Chapter 2
A Systemic Approach to Sustainable Humanitarian Logistics

Aimen Remida

Abstract With the purpose of drawing a general outline of a systemic approach, which take into account the ecological, economic and social dimensions of sustainability and simultaneously the increasing complexity of logistics systems within disaster relief operations, the systems thinking paradigm is briefly introduced and presented in a manner that emphasizes its adequateness and applicability in Humanitarian Logistics (HL) research. The context of sustainable development in general and the Triple-Bottom-Line (TBL) perspective in particular are considered as substantial parts of the polycontextual environment of the sustainable HL-systems, which are the objects of inquiry of Sustainable Humanitarian Logistics (SHL) as a specific research field. The main principles of the suggested systemic approach are described within an analysis which includes concrete application possibilities.

2.1 Introduction

Several challenges are urging the scientific community as well as the economic and political players to consider the requirements of sustainable development in their attempts to find appropriate solutions to the natural, social and technical complications observed in the increasingly complex systems of disaster relief operations. Both concepts of "sustainability" and "systems thinking" are subjects to controversial interpretations. Nevertheless sustainability is itself systemic since it primarily aims to ensure the conditions for the continued existence of the modern economic system in which the negative impacts of the contradictions within this system are abolished or compensated (Elling 2010).

In order to increase the ability of practice and research in Humanitarian Logistics (HL) to deal with the complexity of the events and phenomena on the one hand and

A. Remida (✉)
University Duisburg-Essen, Keetmanstr. 3-9, 47058 Duisburg, Germany
e-mail: aimen.remida@uni-due.de
URL: http://www.uni-due.de/tul/

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the dynamics of the relationships between the involved stakeholders, who are acting in vulnerable contexts with their corresponding changing requirements on the other hand, a systemic approach is needed to emphasize the coextensive consideration of different dimensions of sustainability in conceiving adequate responses to the complex challenges of HL, so that a specific research field could be recognizable, namely: Sustainable Humanitarian Logistics (SHL).

The systems thinking paradigm is offering the opportunity of taking into account interdependent research questions at once by considering the contingent relationships between the system' elements, which could be various entities, belonging to different ontological levels such as objects, organizations, natural and social multisided constructs etc. This could present a promising starting point for dealing with the raising complexity of today's knowledge management in HL.

In this paper the concept of systems thinking as a scientific paradigm is briefly initiated (Sect. 2.2). This occurs with an emphasis on the adequateness of systemic approaches in managing the complexity of contemporary socio-technical systems in general and HL in particular. The subsequent introduction of the concept of sustainable development (Sect. 2.3), with the field of humanitarian aid as analogously standing in the foreground, contributes deducing the main characteristics of sustainable HL-systems. Finally, with regards to this general analysis of sustainability in HL-systems, whereby interrelated requirements are influencing the efforts in practice, research and education, three basic principles of a systemic approach to SHL are identified (Sect. 2.4).

2.2 The Systems Thinking Paradigm

2.2.1 Historical and Methodological Insights

This section aims at presenting some relevant features of the systems thinking paradigm in order to investigate to what extent it could be considered as an appropriate set of tools in studying HL-systems in the context of sustainable development. The word "paradigm" is used here to stress the epistemological wholeness of the concept "system" beyond any restrictions made by predefined scientific theorization. Indeed scientists can agree in their identification of a paradigm without agreeing on, or even attempting to produce, a full interpretation or rationalization for it (Kuhn 1970).

Systems thinking is deeply rooted in human civilizations: Cultural, intellectual and scientific achievements from early Chinese, Egyptian and Greek polymaths and philosophers (e.g. Imhotep, Confucius, Aristotle) to the contributions of the centuries of Renaissance and Enlightenment (e.g. L. Da Vinci, F. Bacon) are witnessing a systems-oriented cognitive tendency. It culminates in the 20th century with the emergence of the General System Theory (GST) (e.g. L. von Bertalanffy, Boulding, Rapoport) and Cybernetics (e.g. Norbert Wiener, Heinz von Foerster) which accompanied the advances in several disciplines and allow the establishment of new research fields and scientific paradigms with the related concepts and terminologies [e.g., Systems Engineering (SE), Operation Research (OR)]. The pioneers of these developments were basically scholars with a solid interdisciplinary background: many of them were biologists and natural scientists with knowledge in philosophy, psychology and social sciences. This is essential to grasp the multi-sided perspectives of today's complex systems which involve almost every aspect of the human activities.

Beside the fact that it seems impossible to fix a genuine definition of the word "system", one could assume with the founders of General Systems Theory that "a system can be defined as a set of elements standing in interrelations" (Von Bertalanffy 1968, p. 55). Going one step further, "an open system is defined as a system in exchange of matter with its environment, presenting import and export, building-up and breaking-down of its material components" (Von Bertalanffy 1968, p. 149). It follows that an extension of these definitions could lead to recognize the existence of three concepts which may be found in almost all systems perceptions since they show an unlimited semantic and functional interchangeability:

- **The environment**: is designing the realms outside of the system. The relations of the system with its environment indicate to which extent the system is called an open or a closed system.
- **The subsystem**: is a part of the system which could be considered either as an element (in a bottom-up approach) or as a system itself (in a top-down approach).
- **The element**: is the basic component of a subsystem (or a system).

