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How Standards and Modularity can improve Humanitarian Supply Chain Responsiveness: The Case of Emergency Response Units

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Abstract

Purpose of this paper

This paper aims to increase understanding of the use of standards and modularity for improving responsiveness in the humanitarian context.

Design/methodology/approach

Based on a conceptual framework and a systematic literature review, we conducted a longitudinal, explorative case on the Emergency Response Unit (ERU) concept in the International Federation of Red Cross Red Crescent Society (IFRC), focusing particularly on the Health ERU in the Norwegian Red Cross.

Findings

The ERU concept makes use of many types of standards that complement and influence each other, and the focus on modularity is increasing due to a growing need for responsiveness. The main challenges are the trade-offs between autonomy and adaptability to the context; these have resulted in more modularization, which may be in danger of breaking the concept.

Research limitations/implications

Results from this study could be refined by surveying staff involved in all types of ERU deployments. Further studies should explore the generalizability of the findings and test the developed propositions.

Practical implications (if applicable)

The study provides greater understanding of the use of standards and modularity for improving responsiveness. Practitioners can use the framework as a check-list to identify potential means for improvements. The case can be used for training, discussions, and reflections. The research feeds into IFRC's and the Norwegian Red Cross ongoing work on their global response tools.

Societal implications

The results of the study can support improvements in humanitarian supply chains, thereby providing affected people with rapid, cost-efficient, and better-adapted responses.

What is original/value of paper

We have developed a framework for categorization of standards and modularity in the humanitarian context. This is the first empirical study of how humanitarian organizations use standards and modularity to improve responsiveness. The paper concludes with a set of propositions on how the concepts are linked.

Keywords

Flexibility, integration, modularity, standard, responsiveness, humanitarian logistics, supply chain, health, ERU.

Paper Type: Research paper

1 Introduction and purpose

Humanitarian organizations typically operate in unstable environments, requiring strategies that enable them to respond to risks and uncertainties in demand, supply, and processes (Balcik and Beamon, 2008). This requires preparedness, rapid deployment of relevant resources, and the ability to adapt efficiently on-site in diverse local contexts. Extant research argues that the operational performance of humanitarian supply chains depends on their ability to respond swiftly to external disruptions and undertake dynamic operations (L'Hermitte et al., 2015). In order to achieve this, supply chains must be responsive (see, e.g., Blecken et al., 2009; Oloruntoba and Gray, 2009; Merminod et al., 2014) and cost-efficient (McLachlin et al., 2009; Pettit and Beresford, 2009).

The ability of a supply chain to quickly and effectively satisfy customers' needs and adapt to sudden changes in the marketplace (Kim and Lee, 2010, Kim et al., 2013) depends on both intra-organizational and inter-organizational capabilities (Araujo et al., 1999; Reichhart and Holweg, 2007; Ghosh et al., 2014). Studies have suggested that responsiveness requires effective coordination of activities and integration of processes along the chain (Ghosh et al., 2014). Other studies have focused on operations' flexibility and suggested modularity and standardization as possible strategies for being responsive (Holweg, 2005). Standards – that is, the product of standardization – are considered to be the basis of a logistics network (Fabbe-Costes et al., 2006). By constituting "rules about what those who adopt them should do" (Brunsson and Jacobsson, 2000, p. 4), standards create homogeneity and function as a coordination mechanism (ibid.). Modularity has been suggested as an approach to reduce supply chain risks and achieve flexibility (Kleindorfer and Saad, 2005; Squire et al., 2009). Being a special form of product and organizational design that "intentionally creates independence between components by standardizing interface specifications" (Sanchez and Mahoney, 1996, p.65), modularity concerns not only technical aspects but also organizing (e.g., Baldwin and Clark, 1997; Spring and Araujo, 2009). Modularity has also attracted attention with regard to services: "Platform thinking can be used to identify and use the shared, i.e. modular, structure and logic of activities and customer offerings in service production" (Pekkarinen and Ulkuniemi 2008, p. 85).

The humanitarian community is increasingly concerned with standards, which were first sought in the 1990s when there was an increasing attention on collaboration and coordination: "…

general emergency logistics standards that are compatible across all organizations" and "… greater standardization across all disaster and emergency response activities" (Beamon and Kotleba, 2006, p. 189). In particular, the camps established in Goma in response to the Rwanda genocide revealed the need for principles, codes of conduct, and minimum standards in international humanitarian response, resulting in the Sphere standards established in 1997 (Kayden, 2015). Humanitarian supply chains also make use of modular solutions: "*pre-packaged modules which can be immediately shipped anywhere in the world*" (Balcik and Beamon 2008, p. 102). Kovács and Spens (2011b) called for more research on this issue. However, we were not able to identify any studies on this subject, apart from two recent papers that mentioned standards and modularity in connection with responsiveness (Bölsche et al., 2013; Merminod et al., 2014).

The present paper aims to fill this gap by reporting from an in-depth longitudinal study of the Emergency Response Unit (ERU) concept as practiced by the International Federation of Red Cross and Red Crescent Society (IFRC). This longitudinal study was deemed particularly suitable for such a study given that the basis of the ERU concept is "… *to respond rapidly to emergencies in a* ***standardized*** *way and with quality … to provide essential services while adjusting according to the* ***standards*** *in the recipient country*" (www.ifrc.org). The ERUs are key rapid disaster response tools that consist of pre-trained teams of specialist volunteers in areas such as logistics and health, together with pre-packed sets and **modules** of standardized equipment ready for immediate use (IFRC, 2013). Its first formal deployment occurred in 1996 when the National Societies (NS) of Norway and Germany each provided a health care unit as part of the response to a meningitis epidemic and cholera outbreak in Nigeria. The present study has focused on the health ERU in the Norwegian Red Cross for two reasons. Firstly, this ERU was the first to be tested and has since developed extensively becoming more modularized. Secondly, one of the authors had participated in trainings and meetings, which provided access to data that was difficult to obtain elsewhere. The literature review was used to develop a conceptual framework and interview guides used for primary data collection, which, together with extensive documentation constituting secondary data, is used for the analysis to answer two main questions: (1) How does the ERU concept make use of standards and modularity? (2) What are the main challenges of the ERU concept in relation to providing responsiveness?

The paper contributes to a better understanding of the links between standards, modularity, and responsiveness in the humanitarian context to help fill the gap in the literature. Our key findings are that the ERU concept makes use of many types of standards that complement and influence each other. The focus on modularity is increasing due to the growing need for responsiveness. The main challenges are trade-offs between autonomy and adaptability to the context; this results in more modularization, which may create a risk of breaking the concept. This study makes two main research contributions. Firstly, we develop a framework for categorizing standards and modularity in the humanitarian context. Secondly, we provide the first empirical study on how humanitarian organizations use standards and modularity to improve responsiveness, concluding with a set of propositions about how the concepts are linked. Section 2 presents the conceptual basis for the study and the results from a systematic review on humanitarian logistics and supply chain management (HLSCM) research. Section 3 describes the research design, while section 4 presents the case study. Discussion and conclusions follow in sections 5 and 6, respectively.

2 Literature review and conceptual framework

This section starts with definitions of the main concepts, starting with supply chain responsiveness, followed by standards and modularity and how they can improve responsiveness. We conclude with a discussion of the gap in the prevailing research based on a systematic review of HLSCM literature.

