation.

The ordering process can be initiated by regular monitoring of stock levels and comparing them to preset minimum stock level. Generally speaking, local sourcing is preferred before the order is escalated to super-ordinate organisational units. All orders should be received and processed by dedicated supply staff. Any order from the local centres or

[392] This can be due to a number of reasons including quality assurance policy, price or other economic considerations or supplier unreliability.

operational sites of the organisation should be treated according to the order priority status. After a check for completeness and soundness, orders are processed preferably electronically to support accountability and supply chain transparency. Order databases are used to secure data integrity and to guarantee proper follow up of outstanding order lines. Upon the reception of an order, the field employees should receive an acknowledgement that the order has been processed and be regularly updated with the order status including additional information such as local availability, expected dates of delivery, mode of transport, contents and overall weight and volume of shipments. If urgently needed items are not available locally, suitable substitutes should be suggested. Order lines may be closed only upon confirmed arrival of the goods at the local operational site. These kinds of confirmations are also an indispensable support for humanitarian organisations' accountability towards donors.

Due to quality issues in many operational countries, specialised and high-value equipment as well as sensitive goods need to be procured internationally at qualified suppliers.

Best practice is to download the latest version of the Standard Item Catalogue from an internet server when made available by the headquarters logistics department. After updating the latest Standard Item Catalogue, the regular ordering process begins. This applies to both local and regional level, depending on where the ordering process is started. The field is responsible for regularly updating the Programme Standard Item List.

The ordering process starts when a need for a specific item or a number of items arises. This need can arise due to various assessment activities such as "Forecast Demand" or "Identify Needs and Number of Beneficiaries". The process displayed here is for one item only but can also deal with an entire order in which the items are separated according to their status (standard or non-standard), priority and type. Before a non-standard item can be ordered it needs to be validated and possibly specified and sourced. Thus, a non-standard item becomes orderable.

Items are separated early in the ordering process according to their status: Items which are included in the Standard Item Catalogue and Programme Standard Item List and which cannot or may not be purchased locally are ordered at the regional centre of the organisation. If possible, goods will be purchased there. Remaining items are ordered with headquarters where the regular purchasing process for standard items is followed (not displayed here).

Items which are included in the Standard Item Catalogue but not in the Programme Standard Item List have to be ordered with the regional centre where goods may be purchased. If items remain, a supplier quotation is requested for the remaining items and sent to headquarters indicating the type of items such that the request can be routed to the responsible specialist.

For items which are not included in the Standard Item Catalogue and thus also not in the Programme Standard Item List a supplier quotation request is sent to the regional centre where goods may still be purchased. If items remain, the supplier quotation request is forwarded for the remaining items and sent to headquarters indicating the type of items such that the request can be routed to the responsible specialist.

The field part of the ordering process for standard and non-standard items is displayed in Figure 47.

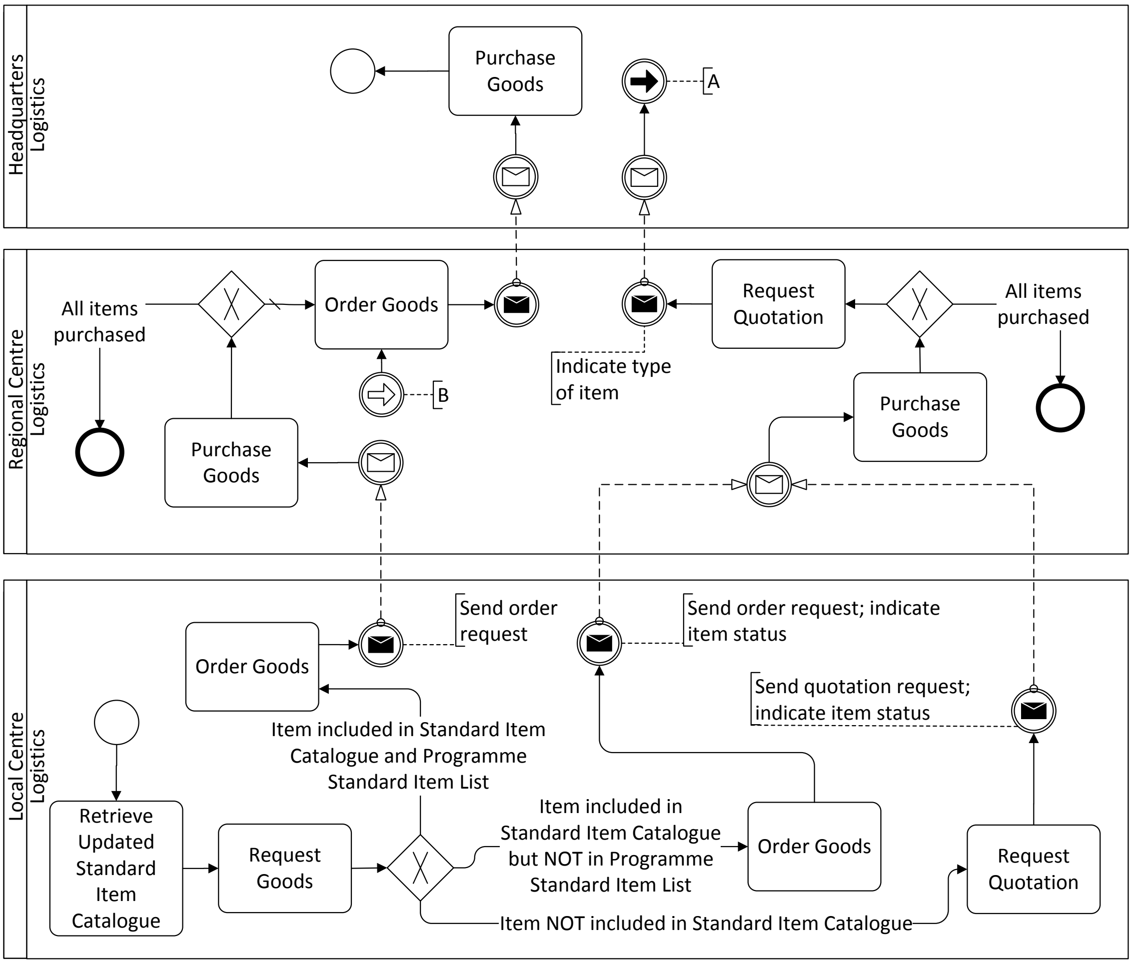


Figure 47: Process “Field Ordering”

The headquarters of the humanitarian organisation regularly updates the Standard Item Catalogue and makes an updated version of the Catalogue available to all operational sites via an internet server. This Standard Item Catalogue should ideally contain all goods required by operations, including all items in the Programme Standard Item List. Having a standardised assortment facilitates the supply process, improves lead times and facilitates concluding purchase agreements with suppliers.

All items not contained in the Standard Item Catalogue are by definition non-standard items. Non-standard items cannot be ordered directly through the procurement department, but follow another process as elaborated in the following. Requests for non-standard items are routed to the appropriate specialist, i.e. health specialist, water and sanitation specialist or general logistics specialist. The specialist investigates whether the requesting project has good reasons to order the item and has to give his consent when validating the order from the field.

Items which are contained in the Standard Item Catalogue but are not included in the Programme Standard Item List can be validated by the specialist directly. If the specialist believes that the request is valid (and no alternative exists on the Programme Standard Item List), they will inform the regional centre that the order is validated and contact the procurement department with the necessary specifications and ask the appropriate procurement officer to source the item. This is either done as a one-off purchase or as permanent addition to the Programme Standard Item List. They will furthermore inform the field that procurement will communicate to them when they have sourced the item. If the specialist does not consider it to be a valid request, they will contact the above mentioned field staff and explain why the request cannot be met.

Items which are not contained in the Standard Item Catalogue (and thus also not in the Programme Standard Item List) are validated upon the advice by the specialist by the head of department. The specialist indicates whether the item is suitable and necessary considering the operational context. If that is the case, they will elevate approval to the level of the head of department at the task "Validate Customer Order (non-standard)". If the request is approved, the field is informed and the procurement department is contacted with the necessary specifications (including information on whether the item needs justification, is a one-off purchase or a structural addition to the Standard Item Catalogue). The appropriate procurement officer will try and source the item. They will furthermore inform the field that procurement will inform them when they have sourced the item. If the specialist does not consider it to be a valid request, they will contact the abovementioned field staff and explain why the request cannot be met.

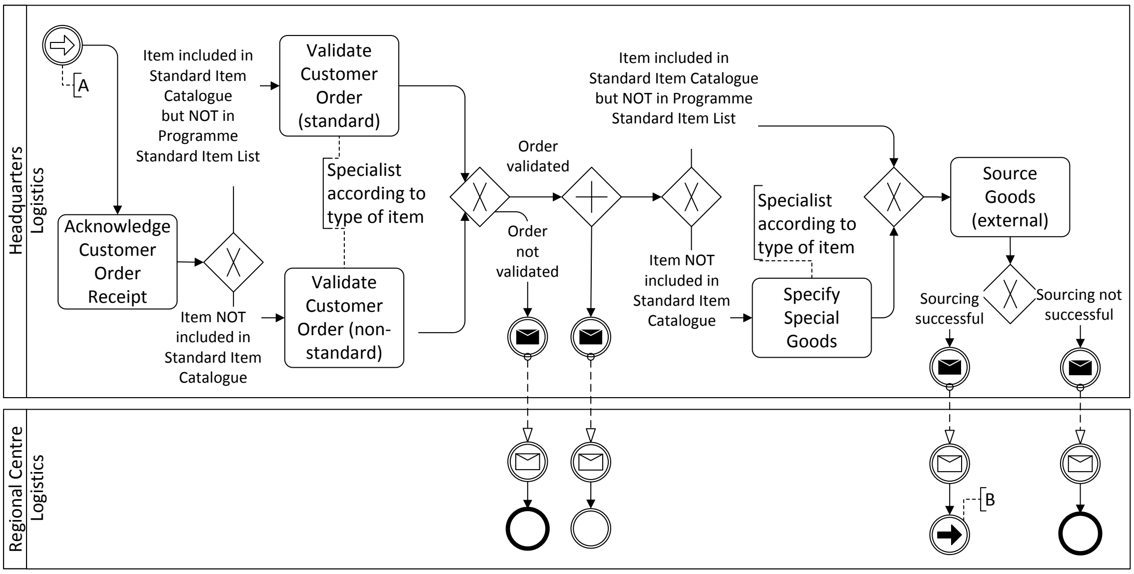


Figure 48: Process "International Ordering"

The procurement officer will inform the field that the item has been sourced and put on the Programme Standard List. The procurement officer will also communicate details like justification and whether the item is a one-off and, in case of an item with a new item code, provide the article file in the right format to be included in the item database. One-offs, including their spares and maintenance parts, should be taken out of the

Programme Standard Item List as soon as they have been processed. Procurement officers are responsible for this process. The headquarters ordering process for standard and non-standard items is displayed in Figure 48.

6.5.6 Purchase of Goods (Local)

Depending on the nature of the humanitarian operation, a large fraction of goods can potentially be procured locally. In practice, this includes mainly goods for construction projects and commodities but can encompass all varieties of humanitarian assistance goods. The process "Purchase of goods (local)" covers the local purchase of goods, i.e. domestically and in proximity of the operational site. Hence, it is applicable to the local and central logistics level in a specific operational country. The objective of this process is to ensure the quality of the local purchasing process.

The process applies to all goods which can be sourced and purchased locally except medical goods. Purchase of medical, pharmaceutical and chemical goods need special authorisation by qualified personnel. Furthermore, high value goods such as vehicles, communication equipment, computers and energy stabilisation equipment are recommended to be purchased internationally. For these kinds of goods specific processes need to be defined.

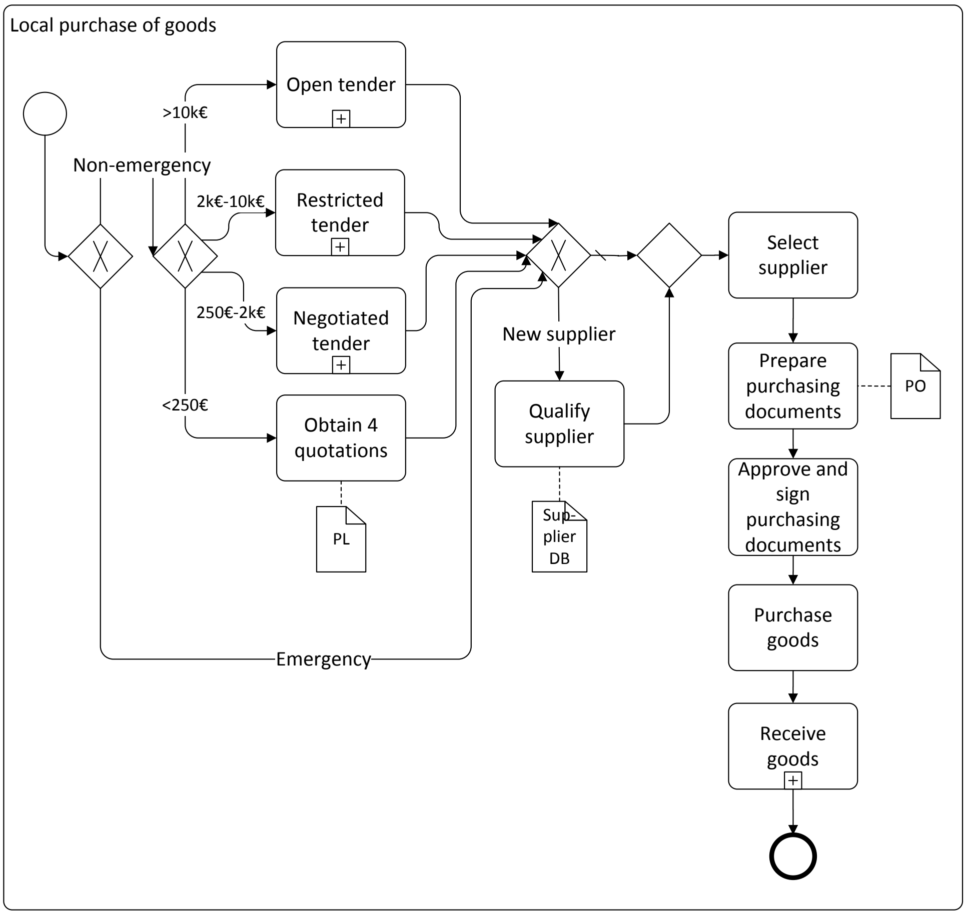


Figure 49: Process "Purchase of Goods (Local)"

After demand has been identified and the decision that goods need to be purchased has been taken, the overall value of the goods needs to be determined. If prices are unknown, the standard item catalogue can help determine an indicative price. Depending on the value of the goods, a different tender process is followed. The decision values as displayed in Figure 49 are recommendations only and depend on the overall budget of the humanitarian organisation, as well as the context of operations. If the overall value of does not exceed 250€, no tender process may be necessary. Rather, the purchasing list can be used to obtain four quotations. Further sub categories can be defined below this threshold, such as a restricted quotation process (not displayed here).

Beyond this lowest threshold, a formal tender procedure needs to be followed. This could either be a negotiated tender, a restricted tender, or an open tender. The open tender process is displayed in Figure 50. The tender notice needs to be published openly and widely in publicly accessible media. The tender notice needs to stay open for a period of 21 days during which requests for information can be received. These requests will be collected during the open period of the tender notice. After the tender notice has been closed, tender details are sent to all suppliers which have requested to take part in the tender during the open period. Among detailed information on the goods or services which are subject of the tender, the tender details also include the criteria which will be used to assess the incoming offers. These criteria can include weighted considerations of quality, price, service, and reliability.

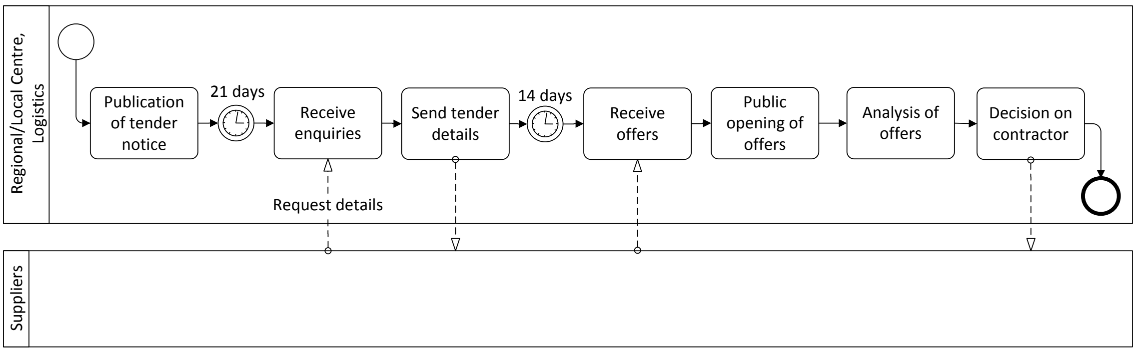


Figure 50: Process “Open Tender”

The suppliers then have the possibility to submit their proposals during a period of 14 days. All proposals will be opened publicly after the period to submit proposals has expired. Offers are subsequently analysed according to pre-defined criteria. The offer which achieves the highest score based on the criteria will be selected and the contractor will be noticed.

During emergencies, the tender thresholds may be altered or omitted altogether. In these cases, only pre-qualified suppliers may be contacted for purchasing contracts.

When a supplier or suppliers for the goods have been chosen, new suppliers need to be qualified first. When selecting suppliers, it needs to be ensured that sources that are suspect of involvement in sales of stolen or looted goods or of producing goods using forced labour and/or child labour are excluded from the selection. Also, conflicts of interest, preferential agreements and discrimination in the organisation and execution of local purchases should be excluded. Suppliers should also be accessible, especially in case that an emergency purchase needs to be made. Suppliers also need to be flexible in terms of special requests and sudden changes in demand volume. Especially during emergencies, it becomes critical that suppliers are able to provide suitable substitutes if necessary. General stock availability of items should be ascertained. Also, conditions and length of warranties, overall order cycle times, variability of lead times, historical service levels, capacity to expedite shipments, response to claims and complaints, returns procedure, and other criteria might be included in the selection criteria.

Based on the outcome of the tender process and the supplier qualification process, a suitable supplier is selected. Subsequently, the necessary purchasing documents such as a purchase order together with a purchasing list are prepared. The purchasing documents need to be approved and signed before goods can be purchased. Purchased goods will have to be received at a warehouse, which is subject to a process elaborated in the following section.

6.5.7 Receive Goods

Incoming shipments, either as a result of a local purchase or an international order are received at the warehouse entry. In case of an international shipment, the reception of goods can be planned for through an announcement of the target arrival date sent by the regional centre or headquarters logistics department. Thus, warehouse space can be planned for and liberated if necessary. Incoming shipments are routed to the receiving area, which is located ideally close to the entrance of the warehouse. Incoming shipments report to the receiving area, and persons from this area would supervise (possibly external) drivers during their time in the warehouse.

Only a limited number of individuals should be authorised to receive supplies at the warehouse. Through these properly authorised individuals, goods must be checked to see that they comply with the specifications of the purchase order/shipping documents. This is particularly important for goods which have been ordered for a specific purpose, rather than for general distribution. Immediately upon unloading of shipments, goods requiring special storage conditions, such as cold chain items, drug products or goods with high value or otherwise highly sensitive goods should be separated and processed with high priority. The number of parcels (inspection of quantity) is checked first when unloading before signing the transport documents for receipt (waybill). Following this, a more detailed control process is performed which incorporates the packing list and a more thorough inspection, if required by specialists.

If, on receiving supplies from a local source, some items are found to be missing or damaged, the defective packages should be segregated immediately. Where parcels are obviously damaged on the outside, the contents should be checked carefully. If it is not possible to check the contents immediately, the receiver should make a respective note on the waybill. The receiver may choose to deny reception of goods if they are damaged. Alternatively, the receiver may qualify the signature on the waybill by writing a comment. Once the loss or damage is verified, the sender or supplier is notified. The sender/supplier can then make a claim against the carrier if applicable, or replace or reimburse the damaged items.

The initial check of incoming shipments is finalised by a signature on the waybill. The waybill serves two different functions: It provides for the carrier taking responsibility for delivering the goods to sign for them; and it provides for the consignee to acknowledge receipt, noting the condition of the goods received and any specific shortages/damages. Waybills should be numbered sequentially and are normally produced in triplicate. One copy, bearing the original signature of the immediate recipient (transporter), is retained for the warehouse records. The original and one further copy accompany the shipment. The consignee will retain the original and the duplicate is returned via the carrier, to the sender as a final receipt and proof of delivery.

Upon the waybill is signed and the carrier released of its responsibility, the packing list need to be counterchecked with the items contained in the parcels. The same procedure applies as before: Once evident, the defect should be verified immediately and a claim procedure is initiated without delay.

The fact that goods have been lost or damaged can affect operations or procurement plans. Reports of lost or damaged items should be detailed and accurate, and may have to be circulated to a number of stakeholders.

When inspecting goods, a distinction needs to be made between goods which can be checked without special qualification and goods which require special qualification to be checked. The first category comprises goods such as blankets, plastic sheeting, etc. These can be checked by comparing them with sample items kept for this purpose. The seconding category includes medicines, pharmaceuticals, generators, IT equipment, etc. Here, a general check of the packing materials for pilferage and damage can be carried out, but the parcels themselves should not be opened until someone qualified is available to do so.

Inspections should be both quick and thorough. Supplies should be kept in the receiving area for the shortest time possible for the following reasons: Goods in receiving areas are not yet entered into the information system and are thus not available to operations; likewise, goods cannot be issued until they are inspected and placed in stock; goods are more likely to be pilfered or damaged in the receiving area; and the reception/outgoing areas are frequently physically one and the same location leading to the chance of congestion if goods are not moved from the receiving area into storage.

Lastly, all the information acquired during the receiving process is entered into the information system. This should be done as quickly as possible after a shipment has been received in order for the goods to become available to operations. The entire reception process of goods is displayed in Figure 51.

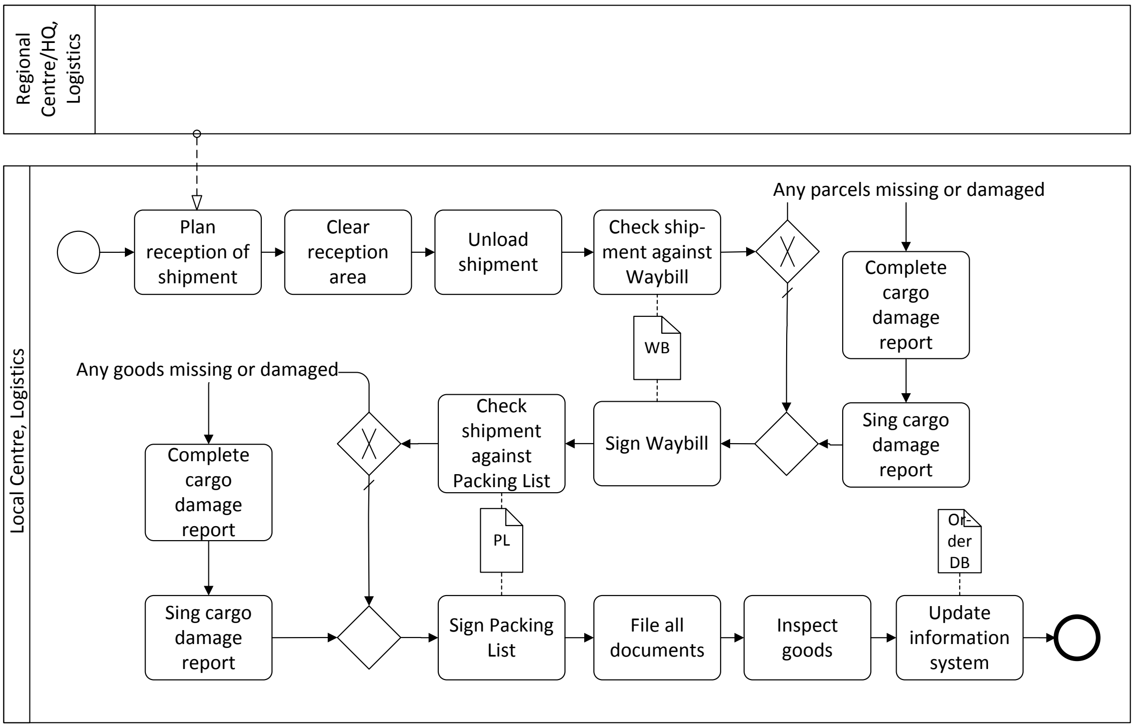


Figure 51: Process “Receive Goods”

6.6 Case Example: Flooding in Uganda

While reference processes have been constructed in the previous section using the tasks from the reference task model, these tasks will be used here in order to show that case examples of humanitarian operations can also be suitably modelled and analysed using the task model. As case example a sudden-onset, natural disaster was chosen which took place in 2007. The humanitarian operation takes place in a distant area and a mostly rural context. The imminent security risk is low and the number of beneficiaries high.

6.6.1 General Context

This case example focuses on a humanitarian organisation providing clean drinking water in a disaster area. The humanitarian organisation is engaged due to flooding in Uganda, East Africa. The organisation has been providing emergency disaster relief for over ten years. In order to give those from poorer countries a chance to work their way out of poverty and live in safety, local partner organisations are encouraged in the areas of development cooperation and crisis prevention. The organisation specialises in poverty relief and emergency relief with a specific focus on water supply and sanitation.

In 2007, many African nations were hit unexpectedly by heavy rainfall which resulted in flooding. “Northern Uganda suffered from the most serious flooding in decades following heavy rainfalls”; “The people of Uganda are accustomed to annual floods following the rainy season – however, water levels have reached an all time high”[393]. It is estimated that there are 300,000 flood victims in Uganda.[394]

In the immediate aftermath of the disaster it is of utmost importance that victims are evacuated to safe areas and provided with food, potable water and other supplies as soon as possible. As this case example involves a flood, it is imperative that those affected are supplied with safe drinking water as soon as possible. Here the water is treated with chlorine tablets to prevent biological contamination and at drinking water treatment stations where the water is first mechanically filtered and then treated with chlorine to ensure it is chemically, biologically and physically purified.

6.6.2 Supply Chain Structure

The humanitarian organisation has its regional headquarters in Kenya, with a large warehouse to supply equipment and provisions to the countries of East Africa, who are often affected by smaller floods. In addition, each country has a local centre to directly supply the disaster area in situ. In Uganda this local centre is located in the centre of the country, between the capital, Kampala, and the North, which is often affected by flooding. On the one hand, the proximity to the capital has the advantage of allowing regional centres good access to the country’s infrastructure. On the other hand, the relative proximity to the areas affected by the flooding provides for immediate assessments of the situation on the ground, whilst ensuring a safe distance is maintained. Due to the frequent flooding which occurs, the warehouse contains an immediately accessible rescue package for the treatment of 15,000 flood victims (emergency preparation/deployment stock). The rescue package consists of plastic sheeting, shelter, food, medical supplies and water treatment supplies.

Unlike the other goods, water treatment stations are designed for a large number of people. They are made up of two drinking water treatment stations, can provide 20,000 people per day with safe drinking water. Moreover, chlorine tablets are kept in stock which can provide 10,000 people with safe drinking water for a week.

6.6.3 Supply Chain Processes

The following scenario concerns the provision of flood victims with clean drinking water in the first week after the disaster. Heavy rainfall and the resulting flooding came as a surprise to many people. The first news services deal with this topic and inform the population and the available aid organisations.

Because of this news, two parallel processes are put into action: Firstly, a needs assessment is initiated and an emergency team is deployed by the regional centre. Whilst this process aimed to collect more precise information for a more accurate needs analysis is ongoing, in the other process a national emergency team, which is always on standby

[393] Kindernothilfe (2007).
[394] Cf. Deutsches Rotes Kreuz (2007).

and ready for deployment at the local centre, prepares the first standardised kits. When assembling these kits, first priority is given to the need to communicate information in relation to the flood. With such information, it could be estimated that two kits would be needed to provide drinking water treatment stations for a total of 40,000 people (each kit can provide 20,000 people with drinking water and has an operating time of 4-8 weeks), and chlorine tablets will be needed for another 10,000 people. Moreover, a need for food, shelter and plastic sheeting is evaluated. These materials are taken from stock at the local warehouse.

Should the assembly process take too long due to the chaos, or something is inadvertently damaged or misplaced, priority will be given to water treatment in order to provide people who have been cut off from their water supply with safe water as soon as possible. In this way, in the case of small floods, drinking water treatment stations for 20,000 people at a time and chlorine tablets for a further 10,000 people which are already in stock can be taken from the warehouse.

Once it has been ascertained exactly what and how much needs to be transported, the route and method of transportation can be selected. Meanwhile, the goods being transported can be loaded and taken to loading bays. Once a supply truck has been selected, these can be loaded while a waybill is produced. This waybill should make it clear what type and quantity of aid materials are allocated and confirms to those at the receiving end that no materials have been lost en route.

On arrival in the disaster area the goods are unloaded and handed over to the assistants on the ground. This first supply was carried out without a precise needs analysis. The reason for this is that waiting for more precise information would have taken up time unnecessarily and in such situations a need for water preparation stations is extremely likely.

Meanwhile, the rescue team from the regional aid organisation has arrived at the site of the flood and has begun a needs assessment. The disaster response is coordinated internationally and in order to deal with the catastrophe the affected area is divided into different sectors. Initial evaluations as to the location and number of people affected and the less accessible areas are made with the help of a helicopter. This and further tasks of the emergency team are communicated to the local centre.

In the local centre the nature and extent of the disaster as well as the needs and number of victims are ascertained from this information. The area which the organisation will need to supply with water treatment stations and chlorine tablets currently comprises approximately 60,000 victims in the urban district of Kampala and 25,000 in less easily accessible regions. Those in the hard to reach areas will be supplied with chlorine tablets, whilst those in the urban district will use drinking water treatment stations.

The delivery of drinking water treatment stations and chlorine tablets which has already been carried out by the organisation is not sufficient for the large number of victims. Once the needs and the number of people affected have been determined, the available water treatment methods which are still in stock or accessible from suppliers in the surrounding areas should be ascertainable after the inventory has been updated.

Since there are no drinking water treatment stations or chlorine tablets available in the immediately surrounding area and since in the first phase of supply everything in this vein has already been taken out of the warehouse, the current inventory is nil. Since all stock has been taken from the local warehouse, the net requirements equal the gross requirement as generated in the earlier needs analysis deducted by the stock taken from the local warehouse. The net requirements plus buffers for contingencies are transmitted. This reveals a need for drinking water treatment stations for 20,000 and chlorine tablets for 15,000.

The demand therefore exceeds the local stock, which has already been loaded directly onto a supply truck or helicopter as a pre-commissioned aid material; the remaining aid materials will be stored for later weeks, in which further demand will arise. In addition, a further drinking water treatment station for 20,000 and chlorine tablets for 10,000 people is ordered and kept in stock, so that later demands which may ultimately be even more urgent can be met. The warehouse comprises drinking water treatment stations for 40,000 people and chlorine tablets for 10,000.

The communication of the demand triggers an order to be initiated during the procurement process. An order will be given to the regional centre based on the previously communicated requirements. The goods and materials which have been prepared in accordance with this order after handling time, are loaded and checked to ensure the order is complete and in working order.

The drinking water treatment station for a total of 20,000 victims and chlorine tablets for 10,000 which are intended to go to the warehouse are transported to the warehouse and stored. Following the announcement of the transportation route and method, the water treatment materials which have already been pre-commissioned by the regional centre for immediate assistance are delivered to their respective vehicles and transported directly without first going to the warehouse.