The interchangeability of these concepts is the cornerstone of the methodology used in this paper. In fact each object of study could be considered either as (1) a system in an environment and thus having its own components (subsystems and elements), or as (2) a subsystem belonging to a system of a higher level, or even as (3) the basic element in a subsystem which is included in a larger system (Fig. 2.1). Some objects of study could also be seen as environments for systems; especially if they are themselves social or cognitive systems.

Within a systemic approach to HL which pursues the objectives of sustainability in the implemented methods of planning, execution and control, the focus will be on various levels and affecting different aspects: the use of environmentally sound equipment, items and transportation and storage systems during the interventions is combined with the planning of social-oriented initiatives and strategies for reconstruction and development assistance which are based on a long term vision of economic prosperity. This requires an enlargement of the current understanding of collaboration between stakeholders and an interdisciplinary orientation in research and practice going far beyond logistics and supply chain management.

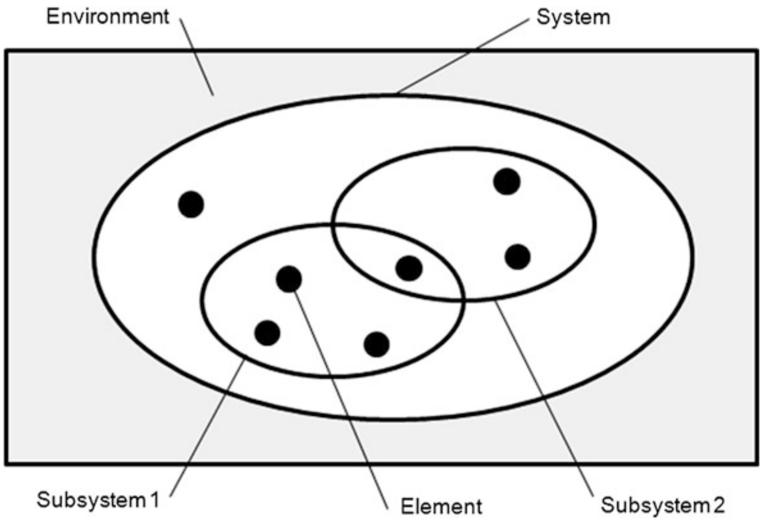

Fig. 2.1 A general system's configuration

2.2.2 Managing Complexity

The systemic approach seeks at a simultaneous consideration of various interconnected sides of complexity: the complexity of the (built and natural) environment which includes the complexity of geopolitical, economic and social contexts with the corresponding phenomena (e.g. urbanization, global, regional and local conjunctures) as well as the complexity of the behavioral issues in relation with decision making and the trade-off strategies between the different, often contrasting, interests of the stakeholders of the HL-systems.

2.2.2.1 The Category of Complex Disasters

The classical distinction between natural and man-made disaster should not hide the existence of specific cases whereby both origins are combined, the so called complex disasters. In addition, it is possible that both sudden-onset and slow-onset disasters strike in the same location at the same time. Kovacs and Spens observe in (2009) that on the African continent some patterns of slow-onset disasters are categorized as complex emergencies as they are the results of armed conflicts. It is for example the case of the population in Darfur, Sudan, which is facing the devastating consequences of repetitive armed attacks while still suffering under drought and famine.

A further recent example of complex disasters is the case of Fukushima, Japan, where on March 11th, 2011 the Tohuko earthquake and Tsunami caused a series of releases of nuclear materials at a nuclear power plant. The effects of the disaster are still difficult to manage since they are not only concerning the local population and ecosystem but also reaching the entire globe if we take into account the economic and political consequences and in particular the lessons learnt in terms of predictability and prevention.

The interrelated difficulties in dealing with complex disasters emphasize the need for a systemic approach to HL-systems which are already denoted by numerous complexities. These are basically regarding unknown factors (place, severity, etc.), time, trained logisticians, media and funding, equipment and information technology and interference (Overstreet et al. 2011).

2.2.2.2 Reduction Versus Absorption

There is a wide consensus among complexity theorists about considering organizations as complex adaptive systems (e.g. Schneider and Somers 2006). Seen as such, they have two main alternatives to deal with the turbulent and complex environment (Fig. 2.2): complexity reduction and complexity absorption (Boisot and Child 1999). Ashmos et al. argue in (2000) that complexity reduction is based on pursuing simplicity in the internal organizational arrangements while complexity absorption rests on facilitating information exchange and allowing the generation of multiple interpretation of information.