2.1 Supply Chain Responsiveness

Since the end of the 1990s, responsiveness has attracted attention in SCM as a key performance measure and been defined as responsiveness towards customers (Beamon, 1999). In other words, supply chain responsiveness indicates the "ability of a supply chain to satisfy customers' needs" (Kim et al., 2013, p. 5602). Ghosh et al. (2014, p. 7) defined responsiveness as "the ability to react to sudden or immediate changes in the marketplace" responding to customer needs in a reliable and timely manner. Thus, responsiveness often refers to how quickly and effectively the supply chain responds to shifting market needs and competitive environments (Kim and Lee, 2010), and is considered as one of the most important ways that firms and supply chains can achieve competitive advantage (Holweg, 2005; Reichart and Holweg, 2007; Singh, 2015).

Most previous studies have acknowledged that the scope of responsiveness lies within the network of players operating the supply chain (Reichart and Holweg, 2007; Ghosh et al. 2014). For Kim and Lee (2010), supply chain responsiveness "denotes the capability of a firm to deploy resources available along the supply chain to identify and react to market changes" (p. 964). A firm's ability to remain responsive comes from the firm itself, its supply chain partners, and their collaborative efforts (Catalan and Kotzab, 2003; Kim et al., 2006; Squire et al., 2009; Kim and Lee, 2010). It is about "coordination of the activities of the chain members and the seamless integration of the relevant business processes" within and across firms (Ghosh et al., 2014, p.7) and that there is a "lack of close collaboration and integration between relations throughout the supply chain" (Catalan and Kotzab, 2003, p. 682). Other studies view responsiveness as based on different types of flexibility,[1] particularly in manufacturing and linked to changes in volumes and product variety (e.g., Holweg, 2005; Reichart and Holweg, 2007; Squire et al., 2009). Another stream of research suggests that responsive supply chains must be lean and agile (e.g., Qrunfleh and Tarafdar, 2013). Holweg (2005) stated that, "In terms of a fit with responsiveness, just-in-time (JIT) or lean production is well placed, since its persistent focus on lead-time reduction and customer value seems apposite within the debate about responsiveness" (p. 609). Furthermore, "Agile manufacturing promotes three major concepts to enable flexibility: introducing "response" buffers, postponing decisions in manufacturing, and to late-configuring products" (p. 610). Recent works (e.g., Singh, 2015) confirm that integration, flexibility, and agility in combination contribute to responsiveness.

It is important to note that research referring to integration or lean (two strategies usually related to cost reduction objectives as antecedents to responsiveness) does not consider the cost output of integration and lean, but their contribution to improve the supply chain capacity to respond quickly and effectively to demand: "By eliminating excess inventory and improving the quality of parts, the [lean] supply chain has the ability to reduce set-up time, adjust capacity, and respond quickly to the customer. As a result, a lean supply chain strategy will enhance the responsiveness of the supply chain" (Qrunfleh and Tarafdar, 2013, p. 574).

[1] "Flexibility is a generic ability to adapt to internal and/or external influences" (Holweg, 2005, p.608); "the ability of any system to adapt to internal or external influences, thereby acting or responding to achieve a desired outcome" (Reichart and Holweg, 2007)

Holweg (2005) stated that "the generic nature of 'being responsive' has to be seen as the reason why a great variety of related approaches claim to achieve this goal" (p. 609). Two such approaches identified in a literature review are modularity and standardization (Fabbe-Costes and Jahre, 2009). However, few studies have explicitly addressed the link between modularity, standards and responsiveness. Qrunfleh and Tarafdar (2013) mentioned that standard products and modularity support responsiveness through agility. Reichart and Holweg (2007) also argued that product modularity and standardized interfaces are important for product architecture vis-à-vis responsiveness. Finally, Squire et al. (2009) demonstrated that supplier responsiveness, flexibility, and modularity positively affect buyer responsiveness. However, even these studies (that is, from the non-humanitarian sector) say little about how modularity and standards improve responsiveness.

2.2 Modularity, standards, and responsiveness

Modularity is an important topic in management science that concerns product and organization design and how they interrelate (Sanchez and Mahoney, 1996; Brusoni and Prencipe, 2001). Worren et al. (2002) stated that "Although the modularity concept originated in technology management, many authors emphasize that firms need complementary organizational resources and capabilities to exploit the 'economics of substitution' afforded by modular product structures" (p. 1128). Further, "*Modularity* is a special form of design which intentionally creates a high degree of independence or 'loose coupling' between component designs by standardizing component interface specifications" (Sanchez and Mahoney, 1996, p. 65). Modularity in product design (e.g., Hsuan, 2003) or service design (e.g., Voss and Hsuan, 2009) makes it possible to decompose (or decouple) products or services sourced from different suppliers and to ease the assembling of the resulting components. Modularity can be seen as "the degree to which a system's components can be separated and recombined" (Schilling, 2000, p. 315), and "… is an important aspect of the design of offerings and the processes (and organisations) by which they are delivered" (Spring and Araujo, 2009, p. 461). The flexibility of a modular architecture stems from its ability to substitute different modules without having to redesign other components (Campagnolo and Camuffo, 2010). Adjusting the product architecture using modularity is seen as a way to employ decoupling points to offer a wide variety of products to end customers while reducing inventory holding costs for products and improving responsiveness (Catalan and Kotzab, 2003; Reichart and Holweg, 2007; Squire et al., 2009). Accordingly, modularity provides responsiveness through flexibility.

For many authors, modularity has an impact on coordination thanks to its standardized interfaces: "… the standardized component interfaces in a modular product architecture provide a form of *embedded coordination* that greatly reduces the need for overt exercise of managerial authority to achieve coordination" (Orton and Weick, 1990). Thus, using technological knowledge to create *modularity in product designs* becomes an important strategy for achieving *modularity in organization designs* (Sanchez and Mahoney, 1996, p. 64). However, Howard and Squire (2007) noted that a shift to modular architectures requires a high level of integration, creating dependencies between firms. This is in line with Brusoni and Prencipe (2001), who stated that "literature on modularity fails to recognize the different, though intertwined, dynamics underpinning products, technology and organizations" (p. 185).

The literature underlines compatibility and adoption of formal and informal standards as conditions for modularity, facilitating coordination among the actors and enabling systems integration: "As for product design, an organizational architecture is modular to the extent to which architecture (modules) interfaces between modules (such as the way they adjust and communicate with each other) and standards (to check modules' conformity to design rules) are designed" (Campagnolo and Camuffo, 2010, p. 276). Worren et al. (2002) empirically confirmed that modular processes rely on codification and standardization of work process and formal procedures and that "codification and standardization in fact are necessary prerequisites for achieving high levels of process flexibility" (p. 1137).