A helicopter is chosen for transporting chlorine tablets in order to deliver them to the less accessible regions. The drinking water treatment stations are taken to the urban district in supply trucks. The respective transportation vehicles are then loaded and a waybill is produced as before. Upon arrival at their destination, the materials and goods are unloaded and handed over.

Figure 52 shows an overview of the entire process.

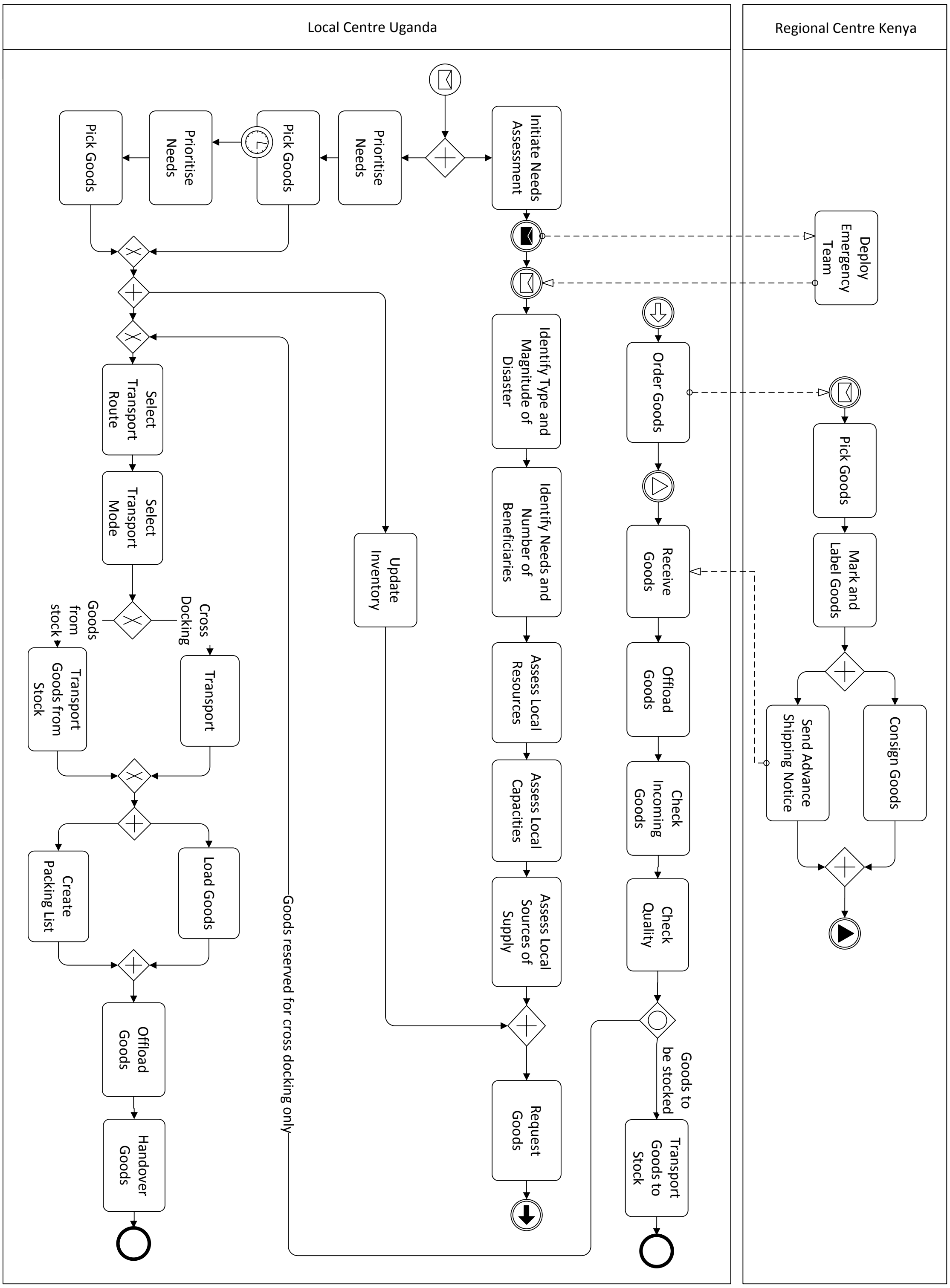


Figure 52: Case Example: Flooding in Uganda

6.7 Excursus: Military Supply Chains

Humanitarian organisations, due to their limited financial resources and frequent lack of logisticians with formal training, have a history of carrying out their logistics activities in a rather ad-hoc way. Also, the importance of supply chain management has long been underestimated. While this is changing and supply chain management becomes increasingly important in the humanitarian domain, it seems worthwhile to broaden the perspective and try and transfer results from other types of supply chains and supply chain management. Probably one of the most obvious choices is the military. What is appealing about the idea of looking into military logistics and try and apply military logistics principles in the humanitarian domain is the fact that neither of these supply chains focuses on supply chain profitability. Naturally, some of the objectives of these supply chains are fundamentally different. While humanitarian operations try to alleviate suffering, military operations do quite the opposite.[395] Yet, the mass deployment of material and human resources in a rapid way in insecure and unknown environments are common to both of these supply chains. In this excursus, the similarities and differences between military and humanitarian supply chains are analysed, cross-learning potentials presented and the subject of cooperation between humanitarian logistics and the military is touched.

Military and humanitarian operations have always been linked to each other. In fact, they both are grounded in war. The first humanitarian organisation, the International Federation of the Red Cross, was founded on a battlefield in the 19th century.[396] “While the military waged war, the humanitarian organisations followed in their wake, mopping up as and when they could.”[397] Since both military and humanitarian operations needed to coexist on or in proximity to the battlefield ever since, there has always been some contact between these two parties which has defined their distinct roles and responsibilities. Since the 19th century, this situation has fundamentally changed with a variety of humanitarian actors now present in crisis situations. These actors can be categorised into UN agencies, NATO, NGOs, and international humanitarian non-governmental and governmental organisations. The use of force has also become more an option but not a determinant of humanitarian operations, i.e. humanitarian organisations are not present in armed conflicts alone but in a variety of crisis situations.[398]

Military supply chains have been called “dynamic supply chains”[399] and described as having to be “proactive as well as reactive, with the ability to reconcile multiple and varied contingencies”[400]. Both military and humanitarian organisations must be flexible enough to establish a working supply chain in a crisis or disaster area with very short

[395] In fact, some authors argue another way and claim that military logistics is about saving lives. This is a controversial discussion and outside the scope of this work. Cf. Long (2003), p. 393, who quotes Lieutenant General William Pagonis, head of logistics in the Gulf War in 1991.
[396] Cf. Dunant (1862).
[397] Gourlay (2000), p. 34.
[398] Cf. Gourlay (2000), p. 34.
[399] Simon (2001), p. 64.
[400] Simon (2001), p. 65.

notice. These supply chains must continue to function effectively in potentially chaotic and volatile environments. Military operations except for their direct warfare capabilities, comprise several areas of expertise from which humanitarian operations can benefit, which include security, transport and logistics, construction and repair, command, control and communications, specialised units, and preparedness. An overview of the capabilities of military operations is given in Table 13. From a supply chain perspective, especially the area transport and logistics is of interest. In military operations it has always been an imperative to be able to rapidly deploy personnel and equipment, as well as maintaining a constant and reliable flow of material and equipment to the field.

Table 13: Operational capabilities of the military[401]

Security	Establishment of "safe havens", protection of relief supplies, maintenance of a credible armed presence to reduce threat of violence
Transport and logistics	Ability to transport personnel and supplies rapidly, provision of an ongoing supply of equipment and materials
Construction and repair	Building or repairing essential infrastructure – roads, ports, airports, railways and storage facilities
Command, control and communications	Reliable communications systems, rapid and complex contingency planning, central planning and direction capabilities
Specialised units	Personnel trained to interface between the military and civilian populations, experts in transportation, business, law, communications, health, policing
Preparedness	Joint training of military and civilian personnel in preparation for, for example, mass casualty situations

Humanitarian operations with their high requirements with respect to lead time, responsiveness, and flexibility seem to be very similar to military supply chains. Indeed, the military does play an increasing role in national and international humanitarian operations.[402] In these operations, it is especially military logistics that supports civilian missions, UN agencies, the International Committee of the Red Cross and Red Crescent, and the NGO sector.[403] The military has extensive experience in unstable settings dominated by similar environmental factors of uncertainty as described above for the humanitarian supply chain. Furthermore, the military usually has extensive resources and experience at its disposal in order to support humanitarian logistical operations. Resources include technical equipment such as own transportation modes (helicopters, trucks, etc.), advanced communication and information technology, and personnel

[401] Source: Adopted from Leaning et al. (1999).
[402] Cf. Tufinkgi (2006), pp. 144-145.
[403] Cf. Pugh (1998), p. 339.

capable to efficiently act in typical disaster settings. Military personnel are highly flexible and adaptable and usually possess knowledge particularly valuable in disaster settings. They have expertise in the areas of logistics, engineering and infrastructure, including water and sanitation, power, roads, and camp construction. Both military and humanitarian operations have a high turnover rate, as soldiers get transferred from one unit to another.[404] Military units solve this problem by standardising training and thus establishing a common knowledge base.

Military organisations emphasize command and control, usually implement standardised operational policies, and focus on top-down hierarchical organisational structures with clear lines of authority and accountability. Substantial resources are dedicated to the acquisition of assets and training of personnel. Thus, they make sure that they can function independently under the most adverse circumstances.[405] On the other hand, humanitarian organisations are less hierarchical in their style of decision-making and operations. Humanitarian organisations focus more on the process by which they accomplish their objectives due to the perceived importance of having long-term impact. Humanitarian organisations have fewer back-up resources and engage in less contingency planning to ensure that short-term objectives are met.[406]

Communication, information and other technology used by humanitarian operations is usually not high-end but rather proven, sturdy and inexpensive equipment. Transportation usually has to be hired and is owned only by larger humanitarian organisations. Humanitarian personnel are equally flexible but often lack adequate training. Turnover rates are very high. Lastly, logistics in the humanitarian domain is only on the verge of being recognised as having highly important interface and management functions.[407]

There are a number of possible conflicts when looking at military-humanitarian cooperation and cross-learning potential. A summary of these conflicts is given in Table 14. Most notably with respect to supply chain management is the fact that military objectives show only limited commitment to long-lasting and sustainable efforts when interacting with local communities as well as the fact that military involvement in conflict settings seldom focuses on disaster relief. Moreover, the military has never had a culture of interaction with other organisations. In contrast, cooperation and coordination in humanitarian operations is becoming increasingly important.[408]

In conclusion, it can firstly be stated that humanitarian organisations need to be very careful about the decision they make when they make use of or even rely on military personnel, supplies, and equipment in order to carry out their activities and thus influence the implementation of their humanitarian values. The use of military organisations in humanitarian operations can offer benefits but is controversial due to a number of

[404] Cf. Long (2003), pp. 393-394.
[405] Cf. Gourlay (2000), p. 36.
[406] Cf. Gourlay (2000), p. 36.
[407] Cf. Thomas and Kopczak (2005).
[408] Cf. for instance Tufinkgi (2006), Schulz (2009).

Table 14: Conflicts between the military and their role in humanitarian crises[409]

Conflict resolution	Military forces are not well suited to aid long-term redevelopment efforts. The imposition of security by outside military forces may also impede negotiation and conflict resolution.
Interaction with other organisations	Military commanders may be unfamiliar with the roles of major international organisations and, conversely, civilians will have little experience of military organisations. There will be differences in strategy, objectives, and tactics.
Conflict with humanitarian agenda	Using military resources to achieve humanitarian goals creates tension and can undermine the appearance of neutrality of relief organisations.
Adequacy of training	Few military officers receive training in disaster relief or humanitarian assistance.
Limited commitment to disaster response	The principal mission of the military is to resolve military conflicts and, generally, less effort and fewer resources are devoted to humanitarian aid unless a humanitarian assistance-specific mission is being conducted.

practical, political, and ethical issues.[410] Some aspects of military organisations, such as the ability to rapidly deploy equipment, supplies, and personnel, an efficient hierarchical chain of command, and the use of standardised material and goods can potentially be advantageous for humanitarian operations. These potentials have not fully been researched yet and it should be investigated whether these principles can be transferred to the humanitarian domain. Cooperation between humanitarian and military organisations can be successful especially in the pre-operational and to a certain extent the operational phase of crisis management, including planning, advice to the chain of command, educating the force and communication, coordination, exchange of information, and setting up of agreements.[411] Closer cooperation between military and humanitarian organisations however proves to have dangerous pitfalls. Military-humanitarian cooperation, militarized humanitarianism have become a reality in many humanitarian operations around the globe, but the effects this has and continues to have on humanitarian operations is that it has become practically impossible for humanitarians to work in certain places such as Iraq and Afghanistan.

[409] Source: Adopted from Leaning et al. (1999).
[410] Cf. Pettit and Beresford (2005), p. 318.
[411] Cf. Gourlay (2000), pp. 42-43.

7 Supply Chain Management Systems for Humanitarian Organisations

This chapter has the objective to assess supply chain management systems for humanitarian operations. First, the purpose of implementing and operating supply chain management systems is presented briefly. Afterwards, a requirements profile is developed based on the specific challenges of supply chain management in the context of humanitarian operations found in the previous chapters. This requirements profile describes the tasks of supply chain management which can be supported by SCM IT systems. It is then used to evaluate a number of SCM systems which are currently used either in humanitarian organisations or in the commercial domain. By creating this requirements profile, a method is provided that can serve to assess available SCM systems. Furthermore, it can be employed to guide the future development of specialised SCM software to better address the specific challenges in humanitarian supply chains.

7.1 Supply Chain Management Systems

Key enabler for effective and efficient supply chain management are appropriate IT systems for supply chain management or so-called supply chain management systems.[412] The essential role of IT systems for supply chain management is to "bind the entire chain together as a single integrated unit"[413]. Thus, SCM systems have both an intra-company dimension (horizontal and hierarchical) and an inter-company dimension (vertical, following the transaction flow, coordinating).

Supply chain management systems focus on supporting an organisation in managing its upstream and downstream supply chain relationships by automating the flow of information between an organisation and its supply chain partners leading to better decisions and improved performance. Supply chain management systems also support organisations in planning, sourcing, manufacturing, and delivering their products and services.[414] These systems help to gather, process, and analyse information which can be

[412] Cf. Stadtler (2005) and Skjøtt-Larsen and Schary (2007), pp. 291-319.
[413] Schary and Skjøtt-Larsen (2001), p. 295.
[414] Cf. Laudon and Laudon (2006), pp. 57-58.

utilised to control and coordinate the organisation's business processes with its partners, i.e. suppliers, distributors, and logistics companies. Hence, supply chain management systems support organisations by providing support in the following exemplary areas: Decisions on when and what to produce, store and transport, communication, order tracking and tracing, forecasting, inventory monitoring, reduction of cost etc.

Busch et al. (2003) note that SCM software can be divided into the areas supply chain design, supply chain planning and supply chain control and collaboration. Supply chain planning systems enable organisations to generate demand forecasts, and sourcing and manufacturing plans for products. SCM systems help companies "make better operating decisions, such as determining how much of a specific product to manufacture in a given time period; establishing inventory levels for raw materials, intermediate products, and finished goods; determining where to store finished goods; and identifying the transportation mode to use for product delivery."[415] Supply chain execution systems on the other hand aim at managing the flow of goods through the supply chain, i.e. from the place of manufacturing, through distribution centres to warehouses, and ensure that goods are delivered to the right locations in the most efficient manner.[416] These systems track the management of goods and materials, warehouse and transportation operations.

SCM software is geared to support, automate and accelerate business processes and facilitate work flow management, in this manner supporting both the respective organisations', as well as its suppliers' and customers' processes. An overarching goal of the use of SCM systems is the creation of transparency in the supply chain, such that the dynamics and the complexity of supply networks can be handled. This gives rise to a number of benefits, including the improvement of customer service level and responsiveness through the reduction of cycle times and increase in supply chain transparency; cost and inventory reduction by lowering or eliminating costs associated with moving a product through the supply chain (e.g. costs for material acquisition, inventory carrying, transportation, and planning); and cash utilisation. Schary and Skjøtt-Larsen (2001) conclude that information technology "compresses time intervals, increasing response to customers and reducing delays," which is of strategic importance for humanitarian operations.

7.2 Requirements for Supply Chain Management Systems

The "wedding of information technology and logistics is key to the effective management of a dynamic supply chain"[417] as can be found in disaster relief and humanitarian assistance programmes. Long and Wood (1995) have already concluded that information systems offer a "major opportunity for improving the logistical support of disaster operations"[418] since they provide humanitarian workers, both in the field and at head-

[415] Laudon and Laudon (2006), p. 389.
[416] Cf. Laudon and Laudon (2006), p. 390.
[417] Simon (2001), p. 66.
[418] Long and Wood (1995), p. 227.

quarters level, with knowledge about available supplies, location of supplies and transportation options. The authors go on to describe some characteristics of an ideal information system which must accommodate for multiple organisational users and their different operating methods, as well as state-of-the-art communication mechanisms. More than ten years later, Oloruntoba and Gray (2006) still claim that "an effective information infrastructure and sensitive needs assessment mechanism at the field level […] would enhance supply chain agility by being very responsive to the changing needs of end users, and by being able to respond almost immediately to those changes."[419]

The need to have suitable IT systems in place in order to effectively and efficiently manage the supply chain during humanitarian operations is evident. Many practitioners and academics have emphasized this need and posited that investing in performance measurement schemes is the path forward in the humanitarian sector.[420] Performance measurement, however, is not possible without an appropriately designed IT system capturing and analysing the relevant operational data. However, research has shown that only "about 25 percent of agencies […] had systems in place to manage goods and supplies that poured in from over 40 countries. […] The majority of field logisticians still use spreadsheets or, equally likely, a pencil and paper to manage incoming supplies during and after a disaster."[421] On the other hand, the recent years have seen an increasing interest of humanitarian organisations to better visualise and monitor their supply chain processes. While the possibility to truly measure the effectiveness and efficiency of the processes was unthinkable just a few years ago, more sophisticated IT systems to track and trace goods flowing through the supply chain have become available and have actually been implemented.[422]

Supply chain management systems are inter-organisational systems since they aim at automating the flow across organisational boundaries. For example, a company employing an SCM system would exchange information with its suppliers or retailers about inventory or point-of-sale data or delivery dates. Thus, in this classical sense, SCM systems always incorporate multiple organisations. This definition will be loosened for this chapter. In humanitarian organisations, headquarters, regional and field level are geographically but also frequently hierarchically decoupled, leaving a large degree of decision autonomy to decentralised operations. Thus, field operations and headquarters can de-facto be considered as separate entities. An information system engineered to automate and accelerate logistical business processes involving any two of these levels

[419] Oloruntoba and Gray (2006), p. 118.

[420] These issues are part of many articles on humanitarian logistics or humanitarian supply chain management. Some authors who specifically refer to this problem include van Wassenhove (2006), Beamon (2004), Thomas and Kopczak (2005), Kovács and Spens (2007).

[421] Source: Fritz Institute, Press Release, San Francisco, September 13, 2007.

[422] ICRC was one of the first organisations to implement a comprehensive IT solution to monitor and control the material flow in their supply chain which became fully implemented in 2004, cf. Lee and Zbinden (2003). In September 2007, the Fritz Institute, a non-profit organisation that works to innovate solutions and facilitate the adoption of best practices for rapid and effective disaster response and recovery, released a new version of their humanitarian supply chain software which "provides a huge step forward in aiding humanitarian relief organisations to catalogue, track and deliver supplies to disaster victims". Source: Fritz Institute, Press Release, San Francisco, September 13, 2007.

can already be considered an SCM system. Thus, the requirement for incorporating different organisations (as opposed to different hierarchical levels in one organisation as described above) will be dropped in the following.

7.2.1 Functional Requirements

In this section, the functional and non-functional requirements for SCM systems for humanitarian operations are described. The basis for the requirements profile is formed by the task model for IT systems for supply chain management presented by Hellingrath et al. (1999), and further developed by Hellingrath et al. (2003) and Hellingrath and ten Hompel (2007).[423] Through a literature review as well as interviews with experts and supply chain managers in humanitarian organisations, this requirements profile has been adapted to the specific needs of humanitarian organisations conducting operations. Kovács and Spens (2008) have illustrated that there are three different phases that can be distinguished when looking at humanitarian operations, viz. preparation, immediate response and recovery/reconstruction.[424] Requirements for SCM systems employed in humanitarian operations will likely change as the operational paradigm shifts from short-term humanitarian assistance (or disaster relief) to a more long-term oriented one in the post-emergency phase. The focus of this requirements profile lies on the immediate response, i.e. disaster relief, thus creating a requirements profile for SCM systems for disaster or emergency relief.

Supply chain management can be decomposed into several tasks, taking mainly the temporal scope into consideration, i.e. the strategic, tactical or operational time horizon.[425] Thus, the areas Supply Chain Design, Supply Chain Planning, and Supply Chain Execution are created. If the perspective on these tasks is generalised from one particular organisation in a supply chain to the entire supply and demand network, these tasks contain both intra-organisational as well as inter-organisational issues. The inter-organisational issues can further be separated in a procurement and distribution side.

Several authors have investigated the structures and processes in humanitarian supply chains.[426] On a high level, a typical humanitarian supply chain with the corresponding material and information flows can be displayed as shown in Figure 53. The humanitarian organisation (such as Oxfam, World Vision, Médecins sans Frontières, etc.) procures its goods from suppliers or receives in-kind donations. In a first step, goods are distributed to field units on a regional or country basis (local centres), before goods and services are then delivered to the end-users, which are ultimately the beneficiaries of the humanitarian operations. Private as well as institutional donors who finance the humanitarian activities initiate the financial flow in this supply chain.

[423] Cf. Section 4.3.6.
[424] Cf. Section 0.
[425] Cf. Section 6.2.
[426] Cf. for instance van Wassenhove (2006), Tufinkgi (2006), and Thomas and Kopczak (2005), see also Section 3.6.

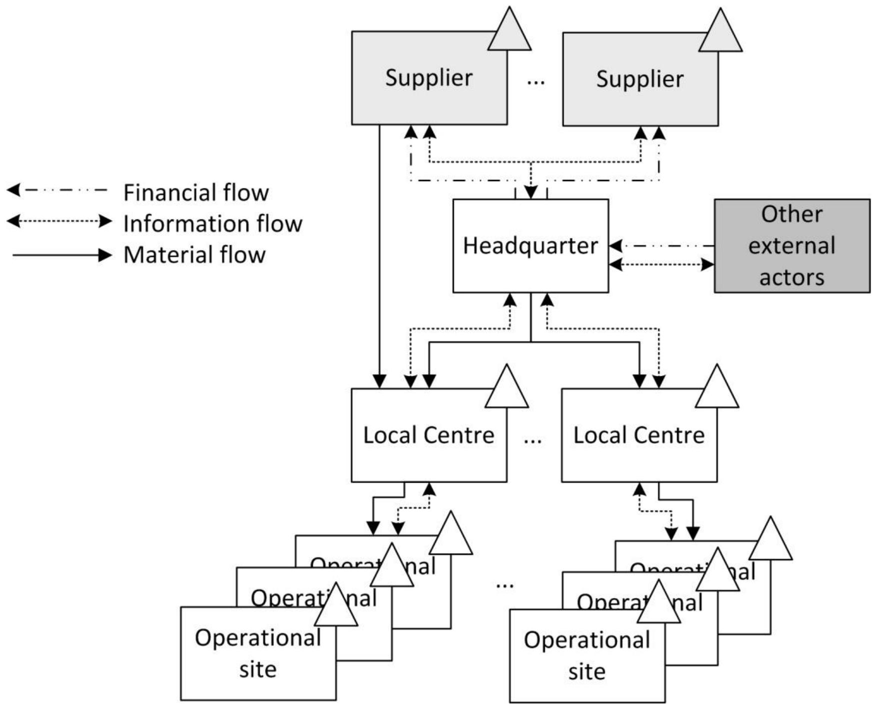


Figure 53: A typical concrete humanitarian supply chain

Hellingrath et al. (1999) have presented an SCM task model outlining the tasks which need to be supported by supply chain management systems.[427] Due to the differences between most commercial supply chains and humanitarian supply chains, not all areas within this task model are equally important. Collaborative tasks in humanitarian supply chains are not limited to inter-company collaboration. Rather, since frequently a large degree of decision autonomy is delegated from the humanitarian organisation's headquarters to regional and local centres, collaboration aspects also need to include "horizontal" collaboration, i.e. collaboration within the humanitarian organisation. Furthermore, humanitarian organisations directly serve non-paying beneficiaries, which is why most customer-facing tasks can be omitted or have to be adapted. Further smaller changes were made to the original model, e.g. the introduction of operational planning or integration of product planning instead of product life-cycle management. Moreover, there are a number of non-functional requirements which need to be fulfilled by SCM systems in order for them to be feasibly deployed in humanitarian organisations.

In the following section, those areas of the SCM task model most relevant for humanitarian organisations are elaborated on and examples of associated decisions are given.

7.2.1.1 Supply Chain Design

Supply Chain Design denotes the design of a supply chain over a strategic time horizon. Here, suggestions are derived for network design, distribution structures, manufacturing programs, etc. Decisions taken in this domain are long-term in nature and consequently cannot be undone or changed only with considerable financial impact.[428] This phase

[427] Cf. Section 4.3.6.
[428] Cf. Kallrath and Maindl (2006), p. 7.

includes decisions on the structure of the supply chain over the coming years; here it is decided what the supply chain configuration will look like, how resources will be allocated and what processes each stage will perform. Besides, decisions regarding the dimension of facilities and transport relations on the basis of forecasted demand are taken. It is decided which products are to be produced at which facilities as well as the structure and technology of information systems to be used in the supply chain. In this phase it is important that organisations align the supply chain configuration with their strategic objectives. Decisions made in this phase must take into account a long time horizon and cannot be altered within a short period of time.

Supply Chain Design aims at the strategic design of the entire supply and demand network in a cost-optimal way. Thus, long-term investment decisions are assessed for the specific elements of the supply chain. Examples include the number and size of locations, warehouses and distribution centres as well as the selection of suppliers. It is necessary to evaluate varying what-if planning scenarios. Thus, the closure or withdrawal of field units or switch of suppliers or more generally speaking the width of the supplier base or the strategic global pre-positioning of stocks can be evaluated. Since humanitarian organisations generally carry out their operations in a multitude of countries, the integration of country-specific information, such as taxes, tariffs, currencies etc., should be possible. Within the context of humanitarian operations, the following further tasks are of special importance: Definition of item catalogues to be used in humanitarian operations; definition of a (possibly multi-tier) distribution strategy; selection of physical distribution channels; the evaluation of dual vs. multiple sourcing strategies and centralized vs. decentralized purchasing; and further investment decisions whose repercussions fall into a strategic, i.e. 3 to 5 years, time horizon.[429]

7.2.1.2 Supply Chain Planning

Supply Chain Planning comprises all strategic, tactical, and operational planning tasks which are necessary in order to optimise process execution within the entire supply chain. The configuration of the supply chain has already been fixed. Now, constraints and restrictions derived from the design phase need to be incorporated into the planning phase. Thus, the planning phase establishes parameters within which the supply chain will have to operate over a specified period of time. Supply Chain Planning decisions include forecasting demand in different markets, determining which locations will be supplying each market, which inventory policies to follow, and the timing and size of marketing promotions.[430] One of the results of the planning phase is the definition of operating policies governing short-term operations. The time horizon considered in the Supply Chain Planning phase is a tactical one, i.e. several months to one year.

Supply Chain Planning is the area addressed most comprehensively by SCM software from the industrial context. There are a number of different tasks with varying impor-

[429] Also cf. McGuire (2006).
[430] Cf. Chopra and Meindl (2004), p. 7.

tance for humanitarian operations. In the following, the most relevant tasks are presented and their importance for humanitarian operations is judged.

Operations Planning (or Demand Planning) and **Product Planning** have the objective to create transparency of short-term demand and optimise the forecast of medium-term and long-term demand of goods and services. Forecasting methods include local information (causal forecasting techniques) as well as extrapolation of past demand data (time series techniques). The manual inclusion of causal factors such as seasonal occurrence of certain diseases or draught periods on product type level needs to be possible in a suitable SCM system. When planning operational demand, forecasts are escalated over the various tiers of the humanitarian supply chain. Data for forecasts needs to be accessible from the underlying supply chain execution system. SCM systems offer a large variety of methods that need to be adjusted to the context the humanitarian organisation is operating in. Especially the modelling of seasonal factors must not be neglected since humanitarian operations like treatment of malaria and Ebola or operations focusing on provision of food have a strong cyclical or seasonal component. Product Planning is aimed at synchronising the operational strategy and demand with the goods available in the humanitarian supply chain. The benefits of having a standardised assortment have been elaborated above. Product Planning thus deals with product specification and product lifecycle management.

At the core of **Network Planning** lies the synchronisation of identified demand with available capacities. Hence, location-specific procurement and distribution plans can be drawn up and goods required for operations can be made available. Also, contracts with suppliers can be negotiated based on the results of network planning. Network Planning should also incorporate emergency preparedness and contingency plans as particular aspects of humanitarian operations.

Supply Planning has the objective to secure punctual availability of goods while minimising stock levels. The considered time horizon lies between days and weeks, coinciding with the most frequently taken supply decisions of humanitarian organisations. Considering available capacity, minimal, maximal, and safety stock levels are devised. Single or multiple sourcing should be considered, as well as different provisioning strategies such as Vendor Managed Inventory. Supply Planning should also support supplier selection and purchasing contracts. Supply Planning is an area which has been neglected by humanitarian organisations for a long time. However, it is of particular interest since procurement expenditures are a major cost factor in humanitarian operations and the corresponding optimisation potential is large.[431]

Transport Planning or Distribution Planning deals with planning, distribution and optimisation of inventory levels between the organisation, its field units and beneficiaries. Goods allocation to the available distribution channels needs to be optimised under consideration of the coverage range of base and safety stock levels. The quantities of goods to be transported over the routes in the supply chain at specific points in time are

[431] Cf. especially Schulz (2009), Annex C, pp. 260-264.

determined. “Distribution planning deals with transportation quantities and stock levels in connection with customer deliveries considering stock and transport capacities whereas transportation planning performs routing and load planning determining cost effective and timely deliveries.”[432] Simulation enables the comparison of different distribution scenarios, within which especially last mile distribution problems need consideration. Consequently, optimised shipment strategies can be established and over-supply or under-supply of certain regions or operational sites avoided. The planning horizon of Distribution Planning lies between days and months. Short-term distribution planning on the other hand has a time horizon of hours to days. Here, transports and routes are scheduled, transport modes selected, routes are planned and optimised. While the area of route planning and vehicle scheduling in humanitarian operations has been the focus of some research activities for some time, practical implementation of these issues has not yet found its way into humanitarian organisations.[433] With typically quite extensive transportation costs involved in humanitarian operations, SCM software implemented by humanitarian organisations should incorporate appropriate Distribution Planning functionalities.

Order Promising (also “available-to-promise” or “capable-to-promise”) deals with assessing the capability of the organisation to fulfil customer orders. When an order for a specific item or service comes in available-to-promise checks quantities in the warehouse and planned receipts from procurement across the entire supply chain to determine a delivery date for the order.[434] Depending on the operational context, it is conceivable that different objectives are pursued: The calculation of the earliest delivery date, acknowledgement of the desired delivery date, amount or product configuration, or the suggestion of suitable substitutes if the desired order cannot be fulfilled within the suggested time frame. Order Promising is a tool that can serve to strongly increase customer service or customer orientation of an organisation. Especially in the hierarchically dispersed and frequently autonomously acting tiers within humanitarian organisations, Order Promising becomes a crucial element of SCM systems.