Organizations which pursue a complexity absorption response to complexity are more successful in dealing with complex environments since they pursue multiple and sometimes conflicting goals, a variety of strategic activities and because of the existence of high levels of participation by multiple stakeholder groups in decision making as well as more informal and decentralized structural patterns (Ashmos et al. 2000).

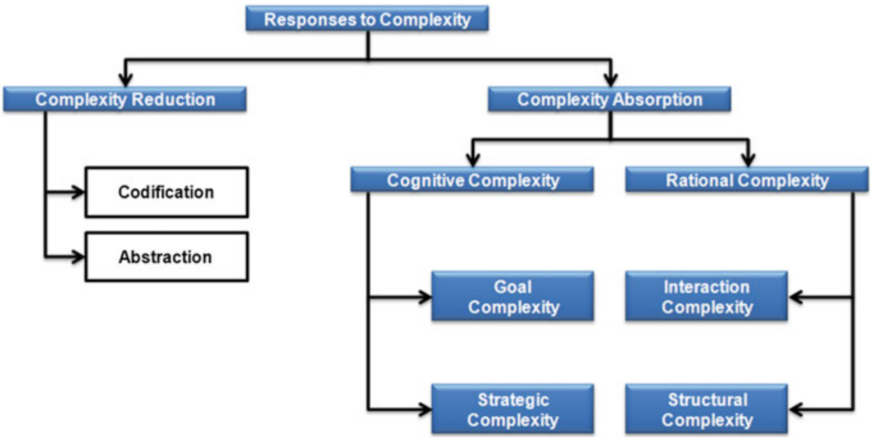

Fig. 2.2 Complexity reduction versus complexity absorption

When transferring these managerial alternatives into the environment of HL-systems, the organizations involved in HL are studied as complex adaptive systems which show different structures, strategies and goals so that sustainable collaboration patterns are often difficult to establish. The first alternative (complexity reduction) could be associated with the use of analytical approaches in order to solve isolated complications while the second (complexity absorption) deals with much more uncertainty and dynamics of the systems' environments and it calls therefore for using a systemic approach.

2.2.3 Analytic Versus Systemic Approaches

Although the two approaches are complementary, the analytic approach has been favored disproportionally in education and research. De Rosnay argued in (1979) that the "classic thought" based on solidity, rigidity, a unique consideration of physical time and reversible phenomena, linear causality as well as further features, as illustrated in Table 2.1, is transformed within the new modes of thought influenced by the systemic approach to emphasize flexibility, adaptability, duration, irreversibility and circular causality. "The dynamics of systems shatters the statistic vision of organizations and structures: by integration time it makes manifest relatedness and development" (De Rosnay 1979).

2.2.4 Applicability to Humanitarian Logistics

Systems thinking could be used for modeling dynamic and complex logistics systems which include several interconnected stakeholders. At a first level, the interrelations between the observed and studied phenomena could be visualized by means of appropriate tools such as Systems Dynamics (SD). Heaslip, Sharif and Althonayan are using in Heaslip et al. (2012) systems analysis and design techniques (SADT) in general and systems archetypes (SA) in particular to draw a detailed causal loop diagram of humanitarian logistics in a conflict-based context.

It should be mentioned that in recent years, several efforts are trying to investigate the application possibilities of Systems Dynamics in various HL-systems (e.g. Besiou et al. 2011; Gonçalves 2011).

Furthermore the systems paradigm includes the usage of Multi-Agent Systems (MAS) to model the behavior of the stakeholders. Within the framework of HL, the existing complex relationships between the donators, the beneficiaries, the international organizations and the logistics providers are investigated and modeled to allow constructing agile and real time-based logistics systems. This could affect the tracking of items, communication tools for the practice side as well as optimization and simulation methods as far as research and education are concerned. Thus this

Table 2.1 Analytic versus systemic approaches based on (De Rosnay 1979)

	Analytic approach		Systemic approach	
	Features	Examples of applications	Features	Examples of applications
1	Isolates, then concentrates on the elements	Detection of machine failure	Unifies, then concentrates on the interactions between elements	Chess play
2	Studies the nature of interactions	Linear correlation	Studies the effects of interactions	Macroeconomic analysis
3	Emphasize the precision of details	Industrial design	Emphasize global perception	Policy making
4	Modifies one variable at a time	Simple regression	Modifies group of variables simultaneously	Multiple regression
5	Remains independent of duration of time; the phenomena considered are reversible	Newtonian mechanics	Integrates duration of time and irreversibility	Processes in thermodynamics
6	Validates facts by means of experimental proof within the body of a theory	Chemistry experiments	Validates facts through comparison of the behavior of the model with reality	Simulation models
7	Uses precise and detailed models which are less useful in actual operation	Econometric models	Uses models which are insufficiently rigorous to be used as bases of knowledge but are useful in decision and action	models of the club of Rome (limits of growth)
8	Has an efficient approach when interactions are linear and weak	Elementary mathematics	Has an efficient approach when interactions are nonlinear and strong	System dynamics
9	Leads to discipline-oriented (juxtadisciplinary) education	One area of expertise in an applied science	Leads to multidisciplinary education	Combining natural sciences and humanities
10	Leads to action programmed in details	Automated systems	Leads to action through objectives	Reduction of GHG-emissions
11	Possesses knowledge of details, poorly defined goals	Division of labor	Possesses knowledge of goals, fuzzy details	Strategy development