Another research stream has studied the roles of standards in logistics networks (Fabbe-Costes et al., 2006). Companies, groups of companies, associations, and administrations have developed standards in order to decrease inter-organizational dependencies and improve supply chain integration (examples include the ISO standards). A standard is a rule approved by a recognized body that provides non-compulsory rules, guidelines, or characteristics for products, processes, or services. Standards – the product of standardization – "constitute rules about what those who adopt them should do" (Brunsson and Jacobsson, 2000, p. 4). In logistics and SCM contexts, standards explicitly or implicitly agree on common specifications at the physical, informational or organizational interfaces between interacting supply chain partners aiming to improve process integration and performance. Some standards are used by companies to spread expected practices in their supply network, and used as leverage for training their suppliers and

auditing their processes. One such example is ISO 14001 for 'greening' supply chains (Chiarini, 2013). Standards create homogeneity and function as a coordination mechanism (Brunsson and Jacobsson, 2000) or convention (Bredillet, 2003). Consequently, inter-organizational standards improve interoperability, which has been defined as "a firm's ability to integrate with heterogeneous partners' systems" (Zhao and Xia, 2014, p. 280). In the context of a digital value network, "interoperability enables firms to respond to market fluctuations by adjusting their digital connections with partners, and makes them flexible, agile, and efficient" (ibid. p. 277). Even if the literature insists on the voluntary adoption of standards, adoption is not easy because of trade-offs (Fabbe-Costes et al., 2006). Studying failures in management standards adoption, Simpson et al. (2012) highlighted the importance of the 'fit' between firms' capabilities and management standards. Zhao and Xia (2014) underlined the modular architecture of some standards and its impact on their adoption.

We can conclude that there is interplay between product and organization modularity and that both are related to standards. Figure 1 presents the conceptual framework resulting from the literature review, which provides the basis for the empirical study.

[Insert Figure 1]

Modularity and standards have complex impacts on integration and flexibility (and therefore on responsiveness). The lack of empirical studies providing insights into how standards and modularity can provide responsiveness calls for further research.

2.3 Modularity and standards – a systematic review of HSCM literature

During the past 15 years in particular, the humanitarian community has worked to develop and use standards to improve response. However, not much research has been reported. We were not able to identify any papers that explicitly relate standards directly to responsiveness, or any papers on modularity. We then conducted a wider search, systematically reviewing literature on each of the key terms separately (Appendix 1).

Merminod et al.'s (2014) paper is the only one to use the term responsiveness in its title. Many papers mention the need for humanitarian supply chains to be responsive, even if the term is not always defined. However, these papers refer (in line with section 2.1) to responsiveness as to how *quickly* the right aid can be provided to satisfy *urgent needs* related to *sudden* and

unpredictable disasters with *shifting* demand. Responsiveness is often linked to agility (e.g., Oloruntoba and Gray, 2006; Heaslip and Barber, 2014), flexibility (e.g., Scholten et al., 2010; L'Hermitte et al., 2014) and interoperability (e.g., Chandès and Paché, 2010; Merminod et al., 2014), but we could not find details about the nature of these links. A majority of the papers emphasized the need for humanitarian supply chains to be integrated and flexible and/or lean and agile, but few reported on how this links with responsiveness. Among the few papers that defined the terms, we did not identify any inconsistency with the results reported in section 2.1.

Few papers have discussed how to be flexible and integrated, lean and agile. Standards and modularity appear as solutions, but are not as frequently mentioned as one could expect. It seems that the humanitarian context focuses on standards (mentioned in 47 of the 62 papers) much more than modularity (mentioned in eight papers). All of the papers identified in the review discuss modularity in relation to standards, and the combination is supposed to improve interoperability (e.g., Heaslip, 2013; Kovács and Spens, 2011a and b). Standards are related to improved compatibility (e.g., Beamon and Kotleba, 2006; Perry, 2007), coordination (e.g., Pettit and Beresford, 2009; Bölsche et al., 2013; Kabra and Gamesh, 2015), collaboration (e.g., Overstreet et al., 2011; Schulz and Blecken, 2010), and flexibility (Chandes and Paché, 2010; Overstreet et al., 2011). The papers provide examples, but no definitions of standards or modularity. Table 1 provides an overview of the different types of standards and modularity mentioned in prevailing research.[2] However, the papers do not discuss the relationships between different standards, or between standards and modularity.

[Insert Table 1]

Results from this review are also line with section 2.2 regarding standardization trade-offs, including lack of contextualisation (Chandes and Paché, 2010; Merminod et al., 2014; Sheppard et al., 2013), difficulty of achieving complete standardization (Chandes and Paché, 2010; Nilsson et al., 2013), inflexibility (Merminod et al., 2014; Blecken, 2010), and lack of adaptability (Scholten et al., 2010). Accordingly, even if many studies have pointed out the need for global logistics standards in emergencies (Beamon and Balcik, 2008; Carroll and Neu,

[2] Numbers in the table refer to the reference list where the papers identified in the systematic review of humanitarian logistics papers have a number at the end in [ ]. The full list of papers identified in the systematic review is available upon request.

2009; Overstreet et al., 2011; Pettit and Beresford, 2009; Bölsche et al., 2013; Baldini et al., 2012; Beamon and Kotleba, 2006; Oloruntoba and Gray, 2009; Tatham and Spens, 2011), care should be taken when designing standards and modules in a humanitarian context.

Our findings are in line with the conceptual framework in Figure 1, but do not provide new insights into the relationships and dynamics between concepts. This confirms the gap concerning the lack of "*product and process standardization and modularization for improving the interoperability of humanitarian operations*" (Kovács and Spens, 2011a). In line with Kovács and Spens (2011a) and Heaslip (2015), we can conclude that further research is needed regarding the humanitarian community's use of standards and modules to improve responsiveness.

3 Research design

Due to the lack of empirical studies on the use of standards and modularity in the humanitarian context, we conducted an exploratory, in-depth, longitudinal case study (Dubois and Gadde 2002). A single case allows greater depth and understanding of the studied phenomenon (Voss et al., 2002; Yin, 2014). With the aim "to understand something in a new way" (Kovács and Spens, 2005, p. 138), the case presented in the present paper is structured and analyzed based on an abductive research logic. Also called systematic combining, this type of logic constitutes a process whereby researchers go back and forth between the theoretical and empirical worlds (Dubois and Gadde, 2002) using an iterative rather than a linear approach. Such an iterative process between the theoretical analysis and data collection means that the case directs attention to the theoretical analysis and vice versa (Dubois and Gadde, 2014). Figure 2 illustrates the timeline of the research process.

[Insert Figure 2]

The research has been conducted in parallel with and as part of other studies with IFRC; firstly in a case study on their logistics preparedness strategy in 2007–2008, and secondly in a case study on how their preparedness improves response in 2014. The data collection was interrupted twice by large disasters (not uncommon in research within this context) in 2010 and 2015. As can be seen, the literature has been reviewed at various stages throughout the process. The final step was a systematic review on the use of standards and modularity in humanitarian logistics research (see Appendix 1 for more details).

3.1 Case selection and unit of analysis

Since its inception, IFRC's ERU concept has been based on the use of standards and increased in modularity over time (Senior officer ERU, 2007). Hence, the initial data collection revealed that this could be a relevant case on the use of standards and modularity providing a "force of example" (Flyvbjerg, 2006, p. 235). In this way, we could say that "the case select[ed] the researcher[s]" (Dubois and Gadde, 2014, p. 1280). There are two main reasons for focusing on the Norwegian Red Cross health ERU.

(1) Access: The case is what Yin (2009) would call revelatory because one of the authors had the opportunity to participate in training courses and had access to information that would have been difficult to capture elsewhere.

(2) Availability of longitudinal data: Norwegian Red Cross was the first to test the ERU concept and has since developed it considerably.

Thus, the health ERU represents what is called a critical case (Patton, 1987; Yin, 2014). Due to its explorative nature, further research is needed to check the extent to which the results can be generalized to other ERUs in IFRC, as well as other rapid response tools in the humanitarian community.