Some of the above mentioned aspects can also be found in collaborative demand, capacity and inventory planning. **Collaborative Planning** has been identified as a key issue in humanitarian operations.[435] The idea of collaborative planning is that partners in the supply chain integrate their capacities and inventories in a common database such that planning decisions can be based on echelon stocks and capacities. Therefore, plans can be optimised and planning stability is increased. Collaborative planning becomes important in humanitarian operations since these operations are characterised by high demand instability and erratic demand occurrence. In these situations, collaborative integration with suppliers and field units ensures timely and adequate response under consideration of the available capacities. Collaborative planning takes place in humani-

[432] Kallrath and Maindl (2006), p. 8.
[433] Cf. Blecken et al. (2009a).
[434] Cf. Kallrath and Maindl (2006), p. 7.
[435] For a through analysis of collaboration and specifically horizontal cooperation in humanitarian supply chains cf. Schulz (2009).

tarian supply chains both vertically and horizontally, i.e. within the humanitarian organisation's internal supply chain tiers and between the humanitarian organisation and external parties.

7.2.1.3 Supply Chain Execution and Supply Chain Event Management

During the Supply Chain Execution phase, supply chain configuration and planning decisions are assumed fixed. The objective of Supply Chain Execution is now to optimise the response to customers by handling a customer request in the best possible manner. Decisions during the execution phase include allocation of inventory to an individual customer order, timely order fulfilment, delivery and production scheduling, and placing of replenishment orders. A clear distinction between Supply Chain Execution and Supply Chain Planning is not always possible and activities cannot always be associated with either planning or execution. One interesting way to visualize the difference between Supply Chain Planning and Supply Chain Execution is given by Zäpfel and Piekarz (1996) who paraphrase planning with "decision-making" and execution with "decision implementation"[436]. The time horizon relevant for the execution phase is based on days or weeks.

Supply Chain Execution comprises all tasks directly linked to order processing and process control. Order management is the interface between suppliers and customers, i.e. field units, in such a way that information concerning a field unit order can be controlled and customer satisfaction improved through availability and feasibility checks. Emphasis is also put on warehouse and transport management since these are the most prominent and everyday tasks in humanitarian operations. Humanitarian organisations need to be capable of executing typical warehouse activities such as rebooking, restocking and controlling as well as routing and scheduling activities within transport management. The ability to include in-kind donations is another important aspect for SCM software for humanitarian operations.

Within the requirements profile for SCM systems for humanitarian organisations Supply Chain Execution and Supply Chain Event Management are the most important areas. This is due to the fact that long-term investments and thus stability of operations is frequently prohibited due to earmarking of funds and the unpredictable nature of natural and man-made emergencies. Thus, most activities in humanitarian supply chains support executive or directly operational or transactional logistics processes. The areas Supply Chain Execution and Supply Chain Event Management deal with a short time horizon and routine processes and decisions that directly concern the physical flows are being made. As will be seen in the following sections, this is the area which humanitarian organisations should value most when assessing and implementing SCM software.

Order management contains all tasks necessary to control and monitor customer orders and all orders for procuring and distributing supplies and equipment for specific operations. Order management is the interface between the distribution side (regional

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[436] Cf. Zäpfel and Piekarz (1996), p. 27.

and local centres of the organisation) and headquarters as well as suppliers. Order management needs to contain all relevant information regarding customer-facing transactions and needs to be tightly integrated with the super ordinate Order Promising requirement.

Supply Chain Event Management deals with the management of planned and unplanned events in a supply chain.[437] Therein, supply chain events can be defined as any individual outcome of a supply chain process, activity, or task. According to Stadtler and Kilger (2005), "[m]anaging events does not only mean to react to events, but also to affect or even prevent their occurrence". Supply Chain Event Management is a concept that allows monitoring, capturing and assessing events within or across partners of a supply chain. It aims to increase the effectiveness of the supply chain while restricting costs by handling events.

Supply Chain Event Management actively monitors material and information flows such that timely response is enabled in the case of disturbances and deviations. Monitoring enables the display of all relevant transactional data and their aggregation to performance indicators. Thus, organisations always have an overview over the available capacities and stocks. Another important part is the Track and Trace function. Tracking and tracing makes the transport and distribution processes transparent by registering the goods at certain points in the physical distribution channel. Especially in humanitarian operations, tracking proves to be useful since it offers rapid access to information fundamentally important to short- and medium-term operational (revision of) plans. Tracking and tracing can potentially be outsourced to a logistics service provider if the organisation decides that international transport is not within its core competencies. Finally, Alert Management informs the user of bottlenecks and critical incidents through the comparison of to-be with as-is states under consideration of tolerance thresholds.

Transport management and **Distribution management** focus on service frequently offered by logistics service providers. Here, administration, billing/invoicing, control and execution of transport and distribution services ranging from international transport to last mile distribution are covered. Among others, tasks such as tracking and tracing, route optimisation, fleet management, creation of shipping documents and bills are addressed.

Warehouse management contains control and optimisation of complex warehouse systems. Here, requirements for SCM systems include all tasks of warehouse management such as customer order processing and release of stocks, inventory management and control, and all other processes which support warehouse operations from order reception to the release of stock.

[437] Cf. Stadtler and Kilger (2005), pp. 256-257.

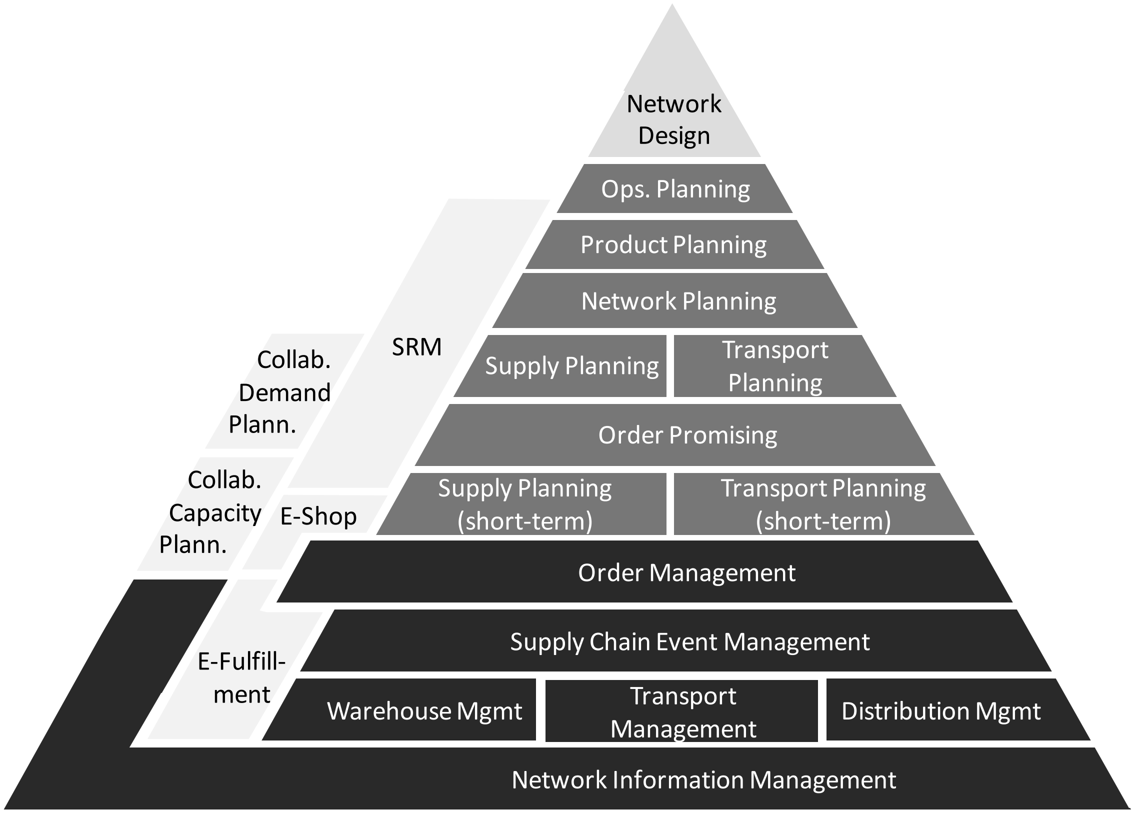

Figure 54: SCM systems functional requirements profile[438]

Several research institutes have developed a task model for SCM systems in order to create an overview over the tasks which software tools for SCM need to address in long-term, medium-term and short-term time horizons (Figure 54). Here, this task model has been developed further into a requirements profile for supply chain management systems for humanitarian organisations. As a result, the figure is partitioned into the three layers of Supply Chain Design, Supply Chain Planning and Supply Chain Execution and Event Management.[439]

7.2.2 Further Requirements

In the preceding section, functional requirements for SCM software for humanitarian operations have been presented taking into account the specific challenges faced by humanitarian organisations in emergency and post-emergency operations. Besides, there are a number of further requirements for these software systems which complement the requirements profile. These will be presented in the following.

7.2.2.1 Documentation

Due to the high turnover of personnel in humanitarian organisations and the frequent lack of formal training of logisticians and supply chain managers in the humanitarian

[438] Source: Based on Hellingrath and ten Hompel (2007) and Hellingrath et al. (1999); cf. also Schary and Skjøtt-Larsen (2001), p. 296.
[439] Cf. Hellingrath and ten Hompel (2007).

context, the SCM system needs to encompass comprehensive, easily accessible and succinct documentation. It needs to cover all areas of the requirements profile incorporating all material and information flow from the suppliers to the beneficiaries. Documentation should be accessible online, as well as offline.

7.2.2.2 Accountability

Two aspects are covered under this requirement:

Reporting refers to the capability of an SCM system to generate reports adapted to the regulatory environment of donors, or more broadly speaking a requesting internal or external entity. Thus, proper reporting is a means to increase accountability and transparency in operations. Since ever more donors have tightened requirements on the accountability of the organisations they fund, reporting capabilities become an important asset in securing funds and planning operations. Lack thereof may result in a loss of confidence and decreasing availability of donations.[440] Besides being the main interface to donors, reporting is also an interface to the media and for this reason it is of utmost importance.

The second notion covered under the accountability aspect is **controlling**. Humanitarian organisations will be held accountable for the use of their financial resources by the donors. Thus, an SCM system should offer the possibility to retrieve financial information which can be added to the reports.

7.2.2.3 Software Structure and Setup

A number of different requirements are covered under the issue of software structure and setup:

First of all, the possibility of **cross-linking** SCM systems is an important requirement for SCM systems for humanitarian organisations. This comprises three aspects: On the one hand, it is desirable to have an intra-organisational networking functionality, e.g. that regional warehouses can be cross-linked with central warehouses to gain visibility of supply chain stocks rather than local stocks only. On the other hand, also inter-organisational networking can be desired when there are multiple organisations present in the field with partly overlapping mandates and objectives. Inter-organisational networking can ease coordination and cooperation and thus improve efficiency of operations and balance out one-sided affluence or scarcity of goods. This kind of cross-linking of systems also supports an integrated view on data of regional and central warehouses, headquarters or even other humanitarian actors present in the field. The third aspect is that the SCM system should offer possibilities to cross-link with software used in other departments of the same organisation such as the human resources or finance departments.

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[440] Cf. Pan American Health Organization (Regional Office of the World Health Organization) (2001).

When systems are cross-linked as described above, a (permanent) internet connection can be used as the most rapid way to transfer and synchronise data. However, in situations of crises and especially in disaster relief, an internet connection is often unavailable. Also, permanently linking computer systems worldwide would incur prohibitively high costs on organisations running operations in remote areas where such a connection comes at a high premium. Thus, any SCM system for humanitarian operations needs to offer an online as well as **offline mode.** Data integrity and security need to be guaranteed.

SCM systems for humanitarian operations need to be modular as well as adaptable. **Modularity** describes the possibility of using only those modules of the software necessary at a given time. Besides, different modules or functionalities may be required for the different tiers in the humanitarian supply chain, e.g. at field unit level, country and regional coordination level, up to headquarters level. At headquarters level the most sophisticated features might be required, while only a simple stock management or order management module will suffice at a remote field location. Adaptability denotes the more general feature of software being customisable to organisations or used in operations differing both in size and objective.

Finally, **usability** of SCM software is of special importance in humanitarian operations. This is due to the fact that the lack of professional staff and the high staff turnover have long been recognised as a major challenge in humanitarian logistics. The time pressure under which humanitarian operations are carried out further emphasises this requirement. Usability denotes both the service ability as well as the user friendliness of a technical system. Service ability consists of effectiveness, efficiency and satisfaction, i.e. how fast can the user get acquainted with the system, and whether he can reach his goals in a suitable amount of time. User friendliness refers to the easy, intuitive and adaptive handling of the system. Usability of SCM systems for humanitarian operations can be enhanced by functions such as a selection of supported languages, familiar layouts as known from standard operating systems, undo-possibilities, Hotkeys, as well an online help system.

7.2.2.4 Costs

Implementation of SCM systems can have both, a positive and a negative financial impact on the supported supply chains. Either impact needs to be controlled carefully in order to arrive at a positive monetary net result. Naturally, costs need to be limited, especially since humanitarian organisations often have to cope with the problem that their funding is earmarked for direct project support and therefore not eligible for long-term investments. Since SCM systems are an investment in long-term operations support, costs cannot directly be attributed to the operations themselves. Furthermore, since humanitarian operations are not profit-driven, communication of potential cost savings brought about by SCM systems will be much harder given the additional start-up effort involved in implementing the software and conducting necessary trainings.

Within this requirement, direct and indirect costs can be distinguished. **Direct costs** can be divided into software and hardware costs. Software costs include both purchasing and running costs such as updates and upgrades. Open-source software and freeware is to be preferred over proprietary or commercial software tools due to the licensing fees involved and adaptability issues. Since only limited technology is available in humanitarian operations, the hardware necessary to run the SCM software needs to be kept at a minimum.

Indirect costs include training costs and costs for customising and consulting. Training costs will occur since logisticians often lack adequate professional training. When considering the total costs incurred from using SCM software, this factor needs to be weighed with the potential benefits reaped by transparency in the supply chain and tighter supply chain process integration.

7.3 Assessment of SCM Systems

In this section, the requirements profile developed above is used to assess a number of SCM systems for humanitarian operations. Two categories are distinguished: The software tools SUMA, LSS, UniTrack, Helios, LogistiX and Sahana have been developed specifically for humanitarian operations. Orion-PI, Enterprise One and mySAP SCM are examples of SCM system from the industrial profit-driven domain. These tools have been pre-selected and examined in detail and will be presented in the following. For each system within the scope of the study, a short introduction is given, followed by a presentation of the key functionalities. Afterwards, all requirements are checked and we discuss to what degree the single requirements are being fulfilled.

The assessment of the software tools was carried out in the following way: Research was conducted to retrieve available literature on the software tools. Whenever the material obtained was insufficient, the producer of the software tool was approached for more in-depth information. In the case of the tools specifically designed for humanitarian operations, the producers of the tools were contacted in order to discuss the requirements profile developed in Section 7.2 with them. Moreover, the tools LSS, LogistiX and UniTrack were available for direct evaluation.

7.3.1 SUMA

The Supply Management system (SUMA) was one of the first SCM systems specifically designed for humanitarian crises. Developed in 1992 by the Pan American Health Organization, SUMA aims to improve management when supplying goods to victims of disasters. The coordination of goods independently of their origin and associated tasks such as sorting, inventory management, priority setting etc. are among the core elements of SUMA, all with the intention to improve coordination and efficiency in disaster response.

7.3.1.1 Functions

SUMA contains three different modules: SUMA Central, Field Unit, and Warehouse (Figure 55). During crisis response, these three modules are used at different organisational levels. SUMA Central is used at the central coordination hub where all data is merged from the other modules. The Field Unit module is used at points of entry such as ports and airports for a first registration and sorting as well as prioritisation of incoming goods. These data are then transmitted to the central coordination hub and the regional warehouses, where the third module is used to register the reception and delivery of goods, as well as other warehouse management tasks. Reports for the central coordination hub are also generated at this level.[441]

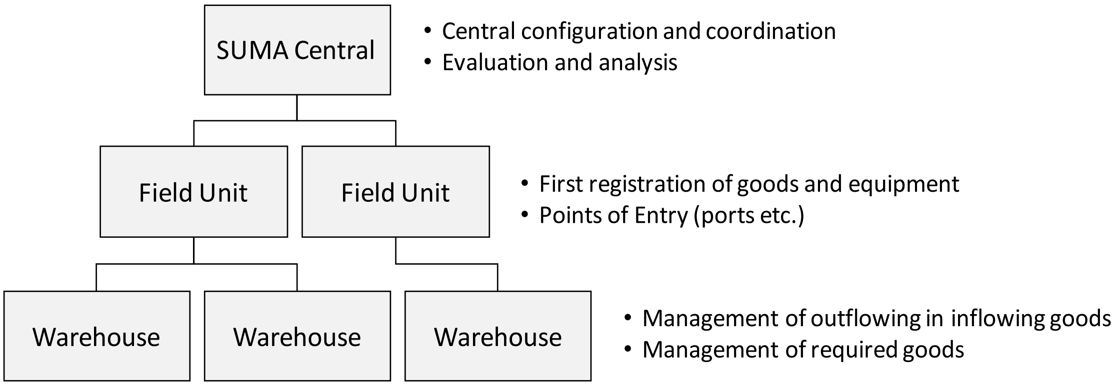

Figure 55: Setup of SUMA

7.3.1.2 Assessment

Cross-linking of systems is only possible by data transfer on diskettes which makes it both, slow and vulnerable. The system is not compatible or connectable with other systems and offers few possibilities for adaptation. Proactive planning is impossible. Introductory workshops are available. Historically, SUMA has been used in many natural and man-made disasters and by several humanitarian organisations, but is currently being displaced by more powerful SCM systems. The key idea behind SUMA was to keep the software very simple, thus making it possible to use the system in even the most remote areas with only limited hardware available. However, technological development also in humanitarian operations has been significant, which convinced the developers to come up with a successor to SUMA presented in the following section.

7.3.2 LSS

SUMA was one of the first SCM tools specifically designed for humanitarian crises, but currently it is being replaced more and more by other SCM systems. The Logistics Support System (LSS) is a direct successor of SUMA and is available free of charge for all humanitarian organisations. It has been developed feeding on the experiences made

[441] Cf. SUMA Project (May 2000a), SUMA Project (May 2000c), SUMA Project (May 2000b).

with SUMA and recommendations given by different countries, NGOs and UN entities, especially UNJLC.[442]

7.3.2.1 Functions

The main objective of LSS is to use the available stock and transport capacities more efficiently (Figure 56). In order to reach these goals, incoming goods are acknowledged and categorised when arriving in the field, creating detailed stock information. Outgoing goods are managed with the help of a deliveries module. All required material is processed in the system by a requests module featuring an interface to a pipeline module. In the pipeline module, all promised and expected shipments are administered. All the information available in the system can be analysed with the reports function. Depending on user preferences, data can be analysed reflecting different criteria and thus be compiled for different addressees.

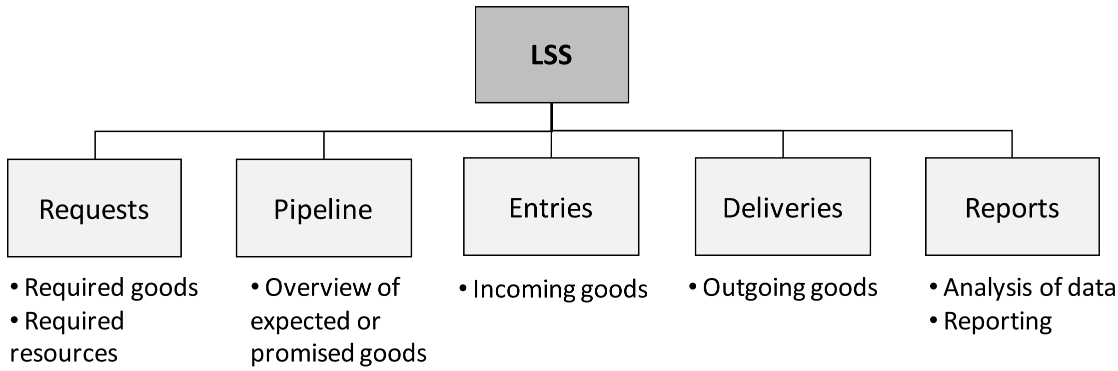

Figure 56: Setup of LSS

7.3.2.2 Assessment

All material flow processes with transactional nature such as inventory, demand, and transport management are covered and various analysis and planning schemes are offered. LSS also offers a wide array of reporting functions. Some requirements for Supply Chain Planning are realised with the pipeline module which also addresses order, warehouse and transport management. Among the biggest strengths of LSS are the networking and synchronisation capabilities integrating the information flow in the system and improving transparency in the supply chain. Monitoring enables access to required data and control of process status. Flexible import and export of data is possible even with different systems.

However, tracking and tracing is not possible. Additionally, some basic procurement features are not covered and warehouse management tasks are restricted to the rather simple entries and deliveries modules.

[442] Cf. Pan American Health Organization (2007), Pan American Health Organization (March 2006).

7.3.3 UniTrack

UniTrack is a UNICEF-developed stand-alone warehouse and commodity management system. It is tailored for environments where humanitarian organisations are faced with the management or support of logistics functions. Within UNICEF, the software was rolled out mainly during 2008 and 2009. Although laid out as an organisation-specific SCM system, UniTrack offers generally applicable SCM functions and is thus included in this assessment of SCM systems for humanitarian organisations. UniTrack is non-proprietary and can potentially be adopted by third parties.

7.3.3.1 Functions

The system enables operational sites to manage inventory and stock movements using standard logistics functionality and end-user monitoring features. The UniTrack system contains several modules and administrative functionalities that can be accessed according to the requirements of the operations and the emergency situation.

UniTrack has a number of features, which enable operational sites to record incoming order requests or purchase orders; for example, recording the physical receipt of items and releasing them to consignee and final destinations. UniTrack eases the tracking of items in the operational sites by recording each transaction and giving histories and printing reports by sector and project. It also provides warehouse layout management by supporting and requiring the definition of zones and locations within the warehouse perimeter. When conducting physical inventory checks, frequently necessary in humanitarian settings, UniTrack assists in the form of count sheets with varying data. Shipping documents such as waybills and packing lists and also labels for the goods in stock can be created and printed with the system. Picking lists can also be created by UniTrack and returned goods can be re-integrated in the system.

Report generation with UniTrack is straightforward and a number of different reports for different addressees can be produced – such as (detailed) stock reports (by site, country, sector, or project), purchase order summary, pipeline reports, stock transaction reports, stock value/aging reports, and received/delivered reports, among other.

The software can be employed to coordinate a number of operational sites through data synchronisation. In order to achieve this, import and export files can be created manually and transmitted electronically between different operational sites in need to synchronize their databases. Furthermore, the software allows for import and export of data into Excel. UniTrack also integrates all internal and external stakeholders relevant in operational countries in a contacts management module, i.e. suppliers, carriers, consignees and other departments within the humanitarian organisation.

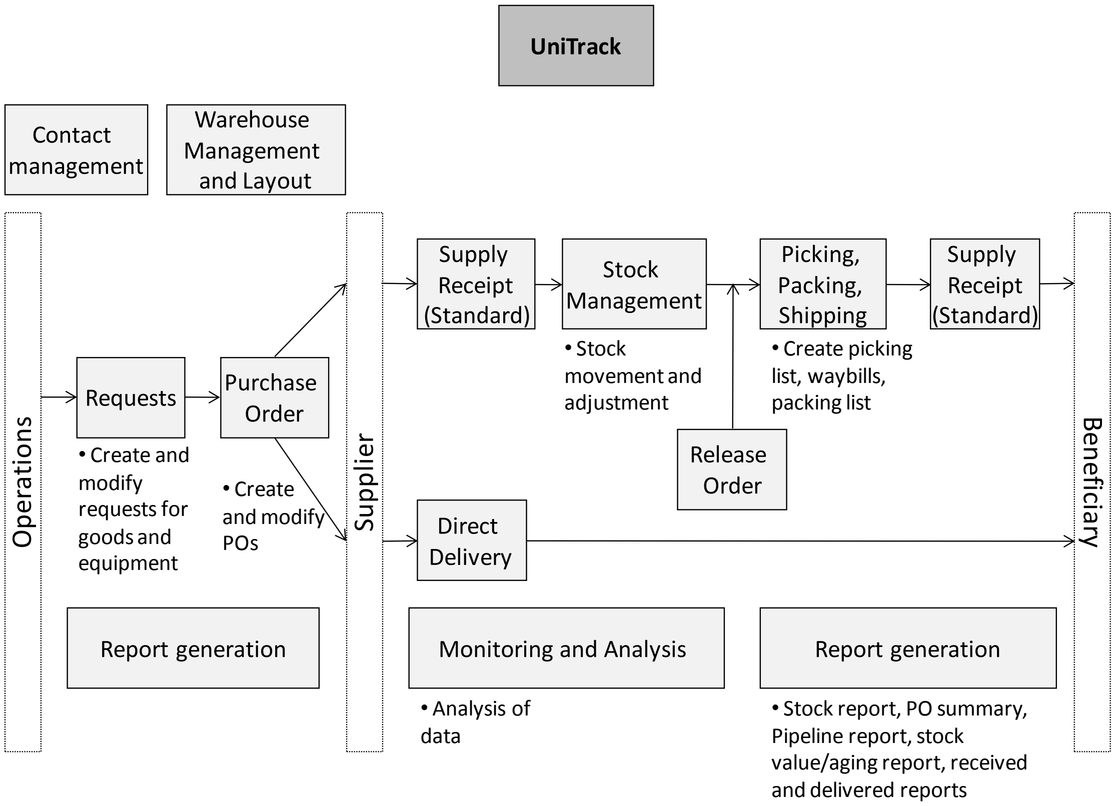

Figure 57: Setup of UniTrack

UniTrack was built as a client-server application using an MSDE database. The user interface was developed with WINDEV. A number of handbooks, FAQs and installation guidelines are readily available. The software is being improved continuously, and a helpdesk exists which can be contacted if problems occur.

7.3.3.2 Assessment

Although originally designed as a pure tracking system, UniTrack has evolved into a more comprehensive SCE system, yet remains limited to the Supply Chain Execution domain. Thus, tracking remains one of its core strengths. It particularly excels in assigning and tracking varying donor-dependent requisition codes to purchase and release orders. Functionalities of the Supply Chain Planning or Supply Chain Design domains are almost non-existent. UniTrack is nearly a pure Supply Chain Execution system. It records and documents all transactions related to the material flow between (local) suppliers and end destinations.

Although the software does not integrate with other information systems upstream or downstream in the supply chain, it does allow for data import and export, especially of standard item lists and item catalogues. However, this import needs to be done manually by each operational site – a clear disadvantage.

The report function is quite advanced and offers a wide variety of different kinds of reports. Combining this with its search function, UniTrack offers a variety of search options for goods and equipment, e.g. by request number, purchase order number, consignee, date, sector, aging, project number, supplier etc.

Further advantages of UniTrack are comprised of a stand-alone warehouse management and tracking solution, its easy installing and simple usage, and its non-proprietary status which prevents software or licensing fees.

UniTrack is a user-friendly system, which can be rapidly implemented[443] and operated even by novice users. Documentation is geared towards inexperienced end users and is both comprehensive and comprehensible. A help menu is available which will provide direct help when operating the system.

7.3.4 LogistiX

LogistiX is an SCM system for humanitarian operations developed in 2006 by the medical humanitarian relief organisation Médecins sans Frontières (MSF). The software is proprietary and does not have a commercial background.[444]

7.3.4.1 Functions

LogistiX can be implemented on two different organisational levels: Mission Coordination and Project Coordination[445] (Figure 58). While Mission Coordination is the super ordinate level, which mainly deals with procurement and administration issues, the Project Coordination level is concerned with the actual consumption of goods, as well as order and request management tasks. Between the two, LogistiX captures the entire material and information flow. Moreover, these levels could be used sequentially in order to accommodate for more hierarchical levels in the supply chain, e.g. by missions being supplied from regional centres. The flow of material is initiated by requests generated at project level. At mission level, requests can be assigned to local purchases, stock transfers or international orders. All incoming goods are acknowledged by receptions; for all outgoing goods the packing module can be utilised to issue waybills or freight manifests. The stock management module, as well as a monitoring module merging information from both levels, can be used at either level.

7.3.4.2 Assessment

LogistiX provides services for a number of Supply Chain Execution and some Supply Chain Planning requirements. Especially tracking of goods becomes possible through monitoring of the physical flows. Supply Chain Planning is supported by the calculation of average inventory levels. Taking into account order lead times, the optimal order size and respective inventory safety levels can be determined. Documentation and Reporting are well integrated with an alarm function in the stock management module. Networking or inter-linking of systems is not possible and data can only be imported and exported manually. Usability could be improved by a clearer menu structure.

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[443] Set-up, training and installation time for an entire country in which operations are run is estimated by roughly one week for each location in which UniTrack is to be used.

[444] Cf. Médecins sans Frontières (January 2007), Médecins sans Frontières (July 2007).

[445] Corresponding to the regional and local centres of the reference organisation or directly at the operational sites.

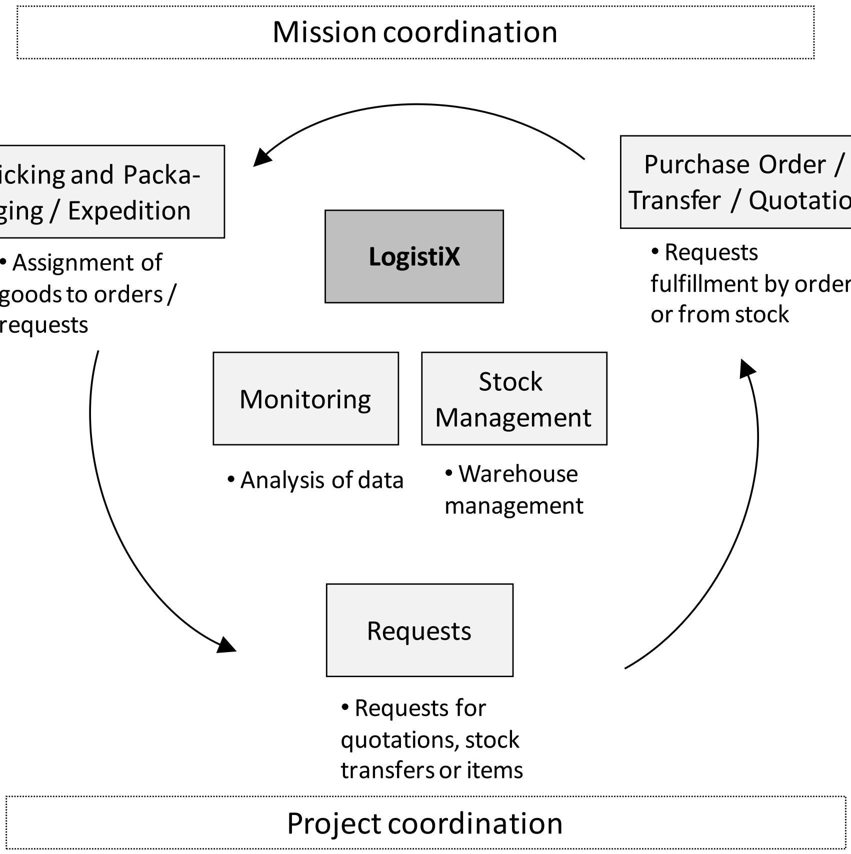

Figure 58: Setup of LogistiX

7.3.5 Helios

Helios is the most recent of the SCM systems specifically designed for humanitarian operations. It has been developed by the Fritz Institute, which was founded in 2001 as a non-profit organisation working in partnership with a number of organisations to innovate solutions and facilitate the adoption of best practices for rapid and effective disaster response and recovery. Helios is the successor of the Humanitarian Logistics Software (HLS) and is currently piloted in several humanitarian organisations such as Oxfam, World Vision International and International Medical Corps.[446]

7.3.5.1 Functions

Every operation is set up with the help of a project for which a number of master data need to be entered or imported. The software then offers five (optional) modules which are Request Processing, Procurement, Warehousing, Mobilization, and Reports (Figure 59). At the Request Processing module, information concerning the issued requests is managed. The issuer, addressee, required goods, date, address, etc. are compiled and assigned to a project. When a request is issued, the freight can be prepared with the help of the Warehousing module, inside which all warehouse or stock management tasks are executed. Amongst others, full or partial deliveries can be processed, identification tags

[446] As of January 2009, also cf. Fritz Institute (2008).

can be printed, and reports can be generated. The Mobilization module deals with in-kind donations and their distribution to one or several projects. Proper accounting and follow-up of donations as well as planning, monitoring and reporting is also possible. The Procurement module encompasses the administration and purchasing of goods and services. Orders are generated, which can be executed in part autonomously depending on the resource usage over the previous periods. Quotations can be generated, checked and analysed. On top of these modules, Helios also offers additional functions such as assessment of suppliers, tax calculation or a calendar in which relevant data such as scheduled delivery dates can be entered or displayed. Helios provides views to a common database. This enables improved coordination across all departments of the humanitarian organisation.