(continued)

Table 2.1 (continued)

	Analytic approach		Systemic approach	
	Features	Examples of applications	Features	Examples of applications
12	Static vision (simple systems)		Dynamic vision (complex systems)	
	Solid			Fluid
	Force			Flow
	Closed system			Open system
	Linear causality			Circular causality
	Force equilibrium			Flow equilibrium

kind of applications could contribute bridging the gaps detected in HL practice, research and education, as well as between these (Kovacs and Spens 2011).

Since systemic approaches are resting upon a holistic understanding and a high adaptiveness to use various kinds of data and techniques, they could be considered as knowledge-based methodologies. Within the field of logistics activities, there is a need of Knowledge-Based Systems (KBS) that can collect, transform and store the organizational knowledge to support the stage of formulating logistics strategy in a systematic way (Chowa et al. 2005). Although this may emphasize a specific adequateness of systems-oriented approaches during the phases of disaster management cycle which require a high level of strategic logistics planning, the complexity of tactical and operational planning as well as the interdependencies of the geopolitical and economic realities make the systemic approach suitable in all phases of prevention, mitigation, preparedness, response and recovery. In fact the success of every disaster management system is highly dependent on the characteristics of the region affected by a disaster in addition to the characteristics and intensity of each particular disaster (Nikbakhsh and Farahani 2011).

2.3 Sustainable Humanitarian Logistics Systems

2.3.1 Modeling the Systemic Approach

One could argue that, broadly speaking, every HL-system is somehow a sustainable HL-system since it contributes in saving lives and improving the life conditions of the population. However this argument could be rejected by stressing the fact that sustainable HL-systems are conditioned by much more directness and effectiveness in pursuing sustainability objectives while HL-systems in general are adapting in-between-targets of the stakeholders which may indirectly serve the purposes of sustainable development.

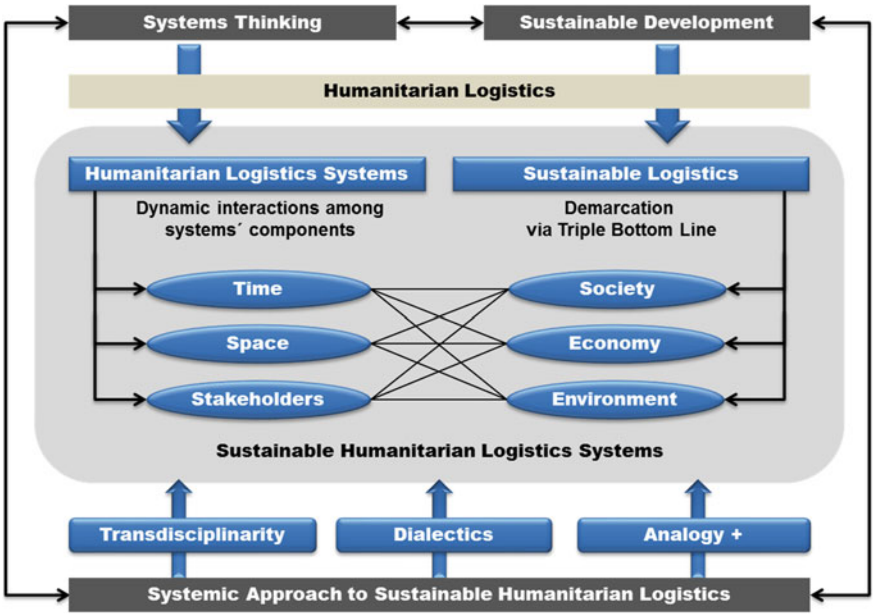

Fig. 2.3 Illustrative model of the systemic approach to SHL

The proposed systemic approach is basically considering HL-systems from the perspective of sustainable development. It combines theoretical starting points with methodological principals to focus on the potentialities to make logistics systems in the research and practice areas of humanitarian aid and disaster management. Figure 2.3 is showing the unifying model of the systemic approach, by highlighting the interrelationships between the elements of various subsystems. These elements could manifest emergent patterns if combined and perceived as components of sustainable humanitarian logistics systems.

2.3.2 A Polycontextual Environment

Interpretations of sustainability and sustainable development: Sustainable development is defined by the Brundtland report of the United Nations World Commission on Environment and Development as being the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). This definition has been a substantial part of a fuzzy discourse and a vague understanding of sustainable development in politics and economy during the last decades. The used formulations contain significant weaknesses which include an incomplete perception of the problems of poverty and environmental degradation, and confusion about the role of economic growth and about the concepts of sustainability and participation (Sharachchandra 1991).