3.2 Data collection

The case study started with a first round of unstructured interviews in Norwegian Red Cross and the IFRC, which familiarized the authors with the ERU concept and its context (Appendix 2). In addition to interviews, data was collected by participating in two courses in Norwegian Red Cross – a one-week Basic Training Course in October 2008 and a one-week simulation training in April/May 2009 where the hospital was set up and put into operation. During this period, we undertook a first review of general logistics and SCM literature, in a search for possible ways to improve both flexibility and integration, which were considered the antecedents of responsiveness (Fabbe-Costes and Jahre, 2009). We also used relevant information from a second round of interviews, conducted in 2014 connected to a case study of the IFRC Philippines Haiyan Operation. A third round of interviews was conducted in May 2015. These were semi-structured using an interview guide (Appendix 3) that was developed based on the initial analysis and literature review. These interviews concerned the use of standards and modularity, lessons learned, and changes in the concept. Another dataset constitutes reports such as real-time evaluations (RTE) of the operations, websites, and other

secondary materials captured over the course of nine years, while one of the co-authors worked with the IFRC and Norwegian Red Cross. As such, the case study uses a multitude of sources, including technical artifacts (for example, physical structures, and product catalogues), systematic interviews, documents, and archival material (Appendix 2 lists secondary data).

3.3 Data analysis

With a "tight and emerging" framework as a basis, we created a reference that could "function as a guideline when entering the empirical world" (Dubois and Gadde, 2014, p. 1279). This reference constitutes the conceptual framework (Figure 1) and the results from the review of humanitarian logistics literature (Table 1). The final structure of the case study emerged through many iterations of data analysis, using color-coding for recurrent themes and contrasting views, followed by sorting and categorizing emerging elements under subtitles and bullet points.

3.4 Research quality

Dubois and Gadde (2014) suggested two main aspects of securing research quality in an abductive approach. First, when presenting the case, we have tried to achieve a balance between providing sufficient description to facilitate the reader's evaluation of the research and limiting the amount of detail to accommodate the reader's need for conceptual arguments. We have done this by focusing on the use of standards and modularity and their ability to improve responsiveness and by referring to specific interviews only when we considered it important for the reader's understanding or when using direct citations.

Second, the methodology is thoroughly described above as recommended by Dubois and Gadde (2014). Furthermore, a number of data sources were used in order to obtain different perspectives and complementary aspects (Dubois and Gadde, 2014); that is, a "multivoiced, rather than convergent understanding of the case under study" (Piekkari et al. 2010, p. 111). For example, timing and data sources may cause differences in how evaluation reports conclude compared to what individuals who participated in a particular operation think. We created a case study database in which we included guides, tapes, and notes from each interview, summaries of all evaluation reports, and other documentation. Interviewees representing both the IFRC and Norwegian Red Cross examined the case report. Interviewees for the final round were selected using the snowball technique. The collected data is skewed towards the people who provide services rather than the affected actors themselves (community, host government,

and beneficiaries). Interviews were conducted with those involved in developing the ERU concept at the HQ level and personnel who had been deployed with the units. Secondary data is also skewed in this respect. For example, the three evaluation reports from Haiti, Pakistan, and the Philippines included 317 interviews, only 39 of which represented the affected.

4 Case study: the ERU – concept

Starting with the ERU concept in general, we continue with a more detailed description of the Norwegian Red Cross's health ERU, focusing on the use of standards and modularity. We then present experiences, as perceived by respondents and evaluations, of how ERUs' standards and modularity contribute to responsiveness.[3]

4.1 The ERU concept in general

An ERU constitutes specific equipment and necessary staff (for example, a field hospital with nurses, doctors, and technicians) and is deployed to a country in need of international assistance following a disaster. While the ERU is self-sufficient for one month with its own equipment and staff and may function as a self-contained unit, it remains an integral part of the overall operation, subject to IFRC rules and regulations described in the Standard Operating Procedure (SOP), including security regulations and policy frameworks (IFRC, 2012). ERU team members must adhere to Federation rules of conduct (www.ifrc.org). Most will have ERU and other training. ERUs must deploy with IFRC standard vehicles and telecommunication to secure integration and support (IFRC, 2012). Emblems and logos on products and uniforms are also standard (IFRC, 2011). Once deployed, the ERU should be operational in the field within a week, complementing existing systems: "*External teams never start a humanitarian operation. They have to integrate themselves in ongoing relief efforts*" (Medical Doctor FACT/ERU 2009). The service provision should ideally contribute to knowledge transfer and the building of (response) capacities inside the host NS (IFRC, 2012). During the first month, the ERU should gradually integrate into local systems and structures, followed by a handover to the host NS, Federation delegation, or local authority within four months. ERU team members then either return home or are absorbed into the local delegation (www.ifrc.org). (See Appendix 4 for an overview of the types of ERUs and their main modules and standards as of 2015.)

[3] Appendix 2 contains all data sources for the case.

The ERU concept was established to serve mainly static refugee camps, but it became rare for the IFRC to be involved with such operations; this necessitated a more modularized approach for greater mobility and adaptability to distribute aid where needed. The IFRC made adjustments, particularly after the Asian Pacific Tsunami in 2004 (IFRC, 2008). The Field Assessment and Coordination Team (FACT) working group and respective ERU technical working groups (water and sanitation, health, etc.) discuss modifications of the ERU concept based on experiences and technology development (IFRC, 2012). Following approval, the Emergency Items Catalogue is updated with the new specifications (www.ifr.org).

ERUs developed from a need to standardize certain equipment required in immediate disaster response so that items coming from different donors and countries could fit together (senior officer ERU, 2007). This also implies standardized training, allowing teams with staff from different countries (Officer FACT/ERU, 2007), However, there are differences between ERUs of the same type: "*the hospitals are, in a way, a reflection of the national health capacities and ways of working and the Finnish hospital and the German hospital and Norwegian hospitals are not exactly the same … of course, it [the concept] needs to be flexible …*" (senior officer ERU, 2007).

4.2 ERU deployments 1996–2015

Between 1996 and June of 2015, 270 ERU deployments had been made to natural and man-made disasters. The average number of deployments per year from 1996–2015 is 13.5, but this number varies widely, between one and 39. For health in particular, the average is 4.1, varying from 0 to 12. Norwegian Red Cross has been involved on an average of 1.4 deployments per year, varying from zero to four. Peaks are simply related to the size and severity of disasters: the Asian-Pacific tsunami in 2004; the Pakistan earthquake in 2005; the combined Myanmar cyclone, the China earthquake, the Haiti hurricane, and cholera outbreak in Zimbabwe in 2008; the Haiti Earthquake and Pakistan floods in 2010; and the Phillippines typhoon in 2013. Such large variations are challenging in terms of cost efficiency. Fixed (being standby) and variable (deployment) costs must be weighed against the need to be responsive (that is, quick response depends on preparedness).

There has been an increase in joint deployments (for example, staff from Canada together with equipment from Norway) from zero in the first five years (1996–2000) to 44 percent of total

deployments over the past five years. This relates to another development, with the average number of NS deploying per disaster rising from three in the first five years to 12 in the last five (IFRC, 2015). Originally, only European NS deployed ERUs, but this changed from 100 percent during 1996–2000 to 67 percent in 2011–2015. More interest from various NS to develop ERUs has created a "*continuous need to standardize training curricula and equipment.*…" (IFRC, 2008). The IFRC states that future deployments to medium and smaller emergencies may, to an increasing degree, constitute only a few international staff, whose main task is to train and supervise local staff, using previously deployed and/or handed-over equipment (IFRC 2012). For example, in response to the Ebola outbreak in 2014, six of the ERU deployments included staff from healthcare, logistics, and WATSAN without equipment (Global Surge Capacity IFRC, 2015).