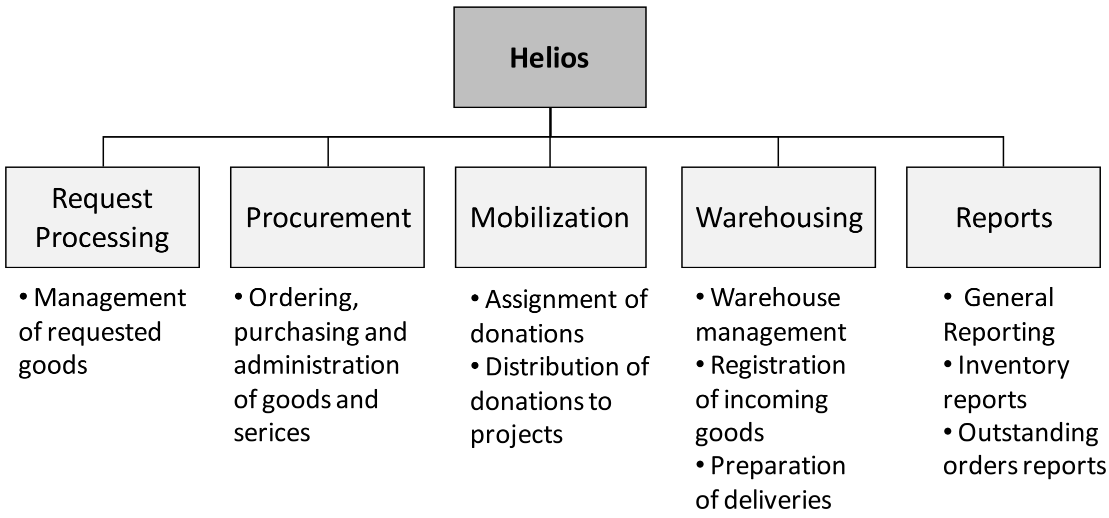

Figure 59: Setup of Helios

7.3.5.2 Assessment

Helios was developed for use in humanitarian organisations of varying sizes. It intends to enable even small humanitarian organisations to deliver their goods and services in a rapid and efficient manner. It is one of the few applications that can be implemented at both, headquarters and field level. Cross-linking is possible and beneficial for a central coordination of the operations. Demand Planning includes automated forecasting techniques. Order management is possible, likewise is Tracking and Tracing. Organisations may obtain information about their donations, from cash to in-kind goods and services. Through the option to work offline as well as online, it is possible to use it in disaster areas without a permanent internet connection. The structure of the software with respect to menus is quite user friendly, but due to the vast amount of different parameters navigation can become quite complex. Also, many abbreviations are used which impedes usability. Among the biggest drawbacks of Helios are missing Supply Chain Design and Supply Chain Planning functionalities as well as route planning and vehicle scheduling mechanisms. The software can be hosted either by the implementing organisation itself or by a service provider. A monthly fee for software maintenance and project support is charged to the humanitarian organisation.

7.3.6 Sahana Disaster Management System

The Sahana Disaster Management System is an open-source project developed in the aftermath of the South-east Asian tsunamis of late 2004. Sahana is the Singhalese word for “Relief”. Sahana has been put in place to provide an automated system to manage disaster relief efforts. It has been used in several disasters, such as the earthquakes in Pakistan in 2005 and in Indonesia in 2006.

7.3.6.1 Functions

Sahana is an internet-based application for disaster management encompassing several optional modules. There are a number of modules which are not directly related to SCM requirements, but to other disaster management tasks and coordination of organisations. Figure 62 displays the modules relevant to supply chain management, i.e. Request/Aid Management, Inventory Management and the Reporting System. The missing components are also indicated. These are Missing Person Registry, Organization and Camp/Shelter Registry, Volunteer Coordination, and Situation Mapping. At the Request/Aid Management module, data is entered concerning the required goods and services as well as promised support. Thus, all participating organisations can gain an overview of the situation and offer support if resources are available. The Inventory Management module offers standard warehouse management features. All incoming goods are registered with detailed information such as quantity, description, expiration date etc. An integrated report function offers the possibility to create individual reports. All functions of a module can be evaluated and graphically displayed which eases data analysis. Some additional modules, such as a catalogue system, administration and preferences module, allow the users to set their own parameters and select the modules they intend to use.

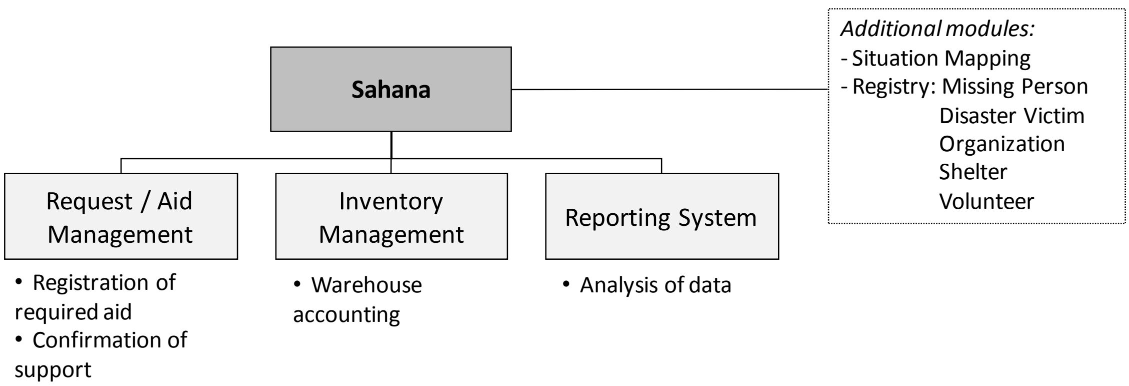

Figure 60: Setup of Sahana

7.3.6.2 Assessment

The focus of Sahana is not on supply chain management but rather on coordination and planning of humanitarian operations. Thus, the material and the information flows are not (yet) captured completely by this system. The open-source approach, which also keeps software costs low, may allow for this problem to be tackled in the future. The software is set up in a highly modular way and is therefore adaptable and flexible. Cross-linking of systems is not only possible, but one of the core ideas of Sahana. Synchronization of stations is supported and Sahana offers sophisticated documentation and reporting mechanisms. The main drawbacks of Sahana remain that supply chain management tasks are not addressed in a consistent and comprehensive way and that data or information cannot be imported or exported to other systems or databases.[447]

7.3.7 Orion-PI

Orion-PI is a supply chain management system by the software company Axxom aimed at small and medium-sized enterprises, as well as corporations. The objective of Orion-PI is to optimise the entire value chain by applying the Adaptive Planning Intelligence (API). Therein, strategic, tactical and operational decisions are supported. This is enabled by combinatorial optimisation algorithms which facilitate the flexible reaction to unanticipated events or changed environmental restrictions.

7.3.7.1 Functions

The software is designed in a modular fashion with basic elements and their extensions. Basic elements include the Strategic Enterprise Optimisation and Network Optimisation. In here, various scenarios for production and logistics networks, including assessment of locations and allocation of products and volumes, can be planned. The option Manufacturing with Constraints aligns transport and distribution plans with environmental restrictions. Another important element is Network Forecasting, which provides a tool for predicting trends and market developments. Further functionalities include available-to-promise/capable-to-promise (ATP/CTP), Vendor or Supplier Managed Inventory (VMI/SMI) and automated replenishment.

There are extended modules available in addition to these basic modules. These application modules serve to generate scenarios and visualisations, they help with the integration of geo-information systems data, provide web-interfaces and GUIs, as well as logistics modules. The logistics modules comprise a variety of functions such as material flow optimisation, tour and order optimisation mitigating bottlenecks, optimal route planning, inventory control and replenishment optimisation, forecasting and pick process optimisation with identification of optimal stock locations and commissioning areas.

7.3.7.2 Assessment

The supply chain management system Orion-PI is geared towards strategic and tactical tasks of supply chain management. It aims at holistic planning and evaluation of the entire supply network. This is complemented by Network-, Supply-, Production- and Distribution-Planning through visualisation and planning tools, as well as specifically developed forecasting algorithms. The logistics module also addresses the tactical and

[447] Cf. de Silva et al. (2006)

operational supply chain tasks through short-term and medium-term supply and distribution planning. This enables the optimisation of the entire material flow. The software is designed modularly. Interfaces to various other software systems exist. Usability is ensured by easily accessible graphical user interfaces. The software incurs relatively high costs to organisations due to licensing and updating fees.

7.3.8 EnterpriseOne

JD Edwards' EnterpriseOne is a complex software not only encompassing SCM functions but also supporting financial control and human resource management. Within the SCM task model, EnterpriseOne is focused on Supply Chain Planning and Supply Chain Execution activities. The software has been designed with small- und medium-sized enterprises in mind and can be used in a variety of different application scenarios such as production and distribution centres.

7.3.8.1 Functions

There are three different areas to the SCM part of EnterpriseOne: In the planning area, strategic and tactical decisions are taken to optimise the supply chain under consideration of material and resource restrictions. Demand forecasting and balancing with available capacities is done by a variety of different methods. Production Planning, Distribution Planning and Order Promising are supported. A scheduling module informs the user of problems when deviations occur. The order management module addresses all tasks necessary for order acknowledgement and processing. The logistics module aids in inventory planning, warehouse management, demand scheduling, transport management and also enables the integration of RFID information. EnterpriseOne is set up in such a way that supply chain visibility can be achieved from any location in the supply chain.

7.3.8.2 Assessment

EnterpriseOne is a comprehensive SCM solution, mainly dealing with Supply Chain Planning and Supply Chain Execution tasks, while offering only limited Supply Chain Design functionalities. Emphasis is put on the order management including inventory, warehouse and transport management. Monitoring and Tracking and Tracing are possible. Usability is achieved by proper documentation and with the help of service areas. Since the software has been tailored for small- und medium-sized enterprises, costs are bearable even for small businesses. The biggest advantage of EnterpriseOne is the adaptability of the software to organisation-specific requirements. Minimal database and hardware requirements enable rapid implementation of the software.

7.3.9 SAP SCM

SAP was founded in 1972 as "System Analysis and Program Development" and is one of the world's leading companies for enterprise software solutions today. Software solutions by SAP encompass the entire range of business processes including enterprise resource planning, accounting, logistics and administration.

7.3.9.1 Functions

One part of the SAP business suite is SAP SCM, SAP's supply chain management system. SCM integrates and synchronises data from all supply chain partners to improve decisions taken on strategic, tactical and operational supply chain management levels. The SAP Supply Chain Management business suite consists of a number of modules, viz. Advanced Planning and Optimization (APO), Forecasting and Replenishment (F&R), Supply Network Collaboration (SNC), Event Management (EM), and Extended Warehouse Management (EWM).

Advanced Planning and Optimization addresses a wide variety of supply chain management tasks necessary for supply chain planning and execution. It supports the inter-organisational cooperation and coordination on tactical and operational, but also partially on strategic planning issues. APO serves to continuously improve and measure the performance of the logistics network.

Forecasting and Replenishment is geared towards retail companies and aims at improving logistics by optimising replenishments. Here, excess stock in distribution centres and retail stores is minimized while bottlenecks and stock outs are avoided; replenishment orders are planned automatically; and total cost of ownership is minimized.

Supply Network Collaboration enables supply chain wide cooperation with suppliers through collaborative demand and capacity planning, joint order processing and synchronisation of supply and demand.

Event Management can connect event messages with application data from the supply network. Thus it enables the monitoring, control and measurement of business processes. Event Management makes the tracking of goods in the network and the monitoring of the system status possible. It further enables the coordination of plans and activities with partners in the supply network through information exchange. Reactions can be defined for critical situations, for instance through the sending of alert messages via email or through triggering of processes in other systems.

Lastly, Extended Warehouse Management (EWM) offers flexible automated support for managing, processing and executing all goods movements in warehouses. The system supports the regular and efficient execution of all logistical processes in the warehouse.

7.3.9.2 Assessment

SAP has been present on the SCM systems market since 1998 with the introduction of the Advanced Planner and Optimizer (APO). Currently, strategic decisions are only supported by the SCM software package in a limited way. However, different scenarios can be created and simulated. Data for MRP is also taken from the interface to the ERP system. Through the unified user interface Supply Chain Cockpit, the application presents itself as an integrated system to the user. Yet, the software is built modularly.

All areas of Supply Chain Planning are covered extensively. This is mainly achieved by the Advanced Planning and Optimization module, which addresses a variety of tasks such as supply network monitoring, demand planning, supply network planning, global available-to-promise/capable-to-promise, transport planning and management, and production planning and distribution scheduling. The same holds true for the Supply Chain Execution area, where all identified transactions are supported by SAP's SCM solution.

Reports can be generated and customised for the requesting entities. SAP's SCM modules integrate with the other business suite modules. This ensures data consistency. One drawback of SAP SCM is the limited usability. Software users need to be very experienced when operating the system since error identification and reconciliation can be extremely difficult. Moreover, the graphical user interface cannot be operated intuitively.

Organisations using SAP SCM incur relatively high costs mainly because of licensing and customisation fees. Moreover, extensive training of personnel is required. This can be a prohibitive factor in humanitarian environments in which staff turnover is very high. Although there is also an SAP solution available for small and medium-sized enterprise (Business One), this solution does not support logistics and supply chain management tasks.

7.4 Synthesis of Results

This section focuses on summarising the most important findings from the assessment of all nine software tools contained in the survey. Due to the different approaches, this discussion is split into two parts, each dealing with either of the two categories. A synthesis of the discussions above is presented in Table 15. In the following table, a (○) denotes that this requirement is not or only inadequately fulfilled by the software; (◍) denotes partial fulfilment as elaborated above and (●) signifies that the requirement is appropriately addressed by the software.

In summary, it can be stated that within the category of SCM software tools specifically designed for humanitarian operations Supply Chain Design and Supply Chain Planning capabilities remain limited. LogistiX and Helios offer some Demand Planning functions by implementing forecasting techniques and LogistiX even supports a few Supply Planning tasks. The focus of all SCM tools in this category clearly lies on tasks within the Supply Chain Execution and Event Management areas. Basic functions of order, warehouse and transport management are offered by most of the tools. Monitoring is possible with those tools also offering online operating modes, such as Sahana and Helios. Moreover, Helios also offers a tracking and tracing possibility while LogistiX features an alert management integrated in its functionalities.

When it comes to documentation, all tools show their strengths. Especially LSS and LogistiX offer comprehensive user manuals. While the same holds true for reporting,

Table 15: Assessment of SCM systems

	SUMA	LSS	Helios	UniTrack	LogistiX	Sahana	Orion-Pi	EnterpriseOne	my SAP SCM
Supply Chain Design	○	○	○	○	○	○	●	◍	◍
Supply Chain Planning									
Operations/ Product Planning	○	○	◍	○	◍	○	●	◍	●
Network Planning	○	○	○	○	○	○	●	◍	◍
Supply Planning	○	○	○	○	◍	○	●	◍	●
Transport Planning	○	○	○	○	○	○	●	◍	●
Order Promising	○	○	○	○	○	○	○	●	●
Collaborative Planning	○	○	○	○	○	○	◍	○	●
Supply Chain Execution									
Order Management	◍	◍	◍	◍	◍	◍	○	●	●
Warehouse Management	○	◍	◍	◍	◍	○	○	●	●
Transport Management	◍	◍	◍	○	◍	○	○	●	●
Distribution Management	◍	◍	◍	○	◍	○	○	●	●
SCEM: Monitoring	○	◍	◍	◍	○	◍	○	●	●
SCEM: Track & Trace	○	○	◍	●	○	○	○	●	●
SCEM: Alert Management	○	○	○	○	◍	○	○	●	●
Documentation	◍	◍	n/a	○	●	●	●	●	●
Accountability									
Reporting	○	◍	◍	●	◍	○	○	●	●
Controlling	○	○	◍	◍	◍	○	○	●	●
Software Setup									
Cross-linking of systems	○	●	●	○	○	●	●	●	●
Offline use / Synchron.	●	◍	●	●	◍	●	◍	○	○
Modularity / Adaptability	◍	◍	◍	○	◍	●	◍	●	◍
Usability	◍	◍	○	●	○	◍	●	◍	○
Costs									
Direct	●	●	●	n/a	n/a	●	○	◍	○
Indirect	●	●	●	n/a	n/a	●	○	◍	○

the objective and coverage of reports differs between the tools. All tools but SUMA offer internal and external reporting formats. Helios and LogistiX offer controlling functions, thus integrating the financial flow in planning and execution decisions, and evaluations. Cross-linking of systems is possible with LSS, UniTrack, Helios and Sahana. Helios and Sahana are taking it one step further by allowing for cross-organisational linking of systems. With all tools presented in this category, offline processing of data is possible. All of them are constructed in a more or less modular way. Sahana can be parameterized the most, while LogistiX offers different modules for different coordination levels, albeit not incorporating the headquarters level. UniTrack, Helios and LogistiX offer tracking and tracing capabilities. The calendar option in Helios seems to be a useful feature to keep track of delivery dates and unexpected interruptions in the material flow or events. While usability could be improved in all SCM tools contained in the survey, Sahana has the clearest and most easily accessible user interface. A major benefit of all tools in this category is their low cost. However, this comes at the expense of limited functionalities, especially in the Supply Chain Design and Supply Chain Planning areas. All in all, the emphasis in this category is being put on Supply Chain Execution tasks and the software tools try to offer readily usable and simple functions.

Those SCM systems not specifically developed for humanitarian operations display a much larger range of functions in all areas of IT-supported supply chain management. Orion-PI is geared towards Supply Chain Design and Supply Chain Planning and does not emphasize Supply Chain Execution or accountability requirements in this module. Usability is increased through graphical user interfaces and planning elements. EnterpriseOne on the other hand has been developed for small- and medium-size enterprises and concentrates on Supply Chain Execution tasks while some Supply Chain Design and Supply Chain Planning functions are being offered. An important part of this software is the variety of available data structures and data import/export formats, which makes this software very flexible. SAP SCM most comprehensively addresses the areas of the SCM task model as well as collaborative aspects, which integrate both suppliers and customers in the supply chain processes. However, usability is hampered by SAP SCM’s high complexity. All of the SCM software tools in this category have the disadvantage of incurring high direct and indirect costs if deployed by humanitarian organisations. EnterpriseOne has specifically been designed for small- and medium-size enterprises and might be the most feasible Supply Chain Execution solution. It remains questionable whether the high number of offered functions and the associated costs can be justified by humanitarian organisations.

7.5 Conclusions

Managing the flow of goods, information and finances in a supply network requires gathering, processing and analysis or large amounts of data. The easier this data can flow across the supply network, the more responsive logistics services can be to changing demand from the field.

Supply chain management systems can potentially offer a variety of benefits for humanitarian organisations:

- Decision support can be given on a strategic, tactical and operational level. SCM systems enable supply chain transparency and thus improved planning.
- Through collaborative planning, the potential of optimisation beyond a single humanitarian organisation or at least within a multi-tiered humanitarian organisation is given. Thus, efficiency of humanitarian supply chain operations can be enhanced significantly.
- SCM systems also allow humanitarian organisations to comply with their increasing accountability requirements imposed by the donors.
- SCM systems allow humanitarian organisations to accurately track and trace goods and obtain status of warehouse inventories and goods delivered to beneficiaries.

The requirements profile developed in this chapter has been used to review and assess a number of SCM systems for humanitarian operations. Thus, the purpose of this chapter has been two-fold: First, the requirements profile for SCM systems for humanitarian organisations can be understood as a tool which mapped the main challenges humanitarian supply chains are facing to a requirements profile for IT-supported supply chain management systems. Thus, this tool can serve to guide the future development of SCM systems, which have the objective to support humanitarian operations. Secondly, through a first review of some of the most widely used and most promising software tools in humanitarian organisations, practitioners can gain a quick overview over state-of-the-art software tools when confronted with a decision to implement SCM systems to support operations.

Various SCM systems have been developed that specifically support humanitarian organisations in running their operations. The very first tools developed concentrated on tracking goods in order to provide data for donor reports only. With the development of SUMA, more sophisticated supply chain tasks such as registering and classifying goods and consigning stock and allocating priorities were supported. Of all the tools examined during the course of the study, Helios and LogistiX are the most promising. Both Helios and LogistiX possess quite powerful Supply Chain Execution features, but miss to fulfil the requirements of the Supply Chain Design and Supply Chain Planning domain. Sahana’s main strength is its open-source architecture. Thus, while supply chain management is not the main focus of this software, it is highly extensible and a promising tool for the future.

Altogether, several conclusions can be made: No supply chain management system covered in the survey is able to simultaneously address all Supply Chain Design, Supply Chain Planning, and Supply Chain Execution requirements. Supply chain management systems specifically developed for humanitarian operations lack Supply Chain Design and Supply Chain Planning functionalities, whereas supply chain management systems from the commercial domain do not satisfy the general requirements. Thus, the combined use of tools to cover all functional requirements is suggested. In order to arrive at a satisfactory overall IT framework, humanitarian organisations need to first decide which kind of data they need to capture, store and analyse electronically and which data are to be handled manually. The benefits of manual records such as reliability, sturdiness and ease of capturing need to be carefully weighed with the benefits of electronic data processing. When data is stored and handled electronically, the level of sophistication of the supporting software also has to be decided on. Helios has the potential of becoming a de-facto standard in the humanitarian domain and could be complemented by a lean Supply Chain Design and Supply Chain Planning system such as Orion-PI. However, such a combination of tools also bears risks regarding data integration and consistency, surplus customizing and consulting fees and increased indirect costs etc., which need to be circumvented. However, a combination of different supply chain management systems can be considered when the tools have different scopes such as separate organisational units or process interfaces. This can be achieved when combining supply chain management systems specifically designed for Supply Chain Design decisions with a capable Supply Chain Execution/Supply Chain Planning software tool.

8 Outlook

Habe nun, ach! Philosophie,
Juristerei und Medizin,
Und leider auch Theologie
Durchaus studiert, mit heißem Bemühn.

J. W. von Goethe, Faust

A summary of the findings of this research is given in this chapter (8.1). It is reviewed how the initial research questions have been answered, and the benefits and limitations of the research are critically reflected upon (8.1.1, 8.1.2). Based on the recognized gaps in the existing literature as well as the results from the empirical survey, open fields of supply chain management in the context of humanitarian operations are identified and suggestions for future research are derived (8.2). These include the areas of performance measurement in humanitarian logistics and the application of methods of operations research in humanitarian organisations.

8.1 Summary

Humanitarian logistics has been recognised as being of crucial importance for the effectiveness and efficiency of humanitarian operations.[448] However, many humanitarian actors have not yet acknowledged this importance and continue to mainly concentrate their efforts on fundraising, communications or public relations. Logistics is commonly viewed as a necessary expense rather than having an interface and management function decisive for the success of humanitarian operations. This has become visible through the empirical survey which set the foundation for this research. The

[448] Cf. Thomas and Kopczak (2005).

main findings from the survey which involved 39 large international humanitarian non-profit organisations conducting operations world-wide can be summarised as follows:

- There is a high degree of complexity involved in the logistics and supply chain management of humanitarian operations.
- Humanitarian organisations neglect logistics and supply chain process modelling, control and management. These organisations are frequently not clear on roles and responsibilities in the humanitarian supply chain.
- Humanitarian organisations do not adequately measure the performance of their supply chains or the associated logistics activities nor do they have the capability to do so.

Moreover, it has been found that the coordination of different humanitarian actors and the collaboration between these actors is still frequently inadequate. Coordination is, especially during the immediate emergency response phase after a sudden-onset disaster, i.e. the beginning of the humanitarian operation life-cycle, of utmost importance.[449] In fact, auf der Heide (2007) states that effective disaster management can only be achieved through inter-organisational coordination. Coordinating logistics activities by actors in the humanitarian supply chain has somewhat improved in the recent past with shared equipment, assets, globally pre-positioned stocks or resources such as aircrafts, trucks, food stocks etc. Nevertheless, it can be claimed that cooperation of humanitarian organisations or rather the lack thereof is still one of the key issues in the humanitarian sector.[450] It can be observed that some actors impede each other's operations, and services are delivered redundantly.[451] Uncoordinated activities have caused an imbalanced distribution of resources in crisis areas.[452]

In order to address the issues identified during the empirical survey, a reference task model for supply chain management which could be used to model and develop supply chain processes for humanitarian operations had to be constructed.

Existing process modelling techniques, supply chain management frameworks and process reference models were examined. Despite some shortfalls, the Business Process Modelling Notation (BPMN) was selected as the most feasible technique to model processes.

A range of frameworks for supply chain management were reviewed and assessed with regard to their applicability in the research domain. It was found that the framework by Fleischmann et al. (2005) could be suitably adapted. This model provided the starting point for developing a reference task model for supply chain management in the context of humanitarian operations.

[449] Cf. Kovács and Spens (2007), p. 109.
[450] Cf. Tufinkgi (2006), p. 185, Thomas and Kopczak (2005), p. 6, auf der Heide (2007), Chapter 3, Kovács and Spens (2007), p. 109, Beamon (2004), p. 6, and many authors.
[451] On the lack of coordination cf. Stirn (1997), p. 39, Thomas and Kopczak (2005), p. 8.
[452] Cf. Rosow (1977).

A large range of existing reference models were reviewed in order to ascertain if these could semantically support the task model. Reference models assessed originate from science and practice, as well as from various industries like retail or the service industry. They focus on various functions such as logistics, warehousing or procurement and are geared to various audiences such as organisation developers or application system designers. A few of the most important reference models were presented in detail. It was found that some elements from certain reference models like SCOR or the R/3 Reference Model could be used to complement the task model. Yet, the requirements for a reference model for the application domain necessitated the construction of a self-contained task model which was generally applicable in the research domain, as well as reusable, modular and adaptable.

The reference task model was developed taking into account the guidelines of modelling. The construction of the reference task model followed the procedure-model for the construction of reference models provided by Schütte (1998). Suggestions and further improvements to the procedure-model by Delfmann (2006) and Knackstedt (2006) were integrated. The reference task model distinguishes the tasks in the humanitarian supply chain along two axes: A hierarchical decomposition of the planning horizon and a division according to the function. On the planning horizon strategic, tactical, and operational tasks were distinguished. On the functional axis, assessment, procurement, warehousing, transport, reporting, and operations support activities were separated. The framework spanned by these two axes was then completed with over 100 reference tasks for supply chain management in the context of humanitarian operations. For those reference tasks content, interdependencies, roles and responsibilities of actors in the humanitarian supply chain were defined. A number of reference processes were constructed with the reference task model and illustrated the flexible application of the model in different scenarios and scopes of humanitarian operations such as emergency and post-emergency contexts. A case example was developed to show how the reference task model can be used for various objectives, viz. the development of reference processes as well as the visualisation of workflows.

Based on the case examples and the reference task model, requirements for supply chain management systems for humanitarian operations were deduced, and a requirements profile was developed. The requirements profile distinguishes functional and non-functional requirements for supply chain management systems. Following Hellingrath et al. (2003) and Hellingrath and ten Hompel (2007) the functional requirements were further separated into requirements for Supply Chain Design, Supply Chain Planning, and Supply Chain Execution capabilities. Various non-functional requirements specific to the sector of humanitarian organisations complemented the requirements profile.

This requirements profile was utilised to assess current supply chain management systems geared to support humanitarian operations. All publicly available supply chain management systems specifically developed for humanitarian organisations were included in the assessment, together with some organisation-specific proprietary solutions as well as supply chain management systems developed for other sectors and industries. It was found that no software tool is able to completely address all requirements of Supply Chain Design, Supply Chain Planning, and Supply Chain Execution at the same time. While some of the tools contained in the survey fulfilled the requirements profile partially, none of the tools was able to completely satisfy all requirements. Supply chain management systems specifically developed to support humanitarian operations lack Supply Chain Design and Supply Chain Planning capabilities while supply chain management systems from the industrial domain do not fulfil the general requirements. Thus, the use of a combination of tools to cover all functional and non-functional requirements was suggested.

8.1.1 Benefits

The reference task model and the requirements profile for IT systems for supply chain management in the context of humanitarian operations developed here offer a number of potential benefits to humanitarian organisations:

- The reference task model provides a tool for humanitarian organisations to rapidly visualise the tasks carried out by the organisation and its supply chain partners. Furthermore, the task model is extensible and hence able to adapt as the role of humanitarian organisations in the humanitarian supply chain changes.
- Since the reference task model identifies the value-adding tasks in the humanitarian supply on three levels, it provides an opportunity for humanitarian organisations to streamline their activities and identify their core competencies.
- The reference task model supports the standardisation of these tasks by clarifying roles, responsibilities, and definitions. It gives humanitarian organisations the possibility to communicate their tasks and processes with their supply chain partners. Thus, coordination and cooperation of humanitarian organisations is eased. Moreover, it also allows for an in-depth analysis of operations, which can help organisations identify the fields in which there is the most potential for improvement.
- The requirements profile provides a method for humanitarian organisations to easily determine their needs with regard to supply chain management systems, to assess existing systems, and to identify weaknesses in the currently deployed systems.
- The requirements profile and the assessment of currently available SCM systems from both the humanitarian and the industrial for-profit domain give humanitarian organisations the opportunity to rapidly identify suitable candidates for organisation-specific IT solutions.

The reference task model and the requirements profile set the basis for the development and implementation of integrated supply chain management systems supporting supply chain processes of humanitarian organisations. This enables performance measurement and ultimately allows benchmarking of these processes and can thus contribute to more effective as well as more efficient humanitarian operations.