Since the concept of sustainability lays a strong emphasis on ethics (Elling 2010), the critical viewpoints are questioning not only the terminological usage but also the very essence of the notions surrounding sustainability; these critical voices are varying from "green washing" reproaches against organizations claiming the pursuit of sustainability goals to the radical denial of any link between climate change and human activity. In scientific and academic circles as well as in mainstream debates, the issues regarding sustainability are often reduced to the point of environment protection.

Technological advances in logistics: The crucial role of different logistics systems in disaster relief and humanitarian supply chain management is discussed in numerous contributions in HL research from an operative but not enough utilitarian perspective. Recent advances in Information and Communication Technologies (ICT), increasing automation, computational systems, and handling equipment and transportation engines are offering unprecedented opportunities towards sustainable logistics systems and hence creating a suitable environment for research, development and implementation.

Economic and geopolitical conjunctures: the so called mega-trends in our globalized world present general contexts for social and economic developments: the increasing urbanization, the demographic challenges, and the infinite prospects offered by internet tools, especially the social media, are among the major elements which shape the present and the future. Nevertheless they are at the same time powerful factors within recurring cyclical crisis and conflicts leading to armed interventions with catastrophic consequences.

2.3.3 The Triple Bottom Line as a Demarcation Framework

In the philosophy of science, the problem of finding a criterion which could distinguish between empirical sciences on the one hand and mathematics, logic and "metaphysical" systems on the other hand is called the problem of demarcation (Popper 2002). Apart from the different philosophical responses to the problem, the use of the idea of demarcation is here restricted to the attempt of determining a goal-oriented framework for a systemic approach which seeks at going beyond the differentiation induction/deduction.

In order to cope with the fuzziness of the concept of sustainable development and to integrate the variables of advanced technical logistics systems, business and managerial models as well as the phenomena surrounding social and physical transformations, a demarcation of the areas of investigation could be helpful while conceptualizing methodological approaches since it contributes in distinguishing between science and pseudoscience.

The trade-offs between the objectives of sustainable development were summarized in an illustrative figure (Manusinghe 1992) which was later further developed and called the sustainable development triangle (Manusinghe 2009). The consideration of the interconnections among the economic, social and ecological

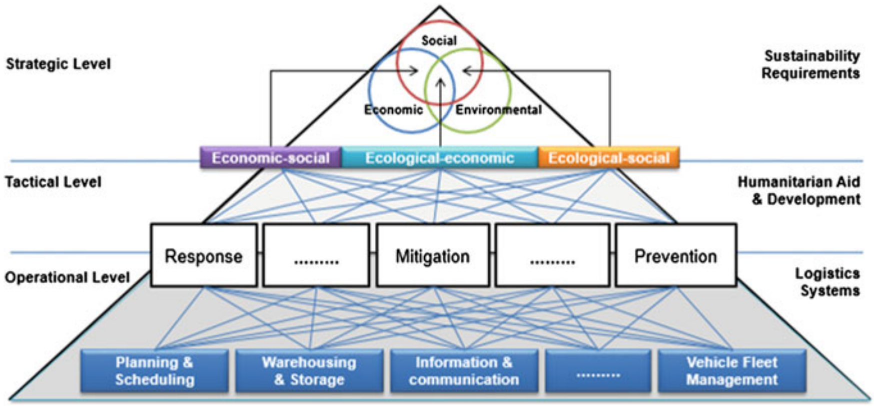

Fig. 2.4 Levels and interconnections among sustainable humanitarian logistics systems

dimensions of sustainability is also known as the Triple Bottom Line (TBL) (Elkington 1998). The three pillars are also referred to as "People, Planet and Profit". This perception of the balanced treatment of the different dimensions is allowing the detection of common areas, which could assist the emergence of new research questions. It was also the basis of particular methodologies and neologisms, such as "sustainomics" which is described as "a transdisciplinary, integrative, comprehensive, balanced, heuristic and practical framework for making development more sustainable" (Manusinghe 2009, p. 32).

According to the considered sustainable HL-systems, the elements, subsystems and interconnections among them, as well as the surrounding environment are undergoing a demarcation process which takes into account the capability of reaching three levels of goals as illustrated in Fig. 2.4: (a) Strategic: sustainability in its three dimensions, (b) Tactical: humanitarian relief as aiming at helping the concerned beneficiaries, and (c) Operational: logistics functionalities (e.g. supply chain, information systems).

2.3.4 Some Characteristics of Sustainable Humanitarian Logistics Systems

2.3.4.1 Enlargement of the Spatio-Temporal Horizon

The systemic reflections about sustainable concepts in HL request an expanding of the potentialities of opportunities in a way that ensure considering the interests of all actual and future stakeholders (next generations). At the same time no area on the globe should be left behind. Integrating different types of participants within an enlarged spatio-temporal perspective with a consideration of sustainability' dimensions is illustrated in Fig. 2.5.