4.3 The health ERU in Norwegian Red Cross

Depending on what IFRC requests, Norwegian Red Cross combines modules in various ways constituting *kits* (medical or tools), stackable *cases/boxes* (for transport and storage, some with trays and shelves for display in the departments of the hospital), *sets* (such as surgical instruments), and *devices* (pulse oxymeters, for example) (senior logistics officer, 2009). Most equipment is packed in lightweight, durable, and splash-proof plywood cases and color-marked, numbered, and marked with weight and content lists for easy identification for sorting, set-up, and storage.

[Insert Picture 1: The standardized and modular concept]

Run by an emergency response coordinator and a standing ERU taskforce (GEG, 2009), Norwegian Red Cross has, like humanitarian organizations in general, developed a roster from which it mobilizes when there is a need. The roster constitutes around 180 delegates (GEG, 2009), mostly health personnel, but also technicians, logisticians, and other administrative functions such as IT, finance, and security. Norwegian Red Cross runs ERU training every year to continuously update of the roster and provide standardized manuals, guidelines, catalogues, and other tools for delegates to use in the field. Each year Norwegian Red Cross deploys 150–200 delegates to international operations, with an average of approximately 60 delegates being on mission at the same time (www.norcross.no). Based on experiences with each new deployment, Norwegian Red Cross updates job descriptions, partly in cooperation with the

technical working groups in IFRC (Norwegian Red Cross, 2011). IFRC offers massive amounts of documents, including policies, handbooks, and training kits on the undertaking of assessments, triage, nutrition, and clinical practice. Guidelines have been developed for the use of foreign field hospitals in general (PAHO 2003). Norwegian Red Cross provides delegates with pre-departure checklists, information letters, a contract, delegate kit, code of conduct, security briefing, media messages, etc. The delegates are responsible for their own health controls and vaccinations and must have the required online training in security and gender issues; this last requirement is a recent addition to deployment standards (Norwegian Red Cross, 2015). Based on experiences from Haiti in 2010, Norwegian Red Cross started to systematically use a so-called Advance Team (AT), which involves one or two people from headquarters deploying ahead of the ERU. Whether an AT comes in addition to the logistics ERUs is a decision made by Norwegian Red Cross, and not part of the IFRC standard procedures. Accordingly, care must be taken to avoid undermining the standardized ERU/FACT concept (logistics coordinator 1, 2015).

In parallel with mobilizing the human resources, Norwegian Red Cross permanent logistics staff prepare the modules, a cool-chain for vaccines, and charter flights, procure what is needed (such as laundry and kitchen kits, food, tarpaulins, mosquito nets, rope), and prepare all documents. The equipment is pre-positioned partly in an outsourced warehouse in Oslo, partly at suppliers' warehouses.

[Insert Picture 2: Pre-positioning and deployment]

Once in the destination country, Norwegian Red Cross selects a site in cooperation with FACT and the logistics ERU. The location depends on access, security, topography, and the ease with which flows may be designed; permissions and relationships with authorities also play an important role (ERU coordinator, 2009). Standards for preventive and evacuation plans are adapted to the specific circumstances in order to cope with potential internal and external hazards (ERU coordinator, 2009). A standard organization chart and guidelines for hiring local staff provides the basis for the set-up and the routine operations, respectively, but these must adapt to the local conditions (ERU coordinator, 2009).

4.4 Experiences – advantages and challenges related to use of standards of modularity

The above paragraphs have described how the ERU concept is supposed to work when deployed: it should be a flexible, rapid, relatively lean and cost-efficient tool that is integrated with the rest of IFRC, its operation, and the local context in which it deploys. Evaluation reports and the conducted interviews reveal that it is not always easy to make this happen in practice. With a focus on the advantages and challenges of using standards and modular thinking, the following presents experiences with the concept.[4]

IFRC considers the ERUs to be a key foundational IFRC contribution in operations, as a tool that works well with high consistent technical standards and fast deployments upon request (Fisher et al., 2010; Burton, 2011; Greenhalgh et al., 2014; Global Surge Capacity, 2015). Since its inception in the 1990s, the concept has become more modular, but it still lacks flexibility in certain situations. "*Over the past decade the ERUs have become more modular, more mobile and more flexible, but still struggle along with other components of the IFRC response mechanism to fully adapt to epidemic response with large dispersed affected populations where there is an existing national health infrastructure*" (Rees-Gildea, 2013, p. 7). Hence, configurations of the health ERUs are not as well defined (or adapted) as they could be for, say, cholera and Ebola. On the other hand, a continuous disassembling of the concept into smaller and smaller pieces (modules) to increase the flexibility must be balanced against the danger of losing the standardized approach that is so important for those requesting the ERUs. "*Need to know from the receiving end exactly what you are supposed to receive […] the more flexible we make them, the more difficult it may be for National Societies with little experience to know what to expect*" (Global Surge Capacity, 2015). Requests for health ERUs, for example, changed during the Sierra Leone Ebola operation (senior logistics officer, 2015; surgical nurse, 2015).

Adaptions to the local context, particularly concerning the organizational standards, are considered particularly challenging (team leader, 2015; Rees-Gildea, 2013; logistics coordinator 2). Table 2 summarizes this and other challenges identified.

[Insert Table 2]

[4] The sources include primary and secondary data as listed in Appendix 2.

The identified challenges are related to the ability (or lack thereof) of available standards and modules to fit with the local context such as different types of disasters, and physical, cultural, and organizational aspects. We also found a lack of standards or lack of knowledge in using them due to lack of training, incomplete standards, or lack of procedures.

We identified four ways in which further development of modules can take place: additional modules, additional functions in modules, adapting existing modules, or adapting the competencies to fit with the modules. Over the years, Norwegian Red Cross has designed and redesigned its modules by testing in simulations and actual operations (senior logistics officer, 2010). Based on experiences in Haiti and Pakistan, IFRC revised the ERU SOP in 2012, particularly regarding joint deployments, the modular approach, and capacity building. A range of standard documents and guidelines, including terms of reference and templates, complement the revised SOPs adapted to the different geographical zones (Global Surge Capacity, 2015). The SOP clarifies the different NS's roles in joint deployments, the individual roles within an ERU, as well as the roles of the different types of ERUs. The IFRC also developed guidelines on the use of social media during operations (IFRC 2012). The SOP states that decisions to design new types of ERUs should be based on a defined need and should be presented and discussed collectively at the ERU/FACT working group. Where possible, they should also be fully field tested to determine the feasibility and any refinement of the internal processes and equipment specifications. The function shall also be within the mandate of the Red Cross and Red Crescent Societies (IFRC 2012). Resulting from recent experiences, the IFRC runs a large evaluation of all the global response tools including ERUs, the FACT, and the head of operation roles (Global Surge Capacity, 2015).

5 Discussion and key findings

The case shows that different ERUs combine to adapt to diverse local contexts. Standardized trainings, guidelines, and procedures facilitate the use of physical standardized resources (for example, for health and WATSAN ERUs). Emblems and logos on uniforms support coordination and staff security. Coordination of different ERUs, such as relief and logistics, calls for compatibility in the physical and organizational standards they use.