8.1.2 Research Limitations

Despite these benefits, this research is subject to certain limitations. The reference task model has to face the criticism which all endeavours to standardise processes are subject to. Although standardisation can facilitate a number of benefits, it also bears the risk of impeding the competitive advantage of a given organisation. Standard solutions never enable an organisation to perform superiorly compared to its competitors. This criticism can be countered, as supply chain management is not the unique selling proposition for humanitarian organisations. Donors measure the impact of their finances by the added value for the beneficiary. This added-value can only be increased when humanitarian organisations cooperate horizontally, i.e. enter a state of cooperation rather than competition.[453]

Another limitation is of more general nature and refers to humanitarian operations themselves. The objective of humanitarian operations is to support people in distress in order to ensure their survival and to help a community restore to its original situation after it has been affected by a disaster and its capacity to cope has been overwhelmed. Whether this goal is reached or whether humanitarian operations can also be harmful to an economy[454] is a question of ongoing debate. Some authors have expressed their view that "relief aid can in fact be detrimental in certain circumstances, exacerbating and prolonging conflicts"[455] by destroying local capacities and fuelling war economies.[456] They claim that humanitarian aid is providing a safety-net and thus helping in many cases to create divisions in society, which are "perpetuating conflict and poverty, as strong political groups transfer wealth from the poor to the rich within a parallel economy"[457]. It is the author's point of view that it needs to be carefully evaluated case by case whether the intended value for the beneficiaries will be achieved when planning and implementing, but also when continuously running operations. While the answer may be easy to derive in immediate response operations following sudden-onset disasters, this assessment is not as straightforward in complex situations such as political emergencies, chronic emergencies and slow-onset disasters.

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[453] Schulz (2009) presents the benefits of horizontal cooperation between humanitarian organisations and makes the case that there is ample room for increased cooperation.
[454] Cf. for example Long and Wood (1995), p. 213.
[455] Munslow and Brown (1999), p. 207.
[456] Cf. Munslow and Brown (1999), p. 210.
[457] Munslow and Brown (1999), p. 221.

8.2 Propositions for Further Research

8.2.1 Reference Task Model 2.0

Since the undertaking of creating a reference model for an entire sector with a scope as large as supply chain management is massive, only a certain level of detail could be achieved during the construction of the reference task model. While developing this task model, setting the level of detail and adhering to this aggregational level has been a challenge. Thus, when humanitarian organisations decide to use this reference task model as the basis for creating organisation-specific supply chain processes, certain organisation-specific details will need to be modelled at run-time. The effort involved in the application of the reference task model could be lowered by adding another layer of hierarchy which provides task descriptions on a more detailed level and which could serve as a resource during the application phase of the reference model. Moreover, the formalisation of BPMN provides the basis for an IT implementation of an adaptable reference task model which could further reduce the development time for organisation-specific supply chain processes.

The reference task model provides the basis for the construction of reference processes. Several examples (Sections 6.5.2 to 6.5.7) have shown the applicability of the model as reference processes were constructed for emergency and post-emergency operations and for dealing with standard and non-standard goods. Yet, several issues could not be tackled due to restrictions of scope of this research: Further processes, e.g. on tactical procurement, cooperation in sudden-onset emergencies, or operation of shared warehouses, need to be developed and the reference task model needs to be applied in practice in order to be further extended and improved. The application of the reference task model in case studies could promote and establish the reference model as an industry standard.

Issues of collaboration and coordination of humanitarian organisations have been omitted from the reference task model at this stage. However, the increasing complexity of humanitarian operations, increased pressure from donors for coordinated disaster response, and the variety of undertakings to coordinate the response of the international community, e.g. the cluster approach by the UN, suggests that this area ought to be specifically addressed in a reference model for humanitarian organisations.

It needs to be recognized that the development of a sector-wide reference model for supply chain management is a massive endeavour. One major challenge in creating the reference task model was to ensure completeness, adherence to a certain level of abstraction, and to ensure both intra-level consistency (i.e. within the same time horizon) as well as inter-level consistency (i.e. between the strategic and tactical and the tactical and operational time horizons). Focusing on the inter-level consistency, the reference task model could be strengthened by further explicating the relationships between the respective tasks. Thus, vertical integration of the reference task model could be enhanced.

Lastly, at present time, only two types of tasks are distinguished, viz. “generic” and “specific” tasks. This classification scheme could be expanded into a tagging system which could also comprise further categories with attributes concerning the size of the organisation, the kind of humanitarian operation, temporal requirements, etc.

8.2.2 Performance Measurement

The need to measure the effectiveness of humanitarian supply chains and the lack of adequate performance measurement has been identified in the previous chapters. While there has been some exploratory research specifically on this topic before, there is currently no thorough insight on how to measure the effectiveness or performance of supply chain management in the context of humanitarian operations. Moreover, the requirements for the design and the implementation of a supply chain performance measurement system with the objective to assess the effectiveness and efficiency of humanitarian supply chains have not yet been clearly deduced. Any such research efforts would need to start out by developing appropriate key performance indicators for humanitarian logistics. While some research has been conducted on performance measurement schemes for certain organisations, the area remains largely under-researched.[458]

The potential benefits of an effective performance measurement system are the same in the for-profit and non-profit humanitarian domain: “Effective performance measurement systems can help non-profit managers make better decisions, improve performance, and provide accountability. Moreover, when they are designed and implemented effectively, performance measures provide feedback on agency performance, and motivate managers and employees to work harder and smarter to improve performance. They can also help allocate resources more effectively, evaluate the efficacy of alternative approaches, and gain greater control over operations, even while allowing increased flexibility at the operating level”[459]. Moreover, Schulz (2009) has shown that performance measurement is also a way to improve cooperation between different humanitarian organisations and between humanitarian organisations and logistics service providers.[460] This is due to the fact that performance measurement enables the ascertainment of benefits of cooperations.

There are four main reasons which motivate the development of generally applicable key performance indicators for humanitarian supply chains. These are:[461]

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[458] For existing contributions to performance measurement of humanitarian logistics, cf. Beamon (2004), Davidson (2006), de Brito et al. (2007), Schulz and Heigh (2007), Beamon and Balcik (2008) who also list further contributions mainly dealing with practitioners’ experience when developing and implementing performance measurement systems in humanitarian organisations, van der Laan et al. (2009), and Kovács and Tatham (2009).

[459] Beamon and Balcik (2008), p. 13 citing Poister (2003).

[460] Cf. Schulz (2009), pp. 206, 230-231.

[461] Cf. van der Laan et al. (2009)

- An increased magnitude and multitude of natural and man-made disasters which necessitate humanitarian operations
- Donors' increasing demand for transparency and accountability
- The increasing competition between non-profit humanitarian organisations and
- The high visibility of humanitarian operations.

Firstly, the rising number of disasters and especially the rising impact disasters and crises have on vulnerable populations puts pressure on humanitarian organisations to improve their supply chain capabilities. Since only processes which are measured can also be improved, appropriate performance indicators may focus the attention of humanitarian organisations on those processes which promise levers for improvement. Secondly, there is an increasing pressure for transparency and accountability in the humanitarian supply chain from donors and beneficiaries alike. This pressure for improved analysis of the impact of humanitarian assistance has grown in line with the increase of resources allocated to the sector. Donors believe that without mechanisms to monitor performance, objectives may not be met and scarce funds may be wasted on inappropriate purchases. Humanitarian operations are being pressured to become more transparent.[462] A further reason is the increasing competition in the non-profit sector. The number of organisations has grown immensely over the past decades. An obvious consequence is that, as more and more organisations enter the market and competition for funding grows, it becomes increasingly important for these organisations to develop good measures of accountability and performance as well as program impact and quality.[463] Finally, the high visibility of some crises calls for humanitarian organisations to run their operations both effectively and efficiently. Media will not hesitate to cover reports of malfunctioning operations or failing services of humanitarian organisations. This can have a dramatic impact on the humanitarian sector as a whole, when both private and public donors lose confidence in the integrity of humanitarian operations.

Humanitarian organisations have traditionally been unable to measure the performance of their supply chains.[464] According to Davidson (2006), this was due to their inability to capture data from operations centrally. Recent developments and implementations of IT systems which are capable of supporting the logistics functions of humanitarian organisations, allow the retrieval of data to measure performance. Gradually, IT systems specifically designed for humanitarian supply chains become implemented. These IT systems can provide visibility in the humanitarian supply chain since they can capture the data of an operation in a centralized location.[465] The lack of complete operational data has long been the single largest inhibitor of standardized performance measurement, so the development and implementation of logistics software is a key enabler for conducting research on supply chain performance measurement in humanitarian supply chains.

[462] de Brito et al. (2007), p. 3.
[463] Cf. Beamon (2004).
[464] Cf. Davidson (2006), p. 2.
[465] Cf. Davidson (2006), pp. 15-16.

There are two possibilities when designing a key performance indicator system. Either new performance indicators are developed from scratch on a case by case basis or a framework system is created which can be used as the basis for adapting performance indicators for a given use case. An overview of existing performance measurements frameworks and systems in the commercial domain has been presented by Keller and Hellingrath (2007). A first attempt to provide a generic framework for performance indicators of humanitarian supply chains has been suggested by Beamon and Balcik (2008), who propose indicators for resource metrics, output metrics, and flexibility metrics. Thus, the performance of the humanitarian supply chain can be evaluated along these three axes. However, further research is needed on the methodology of developing balanced performance measurement systems for humanitarian supply chains, thereby taking into account the shifting operational paradigm as the operations pass through the three phases of the humanitarian operations life-cycle.

8.2.3 Operations Research

It has been shown that due to the changing nature of ongoing conflicts and sudden- and slow-onset disasters which necessitate humanitarian operations, more and more humanitarian organisations which traditionally focussed on emergencies only, find themselves in contexts of complex or chronic emergencies and come to realise that their approaches to humanitarian operations need to reflect the changing nature of present conflicts and disasters. One of the most fundamental changes is that funding for acute disasters is generally available with little restrictions whilst funding for enduring chronic and complex emergencies with little media attention is often scarce and cost-effectiveness becomes imperative. Thus, methods from Operations Research (OR) can be used to derive cost-efficient plans for such operations.

Operations Research comprises the development and application of quantitative models and methods for decision support in organisations.[466] Operations Research takes the approach of optimisation and simulation when modelling and analysing a part of reality. A discipline related to Operations Research is Management Science, which focuses on supporting decisions of executive managers. In general, OR develops methods which are then applied by Management Science. The possible scenarios in which methods of Operation Research/Management Science could be beneficially employed in the context of humanitarian operations are numerous: Planning the response to large-scale epidemic outbreaks, such as pandemic influenza, improved planning and support of search and rescue operations after sudden-onset natural disasters, solutions for sustainable water allocation, more accurate prediction of hurricane paths and devastation among many others.[467]

[466] Cf. in the following Suhl and Mellouli (2006), pp. 5-6. Methods which are frequently used by Operations Research include linear optimisation, mixed-integer optimisation, network optimisation, non-linear programming, stochastic and dynamic programming, heuristics and meta heuristics, and simulation among others.
[467] Cf. Ergun et al. (2009).

Humanitarian logistics has only recently been discovered as a field of science in its own right. Even more, the application of methods of OR to the humanitarian domain is a young and largely unexplored area of academic and practical interest. In the academic literature this topic is studied more intensively, but results have not yet found their way into the practical work of humanitarian organisations. This can be attributed to the fact that humanitarian organisations are mainly preoccupied with delivering aid to victims of natural and man-made disasters, and funds for investments in technology and process improvement are scarce. Moreover, humanitarian organisations have only recently begun to recognise that best practices from business logistics can in fact be beneficially applied to the humanitarian domain.

A comprehensive literature review was conducted which aimed at analysing the state-of-the-art of OR in humanitarian logistics. Despite the current upward trend of academic literature on issues of humanitarian logistics, the review revealed that contributions concerning the development or application of OR methods to issues of supply chain management in the context of humanitarian operations remain limited. The existing contributions can be partitioned into the pre-disaster, post-disaster, and integrated approaches which apply to both the pre- and post-disaster phase.[468] Each of these phases can be partitioned in several sub-phases.

In the pre-disaster phase tasks include the preparation for and mitigation of potential sudden- or slow-onset disasters. This phase gains particular importance in regions with a high imminent risk of disaster, like settlements near an active volcano or in earth-quake-prone regions. Preparation includes the assessment and ascertainment of the availability of resources for disaster response. Operations Research contributions to the pre-disaster phase can be categorised into facility location planning, integrated facility location planning and inventory positioning, site and facility selection, planning of mode and means of transportation, and others.

In the immediate post-disaster response phase, all resources are activated and the main goal is to reach the disaster-affected region as quickly as possible with necessary supplies, equipment and personnel. Thus, tour planning and vehicle routing, loading plans, evacuation planning and scheduling, and coverage of affected regions become crucial. Subsequent is the recovery/reconstruction phase, which can be regarded as a sub-phase of the post-disaster phase with a longer time horizon. Here, the objective is to re-establish self-sufficiency of disaster affected communities. Main tasks in this phase include inventory control, demand forecasting, stock replenishment, and planning of customer service level. OR contributions to the post-disaster phase can be categorized into tour planning, facility planning, inventory planning, and others.

[468] This is in contrast to the common separation of the three phases preparation, immediate response and recovery/reconstruction (cf. Kovács and Spens (2008)), but seemed more natural considering the lack of contributions for the recovery/reconstruction phase. Furthermore, the separation of recovery/reconstruction and preparedness becomes easily blurred, and a clear distinction cannot always be made.

Some OR contributions address the entire humanitarian operations life-cycle, i.e. both the pre-disaster and post-disaster phase. A summary of all current contributions of Operations Research to issues of supply chain management in the context of humanitarian operations is presented in Table 16.

Table 16: OR approaches to humanitarian logistics[469]

Pre-disaster phase	Post-disaster phase
Akkihal (2006), Balcik and Beamon (2008), Batta and Mannur (1990), Bryson et al. (2002), Chang et al. (2007), Doerner et al. (2008), Esogbue et al. (1992), Fiedrich (1995), Jia et al. (2007), Kweku-Muata et al. (2002), Lodree and Taskin (2008), Matisziwa and Murraya (2007)	Barbarosoglu and Arda (2004), Barbarosoglu et al. (2000), Beamon and Kotleba (2006), Chiu and Zheng (2007b), Drezner et al. (2006), Fiedrich et al. (2000), Haghani and Oh (1996), Nolz et al. (2007), Sheu (2007), Özdamar et al. (2004), Pidd et al. (1996), Sherali et al. (1991), Srinivasa and Wilhelm (1997), Tzeng et al. (2007), Yi and Kumar (2007), Yi and Özdamar (2007)
Integrated approaches	
Esogbue (1996), Jenkins (2000), Lodree and Taskin (2007), Tamura et al. (2000)	

In conclusion, it can be stated that while the absolute number of contributions remains limited, there has recently been an increase of papers published on OR approaches regarding issues of supply chain management in the context of humanitarian operations. Facility positioning and maximization of service level through tour planning, and assignment of potential disaster regions to storage facilities are fields which are fairly progressed. Yet, other areas such as inventory planning are only broached. Also, there is a specific lack of contributions to the recovery/reconstruction sub-phase of the post-disaster phase when inventory management becomes crucial. Here, the objective of effectiveness of operations is complemented by the objective of efficiency. Standard inventory management models, however, are not yet applicable as there is some degree of uncertainty left in the operational context. This uncertainty regarding demand, supply of goods and personnel, political instability, as well as other sources of insecurity needs to be accounted for when planning operations.

[469] Cf. Blecken et al. (2009a) who also list the specific issue which is tackled by each of the contributions and the solutions methods employed.

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Appendix A: Humanitarian Operations – A Historical Review

A.1 The Geneva Conventions

The idea that humankind must be protected against the atrocities of war can be traced back to the societies of Antiquity. This tradition was continued by the charitable orders of the middle ages who cared for the wounded and sick.[470] It was not until the 19th century, however, that considerable efforts were made to establish a set of fundamental rules and guiding principles to try to limit the inhumanity of war. The history of the development of modern International Humanitarian Law is the subject of this and the following section. Specifically, it was the First Geneva Convention[471], which signalled the birth of International Humanitarian Law.

In 1859 Henry Dunant, a Swiss businessman, witnessed a battle in Solferino, Italy, and was appalled by the cruelty on the battlefield and the lack of care given to the wounded. Some years later, he published his work "Un souvenir de Solferino" in which he describes the battle at Solferino in the first part, the day after the fighting and the suffering of the wounded, the "chaotic disorder, despair unspeakable, and misery of every kind" in the second, and lastly his wish that all nations of the world should form relief societies to provide care for the wartime wounded. This document was to become one of the cornerstones for the foundation of the Red Cross. On August 22, 1864, on the initiative and insistence of Henry Dunant and his lobbying and travelling to the governments of numerous nations, twelve nations signed an international treaty, commonly known as the First Geneva Convention.

In this treaty the nations agreed to guarantee neutrality to sanitary personnel and to expedite supplies for their use. It covers the treatment of war casualties and its main characteristics can be summarized as follows:

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[470] Cf. Macalister-Smith (1985), p. 9.

[471] More formally, it is known as „Convention for the Amelioration of the Condition of the Wounded in Armies in the Field, 1864".

- It provides written rules of universal scope to protect the victims of conflicts irrespective of their race, nationality or religion;
- It is multilateral in nature and open to all States and Nations;
- It includes the obligation to extend care without discrimination to wounded and sick non-combatants;
- Finally, it provides that medical personnel, transport and equipment shall be appropriately marked and, once marked, shall be protected.

Figure 61: Signing of the Geneva Convention of 1864[472]

Several other conventions in Geneva took place in subsequent decades and a system evolved to cover the way wars may be fought and how individuals are protected. Individuals include all civilians, medics, aid workers etc., but also military personnel who have ceased fighting, i.e. in general non-combatants. The Conventions specifically protect people who no longer take part in the fighting and those who can no longer fight such as wounded, sick and prisoners of war. The parties to a conflict must at all times distinguish between the civilian population and combatants in order to spare the civilian population and civilian property. Neither the civilian population as a whole nor individual civilians may be attacked.

The principles of the Geneva Conventions can be summarized as follows:[473]

- Attacks may be made solely against military objectives. People who do not or can no longer take part in the hostilities are entitled to have their lives and physical and mental integrity respected. Such people must in all circumstances be protected and treated humanely.
- Killing or wounding an opponent who surrenders or who cannot or does not any longer take part in the fighting is forbidden.

[472] Painting by Armand Dumaresq, 1864. Copyright by Photothèque ICRC (DR).
[473] Based on International Committee of the Red Cross (2002), p. 6.

- Using weapons or methods of warfare that are likely to cause unnecessary casualties or excessive suffering is forbidden.
- The wounded and sick must be collected and cared for by the party to the conflict which has control of that area . Medical personnel and medical establishments, transports and equipment must be spared.
- The use of certain distinctive symbols guarantees immunity for the bearer. These signs are a red cross or a red crescent on a white background.
- Captured combatants and civilians who find themselves under the authority of the adverse party are entitled to respect for their lives, their dignity, their personal rights and their political, religious and other convictions. They must be protected against all acts of violence or reprisal

The Geneva Conventions have currently been signed by 194 states. All states who sign the Conventions are required to enact sufficient national laws that make grave violations of the Geneva Conventions a punishable criminal offence.

A.2 The International Red Cross

In 1863, Henry Dunant together with four others founded the "International Committee for Relief to the Wounded" as a society aimed at examining the feasibility of Dunant's plans as laid out in "Un Souvenir de Solferino" to found national societies to help care for the wounded in times of war. The First Geneva Convention and the treaties ratified thereafter by most of the attending governments led to the creation of the "International Committee of the Red Cross" (ICRC) in 1876. The aim of the committee was to act as a neutral intermediary and to ensure the protection of war victims and give assistance wherever needed. The principles of the ICRC must not be confused with the principles of International Humanitarian Law as described in the following section. The principles of the ICRC, as generally embodied in the Geneva Conventions, serve to inspire the actions of the ICRC as a humanitarian organisation. International Humanitarian Law, however, also has an administrative dimension, regulating the conduct of states vis-à-vis their opponents. Nevertheless, there is a link between these two fields, since humanitarian law has its origin in the ideals of the ICRC, which continues to stimulate its development. Thus, there are certain principles, such as those of humanity and impartiality, which are, in a sense, common to both. The principles of the Red Cross are:[474]

- **Humanity**: The Red Cross propagated a without discrimination to the wounded on the battlefield. It endeavours to prevent and alleviate human suffering wherever it is found. Its purpose is to protect life and health and to ensure respect for the human being, and to promote mutual understanding, cooperation and lasting peace amongst all peoples.

[474] Cf. Pictet (1979).

- **Impartiality**: The Red Cross does not discriminate between nationalities, races, religious beliefs, class or political persuasions. It endeavours to relieve suffering by prioritising the most urgent cases.
- **Neutrality**: It does not take sides in hostilities or engage at any time in controversies of a political, racial, religious or ideological nature in order to retain the trust and confidence of all.
- **Independence**: The Red Cross is independent. The National Societies must always maintain their autonomy so that they may be able at all times to act in accordance with Red Cross principles.
- **Voluntary Service**: The Red Cross is a voluntary relief organisation not prompted in any manner by desire for gain.
- **Unity**: There can be only one Red Cross Society in any one country. It must be open to all. It must carry on its humanitarian work throughout its territory.
- **Universality**: The Red Cross is a world-wide institution in which all Societies have equal status and share equal responsibilities and duties to help each other.

Hans Haug, former president of the Swiss Red Cross, describes the relationship between the Geneva Conventions and the ICRC as follows: "In other words, there is now a world-wide organisation and a set of conventions; the one stands for humanitarian assistance and the other for legal protection, and the two go hand in hand and complement each other. Combined, they constitute the force which has given protection, comfort and consolation to thousands of people caught up in the worst imaginable catastrophes"[475].

A.3 International Humanitarian Law

The Geneva Conventions and their supplementary protocols form the core of International Humanitarian Law (IHL). The 1864 Geneva Convention was reinforced by the St. Petersburg Declaration (1986), the peace conferences in The Hague (1899, 1907), a revision of the First Geneva Convention (1906), the Second Geneva Convention (1929), and then a complete revision of the Geneva Conventions in 1949. Two additional protocols were added to the Geneva Conventions in 1977. Apart from these major treaties, many more laws and agreements were drawn up in the second half of the 20th century which were signed by numerous states.

During this process, International Humanitarian Law has become a set of rules which seeks, for humanitarian reasons, to limit the effects of armed conflict and "preserve humanity in the face of the reality of war"[476]. It protects persons who are not or are no longer participating in the hostilities and restricts the methods of warfare.[477] As such,

[475] In: Dunant (1986), p. 30
[476] United Nations Office of the High Commissioner for Human Rights (1991).
[477] Cf. International Committee of the Red Cross (2004).

IHL constitutes a part of public international law. Two main branches of IHL can be identified:

- Laws of Geneva: The laws of Geneva, or the Geneva Conventions, are designed to safeguard civilians, i.e. people not actively involved in fighting and military personnel who are no longer taking part in the hostilities.
- Law of The Hague: The law of The Hague established the rights and obligations of belligerents in the conduct of military operations, and limits the means of harming the enemy.[478]

The United Nations High Commissioner for Human Rights formulates the following goals of International Humanitarian Law:

- To protect persons who are not, or are no longer, directly engaged in hostilities – the wounded, shipwrecked, prisoners of war and civilians;
- To limit the effects of violence in fighting to the attainment of the objectives of the conflict.[479]

There are two important issues to notice: The first is that IHL does not only apply to victims of armed conflicts, but also to all people affected by public emergencies.[480] The other relates to the materials, i.e. the material assistance to victims of conflicts. This is important since it will serve as the basis for humanitarian logistics as defined in the following sections. The Geneva Conventions recognized the right to receive supplies which are indispensable for the survival of victims of conflicts.[481] In particular, this right includes the free passage for consignments of certain materials necessary for the survival of the civilian population[482]; the obligation of the occupying power to ensure essential supplies to the population of territories it occupies[483]; if its own supplies are inadequate, the occupying power must agree to relief provided by outside sources[484]; further: a state at war must accept impartial humanitarian relief schemes carried out without discrimination for the population on its own territory, subject to the agreement of the parties concerned[485]; in a non-international armed conflict relief actions which are of an exclusively humanitarian and impartial nature and conducted without any adverse distinction must be undertaken subject to the consent of the warring parties if the civilian the population is suffering excessive deprivation owing to a lack of supplies essential to its survival.[486] Concerning the latter issue it can be stated that it is now generally recognized that the state must authorize purely humanitarian relief operations

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[478] Cf. International Committee of the Red Cross (2002), p. 4.
[479] United Nations Office of the High Commissioner for Human Rights (1991).
[480] Cf. United Nations Office of the High Commissioner for Human Rights (1991).
[481] Based on International Committee of the Red Cross (2002), p. 22.
[482] Fourth Geneva Convention “Relative to the Protection of Civilian Persons in Time of War”, Art. 23.
[483] Fourth Geneva Convention “Relative to the Protection of Civilian Persons in Time of War”, Art. 55.
[484] Fourth Geneva Convention “Relative to the Protection of Civilian Persons in Time of War”, Art. 59.
[485] Protocol I (1977): Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts, Arts. 69/70.
[486] Protocol II (1977): Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts, Art. 18.

of this nature.[487] Lastly, and highly relevant here, is the "right of initiative", which entitles any impartial humanitarian organisation to offer its services during a conflict.[488] These principles are the basis for modern humanitarian operations and for their legitimacy. Contemporary humanitarian action, its principles and areas of involvement are the subject of the following section.

A.4 Contemporary Humanitarian Operations

The previous sections showed how the concept that "even wars have rules"[489] emerged from the battlefields of the late 19th century and developed through the First and Second World War and the Geneva Conventions into an international political consensus that non-combatants should be spared from the excesses of war by placing limits on the means and methods of warfare and by ensuring the delivery of vital assistance during wartime. It is this fundamental aim of humanitarian action to ensure that non-combatants are spared from undue violence and receive necessary and adequate assistance that has guided the development of humanitarian organisations and operations ever since.[490]

In the aftermath of the First World War, individual states were overwhelmed by the needs of millions of refugees and displaced persons in Europe. It was then that states realised that they needed to collaborate on issues of humanitarian assistance. During the Second World War, a number of governments founded the United Nations Relief and Rehabilitation Administration which marks the beginning of international cooperation in humanitarian assistance.[491] The Geneva Conventions of 1949 placed primary legal obligations on warring parties, but also legitimized the role of impartial humanitarian organisations in promoting the protection of, and providing relief assistance to, non-combatants.[492] Thus, since the Geneva Conventions, contemporary humanitarian operations have evolved to encompass victims of natural and man-made disasters and general humanitarian crises. The latter includes internal conflicts of state when the states gives its consent for humanitarian operations to take place but also other types of humanitarian crises such as complex emergencies and chronic emergencies. The following section will illustrate how traditional humanitarian operations as described in the Geneva Conventions broadened in scope to evolve to what are today classed as contemporary humanitarian operations.

Modern humanitarian operations took their origin in the Nigerian Civil War, also known as the Biafra conflict, which started with an unsuccessful military coup in 1966. In the aftermath of the assassination of the prime minister and certain other high-ranking officials, the country slid into turmoil. The Northern and Southern provinces of Nigeria

[487] Cf. International Committee of the Red Cross (2002), p. 22.
[488] Fourth Geneva Convention "relative to the Protection of Civilian Persons in Time of War", Art. 3.
[489] de Torrente (2004), p. 4.
[490] de Torrente (2004), p. 2.
[491] Cf. McGuire (2006), p. 18.
[492] Cf. de Torrente (2004), p. 4.

were on opposite ends of the spectrum in terms of economic development. In the course of the rising tensions, the governor of the Eastern region declared the formation of the "Republic of Biafra" and thus, the secession of the Eastern region from the rest of Nigeria. A drawn out civil war ensued, which lasted almost two and-a-half years. Both sides used the media heavily in order to gain sympathy and support for their cause, and this was probably the reason why the international community took such a large interest in the conflict. The Biafra conflict is generally considered to be one of the first conflicts in which large-scale humanitarian operations were conducted at a regional level.[493] Biafra was one of the first conflicts where issues of modern complex emergencies, such as the notion of internally displaced people, access for humanitarian organisations and the issues of repatriation and reunification began to develop. It also served to teach the international community lessons in the coordination of humanitarian operations.[494]

Ever since humanitarian operations were first carried out in a systematic manner, humanitarian organisations have regularly faced the dilemma that the immediate objectives of warring parties clash with their stated commitment to International Humanitarian Law. This contradiction arises most vividly when conflicts break out over, rather than around, civilians. While the Geneva Conventions try to remove non-combatants from the conflict itself, the warring parties increasingly tend to place civilians and non-combatants at its centre. The fundamental principles of humanitarian operations, based on the Geneva Conventions and IHL, reflect this contraction. The most important principles of humanitarian operations today according to De Torrente (2004) are humanity, impartiality, and neutrality. He defines these principles as[495]

- **Humanity**: All people have equal dignity by virtue of their membership in humanity.
- **Impartiality**: Assistance is provided based solely based on need, without discrimination among recipients and
- **Neutrality**: Humanitarian organisations must refrain from taking part in hostilities or taking actions that advantage one side of the conflict over another.

De Torrente observes that these are the three most widely accepted principles of humanitarian operations and also serve as the basis of codes of conduct for many humanitarian organisations.[496] These fundamental principles serve two purposes: Firstly, they represent humanitarian operations' singular purpose of alleviating suffering, unconditionally and without any ulterior motive. They also serve as operational tools that help

[493] Cf. Goetz (2001), p. 2.
[494] N.B.: It is interesting to note that in the aftermath of the Biafra conflict, some journalists and physicians who witnessed the obstruction of humanitarian action and indecisiveness of humanitarian intervention, founded the first non-governmental organisation to both provide emergency medical assistance and bear witness publicly to the plight of people in distress, Médecins sans Frontières.
[495] Cf. de Torrente (2004), p. 4.
[496] These are also three of the seven principles of the ICRC (cf. Section A.2). The principles of humanity, impartiality, and neutrality have been retained as the basis for codes of conducts for organisations such as the International Federation of Red Cross and Crescent Societies, and NGOs such as CARE, Oxfam, and the World Council of Churches.

to obtain both the consent of combatants and the trust of affected and target communities for activities of humanitarian organisations, particularly in highly volatile conflicts and crises. While humanitarian operations themselves are not political projects, assisting the neediest and most vulnerable in conflict is a politically charged act.[497] The fundamental humanitarian principles embody the often fragile political agreement among combatants about the conditions for humanitarian activities in the midst of crises. Humanitarian operations are pragmatic, action-oriented endeavours, and their principles are generally not understood to be "sacrosanct straitjackets"[498].

Nowadays, conflicts are often complex and evolving, and they repeatedly pose ethical and practical challenges to humanitarian organisations. As a result, there are differing views on the particular importance and proper interpretation of the humanitarian principles as presented above. Recently, for instance, the meaning of the principle of neutrality has been the subject of diverse debate. Some have argued that neutrality implies passivity or indifference to suffering, while others contend that neutrality entails a failure to recognize differences, principally judged on a moral basis, among belligerents. On the other hand, most practitioners understand neutrality as not taking sides politically, thereby allocating assistance to affected communities only on one side of the conflict. Some organisations claim that neutrality supports denouncing abuses committed by any warring faction with the aim of improving the protection and assistance afforded to victims, while other organisations strictly oppose this kind of witnessing and outspokenness. Furthermore, no matter how the fundamental principles of humanitarian operations are interpreted, applying them to a real life situation will never be without errors. Establishing and maintaining access to the victims of crises is often problematic. Vast parts of many conflict zones around the world are off-limits either because fighting is too intense or because the belligerents do not tolerate the presence of, and sometimes target humanitarian organisations. This is where the latter interpretation of the principle of neutrality may become an obstruction to the effective execution of humanitarian operations. When one warring party perceives that the execution of humanitarian operations or the condemnation of abuse undermines its objectives, this may trigger hostility and rejection towards the humanitarian organisation even when they strive to remain neutral and impartial. In a wide variety of contexts, aid workers have been threatened, kidnapped, assaulted, injured, and killed.