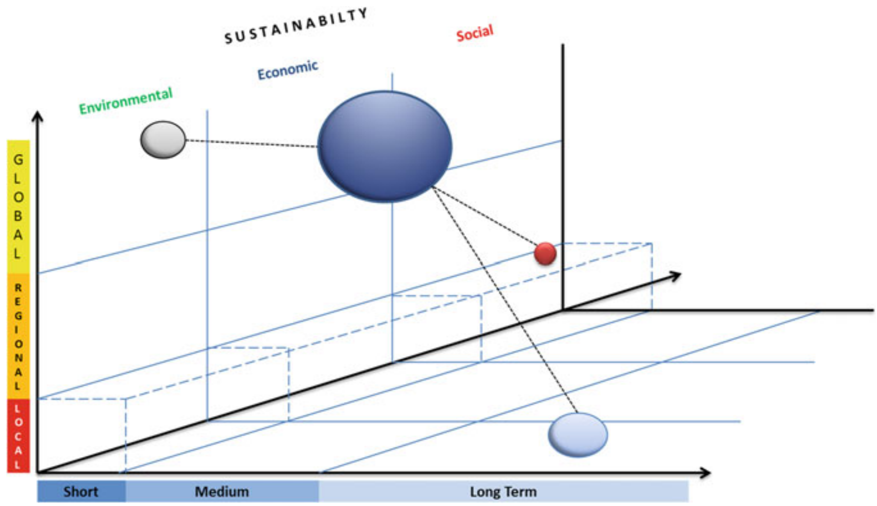

Fig. 2.5 Spatio-temporal horizon and the dimensions of sustainability

Temporal scope: The factor of time is considered in disaster relief management operations as being the crucial criterion in defining the phases of intervention and for assessment and evaluation issues. Broadly speaking one could identify three temporal levels of disaster relief operations, namely the short, medium and long term. These are related to the distinction between the successive phases of the disaster management cycle, i.e. response, recovery, mitigation and preparedness etc. An emphasis on the sustainable development prospects may broaden the long term to forthcoming centuries (Manusinghe 2009).

Spatial scope: a disaster could concern various scales of geographical areas; it could affect merely a local community or an entire region or it could have a global impact. From a systemic perspective the spatial scope is not only the place where a disaster may occur; it is about all spatial considerations along the planning works and all the operative interventions from the collections of donations to the delivery of the required items.

2.3.4.2 Integration of an Expanded Perception of Stakeholders

Traditionally the actors in HL are classified according to their contributions and roles; one could identify four basic categories of stakeholders: donors, beneficiaries, humanitarian agencies and logistics service providers. The suggested systemic approach deals with stakeholders as elements and subsystems of sustainable HL-systems, i.e. as parts of a set of organizations in permanent interactions with other homologous consortia and at the same time with the corresponding complex environments. The most sustainable forms of these interactions are to be found in cooperation and coordination patterns, the lack of which could be coped with by means of systemic tools such as cluster thinking. In fact the cluster concept includes both horizontal (functional) and vertical (supply chain) coordination between stakeholders. However inter-cluster coordination is still considered as a challenge (Jahre and Leif-Magnus 2009). A potential starting point for an appropriate reply to this challenge could be the systemic investigation of new types of clusters and the integration of advanced information and communication systems. This may occur through methodological and conceptual alternatives such as: (1) considering stakeholders as complex adaptive systems (CAS) since they are organizations with adaptable structures, goals and strategies and flexible learning capabilities, and (2) considering sustainable HL-systems with different types of stakeholders as MAS, whereby computational methods are relevant in planning, modeling and controlling collaboration schemes.

2.4 Basic Principals of the Systemic Approach

2.4.1 Transdisciplinarity

In explaining the main features of sustainomics as a framework, Manusinghe distinguishes in (Manusinghe 2009) between multidisciplinarity, interdisciplinarity and transdisciplinarity in order to highlight the faculty of his approach to integrate knowledge from the sustainability and the development domains. Multidisciplinary teams includes efforts of researchers and practitioners from different disciplines, which is required to cope with the multitude and complexity of issues in making HL-systems more sustainable, while interdisciplinarity goes a step further with attempts to bridge the gaps between the various disciplines. The needed level is however transdisciplinarity, which means the creation of holistic scientific knowledge able to achieve innovative concepts and methods.

A transdisciplinary approach should enable the participants in HL in general and logisticians in particular to have an overview, as complete as possible, on various interdependent subsystems of humanitarian relief operations. In fact many organizations have pieces of information, the role of the logistics manager is to put them together by blending first- and third-world logistics and private and public-sector outlooks (Wood et al. 1995).

In the case of a holistic approach to sustainable HL-systems, the desired knowledge is a synthesis made of logistics methods, functions and processes in humanitarian relief, sustainability science, human development to name the main three groups under which several disciplines could be involved from economics and management to engineering and computer science.