The first key finding from the analysis concerns types of standards and modularity in practice, compared with the literature. Standards and modules developed by IFRC and Norwegian Red

Cross as part of the ERU concept are both of physical and organizational nature. The case study reveals that the health ERU concept in Norwegian Red Cross uses many types of standards and modularity, some of which are not previously mentioned in the literature. Compared to Table 1, those that are not identified in the study include standard selection of relief goods and infrastructures for commodity management; for example, warehouse standards. Similarly, standard and modular design of processes or services or standards for cross-functional and community-wide skills were not identified. Finally, the study did not reveal standards related to information system, performance measurement, project management, or procurement. Standards that were identified in the case but not listed in Table 1 include rules of conduct, organization charts, guidelines for hiring of local staff, pre-departure checklists, and standards for deployment, evacuation plans, vehicles, emblems and logos. Information system standards, on the other hand, are operated by the IT and Telecom ERU and relief ERUs, while logistics and WATSAN ERUs use standard vehicles and other large equipment (see Appendix 4). The analysis indicates that, compared to the literature, humanitarian practice seems less focused on organizational standards such as cross-functional skills, project management, performance measurement, procurement, and warehousing. There is also a lack of modularity in the services provided. This is consistent with Table 2, which identifies particular challenges related to local contexts' adaptations, lack of competencies to fit with (changing) modules, and lack of sequencing in which the equipment and according services can be established. On the other hand, compared to practice, the extant literature seems to have overseen organizational standards such as preparation of staff before they deploy and standards for hiring, securing, and organizing staff once deployed.

The second key finding concerns the links between standards, modules, and responsiveness. The case demonstrates how standards and modularity complement each other, but also how they depend on each other. A change in one often requires changes in the other, both of similar (physical/physical) and different kinds (physical/organizational):

- Physical standard vs. another physical standard; for example, item specification vs. packaging.
- Physical standard vs. organizational standard; for example, WATSAN distribution vs. training.
- Physical module vs. another physical module; for example, WATSAN vs. mean for transport.

- Physical module vs. organizational module; for example, kit vs. checklist.
- Module vs. standard; for example, basic health ERU vs. SOP.

Such embeddedness is in line with extant research on standards (e.g., Fabbe-Costes et al. 2006; Hellström and Nilsson, 2011) and resources in general (e.g., Jahre et al. 2006). Accordingly, the different types of standards and modules are highly interlinked, and we can develop propositions with basis in the conceptual framework in Figure 1:

1. Implementation of new or changed physical standards, requires changes in organizational standards and vice versa.
2. Changes in one physical standard, requires changes in other connected physical standards.
3. Changes in one organizational standard, require changes in other connected organizational standards.
4. Changes in one module, whether it is physical or organizational, often require changes in other connected modules.
5. Standards must be combined with modularity to provide cost efficiency and flexibility; that is, responsiveness.

The third key finding from the analysis is that standards have been much more in focus than modularity, both in the literature and in practice. Table 1 lists 29 examples of standards compared to only seven examples of modules. From the case we see that standards were in focus from the inception of the ERU. Modularity came later, as illustrated by the development in the different types of health ERUs (Appendix 4). However, it is becoming increasingly important due to differing requirements, particularly in the local context, types and size of disasters, and more use of joint deployments where the National Societies involved contribute with some modules, each of which are both of a physical and organizational nature. Thus, systematic modular thinking has become increasingly evident over the last few years. This leads to the fourth key finding from the analysis. First, the ERU concept seems to have a better fit in some operations than others and the future might be more challenging than the past because of smaller and other types of disasters, and more local capacity. Second, while the ERU is intentionally highly autonomous, care must be taken in integrating it with other parts of IFRC, other actors, and with the local communities in which they deploy. Third, the increasing modularization, with a corresponding increase in the number of standards, must be weighed against going too far and breaking the concept.

The fifth key finding relates to principal ways a standardized and modularized concept can be changed. The analysis revealed four alternatives: adding modules, adding functions to existing modules, adapting existing modules, and adapting competencies to fit with existing modules. Each of these changes will require adaptions in other modules or standards as suggested in the propositions above.

6 Concluding remarks, implications and further research

We have presented an in-depth longitudinal case study of the health ERU concept as practiced by Norwegian Red Cross, including the main aspects of its context. The research contributes to a better understanding of the links between standards, modularity, and responsiveness in the humanitarian context. To our knowledge, this is the first empirical study on the use of standards and modularity in humanitarian logistics. The study was based on a conceptual framework developed from literature on responsiveness, standards, and modularity combined with results from a systematic review of humanitarian logistics and supply chain management literature on standards and modularity. A large body of primary and secondary information over a long period constitutes the empirical evidence.

We posed two research questions. In response to the first research question, we found that the ERU concept uses various combinations of different organizational and physical standards and that these standards both complement and influence each other. While standards were the starting point, there is an increasing focus on modularity. The main reason for this seems to be a growing need for responsiveness in terms of flexibility and cost efficiency. This need calls for standardized solutions constituting modules that can be combined in many variations and assembled and disassembled according to needs. In response to the second research question, we found that the main challenges of the ERU concept in relation to responsiveness are that (a) The concept seems to work better in some situations than others; (b) there is a trade-off between its intentional autonomy and its ability to integrate with its context; and (c) solving this through more modularization must be balanced against the danger of breaking the concept.

There are two main research contributions from this study. First, we develop a framework for categorization of standards and modularity in the humanitarian context and then use the framework to analyze a real case. Second, we provide the first empirical study on how humanitarian organizations use standards and modularity to improve responsiveness,

concluding with a set of propositions on how the concepts are linked, which can be used for further research.

The main practical contribution of this study is to provide the humanitarian community with more understanding of the use of standards and modularity for improving flexibility and cost-efficiency. Practitioners have called for research rooted more in real problems and real data. In particular, the results can be used to argue for better organizational standards to improve cross-functional skills and skills related to project management, performance measurement, procurement, and warehousing. All humanitarian actors are struggling with responsiveness in terms of a continuous pressure of keeping costs down while providing better service to beneficiaries (and donors). Standards and modularity are two approaches that can help organizations improve. They can use the framework as a check-list for analysing their own use of standards and modular solutions and what might be lacking. The analysis of challenges can also be compared with organizations' own experiences to identify potential and means for improvements. The humanitarian community can use the case study for training, discussion, and reflections. Finally, this research feeds into IFRC's and Norwegian Red Cross's continuous development of the ERU concept and, in particular, to an ongoing IFRC evaluation of their global response tools, including the ERU concept.

There are numerous avenues for further research. One is to undertake empirical studies of other ERU types in the IFRC, and similar concepts in other organizations such as ICRC and MSF. These would preferably include more data from the local context compared to this and previous studies; for example, by field studies in ongoing operations. Other research designs such as surveys and experiments would be interesting. Another avenue is to expand on the theoretical foundation for studying standards and modularity to understand more of the following areas:

- The nature and role of standardized interfaces; see, for example, Brusoni and Prencipe (2001), Langlois (2002), Jahre et al. 2006, and Campagnolo and Camuffo (2010).
- Coordination and integration using such concepts as the near-decomposability of complex systems (Simon 1962), loose coupling (Orton and Weick, 1990), and differentiation and integration (Lawrence and Lorsch, 1967).
- Service modularity concepts; see, for example, Pekkarinen and Ulkuniemi, (2008), Bask et al. (2009), Tuunanen et al. (2012), de Blok et al. (2014).