Taking this into account, it becomes obvious that establishing transparent relationships with local authorities and communities based on an unambiguous humanitarian identity as well as supporting that relationship with the effective execution of humanitarian operations is of vital importance for the security of humanitarian workers and organisations. Security concerns remain among the most prominent operational constraints. On the other hand, the deployment of humanitarian workers in active conflict zones has proven the feasibility of humanitarian operations guided by the principles presented here. Evidently, there are limits to the application of the fundamental principles guiding

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[497] Cf. de Torrente (2004), p. 5.
[498] de Torrente (2004), p. 5.

humanitarian operations, but there is a difference between recognizing these limits and abolishing these principles altogether. These tested principles of neutrality and impartiality exist to guarantee access to affected communities and security of humanitarian organisations in carrying out their operations in volatile, fragmented, and contested environments.[499]

[499] Cf. de Torrente (2004), p. 28.

Appendix B: Typology of Humanitarian Operations

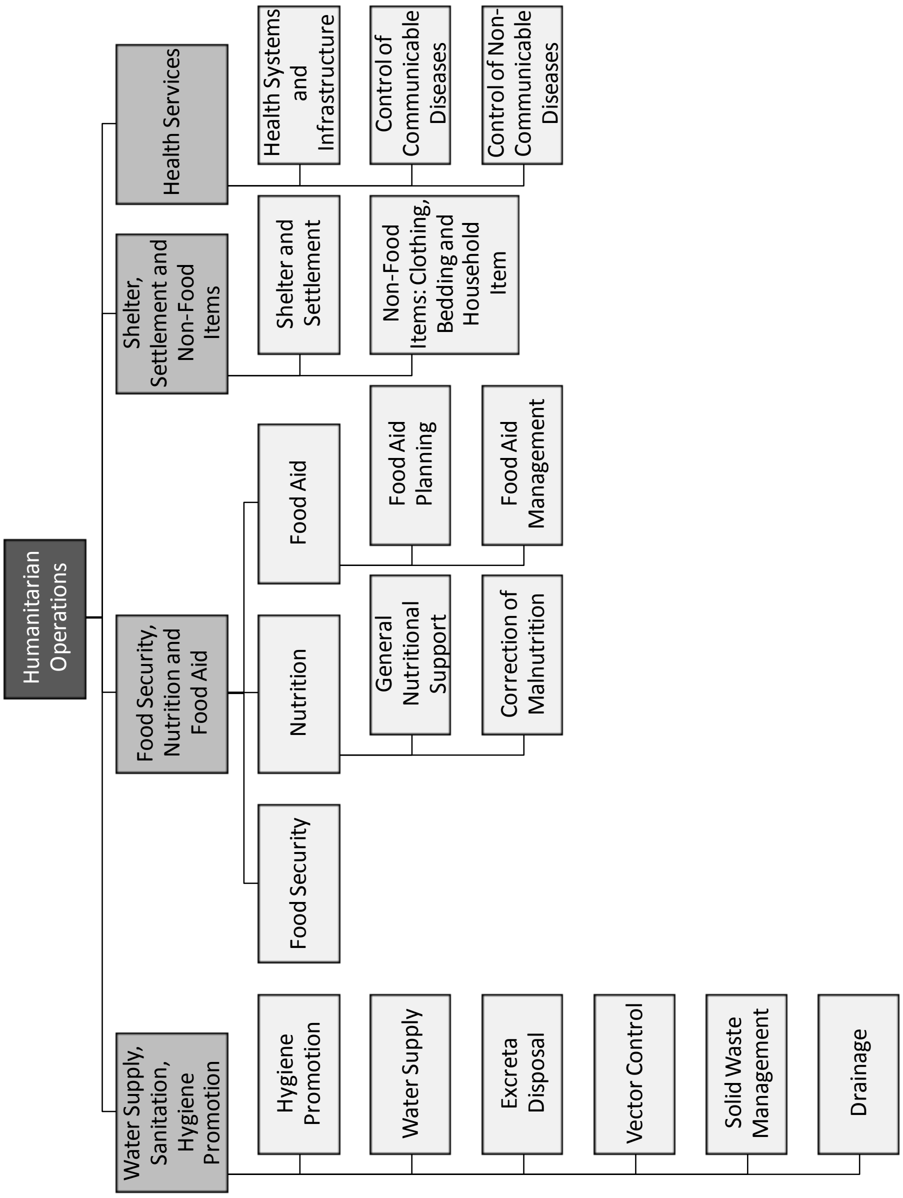


Figure 62: Categories and subcategories of humanitarian operations[500]

[500] Source: Based on The Sphere Project (2004).

Appendix C: Selected Humanitarian Organisations

Table 17 lists all humanitarian organisations which were included in the pre-study of the empirical part of this thesis. Based on an internet key-word search, databases, and organisation catalogues such as VENRO[501] or ICVA[502], this list was compiled. The information contained therein mainly stems from annual and financial reports of the fiscal year 2007. Based on the annual budget and a description of the organisations' activities, organisations were classified. All organisations classified in category "A" were included in the main study. The highest rating organisations of class "B" were likewise included in the main study.

Table 17: List of humanitarian organisations with logistical activities

Number	Name of Organisation	Yearly budget (in M€)	# countries w/ ops	Classification	E-Mail	Telephone Number	Homepage
1	Action contre la Faim	64.00	20	A	info@ actioncontrelafaim.org		www.actioncontrelafaim.org/
2	Action medeor	4.80	15	B	Christoph.Bonsmann @medeor.org; info@medeor.org	+49 21 56 97 88 93	www.medeor.org
3	ActionAid	178.14	50	B		+32 02 502 55 01	www.actionaid.org
4	ADB Asian Development Bank	7.30	20	C		+632 632 4444	www.adb.org/default.asp
5	ADRA Deutschland e.V.	11.39	19	B	info@adra.de	+49 6151 8115 0	www.adra.de

[501] http://www.venro.org, accessed on February 4, 2009.
[502] http://www.icva.ch, accessed on February 4, 2009.

6	Advance Aid			B	david.dickie@ advanceaid.org		advanceaid.org
7	African Humani-tarian Action	4.80	11	C	info@ africahumanitarian.org	+251 11 551 1224	www.africahumanitarianac-tion.org/
8	Akademie Klausenhof		6	C	info@akademie-klausenhof.de	+49 2852 89 0	www.akademie-klausenhof.de/
9	Aktion Canchanabury e.V.	0.80	9	C	info@cahchanabury.de	+49 234 9 35 78 46	www.canchanabury.de/
10	Aktion Deutsch-land Hilft			B			
11	Aktionsgemein-schaft Solida-rische Welt e.V.	0.90	7	C			aswnet.de/
12	All Africa Conference of Churches (AACC)	1.68		C	secretariat@ aacc-ceta.org	+254 2 44 14 83	www.aacc-ceta.org
13	Andheri Hilfe Bonn	4.99	2	C		+49 228 67 15 86	www.andheri-hilfe.de/
14	Arbeiter-Samariter-Bund Deutschland e.V.		30	B		+49 221 47605 323	www.asb.de
15	Arbeitsgemein-schaft für Entwicklung-shilfe	17.00	50	C	infoline@ageh.org	+49 221 8896 0	www.ageh.de/
16	arche noVa - Initiative für Menschen in Not e.V.	0.54	18	B	logistic@arche-nova.org; info@arche-nova.org	+49 351 49 43 591	www.arche-nova.org
17	Ärzte der Welt e.V.	0.51	5	B	info@aerztederwelt.org	+49 89 62420955	www.aerztederwelt.org/
18	Ärzte für die Dritte Welt	8.24	7	B	aerzte3welt@ aerzte3welt.de	+49 69 7079970	www.aerzte3welt.de/
19	Ärzte ohne Grenzen e.V.	31.70	48	A	office@berlin.msf.org	+49 30 22337700	www.aerzte-ohne-grenzen.de/
20	Austcare	5.49	12	B	info@austcare.org.au		www.austcare.org.au
21	AWO Interna-tional e.V.	3.18	5	B	mail@ awointernational.de	+49 30 25389300	www.awointernational.de/
22	Bischöfliches Hilfswerk Misereor e.V.	153.20	30	B	Via website	+49 241 4420	www.misereor.de
23	Brot für die Welt	59.57	50	B	projektinfo@ brot-fuer-die-welt.de	+49 711 2159 0	www.brot-fuer-die-welt.de/
24	Bundesamt für Bevölkerungss-chutz und Katastrophenhilfe	73.30		B		+49 228 99550 0	www.bbk.bund.de
25	Bundesanstalt Technisches	148.60		A	poststelle@thw.de	+49 228 9402777	www.thw.bund.de/

	Hilfswerk (THW)						
26	Cap Anamur Deutsche Not-Ärzte e.V.	2.64	20	B	office@cap-anamur.org	+49 221 9138150	www.cap-anamur.org/
27	CARE Interna-tional	484.00		A	cisecre-tariat@careinternational.org	+41 227951020	www.care.org
28	CARE Interna-tional Deutsch-land e.V.	13.60	70	A	info@care.de	+49 228 975 630	www.care.de/
29	Caribbean Disaster and Emergency Response Agency (CDERA)		16	C	cdera@caribsurf.com	+1 246 425 0386	www.cdera.org
30	Caritas Interna-tional	48.00	57	C	ursula.hartwig@caritas.de	+49 761 200 590	www.caritas-international.de
31	Casa Alianza		4	C	kontakt@casa-alianza.de	+49 2224 5884	www.casa-alianza.de
32	Catholic Relief Services	0.45		B	Via website		crs.org/
33	CCF Kinderhilf-swerk	10.00	22	C	onlineformulare@ccf-kinderhilfswerk.de	+49 7022 9259 0	www.ccf-kinderhilf-swerk.de/
34	Children's Relief - Hilfe für Kinder in Not e.V.		9	C	info@childrens-relief.de	+49 511 980 5556	https://www.ssl-id.de/childrens-relief.de/
35	Christiliche Initative Romero		3	C	cir@ci-romero.de	+49 251 89 503	https://www.ci-romero.de
36	Christoffel-Blindenmission e.V.	52.48	15	C	communica-tions@cbm.de	+49 6251 131 0	www.christoffel-blindenmis-sion.de
37	Concern	121.00	30	A	Via website	+353 1 417 7700	www.concern.net
38	Das Hunger Projekt e.V.	0.40	13	C	dhpbrd@thp.org	+49 7626 972568	das-hunger-projekt.de/
39	Defence for Children international		1	C	info@dci-is.org	+412 27340558	www.dci-is.org/
40	DESWOS	2.00	26	C	public@deswos.de	+49 221 579 89 0	www.deswos.de/
41	Deutsche Humanitäre Stiftung (DHST)	0.07	3	C	info@dhst.org	+49 6337 993 153	www.dhst.org/
42	Deutsche Lepra- und Tuberkulose-Hilfe e.V.	13.00	36	C	info@dahw.de	+49 931 79480	www.dahw.de
43	Deutsche Stiftung Weltbevölkerung	0.41	12	C	info@dsw-hannover.de	+49 511 943730	www.weltbevoelkerung.de/
44	Deutsche Welthungerhilfe e.V.	166.20	27	A	info@welthungerhilfe.de; kerstin.bandsom@dwhh.de	+49 228 2288 0 +49 228 2288 127	www.welthungerhilfe.de/home.html

45	Deutscher Feuerwehr Verband e.V.			B		+49 30 288848822	www.dfv.org
46	Deutsches Blindenhilfswerk e.V.	0.80	4	C	info@blindenhilfswerk.de	+49 203 355 377	www.blindenhilfswerk.de/
47	Deutsches Rotes Kreuz	115.20	52	A	drk@drk.de		www.drk.de/
48	Diakonie Katastrophenhilfe	22.99	43	A	kontakt@diakonie-katastrophenhilfe.de	+49 711 21 59 0	www.diakonie-katastrophen-hilfe.de/
49	Difäm		4	C	info@difaem.de	+49 7071 206 529	www.difaem.de/
50	ECHO	768.50		B	Via website		ec.europa.eu/echo
51	EIRENE - Internationaler Christlicher Friedensdienst e.V.	3.50	15	C	eirene-int@eirene.org	+49 2631 83 79 0	www.eirene.org/
52	Food and Agriculture Organization of the United Nations	1.324.80		B			www.fao.org/
53	Food For The Hungry	71.28	1	B	Via website	+1 480 998 3100	www.fh.org/
54	HELP - Hilfe zur Selbsthilfe e.V.	16.00	15	C	info@help-ev.de	+49 228 91529 0	www.help-ev.de/
55	HelpAge International	22.16	50	B	Via website	+44 2072787778	www.helpage.org
56	Hilfswerk Evangelischer Entwicklungsdienst (EED)	145.60	70	C	eed@eed.de	+49 228 8101 0	www.eed.de/
57	Hope e.V.	0.08	3	C	johannis@hope-net.de	+49 231 553403	www.hope-net.de/
58	Human Appeal International		20	C	haiuae@emirates.net.ae	+971 6 747 1777	www.hai.org.uk/
59	Humanity First	0.69	16	C	info@humanityfirst.org.uk	+49 69 50688 572	www.humanityfirst.org.uk
60	humedica e.V.	8.57	21	B	info@humedica.org	+49 8341 966148 0 +49 8341 966148 36	www.humedica.org/
61	International Catholic Migration Commission (ICMC)	13.60	30	B	icmc@icmc.net	+41 22 919 10 20	www.icmc.net/e/index.htm
62	International Committee of the Red Cross	613.60	14	A	Various, see website	+41 22 734 6001	www.icrc.org/

	(ICRC)						
63	International Federation of Red Cross and Red Crescent Societies (IFRC)	319.15	30	A	Various, see website	+41 22 730 42 22	www.ifrc.org/index.asp
64	International Medical Corps	69.68	26	A	imc@imcworldwide.org	+1 310 826 7800	www.imcworldwide.org
65	International Organization for Migration (IOM)	586.64		B			www.iom.int
66	International Rescue Committee	200.80	>25	A	geneva@theIRC.org	+1 212 551 3000	www.theirc.org
67	Internationale Humanitäre Hilfsorganisation e.V.	1.80	24	C	info@ihh.com	+49 69 80108010	www.ihh.com/
68	Islamic Relief	116.70	22	A	info@islamicrelief.de HQ@islamic-Relief.org.uk	+49 221 2004990	www.islamic-relief.com/
69	Johanniter-Unfall-Hilfe e.V. / Johanniter-Auslandshilfe	8.10	28	B	Via website	+49 30 26 99 7 0	www.johanniter.de/
70	Kinderhilfswerk Global-Care		2	C	info@kinderhilfswerk.de	+49 5622 6160	www.global-care.de/
71	Kindernothilfe	49.90	27	B	info@kindernothilfe.de	+49 180 33 33 300	www.kindernothilfe.de/index-id-28.html
72	Lichtbrücke		1	C	info@lichtbruecke.com	+49 2263 2103	www.lichtbruecke.com/
73	Lotus Hilfsprogramme			C	Via website		www.lotushilfe.de/
74	Luftfahrt ohne Grenzen		7	C	info@luftfahrtohnegrenzen.de	+49 69 69023256	www.luftfahrtohnegrenzen.de/
75	Malteser International	27.07	30	A	info@malteser-international.org	+49 221 9822 151	www.malteser-international.org
76	Medair	20.64		A	deutschland@medair.org	+49 89 82 000 973	www.medair.org/
77	Médecins du Monde	50.15		A	info@aerztederwelt.org	+33 01 44 92 15 15	www.medecinsdumonde.org/
78	Médecins sans Frontières	569.00	80	A	kontakt@berlin.msf.org	+41 228498400	www.msf.org
79	Menschen für Menschen	18.88	1	B	info@mfm-online.org Via website	+49 89 38 39 79 0	www.menschenfuermenschen.de
80	Mercy Corps	157.60		A	Via website		www.mercycorps.org/
81	Merlin	40.95		A	Via website	+44 20 7014 1 600	www.merlin.org.uk/
82	Muslime Helfen	1.19	25	C		+49 89 321 99 190	www.muslimehelfen.de/
83	Östereichisches	8.86	20	B	helga.kohl@roteskreuz	+43 01 58900	www.roteskreuz.

	Rotes Kreuz				.at	332	at/24.html
84	Oxfam (International)	3.76	100	B	info@oxfam.de	+49 30 4285 0621	www.oxfam.org
85	Oxfam (UK)	436.05		A	Via website	+44 8703332700	www.oxfam.co.uk/
86	Relief International	15.44	1	B	info@ri.org	+1 310 478 1200	www.ri.org
87	Save the Children	1.80	20	C	info@savethechildren.de	+49 30 27595979 0	www.savethechildren.net/
88	SEEWA (THW)			C	siehe THW	siehe THW	siehe THW
89	SOS-Kinderdörfer	120.63		C	info@sos-kinderdoerfer.de	+49 89 17914 140; Ansprechpartner: -224	www.sos-kinderdoerfer.de/
90	Terra Tech e.V.	1.23	7	C	info@terratech-ngo.de	+49 6420 839940	www.terratech-ngo.de
91	terre des hommes	89.66	21	B	info@terredeshommes.org	+41 22 7363372 +49 541 71 010	www.tdh.de/content/index.htm
92	UNICEF / UNICEF Supply Division	2224.80	50	A	mail@unicef.de	+49 221 93650 0	www.unicef.de/home.html
93	United Nations Department of Humanitarian Affairs (UNDHA)			C		n/a	www.un.org/Depts/dha/
94	United Nations Development Program (UNDP)	3552.00		B		+1 212 906 5317	www.undp.org/
95	United Nations High Commissioner for Refugees (UNHCR)	1200.00	50	A	Via website	+41 22 739 8111	www.unhcr.ch/
96	United Nations Office for the Coordination of Humanitarian Affairs (OCHA)	248.40	43	A	Via website		ochaonline.un.org/
97	UNO-Flüchtlingshilfe	2.63	7	C	info@uno-fluechtlingshilfe.de	+49 228 629860	www.uno-fluechtlingshilfe.de/
98	WMF BARMHERZIGKEIT e.V.	3.80	18	C	info@barmherzigkeit.org		www.barmherzigkeit.org/
99	World Food Program (WFP)	2.164.00	78	A	wfp.berlin@wfp.org wfpinfo@wfp.org	+49 30 206 149 0 +39 06 6513 1	www.wfp.org/german
100	World Health Organization (WHO)	1.370.00	30	B	prenticet@who.int	+41 22 791 2111	www.who.int/en/

101	World Vision Deutschland e.V.	90.77	46	A	daniel_ginsberg@wvi.org	+49 6172 763 234	www.worldvision.de/
102	World Vision Unites States	760.49		A	info@worldvision.org	+1 888 511 6548	www.worldvision.org
103	Global Aid Network (GAiN)		25	A	Scott.Hendrix@gainusa.org; info@gain-germany.org	+1 972 234 0800	www.gainusa.org/about_us.cfm
104	Wirtschaftsstelle Ev. Missionsgesellschaften (WEM)	15.00		A	wem@wem-hamburg.de	+49 4131 77800	www.wem-hamburg.com/wem/site/en/1.php

Appendix D: List of Interviews

In the following table the interviews conducted during the course of the empirical part of this research are listed according to the affiliation of the interview partner. The interview partners are listed along with some additional information such as the position of the interview partner within the respective organisation together with date and place of the interviews. The empirical study lasted from May 2008 until January 2009. While most interviews were conducted via telephone some interviews were conducted through an iterative email exchange or face-to-face interviews. The outcomes of the interviews were integrated in the construction of the reference model and the formulation of the use cases.

Table 18: List of interviews

Organisation	Name	Position	Type and Place of interview	Date
Action medeor	Dirk Angemeer	Bereichsleiter Procurement & Humanitäre Hilfe	Telephone Tönisvorst, Germany	22/07/08 09/09/08
Advance Aid	David Dickie	Director	Email	25/11/08
Ärzte für die Dritte Welt	Mrs Marly		Telephone	27/05/08
Ärzte ohne Grenzen e.V.	David Trevino	Logistical Advisor	Berlin	10/10/08
AWO International e.V.	Friedemann Kongeter	Desk Officer Humanitarian Aid and Health	Email	22/07/08
Bundeswehr	Frank Skubowius	Abteilungsleiter Supply Chain Management	Telephone	13/12/07

CARE International	Loïc Cohen	Senior Logistics Specialist, Emergency Group	Telephone	03/07/08
CARE International Deutschland e.V.	Wolfgang Tyderle	Notfallkoordinator	Telephone	24/07/08
Concern	Donal Darcy	Supplies & Logistics Unit	Email	21/08/08
Deutsche Welthungerhilfe e.V.	Jürgen Lüdemann	Head of Procurement & Logistics	Email	05/06/08
DRK	Richard Munz	Delegate, Author	Telephone	28/07/08
DRK	Clemens Pott	Disaster Response Unit	Telephone	27/11/08
Food for the Hungry	Andrew Crawford	Director, Gifts-In-Kind Resources	Email	30/05/08
Fritz Institute	Fraser Stephens	Product Manager	Telephone Lugano, Switzerland	04/08/08 30/06/08
GAiN	Scott Hendrix	Director, Humanitarian Aid	Telephone	07/09/08
HelpAge International	Lucy Blown	Emergency Unit	Email	27/10/08
humedica e.V.	Hermann Schäffler, Thomas Lang	Warehouse/Logistics	Email	26/11/08
IFRC	Martin Bush	Senior Officer, Systems and Processes	Email	04/08/08
International Medical Corps	Marin Thomas	Global Logistics Manager	Email	25/08/08
International Rescue Committee	Alan Manski	Emergency Operations Coordinator	Email	24/07/08
Johanniter-Auslandshilfe	Magdalena Kilwing, Oliver Rodewald	Logistik Auslandshilfe	Email	03/09/08

Malteser International	Walter Kahn	Logistics Officer	Telephone	01/08/08
Medair	Klasien Hoeve	Logistics Manager	Email	02/06/08
Médecins du Monde	Fabio Baccan	Logistics Advisor	Telephone	07/09/08
Mercy Corps	Greg Shortreed	Operations and Procurement Specialist	Telephone	12/08/08
Merlin	Nico Tillon	Logistics Officer	Telephone	03/06/08
MSF – Belgium	Jean-Eric Schaefer	Logistics Advisor	Telephone	14/02/08
MSF – Switzerland	Jean-Luc Castell	Director of Logistics	Geneva, Switzerland	16/01/09
MSF – Switzerland	Regis Ghesquier	Supply Chain Manager	Geneva, Switzerland	16/01/09
MSF – Switzerland	Pierre Beurrier	Manager/Controller	Geneva, Switzerland	16/01/09
MSF Supply	Marc Schakal	General Director	Merchtem, Belgium	04/04/08
OXFAM	Rod Hogg	Programme Logistics Manager	Oxford, Great Britain	25/07/08
Relief International	Richard Whipple	Operations Associate	Telephone	12/08/08
terre des hommes	Robert Borgelt	Logistics Manager	Telephone	28/07/08
UNICEF Supply Division	Jean-Cédric Meeùs	Logistic Specialist (Emergency)	Telephone and Copenhagen, Denmark	25/07/08 22/04/09
UNICEF Supply Division	Paul Molinaro	Logistics Officer	Copenhagen, Denmark	22/04/09
UNICEF Supply Division	Ayako Odashima	Logistics Specialist	Copenhagen, Denmark	22/04/09
UNICEF Supply Division	John Roger Nielsen	Warehouse Supervisor	Copenhagen, Denmark	22/04/09
UNICEF Supply Division	Lene Hansen	Contracts Manager	Copenhagen, Denmark	22/04/09

UNICEF Supply Division	Jens Grimm	Logistic Specialist (Emergency)	Copenhagen, Denmark	22/04/09
UNICEF Supply Division	Svein J. Hapnes	Shipping Manager	Copenhagen, Denmark	23/04/09
UNICEF Supply Division	Søren Winther Hansen	Chief, The Logistics Center	Copenhagen, Denmark	23/04/09
WFP	Martin Ohlson	Chief OMLT - Transport Service	Email	30/05/08
World Vision Deutschland e.V.	Daniel Ginsberg	Logistics Manager	Fridrichsdorf, Germany	21/05/08

Appendix E: Interview Guideline

The interviews conducted during the course of the empirical part of this research followed the guideline presented in this chapter. The interviews aimed at gathering both qualitative and quantitative data on supply chain structure, processes and technology through a semi-structured approach. Interview language was either English or German depending on the mother tongue of the interview partner. The interviews centred around four core questions from which more detailed questions were derived depending on the applicability to the organisation's specific approach of delivering humanitarian aid. Questions put to interviewees were taken from the following non-exhaustive list:

Introductory questions:

- What is your position within your organisation?
- What are your responsibilities within your organisation?
- What are the activities that your organisation carries out? What kind of humanitarian programmes do you run?
- How many FTEs are employed in your organisation (at headquarters level / at field level)?
- How does the supply chain of your organisation work? What does the flow of goods in your supply chain look like?
- How is the logistics department integrated in the overall structure of your organisation?
- To what extent is the logistics department involved in your project activities including strategic and tactical decision-making?
- How is logistics organised at field level? What kind of tasks do field logisticians have? Do you have dedicated supply chain specialists deployed at field level?

Core question 1: Are there written process descriptions for logistical processes and activities, e.g. in procurement, warehousing, distribution etc.?

- Do you possess Standard Operating Procedures? Are these SOPs updated regularly? Are they and if so, how, implemented?

- Are your processes audited, e.g. to attain HPC status?
- Are any of the activities such as assessment, procurement, warehousing, transport or evaluation of project activities, standardised or formalised?
- Is there a logistics / supply chain operations handbook?
- Do you offer standardised trainings for new (logistical) personnel?
- Do you plan to formalise your supply chain processes in the future?

Core question 2: Do you distinguish between process descriptions of different types of operations, e.g. emergency vs. stable contexts?

- What kind of different types of projects do you distinguish?
- In what way does your organisation react differently depending on the nature of the humanitarian crisis?
- How does your organisation handle the procurement of relief goods in general?[503]
- Do you stock goods? Internationally? Regionally? Locally?
- Do you globally pre-position goods at strategic positions?
- What procurement policy do you have? Do you purchase items internationally / regionally / locally? Does this change depending on the humanitarian context you are working in?
- What kind of transport is used in either of these contexts?
- Do you have emergency preparedness plans / contingency plans at headquarters / regional / local level?

Core question 3: Which processes and activities are the most decisive for the successful logistical support of your projects?

- What are the most decisive differences in the reaction to acute emergencies and "regular" humanitarian projects form a logistical point of view?
- Where do you think are weakest links in the information/material/financial flow in the supply chain?
- How do you think these impediments could be overcome?
- How do you think the ideal logistical process should look like?
- Which activities are most time-consuming when running emergency projects?
- Which activities are most time-consuming when running post-emergency projects?
- What are the most severe problems you have to cope with from a logistical point of view?

[503] This question was part of a sub-study of a few selected humanitarian organisations which specifically aimed at creating a key performance indicator framework for humanitarian organisations. Also cf. Keller and Hellingrath (2007).

Core question 4: Do you measure the performance of the logistical processes (such as order lead time for instance)?

- Where are the headquarters of your organisation?
- What kind of software / IT tools are used at headquarters / regional / local level?
- Do you have defined key performance indicators? If yes, how do you measure them?
- Do you know how much echelon stock of a specific item there is in your entire supply chain?
- With how many suppliers has your organisation had a volume of €500.000€ or more during the last year?[504]
- How many humanitarian operations / missions / projects has your organisation carried out with a volume of €500.000 or more during the last year?
- How long was the product life-cycle of the most important relief good in your organisation?
- How many relief items with a high specificity are there in your organisation?
- Which demand variability of relief goods did your organisation experience in the most important humanitarian operations during the last year?
- Which demand variability of relief goods did your organisation experience for the relief items with the highest specificity or which are procured from your most important suppliers during the last year?
- Which replenishment lead-time variability did your organisation experience for the relief items with the highest specificity or which are procured from your most important suppliers during the last year?
- Which delivery time variability did your organisation experience for relief goods in the context of the most important humanitarian operations?
- What was the average replenishment lead-time for the relief items with the highest specificity or which are procured from your most important suppliers during the last year?

[504] This and the remaining questions were part of a sub-study of a few selected humanitarian organisations which specifically aimed at creating a key performance indicator framework for humanitarian organisations. Also cf. Keller and Hellingrath (2007).

Appendix F: Reference Task Model: Roles and Responsibilities

The application of the reference task model includes the specialisation of tasks in a specific use case including the instantiation of responsibility and accountability as well as the definition of information flows. In order to do this a responsibility assignment matrix is used. A responsibility assignment matrix (RAM) is generally used to connect activities or tasks to people or resources in order to ascertain that proper task distribution and responsibility delegation. The definition of the roles used in the reference task model are listed in Table 19.

The RAM is used in the following to support the construction of detailed organisation-specific variants of the reference model. Various other roles which extend the RASCI model presented here have been suggested but are omitted in order to limit complexity and improve understandability of the organisation-specific models. The suggested roles have advisory character only and need to be adapted when constructing an organisation-specific model. Care needs to be taken that the role R is only assigned once for each tasks. In the following table R may appear more than once in each line. This is due to the fact that tasks can be carried out at different levels in the humanitarian supply chain. When constructing an organisation-specific model, only one entity may bear the responsibility for a specific task.

Table 19: Responsibility Assignment Matrix

Role	Definition
Responsible (R)	This role owns the problem and initiates and executes the task. R carries disciplinary and conceptual responsibility for the task. For each task, there has to be at least one R and preferably not more than one R in order to avoid confusion of responsibilities. Exceptionally, several R can be used when a task is explicitly performed in a team.
Accountable (A)	This is the role to which R is accountable. A approves the completed task and is held accountable for it. A can also sign off when its approval is necessary. There must only be one A for each task.
Supportive (S)	This role provides additional resources to execute the task the work or provides support during implementation. S is usually triggered by R and supports the task execution.
Consulted (C)	This role provides information or expertise necessary to execute the task. C carries conceptual responsibility for the task. The R-C relationship is usually a two-way communication.
Informed (I)	This role is to be informed of progress and results of task execution. I can also have the competence to acquire information from a given task. The R-I relationship is usually a one-way communication.