2.4.2 The Dialectical View

The suggested systemic approach rests on a predefined understanding of the specificity of sustainable HL-systems; the subsystems in this kind of systems are denoted by several pairs of features, which may appear as controversial but should be considered within a dialectical thinking as two faces of the same coin:

2.4.2.1 Immediateness of Reaction Versus Durability of Effect

Kovacs and Spens identify in Kovacs and Spens (2009) three types of challenges in HL, namely (a) challenges related to different types of disasters, (b) challenges related to different types of humanitarian organizations and (c) challenges related to disaster relief phases. As far as the third type is concerned, the contradiction between the need for immediate reactions in the response phase and the ability to establish efficient structures according to a post-disaster needs assessment, which take into account the medium and the long term, in the mitigation, reconstruction and recovery phases, is impeding the achievements of sustainable systems. The systemic approach could indicate some theoretical paths towards solving this problem by rethinking the range and the characteristics of "preparedness" and "participation" and thus developing advanced planning mechanisms supporting sustainable development. In fact, in order to avoid redundancy and to gain precious time, especially in the prevention planning phase and during the implementation of concrete preparedness measures, learning from previous experiences could assist the work of creating the required conditions for sustainable development.

2.4.2.2 Private Versus Public Spheres

There is a set of conflicting perspectives within private and nonprofit stakeholders of disaster relief operations which is closely related to the differences between the commercial and the humanitarian supply chains. The balance between cost and speed regards both phases of response and preparedness and the efforts towards its achievement require collaboration between the private sector, the humanitarian agencies and the local communities, which help not only reducing costs and increasing speed but also creating learning and business development opportunities as well as contributing enhancing the local capacities of the communities (Tomasini and Van Wassenhove 2009). Numerous examples of general controversial aspects of HL operations are related to the motivation, scope and results of interventions. In their identification of three dimensions as a basis for theoretical development in HL, Jahre, Leif-Magnus and Listou present in Jahre et al. (2009) some starting points which may refer to the discussed dialectical perspective such as permanent versus temporary networks, vertical versus horizontal coordination and centralized versus de-centralized structures.

2.4.3 Transcending the Analogy

This principle is about using a transdisciplinary approach while learning from analogous structures and schemes among diverse complex logistics systems. It rests upon a mixture of rationality (logical comparison), criticism (seeking optimization) and creativity (inspiration-based design) as within the science of bionics (learning from nature), whereby the focus could be on how instinct based reactions are functioning while facing emergency situations.

2.4.3.1 The Supply Chain

Commercial logistics operations at their international dimension are offering case studies and best practices in terms of the general configurations and internal structural aspects of the supply chain. One could begin with highlighting the different functional systems of the science of logistics (Fig. 2.4) and attempt to establish a concrete road map for the conception of sustainable HL-systems using analogy in learning from the similarities among supply chain applications in international logistics and transferring the obtained knowledge from the exclusive commercial level to the sphere of HL (Table 2.2).

The identification of such components and the analysis of potential similarities should occur within a predefined perception of the sustainable supply chain in humanitarian relief. The setting by the systemic approach of strategic goals for the supply chain design in HL could rests on three main pillars: globalism, agility and greenness.

Globalism: The analogy with the global supply chain has been used to develop hub and spoke networks in HL and to design several architectures of distribution and supply, e.g.: the regional logistics concept of international Federation of red Cross and Red Crescent Societies (IFRC) and the United Nations Joint Logistics Centre (UNJLC). Nevertheless global, regional and supranational structures in

Table 2.2 Examples of systems and subsystems in humanitarian logistics

HL-systems	Functions	Eventual related subsystems
Transport logistics	Freight and *passenger* transportation	Intermodal supply chains
Distribution logistics	*Last mile* logistics operations	Permanent hub and spoke networks
Procurement logistics	Availability and management of physical donations	Recycling of urban waste
Information logistics	Transparency, accessibility and circulation of data	Tracking and tracing tools, cloud computing
Warehousing	Storage of relief items	Inventory management ergonomic handling equipment

supply chain management require adequate methods able to deal with complexity and vulnerability. The usage of OR to adapt supply chain best practices to HL may lead to significant improvements (Van Vassenhove and Pedraza Martinez 2010). On extended geographical scales, data analysis and statistics are critical factors for intervention planning: Wood et al. argue in (Wood et al. 1995) that forecasts as parts of information management systems allow regions at risk to prepare themselves and relief agencies to anticipate their arrangements.

Agility: Agility is defined twice by Christopher in (2000): firstly as being a business-wide capability that embraces organizational structures, information systems, logistics processes and, in particular, mindsets. After this "systemic" definition he argues that agility is needed in less predictable environments where demand is volatile and the requirement for variety is high, to formulate the second definition of agility as being the ability of an organization to respond rapidly to changes in demand both in terms of volume and variety. Within a systemic perspective the analogy between agile systems is bidirectional. Since the environment of HL-systems is just as characterized by uncertainty as the business environment, experiences from the humanitarian context could be helpful for the commercial supply chain in terms of learning how to improve the supply chain agility (Charles et al. 2010). An extension of this may involve several issues related to risk management and the resilience of complex systems.