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Appendix 1: Systematic literature review process (based on Seuring and Gold, 2012, p 550)

Categories	**Definition**	**What has been done**
1. Aim of research	States the overall topic/objectives of the literature review	Study the means that permit supply chains to be responsive, or integrated and flexible, or lean and agile. Focus on two means: standards and modularity.
2. Data collection method	Reported tools/procedure for identifying, delimitating, and gathering the relevant literature sample	Used Emerald database. Search rechecked 7th of May 2015 and completed September 2015. Used keywords in combination ("logistics" or "supply chain" in abstract, plus "humanitarian" in abstract, plus "responsiveness" or "lean" and "agile" or "flexib*" and "integrat*" anywhere) to identify potentially relevant articles. Six lists of references with a total of 197 papers. Elimination of cross-references => 77 remaining papers. Read abstracts and articles to eliminate non-relevant papers (those not related to Humanitarian logistics or SCM). **62 papers** in the final sample.
	Number of publications in the literature sample	The search considered every peer-review journal in the Emerald database.
	Time period covered	No specific period given
3. Data analysis method	Reported tools/ procedure for analysing the literature sample	Use of search function in pdf files to track the keyword (responsiveness, integrat*, flexib*, modul*, standard*). Catch every sentence relevant in line with research aim. In-depth reading of papers with responsiveness, integration/ flexibility lean/agile at the core with data related to standards or modularity as means to combine.
	3.1. Type of data analysis	Qualitative analysis of elements.
	3.2. Descriptive specification of the literature sample	The sample concerns 62 articles from 13 different journals. HLSCM and IJPDLM were the most represented (26 and 13 articles, respectively). The first paper was published in 2005.
	3.3. Analytic categories for analysing the contents Main structuring (deductively or inductively derived) Categories/arguments applied for analysing and/or synthesizing the body of literature	Content analysis: • Looking at how paper report responsiveness, flexibility and integration, lean and agile; • Looking at the combination of flexibility/integration; lean/agile; • Gathering everything about standards and modularity in the papers and looking at their combination; • Looking at their direct and indirect relationships with responsiveness; • Listing and grouping the cited types of standards and modules; • Noticing every benefit or trade-off related to the use of standard and/or modularity
4. Quality measures	Reported quality, replicability, reliability, and validity	Anyone can conduct a similar search following the above explanation and compare the results with ours.

Appendix 2: Data for case study[5]

PRIMARY			
Interview no.	**Department/Division**	**Position**	**yy/mm/dd**
1	Norwegian Red Cross	Basic Training Course Material	2008 Oct/Nov
2	Norwegian Red Cross	ERU Simulation Training Material	2009 April/May
3	Norwegian Red Cross	ERU Coordinator	20150528
4	Norwegian Red Cross	Nurse ERU Health	20150528
5	Finnish Red Cross	Team Leader Logistics ERU 2	20140218
6	IFRC Disaster and Management Department	Global Surge Capacity	20150518
7	Zonal Logistics Unit Kuala Lumpur	Zone Logistics Coordinator	20140212 20140213
8	Canada Red Cross	FACT Logistics Coordinator	20140216
9	Norwegian Red Cross	ERU Coordinator	20090507
10	Operations Support Department	Officer for FACT/ERU	20070910
11	IFRC Country Office Philippines	Head of Operation	20140311
12	Norwegian Red Cross	Senior Logistics Officer	20090507
13	Norwegian Red Cross	Senior Logistics Officer	20100418
14	Norwegian Red Cross	Senior Logistics Officer	20150527
15	British Red Cross and IFRC	FACT logistics	20150521
16	Norwegian Red Cross /Australian Red Cross	Head Nurse	20150521
17	Norwegian Red Cross	Logistics Coordinator 2	20150519
18	IFRC	Safety/Resilience Coordinator	20140220
19	Zonal Logistics Unit Kuala Lumpur	Zone Procurement Coordinator	20140212 20140213 20140221
20	Norwegian Red Cross /Island Red Cross	Logistician ERU Health	20150521
21	IFRC	Deputy Head of Operation	20140319
22	Logistics Philippines Red Cross	Warehouse manager	20140219
23	IFRC	Dr.med, FACT/ERU, ERU Simulation Training	2009 April/May
24	Asia Pacific Zone Office	Head	20140212
25	British Red Cross	Team Leader Logistics ERU 1	20140219
26	NORCROSS	Logistics Coordinator 1	20150526
27	Operations Support Department	Senior Officer, ERU	20070911
28	NORCROSS	Team Leader	20150521

SECONDARY	
A	ACAPS (2015), ENAP Sierra Leone Assessment. ACAPS – Ebola Needs Analysis Project. Sierra Leone Multi-sector Needs Assessment Report, April 2015.
B	Burton, C. (2011), Real-Time Evaluation of IFRC response to 2010 Pakistan Floods, 20 January.
C	Fisher, M., Bhattacharjee, A., Sanez, J., and Schimmelpfennig, S. (2010), The Haiti Earthquake Operation: Real-Time Evaluation for International Federation of Red Cross and Red Crescent Societies, June 2010, Final Report.
D	GEG (2009), Health ERU Evaluation Report, Undertaken for Canadian Red Cross by Global Emergency Group, March 13.
E	Greenhalgh, L., Bamforth, T., Neudorf, G., and Siddiqui, A. (2014), Real-Time Evaluation of the Philippines Haiyan Response, February–March 2014.
F	IFRC (1996), Nigeria: Outbreak of Cerebro Spinal Menigitis, Appeal no. 04/96, Situation report no.1, 18 March 1996.
G	IFRC (2008), Emergency Response Unit 2008, IFRC, Geneva.
H	IFRC (2010), Management response to the Real-Time Evaluation (RTE) of the Haiti Earthquake Operation, 7 October, Geneva.

[5] Letters are used for reference in Table 2.

I	IFRC (2011), Management Comments and Recommended Actions. Evaluation of the Relief Phase of the IFRC 2010 Pakistan Monsoon Flash Floods Operation, 21 November, Geneva.
J	IFRC (2011), Management Response to the Real-Time Evaluation (RTE) of the IFRC Pakistan Floods Operation 2010, 28 February, Geneva.
K	IFRC (2012), ERU Emergency Response Unit: Standard Operating Procedures Revised 2012, Geneva.
L	IFRC (2013), Principles and Rules for Red Cross and Red Crescent Humanitarian Assistance, Geneva.
M	IFRC (2014), Management Response to the Real-Time Evaluation (RTE) of the Philippines Typhoon Haiyan Response, 16 May 2014.
N	IFRC (2015), IFRC's management response to the Real-Time Evaluation (RTE) of the West Africa Ebola Virus Disease (EVD) operations, 27 February 2015.
O	IFRC (2015), Updated ERU statistics provided by IFRC, February 5th, IFRC Geneva.
P	IFRC Annual Reports 2010, 2011, 2012, 2013, Geneva
Q	Kayden, J. (2015), Sphere Standards, Lecture February 4th in International Humanitarian Response, Harvard School of Public Health.
R	Murray, A., Majwa, P., Roberton, T., and Burnham, G. (2015), Report of the real-time evaluation of Ebola control programs in Guinea, Sierra Leone and Liberia, 25 January 2015.
S	Murtaza, N. (2010), Pakistan Floods 2010. Evaluation of the Relief Phase of the International Federation Red Cross Red Crescent Societies/Pakistan Red Crescent Society, Monsoon Flash Floods Operation
T	Norwegian Red Cross (2011), Follow-up Lessons learned to Lessons Implemented after Haiti and Pakistan ERU operations 2010, Oslo, 13th May 2011.
U	Norwegian Red Cross (2015), Field Personnel Unit Norwegian Red Cross via Doodle, Nepal Earthquake ERU 2015, e-mail to all staff on roster, April 26th, 2015.
V	PAHO (2003), WHO-PAHO Guidelines for the Use of Foreign Field Hospitals in the Aftermath of Sudden-Impact Disasters, Department of Emergency and Humanitarian Action, World Health Organisation and Area on Emergency Preparedness and Disaster Relief, Pan American Health Organization, Washington DC, USA.
X	Sælør, C.C. (2015), Resource requirements in response to changing needs for improving logistics preparedness and response: A case study of Norwegian Red Cross, Master thesis, BI Norwegian Business School, September.
Y	Rees-Gildea, P. (2013), Sierra Leone Cholera ERU Operation Review, IFRC, January 2015.
Z	The Sphere Project (1998), Humanitarian Charter and Minimum Standards in Disaster Response, The Sphere Project, Geneva.