Table 20: Reference task model (roles and responsibilities)

			Supplier	LSP	Other External Actor	HO Headquarters						HO Regional Centre						HO Local Centre	
						Management	Resources			Operations		Management	Resources			Operations		Management	Resources
							Logistics	HRM	Finance	Regular	Emergency		Logistics	HRM	Finance	Regular	Emergency		Logistics
Strategic Tasks																			
	Assessment																		
		Create Mission Statement			I	R	S	S	S	S	S	S							
		Plan Emergency Preparedness				I	C	C			R	A	C	C			R	I	I
		Plan Programme Strategy				A	C			R		A	C			R		I	
	Procurement																		
		Plan Emergency Supply Strategy	C				R		S		C		R		S				I
		Plan Kits	C				R			C	C		C			C	C		
		Plan Standard Item Catalogue					R			C	C		C			C	C		

		Plan Supply Strategy	C				R		S	C			R		S	C			
	Warehousing																		
		Plan Warehouse Capacities				A	R			C			R						
		Plan Warehouse Network				A	R		C	C		I	C						
	Transport																		
		Plan Transport Capacities		C		A	R						C			C			
		Plan Transport Network		C		A	R						C			C			
		Plan Transport Strategy				A	R			C	C		C			C	C		
Tactical Tasks																			
	Assessment																		
		Plan Demand				A	C			R		A	C			R		C	C
		Plan Emergency Team				A		C			R	A		C			R		
		Plan Project Activities				A	C		C	R		A			C	R		R	
		Plan Standard Item List					C			R			C			C			I
		Select Project Sites										A	C			R		R	C
	Procurement																		
		Negotiate Framework Agreement	C		C		R		S	C									
		Plan Programme Item List					C			C		A	C			R			I
		Plan Purchasing Methods	C	I			R		S				R		S				I
		Plan Sourcing Methods			C		R		S	C	C		C		S	C	C		
		Plan Supply of Operations (local)	C										R			C			C
		Plan Supply of Operations (regional)	C				R			C			C			C			
		Plan Tender Procedures			C		R		S				I		I				I
		Pre-Qualify Suppliers	S				R		S				R		S				

	Warehousing																		
		Plan Emergency Stock Positioning				A	C				R	A	C				R		I
		Plan Quality Assurance					R			C			I			I			I
		Plan Warehouse Layout					R						R						
		Set Inventory Control Policy	C				R						R						
	Transport																		
		Plan Consolidation Policy		S			R						R						
		Plan Transport of Special Goods		S			R												
		Plan Transport Modes		S			R						R						I
		Plan Transport Routes		S			R						R						I
		Schedule Transport		S			R			C			R			C			I
Operational Tasks																			
	Assessment																		
		Assess Local Capacities								I		A	R	S		C	C	R	C
		Assess Local Resources								I		A	R	S	S	C	C	R	C
		Assess Local Sources of Supply					I						R						R
		Deploy Emergency Team				R		C			S	R		C			S		
		Deploy Exploratory Team				R		C		S		R		C		S			
		Forecast Demand	I	I	C		R		I	C	C		R			C	C	I	R
		Identify Needs and Number of Beneficiaries									A					R			
		Identify Type and Magnitude of Disaster										A					R		
		Initiate Needs Assessment				R	S			C		R	S			C		R	S
		Initiate Search and Rescue				A					R	A					R		
		Order Goods					R		S				R		C	C			R

		Prioritise Needs				A	S			R	R	A	S			R	R	A	R
		Request Goods					R						R						R
	Procurement																		
		Acknowledge Order					R						R						
		Analyse Comparative Bids					R						R						R
		Consolidate Orders		S			R			C			R			C			
		Execute Justification Procedure				I	R		C	C		I	R		C				S
		Execute Tender Procedure					R		S				R		S				R
		Mobilise Supplies (ad-hoc)	C		C		R			I	I		R			I	I		R
		Monitor Pipeline	S	S			R						R						R
		Obtain Quotations	S				R						R						R
		Purchase Goods					R		S				R		S				R
		Qualify Suppliers	S				R			I	I		R			I	I		R
		Record Order and Shipment Information				R		S				R		S				R	
		Select Supplier					R			I	I		R			I	I		R
		Set Order Priority Status				A	R			C	C	A	R			C	C	A	R
		Source Goods (external)					R		S				R		S				R
		Source Goods (internal)					R						R						R
		Specify Special Goods	C				C			R			C			R			R
		Specify Standard Goods	C				C			R			C			R			R
		Validate Order (Non-Standard)					R		S				R		S				
		Validate Order (Standard)					R		S				R		S				
	Warehousing																		
		Assemble Kits					R						R						

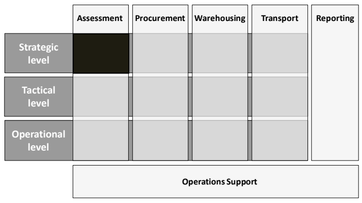
		Assure Quality					R						R						
		Check Incoming Goods					R						R						R
		Check Quality					R						R						
		Consign Goods					R						R						
		Count Stock					R		S				R			S			R
		Create Packing List					R						R						R
		Create Waybill					R						R						R
		Dispose Goods					R			C			R			C			R
		Issue Replenishment Order	I				R		S				R		S				R
		Mark and Label Goods					R						R						R
		Monitor Stocks					R			I			R			I			R
		Pick and Pack Goods					R						R						R
		Prepare Shipping Documents					R		S				R		S				R
		Prepare Special Certificates					R		S				R		S				R
		Prepare Stock Transfer					R			I			R			I			R
		Receive Goods					R			I			R			I			R
		Receive Goods (unsolicited)				A	R			C		A	R			C			R
		Return Goods	I				R			I			R			I			R
		Store Goods					R						R						R
		Transport Goods to/from Stock					R						R						R
		Update Inventory					R			I			R			I			R
		Verify Shipment Information					R		S				R		S				R
	Transport																		
		Consolidate Transport		S			R			C			R			C			

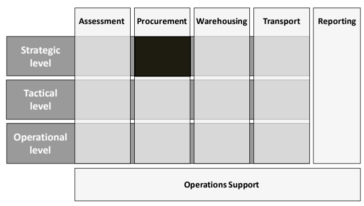
		Export Goods	R	R			R		S				R		S				
		Handover Goods	R	R			R						R						R
		Import Goods and Clear Customs		R			R		S				R		S				
		Load Goods					R						R						R
		Obtain Signature	R	R			R						R						R
		Offload Goods					R						R						R
		Prepare Customs Documents	R	R			R		S										
		Schedule Deliveries		C			R			C			R			C			I
		Select INCOTERMS Mode		C			R		S						S				
		Select Transport Mode		C	C		R						R						R
		Select Transport Route		C	C		R			C			R			C			R
		Send Advance Shipping Notice	R	R			R						I						I
		Track and Trace Shipment		R			R			I	I		R			I	I		I
Reporting																			
		Create Asset Report				A	R		S			A	R		S			A	R
		Create Donor Report				A	C		C	R	S	A	C		C	R	S	A	R
		Create Inventory Report				A	R		S			A	R		S			A	R
		Create Damage/Loss Report		I		A	R		I			A	R		I			A	R
		Create Needs Assessment Report			C	A	C	C	C	R	R	A	C	C	C	R	R	A	R
		Create Outstanding Order Report	I			A	R			I		A	R			I		A	R
Operations Support																			
		Implement Basic Infrastructure	S		C		R						R						R
		Mobilise Auxiliary Equipment	S		C		R		S				R		S				R
		Mobilise Equipment	S		C		R		S				R		S				R

		Mobilise Personnel			C		C	R	C				C	R	C			R	C
		Operate OS Systems					R						R						R
		Prioritise and Allocate OS Resources			C		R			C	C		R			C	C		R

Appendix G: Reference Task Model: Task Descriptions

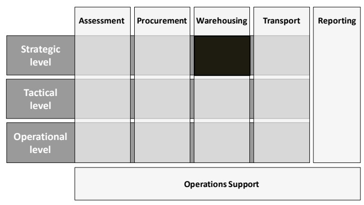
Table 21: Reference Tasks

Strategic / Assessment	
Create Mission Statement	A mission statement outlines the overall mandate and strategy of the humanitarian organisation. It also includes the purpose and scope of operations, i.e. decisions on the range and purpose of operations, and performance indicators and thresholds. A mission statement can be used by staff of the organisation or by external actors and serves as a guideline during design, planning and implementation of supply chain structures and processes. The mission statement can also be a means to facilitate and improve coordination in the humanitarian supply chain.
	Type: *Generic*
Plan Emergency Prepared-ness	Humanitarian organisations aim to respond quickly and effectively to humanitarian emergencies, which can potentially occur at any place around the globe. Therefore, contingency plans or Emergency Preparedness Plans (EPP) have to be developed at various tiers in the supply chain. It needs to be possible to implement EPPs with immediate effect. EPPs identify types of disasters that may occur in countries or regions where the organisation is already conducting or could potentially run operations. EPPs record information about possible areas of activities that may be used in emergency operations such as availability of resources for logistical support (sources of key supplies, transport capacity, availability of support for initial assessment/emergency teams, possible sites for warehousing, availability of repair facilities, capacity of ports and airports), infrastructure vulnerability (systematic

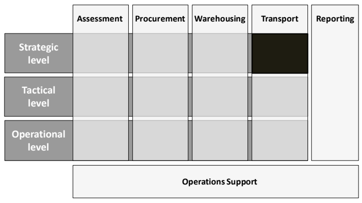
	mapping and evaluation of national and regional transport infrastructure; analysis of the historical meteorological national or regional records; monitoring of changes to existing structures) and liaison and understanding of government policies and emergency plans. EPPs may comprise a number of possible scenarios based on assumptions concerning the possible developments of humanitarian crises. EPPs need to be updated on a regular basis.
	Type: *Generic*
Plan Programme Strategy	The programme strategy details the overall strategy as set in the mission statement. The programme strategy outlines the type (emergency or post-emergency; nutrition, water, health care, shelter, or general) and size of the operational programmes. Furthermore, the extent to which the humanitarian organisation aims to respond and the means, which they will deploy in their operations, are determined. These decisions will have an impact on strategic, tactical and operational decisions in the supply chain, e.g. planning and allocation of required logistical resources and capacities.
	Type: *Generic*
Strategic / Procurement	
Negotiate Framework Agreement	Framework agreements should be negotiated for all regular and high-volume suppliers and suppliers of critical items or items necessary in acute emergencies for which stock-outs have to be avoided. Framework agreements regulate reserved stock or capacity, which can be demanded in emergencies. Price, quality and lead time should be indicated. Framework agreements can improve responsiveness of a humanitarian organisation and lower overall cost. Suppliers have to be qualified through the regular qualification procedure.
	Type: *Generic*
Plan Emergency Supply Strategy	An emergency supply strategy needs to be derived for each region or area in which operations are conducted and in which sudden-onset emergencies can happen. The emergency supply strategy may differ from the mission supply strategy. The emergency supply strategy details the ways in which emergency stocks will be replenished in the case of a sudden-onset humanitarian crisis. The emergency supply strategy also details how to deal with high priority orders. For more details on the semantics of this task, cf. the task "Plan Supply Strat-

	egy”.
	Type: *Generic*
Plan Kits	Kits are self-contained assortments of carefully selected goods in predetermined quantities and are designed for providing specific services such as first aid, medical treatment in a clinic or immunization services.[505] Kits are an important means to efficiently run humanitarian operations. The kit concept can be extended to include special medical services such as surgical kits or Ebola kits. There are also kits available to address energy and water supply amongst various others. If needed entire field hospitals or warehouses can be delivered as kits. While kits cannot be applied in every kind of operation, they allow for a rapid response to a majority of operations especially during the acute emergency phase when it is not yet possible to determine or forecast detailed demands.[506] This task details the type of kits to be employed in operations, discriminating between emergency and post-emergency operations. Items included in kits should be drawn from the standard item catalogue.
	Type: *Generic*
Plan Standard Item Catalogue	The standard item catalogue contains specifications for items commonly used in operations. Standard item specifications help to ensure product quality and simplify ordering and stock keeping. Additionally, they help to reduce the complexity of handling a large number of different items in the supply chain. Standard specifications should contain only the minimum detail necessary to allow the required flexibility in choice of suppliers; generic names should be preferred over brand names. Item catalogues cannot only be used for selection of international suppliers but can also guide local purchase of goods. Generic specifications can be drawn up for telecommunications equipment; shelter, housing, storage and kitchen equipment; water supply and distribution equipment; food; hygiene and sanitation goods and equipment; equipment for the handling of different materials; electrical power supply equipment; medical supplies and equipment; and drugs. A number of organisations have published their standard item lists which can serve as a template when creating the standard item catalogue.[507] The use of standard item catalogues also provides benefits in

[505] McGuire (2006), p. 46.
[506] For a more comprehensive discussion on the advantages and disadvantages of using kits in humanitarian operations, cf. McGuire (2006), p. 141.
[507] Cf. International Federation of Red Cross and Red Crescent Societies (2004), United Nations Development Program (UNDP) (1995/1996).

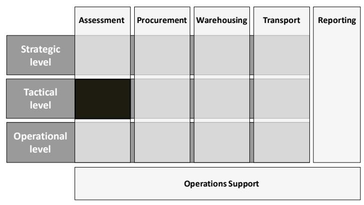
	terms of risk pooling[508], increased forecasting accuracy and reduced safety stock levels.
	Type: *Generic*
Plan Supply Strategy	A general supply strategy needs to drawn up which sets basic parameters of procurement, i.e. sourcing and purchasing of goods and equipment. The supply strategy comprises sourcing decisions including decisions on which (types of) goods to borrow from other organisations or to accept as donations in kind. The supply strategy also determines which (types of) goods are procured from a single source and which goods are procured from dual or multiple sources. Further parameters set in the supply strategy include decision on the width of the supplier base and implementation of VMI or contingency stocks at suppliers. While the supply strategy set the general framework for sourcing and purchasing methods, the concrete parameters will be set by the tasks "Plan Purchasing Methods" and "Plan Sourcing Methods".
	Type: *Generic*
Strategic / Warehousing	
Plan Warehouse Capacities	Warehouse capacities are dependent on the type of warehouse, i.e. general warehouse (e.g. a regional and capital warehouse), slow rotation warehouse (non-urgent, reserve and MRO stocks), quick rotation warehouse (warehouses with high turnover usually close to the crisis area) or temporary collection sites (ad-hoc storage places made out of reinforced plastic, corrugated iron or prefabricated structures).[509] When planning warehouse capacities, available and required resources such as staff, equipment and material also need to be taken into account.
	Type: *Generic*
Plan Warehouse Network	A warehouse location plan includes the number and location of facilities in the humanitarian supply chain. Since only finished goods move through the humanitarian supply chain, only warehouse facilities are considered. Planning warehouse locations includes consideration of the global positioning of stocks, preparedness plans, the type of warehouse, types of goods to be stored and temporal scope of the warehouse (whether it is a permanent or temporary warehouse). Warehouses

[508] Due to the fact that single items substitute various other items, cf. also Simchi-Levi et al. (2000).
[509] Cf. Pan American Health Organization (Regional Office of the World Health Organization) (2001), pp. 83-84.

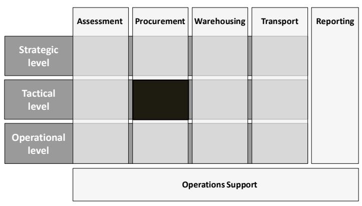
	should be located along or near established transport routes and have access to basic infrastructure, such as power supply and communication lines. While every warehouse location added to the network potentially improves service levels, costs and complexity of the supply chain also increase. Warehouses become necessary at those nodes in the supply chain where there is a necessary change of transport mode. As a general rule, supply chains should be as simple as possible. Warehousing can also be outsourced, thus, humanitarian organisations need to decide whether to in- or outsource warehousing and storage services.
	Type: *Generic*
Strategic / Transport	
Plan Transport Capacities	Planning of transport capacities is dependent on the overall transport strategy (cf. the task “Plan Transport Strategy”). Capacity decisions are based on in- or outsourcing decisions and determine what kind of transport capacities will be held continuously and in case of emergencies. Capacity planning is necessary for all stages in the humanitarian supply chain and can differ between operational regions or areas. Transport capacities are planned to meet security needs for cases when the evacuation of staff becomes necessary. Available transport capacities will also affect options on expedited shipments, especially expedited domestic shipments. Capacity decisions will be based on overall annual volume and weight of shipments rather than individual orders or shipments. Maintaining transport capacities which cover the overall transport volume only partially increases overall utilisation of in-house transport capacities while limiting additional costs for outsourcing. However, the availability of out-sourced transport capacities even in emergencies needs to be guaranteed.
	Type: *Generic*
Plan Transport Network	Planning the transport network includes deciding where to draw the boundaries of the humanitarian organisation’s own transport network and commercial transport networks. The humanitarian organisation could potentially own and operate a fleet to transport goods from the supplier to the final point of delivery. At the other end of the spectrum, the supplier could ship the goods directly to the final point of delivery such that the goods only enter the supply chain of the humanitarian organisation at this final point of delivery. When planning the transport network, one must consider that every change of transport mode will

	require an intermediate storage facility, which will, in turn, increase cost, security risks and complexity of the supply chain. Planning of the transport network is closely related to planning warehouse locations.
	Type: *Generic*
Plan Transport Strategy	The transport strategy may have to take all global transport into account, since humanitarian emergencies can arise anywhere in the world. Humanitarian organisations need to make decisions about whether to partially or fully in- or outsource transport services. Thus, carriage can be private, contract or common for transport of goods in the humanitarian supply chain. Humanitarian organisations may share transport resources or draw up agreements on shared transport in acute emergencies. The transport strategy also details preferred modes of delivery, e.g., direct delivery, which bypasses at least one node in the network, therefore avoiding additional handling, storage, picking and packing, increased cycle time and security risks or risks of theft. Furthermore, policies on transshipments between the same levels in the supply chain are detailed in the transport strategy.
	Type: *Generic*

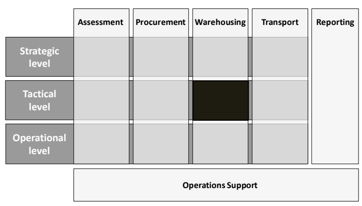
Tactical / Assessment



Plan Demand	Demand planning must be based on the overall programme strategy. Planning of demand involves various stages in the humanitarian supply chain. Proper and precise planning of demand is especially important for items with strategic importance for operations, items with limited supply or procurement difficulties, and items with long lead times. Demand is planned based upon the operations and programme strategy of an individual item or kits level. Demand plans must also integrate available funding. Planning of demand is different from forecasting demand in that the forecasting tasks only execute the parameters set within this task, e.g. the forecasting method or the integration of causal factors into the demand forecast.
	Type: *Generic*
Plan Emergency Team	A number of experts on various key tasks of humanitarian operations such as operational management, needs assessment, supply chain management, communications etc. need to be available at all times in order to be deployed at short notice during an acute emergency. A sufficient number of well-trained and motivated staff needs to be

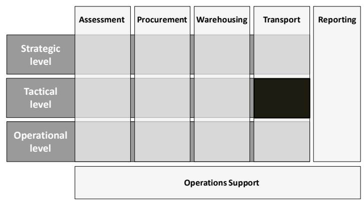
	planned for in order for the humanitarian organisation to be able to deploy an emergency team at all times.
	Type: *Generic*
Plan Project Activities	When an overall programme strategy is set, project activities can be planned accordingly. While the programme strategy is set at senior management level in headquarters, project activities can be planned regionally or locally. Project activities include planning of operations within a certain area, drawing up memorandums of understanding with local authorities and detailing budget and time frames of operational activities.
	Type: *Generic*
Plan Standard Item List	The standard item list intends to support the selection of suitable items for local or regional operations. Standardisation is a means to improve quality insurance, communication and reporting, and to avoid inappropriate in-kind donations. The standard item list contains generic specifications for essential items for the specific operational programme. These specifications are usually taken from the standard item catalogue. While the standard item catalogue may contain several thousand items, a standard item list should not contain more than a few hundred items in order to limit complexity of the operation and enable a feasible and cost-efficient supply plan.
	Type: *Generic*
Select Project Sites	Selection of project sites includes identification and assessment of possible sites from which and where operations are run. Selection of project sites is then done based on a number of factors such as assessment of beneficiaries in the operational areas, access to basic infrastructure, environmental hazards and other safety and security risks for staff, goods and equipment. This task can be carried out at any of the stages of the internal supply chain of the humanitarian organisation, depending on the degree of decision autonomy of the regional and local centres.
	Type: *Specific*
Tactical / Procurement	
Plan Programme	The programme item list contains the majority of items regularly used in a specific humanitarian operation. When planning the programme

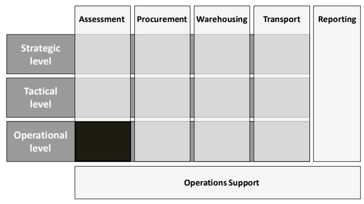
Item List	item list, care should be taken to include only such items, kits or equipment, which are compatible with one another. While items on the porgramme item list should in general be taken from the standard item catalogue, exceptions can include such items with an explicit value only to the specific operation or region or where import restrictions inhibit the inclusion of standard items in the programme item list.
	Type: *Specific*
Plan Purchasing Methods	Planning purchasing methods includes decisions on which items to purchase centrally, regionally or decentrally. For instance, purchasing could only be done at headquarters level, i.e. by one central purchasing team of the logistics department. The other extreme is that all purchases could be performed at the local level directly at the operational site. The main trade-off between centralised vs. decentralised purchasing is transport cost and lead time vs. quality considerations. Other purchasing method decisions concern local purchase, bulk purchase, and external purchase. Purchasing methods may differ according to type of item, operation or region. Importation restrictions may require decentralised purchasing. Sourcing and Purchasing Method need not coincide. This task needs to respect the foundational decisions set by the task "Plan Supply Strategy".
	Type: *Generic, Specific*
Plan Sourcing Methods	Planning sourcing methods includes decisions on which items to source domestically, regionally/internationally, or globally. Planning of sourcing methods also includes decisions on direct sourcing vs. sourcing through intermediaries or wholesalers. Single sourcing vs. multiple sourcing decisions are taken. The main trade-off in single source vs. multiple sources decisions is economies of scale and low administrative costs vs. availability and flexibility in emergency situations. Sourcing methods may differ according to the types of item, operation or region. Importation restrictions may require local sourcing. Sourcing and Purchasing Method need not coincide. This task needs to respect the foundational decisions set by the task "Plan Supply Strategy".
	Type: *Generic, Specific*
Plan Supply of Operations (regional)	A regional supply plan must take the demand planning of that region and details the overall supply strategy into account. Supply plans can be created separately for each stage in the supply plan, i.e. the supply plan for a certain region can be decoupled from the supply plan of the local operations conducted in that region. Supply plans must incorporate available funding.
	Type: *Specific*

Plan Supply of Operations (local)	A local supply plan must take the demand planning of that project and details the regional operational supply plan into account. Supply plans can be created separately for each stage in the supply plan, i.e. the supply plan for a certain region can be decoupled from the supply plan of the local operation conducted in that region. Supply plans must integrate available funding.
	Type: *Specific*
Plan Tender Procedures	Tender procedures are used to purchase items of different type or value. Open, restricted and closed tender procedures exist. In open tender procedures all interested parties can participate. Due to the potential large number of participating suppliers, open tenders should only be used for goods which do not require exhaustive supplier qualification. In restricted tenders, only those suppliers, who have been evaluated, approved and registered, can participate. In closed tenders only invited suppliers can participate. The parameters or monetary thresholds for different tender procedures are set. Typical values are: Total volume of purchase <250€: Purchasing list and quotations only; 2000€ <Total volume of purchase <10000€: Purchasing contract and quotations; Total volume of purchase >10000€: Open tender, purchasing contract and approval from senior management. An alternative to formal tender procedures is direct purchase with or without a comparative bid analysis.
	Type: *Generic*
Pre-Qualify Suppliers	Pre-qualification of suppliers for highly critical items and other strategic items eases procurement of these items when demand changes unexpectedly. Goods for which suppliers have been pre-qualified need not be purchased through a tender procedure but can be bought directly at the respective supplier. Price, quality and lead time are determined during the pre-qualification. The requirements for potential suppliers are set by the quality assurance policy and donors. All suppliers have to be financially sound. Suppliers eligible for pre-qualification can be commercial (for-profit) or public (for-profit or non-profit) organisations.
	Type: *Generic*
Tactical / Warehousing	
Plan	Emergency stock positioning follows the framework as set in the

Emergency Stock Positioning	respective emergency preparedness plan. Emergency stocks must be held in the supply chain in order for the humanitarian organisation to be able to respond swiftly to sudden-onset crises. However, decisions must be made regarding which stage of the supply chain, what kind and what amount of emergency stocks should be held. Emergency stocks can be positioned at any stage in the supply chain, i.e. centrally in one or several warehouses around the globe, regionally, domestic/centrally, or domestic/decentrally. Immediate response to sudden-onset crises requires holding at least a minimal amount of emergency stocks domestically. In order to reduce cost, emergency stocks may be physically stocked in the same location with stocks for continuous operations.
	Type: *Generic*
Plan Quality Assurance	All goods entering the humanitarian supply chain, especially high-value goods, drugs, hazardous and fragile items or items with a limited shelf life or with special handling and storage requirements, need to be carefully inspected by qualified staff. Planning of quality assurance needs to incorporate considerations of availability of qualified staff at decentralised locations. Centralised quality assurance, however, has an impact on possible purchasing methods.
	Type: *Generic*
Plan Warehouse Layout	The following parameters need to be taken into account when planning and setting up warehouses: Capacity, availability, ownership, costs, adequacy of construction (including ventilation, lighting, hard floor, fireproofing, loading docks and condition of roof), availability of loading and unloading equipment such as pallets and forklifts etc.; appropriate physical security such as perimeter fences, sufficient lighting and guards; availability of cold chain; establishment, maintenance and supervision for the warehouse facilities in order to prevent loss and damage.[510] When planning the warehouse layout, enough space should be planned for moving goods to and from the stock. Goods with high turnover or high criticality should be easily accessible. If possible, warehouse layout should be planned in such a way that extensions to the warehouse are possible since demand may increase suddenly and dramatically during acute emergencies. Further areas to be accounted for include unloading/arrival, sorting and classification, packing, quarantine, administrative, and loading/delivery. Warehouse access and integration with public transport infrastructure need to be planned. Both internal conditions and external conditions of warehouses have to be accounted for including security measures.

[510] Cf. International Committee of the Red Cross (2006), pp. II-78/II-79.

	Type: *Specific*
Set Inventory Control Policy	The inventory control policy regulates the frequency of physical stock counts and methods of order initiation. Frequency and method of replenishment orders are set based on the nature of operations, on category, nature and origin of goods and predictability of demand. Standard replenishment strategy is periodic ordering, combined with orders triggered by minimal stock level monitoring to compensate for planning inaccuracy. The replenishment policy should be reviewed periodically to ensure that it is relevant and effective under actual operational conditions.
	Type: *Generic*, *Specific*
Tactical / Transport	
Plan Consolidation Policy	Consolidation of shipments is achieved by combining a number of orders in a single shipment. Thus, consolidation allows for the benefit of economies of scale, while generally increasing lead time and lead time variability. In the consolidation policy, a determination is made as to which kinds of items with which priority status should be consolidated on which relations in the supply chain. The consolidation policy has to be reviewed regularly.
	Type: *Generic*
Plan Transport of Special Goods	Transport of special goods such as flammable items, cold chain items, drug products, and heavy equipment needs to be planned separately. Requirements for the transport of such goods need to be clearly documented and accounted for when planning transport mode, route and packaging.
	Type: *Generic*
Plan Transport Modes	Transport in humanitarian supply chains can include a large variety of transport modes such as air (including air planes and helicopters), land (including motor vehicles and rail transport), maritime, river and human or animal transport modes. When transport modes are planned, various trade-offs need to be accounted for: Transport frequency vs. cost, responsiveness and minimum safety stock levels; consolidation of shipments vs. cost, flexibility and demand data distortion.
	Type: *Generic*, *Specific*

Plan Transport Routes	Planning of transport routes takes place before transports are scheduled. Planning of transport routes should incorporate already existing transport networks such as those of other humanitarian organisations or networks. When assessing the use of established transport networks instead of establishing parallel systems, issues such as security, flexibility, reliability, cost, and responsiveness need to be assessed. Transport routes may need to be re-planned in case of unexpected events. Thus, alternative routes can already be included in the initial planning. When planned transport routes cross international borders, contact with respective customs authorities needs to be established and possibly special conditions such as tax exemptions or priority processing of shipments negotiated.
	Type: *Generic, Specific*
Operational / Assessment	
Assess Local Capacities	The assessment of local capacities includes the assessment of local infrastructure, including transport, communications, water or electricity infrastructure and existing health facilities. These kinds of infrastructure can be damaged depending on the sources of the crisis. The degree of damage or the degree to which this infrastructure is still accessible needs to be evaluated. Moreover, assessment of local capacity in terms of transport and warehouse or storage service providers is carried out. When assessing local capacities, the security situation and coping mechanisms of the affected community also have to be taken into account.
	Type: *Specific*
Assess Local Resources	The assessment of local resources analyses local financial and material, institutional or infrastructural resources as well as available human resources and therefore supports the overall needs assessment. Human resources include availability of qualified and unqualified staff which can be drawn from the local and/or affected population. The level of training of potential staff has to be assessed. Material resources include food, cooking utensils, water containers, soap, blankets and clothes amongst others. Natural resources such as trees, topography, water, soil, and stone are also included. Infrastructural resources include transport (roads, rail, rivers, and airports) and communication systems (phone, fax, mail, radio, satellite). Institutional resources may include the local government, the local commercial sector, and the military or

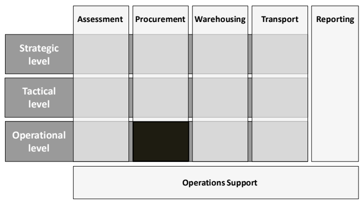
	other external actors. When assessing local resources, the security situation in the region has to be taken into account.
	Type: *Specific*
Assess Local Sources of Supply	All local sources of supply have to be carefully reviewed. Local sources of supply do not only comprise commercial sources but can also include private or public sources. In most circumstances, local sources of supply should be preferred over regional or international purchase. Exceptions to this general rule might include health care or other goods with high requirements for quality which a local source could not guarantee.
	Type: *Specific*
Deploy Emergency Team	The deployment of an emergency team is an extraordinary task before a humanitarian operation is started. The emergency teams are trained groups of specialists together with their equipment that are ready to operate at short notice and capable of being deployed for a period up to several months. A team consisting of a number of experts on the operational programme (such as a coordinator with experience in emergencies, a logistician and a health advisor) are selected and deployed to an area in which the assessment is to be carried out. The emergency team has the task to collect and process information that will enable the humanitarian organisation to decide whether an operation in the affected area will be begun within a given time frame. It is essential that all members of the Emergency Team have a good understanding of the requirements for accountability of the organisation.
	Type: *Specific*
Deploy Exploratory Team	The deployment of an exploratory team is a regular task during an ongoing humanitarian operation. A team consisting of a number of experts on the humanitarian programme (such as a coordinator, a logistician and a health advisor) is selected and deployed to an area in which the assessment is to be carried out. The exploratory team has the task to collect and process information that will enable the humanitarian organisation to decide whether an operation in the affected area will be expanded, reduced, continued or closed within a given time frame.
	Type: *Specific*
Forecast Demand	The information obtained with the help of survey or cluster samples during the task “Identify Needs and Number of Beneficiaries” can be used as a baseline to forecasting future demand. The task “Forecast Demand” is based on a detailed analysis of the situation of the affected community. Detailed and dependable consumption data is necessary in

	order to appropriately forecast demand. This task takes place several weeks after the onset of a crisis and when the immediate response activities have been carried out. Forecasting is done by programme experts based on extrapolating past demand and taking into account causal factors such as weather forecasts, seasonal changes, morbidity patterns, general outlook on the humanitarian crisis, and planned operational changes. Demand forecasting takes place at various stages in the supply chain with a varying degree of demand aggregation, but should also originate as close as possible at the point of consumption. If demand forecasts are passed upstream in the supply chain, they should not contain buffers, so as to avoid repeated planning of buffers and thus creating large overstocks at the various levels of the supply chain.
	Type: *Specific*
Identify Needs and Number of Beneficia-ries	This task has the objective to generate qualitative and quantitative information on the target population of a possible humanitarian operation. Qualitative information on the affected population can be drawn from observations, interviews with key informants and focus group discussions. Sample surveys can be used to obtain basic demand information. Basic information required to derive the needs of the affected population includes sources of water supply, with information regarding its quantity and quality and, if displacement of groups of people has taken place, their conditions must be evaluated. The needs will also be dependent on various key data about the affected population such as demography (total population, age, sex); ethnic background, clan structures etc.; socio-cultural characteristics (religion etc.) and identification of vulnerable groups (children, elderly, pregnant women etc.). In order to identify the number of beneficiaries, a variety of methods can be used: Aerial or satellite photographs, census (to estimate the total number of people in an affected area) or sample or cluster surveys. Needs are also dependent on locally available goods, in terms of water, food, shelter and other non-food items, and health services. The assessment of the health status of an affected population includes information on rates and causes of mortality, diseases with epidemic potential, prevalence of acute malnutrition, data on vaccine coverage and morbidity data on the most common diseases. The results of this task need to feed into the task "Forecast Demand".
	Type: *Specific*
Identify Type and Magnitude	The type and magnitude of a disaster is identified. This includes the gathering of information on the physical characteristics of the environment, including weather forecasts. An outlook on the future development of the crisis needs to be derived in order to support the tasks

of Disaster	"Forecast Demand" and "Identify Needs and Number of Beneficiaries". Moreover, the geo-political context needs to be analysed, including information on the cause of the humanitarian crisis, e.g. displacement by war, earthquake, floods or other natural or man-made disasters. The situation in the region, where the crisis is taking place as well as in surrounding regions (if possible), also has to be assessed.
	Type: *Specific*
Initiate Needs Assessment	This is the initial task of any needs assessment activity. The methods used during the needs assessment need to be defined. These methods can include interviews with the affected population, discussions with local authorities and other actors present in the crisis, various kinds of surveys, cluster samples or direct observation. The objective, scope and timeframe of the needs assessment have to be defined. Needs assessments can take place either as ongoing assessments (in post-emergency contexts) or as initial assessments (in emergencies, which are characterised by extremely high time pressure).
	Type: *Specific*
Initiate Search and Rescue	In the immediate 48 hours following the onset of a disaster, search and rescue operations are launched and carried out. These operations require specialised staff and equipment and are conducted in parallel to a general needs assessment. The objective of search and rescue operations is to localise the wounded, especially in the aftermath of earthquakes or other natural disasters.
	Type: *Specific*
Order Goods	The objective of this task is to compile correct specifications, price indications, potential suppliers and further information needed before ordering goods at the upstream level in the supply chain. Orders for goods to be distributed in humanitarian operations can either be initiated via the beneficiaries and thus the logistician at the respective level of the supply chain or in anticipation of future demand and thus by the respective management level, which is involved in planning and forecasting demand. Replenishment orders should be based on a clear and transparent inventory control policy in order to reduce information distortion at the various levels of the supply chain. Shortages of critical goods should be avoided in order to be able to minimise transport costs by avoiding expensive international expedited shipments. Special restrictions such as cold chain requirements should be indicated when ordering goods. All orders need to be documented. This task can initiate local, regional or international purchase.
	Type: *Specific*

Prioritise Needs	The priorities of a possible intervention need to be defined. This includes selection of the population to be served, selection of specific programme components and prioritisation of the most urgent needs. The task "Prioritise Needs" is also linked to all activities associated with coordinating activities with other actors present in the operational context.
	Type: *Specific*
Request Goods	Goods are requested when a specific need is identified or when reordering is required upon the consumption of a good. Requesting goods can be initiated by all staff of the organisation at a level of the supply chain serving the beneficiaries. Requests are communicated using standardised forms containing detailed specifications, which are completed by the requestor and duly authorised, in order to initiate an ordering or sourcing process. The logistician is responsible for verifying the need, item specification, requested quantity, and requested delivery date. This task can initiate a stock transfer or local, regional or international sourcing.
	Type: *Specific*

Operational / Procurement



Acknowledge Order	Once an order has been received, the order has to be acknowledged. If possible, pre-information concerning the validation status of the order can be included in the acknowledgement. The acknowledgement should be issued in written or electronic form to enable better planning at the receiving end of the downstream supply chain tier. Furthermore, if indications on expected delivery dates are possible, these should be given. In case of intolerable long lead times, ordering of goods can be altered taking into account possible substitutes.
	Type: *Specific*
Analyse Comparative Bids	When bids have been received either as part of a tender procedure or through request for quotations, they have to be compared and analysed. All bids received must be compared according to defined criteria such as quality, price, service, and reliability. Normally, the offer with the overall best weighted rating will be selected. If circumstances exist, which favour selection of another offer, these need to be elaborated and documented.