Greenness: A green supply chain is often associated with the reduction of GHG-emissions in transportation and warehousing activities. In addition the usage of environmentally friendly items and equipment is seen as an attribute of sustainable logistics systems. A further aspect is the multimodality. The decision about the usage of different transportation modes is depending on several factors: delivery (transportation) time, load capacity, type of freight which has to be adapted to the requirements of humanitarian aid context. Several theoretical and practical efforts could be registered in transferring logistics knowledge to the research fields of HL by investigating general problems under specific assumptions related to HL like combining facility location and stock pre-positioning decisions responding to quick-onset disasters (Balcik and Beamon 2008) or studying Field Vehicle Fleet Management (Field VFM) of large International Humanitarian Organizations (IHO) (Pedraza Martinez et al. 2011). These efforts could be developed onwards by including green logistics concepts related to renewable energy systems and biotechnology-based innovations and hence transferred to the realm of sustainable HL.

2.4.3.2 Military Logistics Operations

Policymakers around the world are recognizing that the ability to achieve sustainable development can be increased by reducing the impacts of natural disasters (Clarke and Manusinghe 1995). To that one could argue that regarding the statistics of refugees and wars casualties, man-made disasters have to be integrated in a holistic approach towards sustainable HL-systems. Military forces are able to perform complex logistics operations since they have the necessary resources and the required know how. Bayman, Lesser, Pirnie, Bernard, and Waxman present in Bayman et al. (2000) several contributions in studying the role of American military forces as partner of Non-Governmental Organizations (NGO) and European allies in disaster relief operations and notice important potential transatlantic synergies in humanitarian contingencies. This illustrates an application of a systemic integration of stakeholders in a broad spatial perspective. A further extension could involve other regional authorities and even multinational corporations. As a form of advanced Public Private Partnership (PPP) the possibility of enlarging the coordination consortium to involve various governmental and private organizations increases the potentialities of reaching sustainable solutions when dealing with complex disasters.

A systemic approach is promoting the efforts of innovative collaboration concepts by emphasizing the pragmatic consequences of analogy detection. Tatham et al. notice in (2012) the numerous similarities in the challenges facing military forces in complex emergencies and humanitarian agencies in natural disasters and build upon them to conceptualize an analysis and planning tool which is inspired from the Defence Lines of Development (DLOD) framework. The collaborative use of existing military devices and infrastructure (e.g. military bases) in disaster relief operations could occur within the framework of Civil Military Co-ordination (CIMIC). Although this particular context suggests the seamless division of labor between aid workers and international military forces (Heaslip et al. 2012), the mutual operational exercise may establish a concrete basis for sustainable initiatives, i.e. with long term effects. As far as the army is concerned these initiatives could incorporate some recommendations made by Bayman et al. (2000) such as systematically and routinely briefing agencies on military capabilities, appointing permanent "humanitarian advisors" and sponsoring partnerships with Center of Excellence as well as conferences and seminars.

2.5 Conclusion

Skyttner identifies in (2005) a set of general principals which characterize the systems thinking approach: Holism, regulation, hierarchy, differentiation, entropy, equifinality and multifinality are among the most relevant. The consideration of such principals while attempting to make logistics systems in general and HL-systems in particular more sustainable is the core of systems-oriented methodologies not only in research and education but also in any practical implementation.

A systemic approach to sustainable humanitarian logistics rests on the continuous awareness that the objectives of sustainable development could not be achieved unless ecological, social and economic goals are reached within a holistic perspective. This awareness leads to considering humanitarian logistics systems in their complex environments on the one hand and to focus on the complex interrelations between the components of the systems (elements and subsystems) on the other hand. The implementation of the systemic approach refers to a multisided dynamic process including an enlargement of the spatio-temporal context of humanitarian relief operations together with an involvement of various types of stakeholders and hence the consideration of their different goals, strategies and methodologies in both practice and research. This could occur by means of multi-criteria analyses able to transcend the observable analogies in supply chain management and military logistics operations. Because of the heterogeneous contents of the involved fields as well as the controversial targets and interests of different agents and organizations, a dialectical view is needed for more consensus and trade-offs.

Ringers and White point out in Mingers and White (2010) that the number of applications of systems ideas is tremendous and they are making contributions to several domains, particularly health, production and sustainability. They argue that "there are also potentially new opportunities, given the context of a global economic downturn and global climate change, for systems approaches which may bring fresh thinking to existing problems and to a future uncertain world". Correspondingly the emphasis on transdisciplinary efforts within the suggested systemic approach aims at contributing making the responses to HL-challenges more sustainable and thus creating the required conditions for a generalized sustainable development of not only the concerned areas and populations when disasters strike but also of the interdependent rest of the planet as well as the world of the forthcoming generations.

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