	Type: *Specific*
Consolidate Orders	Consolidation of orders has the benefit to leverage better rates from suppliers while an overall increased lead time has to be accounted for. Consolidation of orders can potentially take place at all tiers in the supply chain. The trade-off between lower costs and increased lead time is only beneficial in post-emergency settings and mostly at an upstream tier in the supply chain where order quantities and frequencies are sufficient.
	Type: *Specific*
Execute Justification Procedure	All goods that are not contained in the programme standard item list, which are of high value or treated under any other restriction, must be properly justified. The justification procedure comprises a number of steps that have the objective of obtaining content (i.e. by an appropriate technical or medical specialist) and budgetary approval for the purchase, transport and/or importation of a specific good.
	Type: *Specific*
Execute Tender Procedure	The tender procedure depends on the purchasing value. Dependent on the parameters set at the planning level, the suitable tender procedure is chosen. Tenders can be open, restricted or closed (upon invitation only). At low purchasing volumes, a collection of a number of quotations can be sufficient. This task comprises a number of steps which are not further detailed here.
	Type: *Specific*
Mobilise Supplies (ad-hoc)	Ad-hoc mobilisation of supplies takes place following acute emergencies. This task can take place parallel to needs assessment activities. Mobilisation of suppliers includes prioritisation of required supplies; mobilisation and transport of suppliers. The objective of this task is to provide immediate assistance in a humanitarian operation without a prior needs assessment. This task improves reactivity but may impede accuracy and consistency of operations. Mobilisation of supplies often includes utilisation of kits.
	Type: *Specific*
Monitor Pipeline	The objective of this task is to monitor the actual demand and supply and to feed forward the results to the forecasting task. If necessary, adjustments are made to the forecasts, based on the demand forecast, items in the pipeline and actual consumption. Unplanned congestion in the material flow has to be detected, reported and if necessary appropriate action has to be taken.

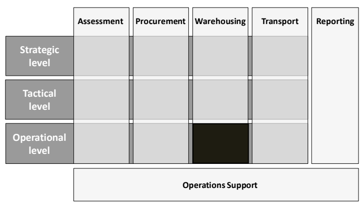
	Type: *Specific*
Obtain Quotations	This task can be part of a tender procedure or can be used at the local operational level to justify low-value purchases. Usually, at least three quotations are obtained from different suppliers for each purchasing contract. Quotations must describe the goods or services to be delivered in detail and contain information on time frame and quality standards. A quotation can be obtained through a request for quotation, which is a solicitation document that describes the requirements quantitatively and qualitatively and requests prices and commercial terms from vendors, for goods that are available on the local market.
	Type: *Specific*
Purchase Goods	Once the supplier of a specific good has been selected, the purchase transaction can take place. Except for direct purchasing with a local supplier and low purchasing volumes, a purchasing contract should be drawn up for every purchase. All purchasing transactions should be thoroughly documented in order to support reporting activities, to enable transparency of prices and to improve organisational learning. When purchasing goods with a purchasing contract, a maximum allowed lead time, minimum quality standard, trade terms, price, currency and terms of payment should be specified.
	Type: *Specific*
Qualify Suppliers	Qualification of suppliers takes place as part of a tender procedure or during low-value domestic purchase transactions. The requirements for potential suppliers are set by the quality assurance policy and donor requirements. All suppliers have to be financially sound. Suppliers can be commercial (for-profit) or public (for-profit or non-profit) organisations.
	Type: *Specific*
Record Order and Shipment Information	Accurate order information is necessary to generate order overview reports. Recording and updating order and shipment information whenever an order or shipment passes through a node in the supply chain is a necessary task, which enables proper tracking and tracing of orders and shipments. If possible, recording of order and shipment information should be performed electronically. Manual records may be used if no access to IT equipment is possible.
	Type: *Specific*
Select	Supplier selection can take place either by pre-qualifying suppliers, by a comparative bid analysis or through a regular tendering process.

Supplier	Suppliers should be easily accessible and flexible in responding to changing demand, reliable in case of high-priority orders and offer low total cost of ownership of goods and services.[511] Depending on the sourcing methods, suppliers with worldwide locations can be beneficial in order to guarantee consistent quality standards in all operations. Suppliers must be able to provide detailed information on the goods or services, including documentation on manufacturing processes, handbooks for equipment and machinery, and lead times.
	Type: *Specific*
Set Order Priority Status	Order priority status can be changed at any time in the ordering process due to unexpected increases of demand resulting from unplanned events. High priority orders need to be treated and served with priority, while all other orders are treated in sequence or according to the consolidation policy. Orders in response to sudden-onset disasters usually receive high-priority status.
	Type: *Specific*
Source Goods (external)	Sourcing of goods with external suppliers takes place when internal sourcing is impossible or infeasible due to intolerable lead time or high (transport) cost. Local sourcing is to be preferred over regional or international sourcing. If no local source can be found, an order is placed with the next upstream tier of the supply chain.
	Type: *Specific*
Source Goods (internal)	Sourcing of goods within the same organisation, i.e. in a local, regional or international warehouse or at other sites where operations are carried out, is generally preferred over external sourcing of goods. Possibility of transshipments has to be checked. While internal sourcing generally has a lower lead time than external sourcing, this has to be checked on an individual basis.
	Type: *Specific*
Specify Special Goods	This task covers the specification of special items on orders and requests. Special items include all items not contained in the Standard Item Catalogue or the Programme Standard Item List. The objective of this task is to ensure that these items are correctly specified and procurement of these items is feasible and therefore, also includes an appropriate technical or medical specialist. Specifications of special goods should be as detailed as possible and provide information on possible substitutes.

[511] For a discussion on total cost of ownership, cf. Skjøtt-Larsen and Schary (2007).

	Type: *Specific*
Specify Standard Goods	This task covers the specification of standard items on orders and requests. The objective of this task is to ensure the use of the available standard items. A specification consists of the item code and an item description. Specifications of standard goods are usually drawn from the Programme Standard Item List or the Standard Item Catalogue. Information on possible substitutes should be provided.
	Type: *Specific*
Validate Order (Non-Standard)	The consistency and completeness of the orders are validated upon receipt. Non-standard orders contain items, which are not on the programme standard list, items that are not contained in the item catalogue, or very expensive items. Validation of non-standard orders includes a technical or medical specialist or requires validation from senior management. Validation also includes financial, logistical and possibly medical justification. Validation is documented either in an IT system or with a signature on the ordering documents.
	Type: *Specific*
Validate Order (Standard)	The consistency and completeness of the orders are validated upon receipt. Validation also includes financial, logistical and possibly medical justification. Validation is documented either in an IT system or with a signature on the ordering documents.
	Type: *Specific*

Operational / Warehousing



Assemble Kits	Kits are assembled within a warehouse following a standard picking and packing list. In order to reduce lead time in the case of an acute emergency, kits can be assembled and stored without consignation to a specific operational site or concrete emergency. Kits are labelled with all items contained.
	Type: *Specific*
Assure Quality	Depending on the type of good, quality is assured by visual, physical, biological, chemical or pharmaceutical checks. All special and non-standard items are checked by qualified staff. All goods not meeting the quality requirements are temporarily moved to a quarantine zone and eventually returned to the supplier. If return to the supplier is not

	feasible, goods may need to be disposed of or properly destroyed.
	Type: *Specific*
Check Incoming Goods	Once goods have been received and the shipment information has been verified, correct packaging and labelling of goods is checked. The packages should contain information on storage requirements. Incoming goods have to be checked for completeness (with reference to the applicable transport documents), contents (a quick overall check has to be done immediately upon receipt, while more detailed checks are done at a later point in time during the "Receive Goods" task) and whether transport damage has occurred.
	Type: *Specific*
Check Quality	It is ensured that all purchased items, kits and equipment comply with the required quality standards. For items with a limited shelf life, a minimum remaining shelf life should be guaranteed. Specifications of received goods need to be compared with supplier documents. If sufficient quality cannot be assured, goods are returned to the supplier.
	Type: *Specific*
Consign Goods	Goods from stock are consigned to specific orders. Thus, the inventory is reserved for a specific operational site and cannot be diverted to other sites. Consignment of goods becomes necessary when the order contains items of various lead times but has to be shipped in total. Consignment decisions can only be overridden by senior management.
	Type: *Specific*
Count Stock	Physical stock counts are carried out in regular intervals. Periodic stock counts are an important aspect of proper logistics, specifically in inventory management. Not only does it present the opportunity for physically verifying the quantity of items in stock and catching stock losses early, it also provides for the assessment of the quality of the items in stock. By catching storage problems of dampness, mould, or infestation before all stock is affected, the amount of stock requiring disposal and destruction at a later date may be significantly reduced. Stock counts should be double checked and verified by an independent third person if discrepancies are discovered. Inventory levels are then updated accordingly. A physical stock count can lead to regular as well as incidental orders if stock levels have fallen below the minimum stock level threshold.
	Type: *Specific*

Create Packing List	A packing list is used for parcels containing a large variety of different items. A packing list contains information on all goods included in a specific parcel. A packing list contains the following general information: Date of shipment, order reference number(s), consignee, and origin. A packing list contains the following information for each item: Quantity of item including unit, description of item, weight and/or volume, and special remarks such as expiry date.
	Type: *Specific*
Create Waybill	A waybill is used for all movements of goods within the supply chain of the humanitarian organisation. A waybill is created for each vessel used for a shipment and lists all goods on that particular vessel. A waybill is issued by the sending entity, signed by the transporter and counter-signed upon correct receipt by the consignee. A waybill contains the following information: Date of shipment, order reference number(s), consignee, origin, and number of parcels together with contents, quantity of item including unit, description of item, weight and/or volume, and special remarks such as expiry date. If packing lists are used, a reduced amount of information is noted on the waybill.
	Type: *Specific*
Dispose Goods	If goods have expired, are damaged beyond repair or if the quality is no longer sufficient for distribution, they have to be destroyed and appropriately disposed of. Disposal of medical items is frequently subject to legally binding procedures and requires reporting and supervised destruction.
	Type: *Specific*
Issue Replenishment Order	The objective of this task is to ensure the right composition of the stock (items and quantities) through a periodical replenishment of the stock. A replenishment order is issued when stock levels have reached a pre-defined minimum stock level. The quantity of the replenishment order is set by the inventory control policy.
	Type: *Specific*
Mark and Label Goods	Parcels are marked with the required storage conditions, quantities packed, safety instructions and special handling requirements. Hazardous materials require special labelling. A labelling and/or colouring scheme can be used to appropriately mark goods and enable rapid identification and sorting upon arrival at the destination. If shelf life is limited, an expiry date should be clearly marked. Marking and labelling may have to be done in several languages.

	Type: *Specific*
Monitor Stocks	This task covers the administration and management of local stocks. The objective of this task is to ensure accuracy of stock levels and quality of stock keeping practices. The inventory control policy set at the tactical level may define regular time intervals at which stock levels are checked. At this time, theoretical and physical stock levels are cross-checked. Inventories are adjusted for calculation errors, obsolescence and theft and corrective action is taken. If minimum stock level thresholds have been crossed and no order has yet been started, missing goods are ordered according to the inventory control policy. In crisis areas, where adverse environmental conditions play a role, or if there are security concerns, this task should be carried out more frequently in order to avoid sudden and unexpected stock outs.
	Type: *Specific*
Pick and Pack Goods	Picking of goods should follow a rigorous picking plan in order to maximise the shelf life of the remaining goods.[512] When packing goods, quantities are indicated on a packing list, which is included in the final shipment. Packing increases handling efficiency, serves as a means to identify goods and improves protection from damage. Packing material should be adjusted to the goods' susceptibility to damage and to their value.[513] Packing should also be suited to the context of the recipient country, including possible delivery to remote areas. High value goods should be packed discretely in order to reduce the risk of theft. The size and weight of parcels should be adjusted to the transport mode(s).
	Type: *Specific*
Prepare Shipping Documents	Shipping documents such as a waybill or freight manifests need to be completely and accurately filled. The information contained in the packing list depends on the goods transported. Information on consignee, address, date, item type, quantity, size and weight are always included, along with a unique shipment number. Indications regarding the order or contract number or other reference numbers, vehicle registration and name of driver may also be given. Furthermore, specific information on manufacturer, country of origin, batch number and expiry date may become necessary when shipping special items.

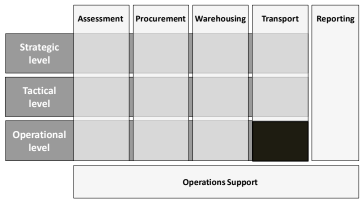
[512] Most likely, picking will take place according to either the FIFO rule, i.e. first-in/first-out or the FEFO rule, i.e. first-expiry/first-out, which is appropriate when dealing with goods with only a limited shelf life. The FEFO rule will maximise overall remaining shelf life through strict stock rotation and thus minimises waste through expired items.

[513] Cf. Bowersox et al. (2007).

	Type: *Specific*
Prepare Special Certificates	Special certificates are necessary for the transport of all kinds of hazardous materials. Hazardous materials include radioactive, explosive, poisonous and toxic flammable solids and liquids or corrosive items such as fuels, chlorinated products, cooking gas, oxygen, and laboratory reagents. Special certificates might also be necessary for other types of goods, including cold chain goods, drug products and expensive equipment. These certificates are needed to allow importation into the country of destination.
	Type: *Specific*
Prepare Stock Transfer	Stock transfers are carried out when transporting goods vertically or horizontally within the organisation or via re-consigning stocks within a warehouse. Advance notice is sent and stocks may be moved from the stock to the loading area of the warehouse.
	Type: *Specific*
Receive Goods	All goods are verified upon receipt and are registered with information about whether goods are in compliance with ordered specifications, are in good condition, and that shipping documents and invoices match the shipment. When receiving goods, all goods requiring special handling or storage conditions must be treated separately and with high priority. Urgently needed goods may then be separated for cross-docking and immediate onward transport. Receipt of goods is documented with a signature by the recipient. Proper documentation of the receipt of goods is crucial for humanitarian organisations' accountability to donors and beneficiaries. In case of mismatches between documents, invoices and shipment, corrective action has to be taken immediately. After verification of received goods is complete, details on the condition and contents of the shipment are communicated to the sender.
	Type: *Specific*
Receive Goods (unsolicited)	When receiving unsolicited goods, all goods requiring special handling or storage conditions must be treated separately and with high priority. A quality check after receiving unsolicited goods is mandatory. Receipt of goods is usually documented with a signature from the consignee. Proper documentation of goods reception is crucial to humanitarian organisations' accountability to donors and beneficiaries.
	Type: *Specific*

Return Goods	This task is associated with returning goods to upstream levels in the supply chain. Returning goods becomes necessary when an operation is terminated, when large quantities of goods run the risk of expiring and donation of these goods is not feasible, when unexpected decreases in demand occur, in the case of forecasting errors, or if importation into the country of destination becomes impossible or infeasible.
	Type: *Specific*
Store Goods	Special restrictions must be considered upon the storage of goods. These include requirements related to temperature, humidity, security or exposure to sunlight. The warehouse layout as determined on the tactical level, determines the storage policy. Stored goods must be protected from deterioration caused by insects, rodents, birds, dust, water, sand, sunlight, humidity and inappropriate temperature. When storing goods, an appropriate scheme such as alphabetizing or ordering according to the item code should be respected in order to improve picking speed and inventory monitoring.
	Type: *Specific*
Transport Goods to/from Stock	Transporting goods to/from stocks includes all internal movement of goods from the unloading area, rearranging stocks, and moving items to/from the quarantine zone or to/from the loading area. When handling goods during internal transport, care must be given to all items requiring special handling, such as cold chain or fragile items. Careful handling is also necessary to avoid damaging goods.
	Type: *Specific*
Update Inventory	Whenever goods are added or removed from the stock, the inventory is updated. This can be done by electronically or manually updating the inventory card and noting date, quantity, source or destination, request or order number and expiry date of the added or removed items. Updating the inventory with this information is crucial in order to ensure accountability and to enable proper reporting and supply chain transparency.
	Type: *Specific*
Verify Shipment Information	The quantity of parcels and (if possible) the quantity of items is verified. Also, parcels are checked for transport damage and if necessary, a respective report is filed. Shipment documents such as waybills, packing lists or freight manifests are signed.
	Type: *Specific*

Operational / Transport



Consolidate Transport	Consolidation of transport has the benefit of reducing overall cost and security risks, while increasing lead time. Consolidation of transport can potentially take place at all tiers in the supply chain, however, it must first be determined whether the trade-off of lead time versus transport cost and lower security risk is acceptable. Consolidation of transport can be achieved when a milk-run type of route is selected for in-country deliveries.
	Type: *Specific*
Export Goods	All shipments, which cross international borders, must be exported from the country of origin. Exporting necessitates the preparation of the shipment including appropriate packing, labelling, documentation, and insurance. Exporting of goods is frequently done by logistics service providers. Goods in transit, which are exempt from duties and taxes, must be stored in a bonded warehouse.
	Type: *Specific*
Handover Goods	Handing over goods closes all transport activities. In order to transfer responsibility for the shipment, a signature is required on shipping documents, such as a waybill. Handing over goods also takes place at the final point of delivery, when goods are handed over to the beneficiaries or distributing agents.[514]
	Type: *Specific*
Import Goods and Clear Customs	In order to avoid unnecessary delays and associated risks of damage, theft or obsolescence when importing goods, shipments should be cleared at the destination before the shipment is initiated. Appropriate documentation is submitted to the customs authority in advance, necessary permits are obtained, and duties and taxes paid. Importation of goods can be outsourced to clearing agents or be part of the services offered by an LSP. As ratified in several international agreements, clearance of goods can be simplified or accelerated for humanitarian organisations.
	Type: *Specific*

[514] As indicated in Section 6.2.4, final distribution of goods is not in the focus of the reference task model. Distribution of goods takes place after goods are handed over at the final point of delivery.

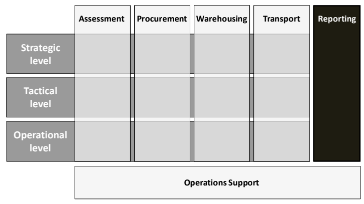
Load Goods	Goods are loaded onto the transport vessel. When loading, parcels should be loaded in such a way, that risk of transport damage is minimised. All freight must be securely fastened. The maximum weight limit of the transport vessel needs to be respected. When conditions on the transport route are rough, the maximum weight limit may be reduced. Loading goods can require auxiliary equipment. Routes with intermodal transport must only contain loading/offloading points, which possess the necessary auxiliary equipment.
	Type: *Specific*
Obtain Signature	A signature on applicable documents, such as shipping documents, order documents or purchasing documents, is obtained in order to transfer responsibility for the shipment or to approve the transaction. In order to comply with accountability requirements, copies of the signed documents are kept by both parties involved and filed.
	Type: *Specific*
Offload Goods	Upon arrival of a transport, all goods are offloaded into the transit area of the warehouse. Once all goods are offloaded and reception of goods has been completed, the transit area must be cleared as soon as possible.
	Type: *Specific*
Prepare Customs Documents	All shipments crossing international borders must be accompanied with customs documents. A customs declaration is a statement that contains all required information in a form prescribed or accepted by customs. In the customs declaration the customs procedure to be applied is indicated. All shipments going through customs must include at least a waybill/bill of lading (depending on the mode of transport), a cargo manifest, and a packing list. Other documents, such as donation certificates, health certificates, or declaration of hazardous materials may be necessary depending on the circumstances.
	Type: *Specific*
Schedule Deliveries	A delivery schedule for local or regional operational sites has already been drawn up at the tactical level. This task includes the detailed scheduling of the deliveries, including consignments, loads, and delivery times. Advance notice is sent concerning the contents of the delivery. Deviations from scheduled deliveries (postponement or advance deliveries) should be avoided since storage space is usually limited and irregular deliveries increase overall cost.

	Type: *Specific*
Schedule Transport	Regular transport schedules can be implemented in order to enable better planning at the regional and local operations level. Weekly or daily milk-runs enable a steady, reliable and plannable supply of goods to operations. When scheduling transport, national legislation and regulations concerning issues of safety, vehicle and load specifications and other requirements need to be taken into account. All transports need to be accurately tracked in order to comply with accountability requirements towards humanitarian organisations.
	Type: *Specific*
Select INCO-TERMS Mode	INCOTERMS (International Commercial Terms) provide a set of international rules for the interpretation of the terms used in international trade contracts.[515] The international purchase and transport of goods is subject to international trade standards under a unified terminology, known as INCOTERMS. These terms specify the conditions that apply to the transaction and the responsibilities of the shipper and consignee regarding costs and insurance risks, the place of delivery, etc. The most common INCOTERMS are CIF/CIP (Carriage, Insurance, Paid to), FOB (Free on board), and ExW (Ex Works).[516]
	Type: *Specific*
Select Transport Mode	A suitable transport mode must be selected if several modes of transport are available. Within a multi-echelon humanitarian supply chain, the last stage usually consists of road transport, although other modes of transport such as small boats or air drops are conceivable. When selecting a transport mode, several factors, such as cost, lead time, speed, flexibility, and robustness need to be taken into account... Hazardous materials or material requiring special handling, restrict suitable transport modes.
	Type: *Specific*
Select Transport Route	When selecting a transport route, several factors such as security of staff, assets, and goods need to be taken into account. Transport routes should be easily adaptable in case of unexpected events. In case of an unforeseen event, transport routes may need to be re-planned.
	Type: *Specific*

515 Davis and Lambert (2002), p. 114.
516 Cf. Pan American Health Organization (Regional Office of the World Health Organization) (2001), pp. 58-59.

Send Advance Shipping Notice	Sending an advance shipping notice to the consignee of a shipment enables better planning at the receiving end of a transport leg. An advance shipping notice is usually sent electronically and includes copies of the shipping documents.
	Type: *Specific*
Track and Trace Shipment	The objective of tracking is to monitor the movement of goods through the supply chain and deliver status updates upon request. Tracing denotes the task of accurately reconstructing the shipment history ex post with all events. Tracing includes the location of lost or late deliveries. Proper Tracking and Tracing of shipments may be difficult for a humanitarian organisation to achieve. Transport of goods can be outsourced to commercial carriers offering tracking and tracing services. Thus, humanitarian organisations do not have to implement their own tracking and tracing system.
	Type: *Specific*

Reporting

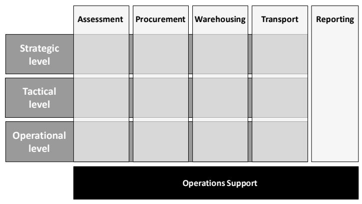


Create Asset Report	Two types of asset reports can be distinguished: Internal asset reports and external asset reports. The internal asset report is compiled according to the standards of the humanitarian organisation, while the external asset report follows other stakeholders, e.g. donors, guidelines. Assets of humanitarian organisations include all purchased equipment, spare parts, furniture or other non-expendable items having a life-cycle of more than one year and a total value beyond a certain threshold. Frequently, this threshold is set to around 500€, but may differ depending on the requesting organisation. Information contained in the asset report includes asset ID, item manufacturer, origin, description, serial number, model, asset condition, asset location, asset controller and assigned user. The asset report should be updated on a regular, e.g. monthly basis.
	Type: *Generic, Specific*
Create Donor Report	A donor report is a means to inform donors and their constituents that their resources (financial or in-kind) have been effectively and efficiently used for the intended purpose. Proper donor reporting supports sustainability of operations by promoting future funding of the operations.

	Type: *Generic, Specific*
Create Inventory Report	The Inventory Report shows how much of each commodity is held in storage in one or more warehouses at a particular moment and also includes other key data such as age, expiry date, historical consumption, etc. The report can show details for the storage facilities of an entire operational region or for the facilities of one location within an operational country only. The Inventory Report includes information about stock turnover, dispatches and receptions at the locations within the scope of the report.
	Type: *Generic, Specific*
Create Damage/Loss Report	A damage/loss report is used to record any losses or excesses of goods or damaged goods in the supply chain of the humanitarian organisation between two specified dates. This includes damages/losses in transit and damages/losses in storage due to theft or discrepancies between theoretical stock balance and physical checks. The loss report is also used to record any excess deliveries and to make adjustment on the stock level of a specific item. One loss report is filed for each shipment that needs to be adjusted. A damage report is filed for all goods that arrive in damaged condition at a storage point in the humanitarian supply chain.
	Type: *Specific*
Create Needs Assessment Report	A needs assessment report is generated to plan operations on a short- to medium-term time horizon. Data from the needs assessment report can be used to derive net needs of an affected community. Needs assessment reports can also be used to apply for operational funding. The needs assessment report then includes a logical framework, which contains narrative information on the intended operations, as well as the required budget. The logical framework presents the key components of a project in a systematic, concise and coherent way, clarifying and exposing the logic of how the operations are expected to work. It clarifies underlying judgments about efficiency and effectiveness of the operations and identifies the main factors related to the success of the operations. Other actors, who are present and able to respond, are identified. The logical framework should be drawn up with the input of all stakeholders of the operations.
	Type: *Specific*
Create Outstanding Order Report	All items which cannot be fulfilled in a specific order need to be documented and added to the outstanding order report. There should be one continuously updated outstanding order overview accessible to all tiers of the supply chain. Likewise, all stages should be able to

	update this overview. Order lines can only be removed from the outstanding order overview if receipt has been validated by the consignee. Upon discovery of discrepancies or irregularities in the outstanding order overview, they need to be resolved internally or externally.
	Type: *Specific*

Operations Support



Implement Basic Infrastruc-ture	When personnel, equipment and auxiliary equipment has been mobilised, these resources can be used to implement basic infrastructure in the area of operations. Infrastructure includes communication and IT systems, electricity for operations, water, sanitation, and shelter for personnel, transport for personnel, equipment and goods. This basic infrastructure is established in order to support operations and enable the efficient material and information flow in the supply chain. Security of basic infrastructure and OS systems needs to be planned and security policies implemented.
	Type: *Specific*
Mobilise Auxiliary Equipment	Mobilisation of auxiliary equipment can take place both in an ad-hoc fashion following acute emergencies or in a planned way in post-emergency contexts. Ad-hoc mobilisation takes place parallel to needs assessment activities. Mobilisation of auxiliary equipment includes prioritisation of required auxiliary equipment, mobilisation of auxiliary equipment, transport, preparation, and installation of auxiliary equipment.
	Type: *Specific*
Mobilise Equipment	Mobilisation of equipment can take place both in an ad-hoc fashion following acute emergencies or in a planned way in post-emergency contexts. Ad-hoc mobilisation takes place parallel to needs assessment activities. Mobilisation of equipment includes prioritisation of required equipment, mobilisation of equipment, transport, preparation, and installation of equipment.
	Type: *Specific*
Mobilise Personnel	Mobilisation of personnel can take place both in an ad-hoc fashion following acute emergencies or in a planned way in post-emergency contexts. Ad-hoc mobilisation takes place parallel to needs assess-

	ment activities. Mobilisation of personnel includes prioritisation of required personnel, mobilisation of personnel and transport.
	Type: *Specific*
Operate OS Systems	The objective of the operation of OS systems is the support and enabling of the delivery of goods and services to the affected community. Operation of OS systems includes activities concerned with maintaining, adapting and further developing these systems, following a possible change to operational requirements. Adaptation of OS systems to the local environment includes integration of local resources into the operation of the OS systems and outsourcing of OS system services to local providers.
	Type: *Specific*
Prioritise and Allocate OS Resources	This task precedes all tasks occupied with the mobilisation of resources. OS resources are scarce and need to be prioritised in case operations are being conducted in various regions. The available OS resources need to be (pre-) allocated to these regions and, thus, set boundaries within which ad hoc mobilisation can take place. In order to integrate its findings, prioritisation may need to be re-run after the initial assessment has been concluded.
	Type: *Specific*