Appendix 3: Interview guide

GENERAL

1. What do you normally do and how long have you worked with ERUs?
2. What was your role (if deployed) in Haiti EQ 2010, Pakistan Floods 2010, Philippines Typhoon Haiyan 2013, Sierra Leone Ebola 2014, Nepal 2015?
3. What ERU (type/equipment/type and number of people) was deployed? What determines the decision of which type to deploy?
4. Do you have any thoughts on how to secure lessons learned from one operation to the other?
5. To your knowledge, does this give a fair picture of the use of standards and modular thinking in the ERU concept (see matrix on standards/modularity, p. 3)?
    a. Are there additional standards and modular aspects that should be included?
    b. According to your experiences, what are the most important ones to ease quick and cost efficient deployments?
6. According to your experiences, what are the main challenges of ERU deployments? Are they mainly technical or organizational (see list of challenges, p. 4)?
7. Do you have any thoughts on additional ERU types?
8. What are the main challenges of joint deployments?
9. How can the ERU concept be adapted to smaller/medium scale disasters?
10. Would you agree with the statement that the "*ERUs have become more modular, more mobile and more flexible?*" Is there a limit to how far the modularization can go before the concept breaks up?

NORWEGIAN RED CROSS HEALTH ERU

11. BHC, RPD and Referral Hospital; do they use the same modules?
12. Elements of the health ERU Norwegian Red Cross concept:
    a. NorHosp modules: What do you use and not use?
    b. NorAid modules (including vaccination, blood-bank and laboratory equipment: how are these related to NorHosp; what do you use, what do you not use?
    c. Roster: How many in total, how many logisticians and other support staff compared to health personnel?
    d. The ERU organization in Oslo HQ: Emergency Response Coordinator, ERU Taskforce – can you explain? Do you have an updated organization chart?
    e. Trainings/manuals/handbooks/Emergency Items Catalogue/ documentation for staff, etc.: Example of what Norwegian Red Cross has developed vs. what standards are used from IFRC.
    f. Documents related to the physical modules when you deploy; packing lists, etc. What about documents when you finalize the operation? Stock reports, etc.?
    g. Support systems: Which systems do you use out of those offered by IFRC (e.g. HLS, FLEETWAVE, LOGIC)? What about special Norwegian Red Cross systems?
13. Alterations in the original from 1982; 1989, 1992, 2006. Changes after this? For example, changes in the Rapid Deployment Hospital after Haiti? When was the psychosocial module added?
14. Any plans for additional modules?
    a. Beneficiary communications in epidemics
    b. Additional specialist staff
    c. Additional administrative/support staff (GIS, admin, logistics, finance, procurement)
    d. WATSAN
15. What about the process when you make changes? With whom do you cooperate?
16. Sequencing of the deployment in epidemics has been suggested. What would be required in terms of changes in organizational/technical standards/modules?
17. Gender and security issues have been pointed out as somewhat problematic – any experiences/viewpoints on this?
18. It has been pointed out that the standard BHC assets do not really fit in epidemics. Is this correct? If so, what is not needed and what should be added? Did the Ebola response pose particular problems regarding ERU (health) deployments? What about standardization of PPE high vs. low risk?
19. The process after alert from IFRC
    a. Offer from Norwegian Red Cross: How do you decide whether/what to offer?
    b. Once offer is accepted: What happens next? With the delegates? With the equipment? Can you take me briefly through what happens in your job once decision about deployment is taken?
    c. What contact do you have with the delegates once they are in operation in the field? What services does Norwegian Red Cross offer them?
20. Sourcing and procurement for preparedness, deployment and replenishment: local vs. global

a. Drugs
b. Medical equipment
c. Vehicles
d. IEHK – kit: from where do you get this?
e. Tents and rub-holes: How do suppliers and equipment link with NorHosp?
f. Logistics services
g. Other

21. Warehousing – where do you store and do you see any changes in the future?
    a. Donate to IFRC who stock in ZLUs
    b. Own stock in ZLUs and managed through standard service agreements between ZLU and Norwegian Red Cross
    c. Supplier-owned stocks in ZLU
    d. Supplier reserved stocks in suppliers premises
    e. Own stock in Norway
    f. Goods or services provided by commercial sponsors

What other people should I talk to?

Appendix 4: Types of ERUs (www.ifrc.org; Global surge capacity, 2015)

Type of ERU	First deployed	Size	Function	Main Modules/Standards
Logistics	**Jan. 2001**	4–6 staff	Manage arrival of relief goods by air, land or sea; clearance, storage and subsequent forwarding to distribution points.	A standard kit with large equipment such as vehicles, forklifts, rubholes. Can also be deployed without equipment; that is, solely with human resources.
IT & Tele-com.	**Nov. 1996**	4–6 staff	Assist NS and establish local communication networks and links to help ensure smooth information flows.	Satellite phone systems, high-/very high-frequency radio systems and VSAT, depending on location and needs
Water & Sanitation Staff: average 4–8 water engineers/ technicians / hygiene promoters. WHO Drinking Water Guidelines and Sphere standards guide the work	**July 2007**	**Type 15** 20 MT; 160m^3	Provide treatment and distribution of water up to 225,000 liters a day for a population of 15,000 people, with a storage capacity of a maximum of 200,000 liters a day. Also provides basic sanitation and hygiene promotion for up to 5,000 people. Designed for response to scattered populations.	Three variations according to water volume and quality required and to beneficiary numbers and locations. Modular – can be deployed singly, jointly, and/or in multiples but all with "stand-alone" capacity. Modules include (1) Treatment and supply; (2) Distribution and trucking; (3) Specialized Water and Sanitation; (4) Mass Sanitation Module (MSM). The integrated distribution and trucking capacity for the transport of treated water to dispersed populations has a capacity of up to 75,000 liters a day and the option to set up nine different storage and distribution points.
	July 2007	**Type 40** 25 MT; 110m^3	Provide treatment of up to 600,000 liters a day for a population of up to 40,000. Better packed equipment than Type 15 provides less volume.	
	July[6] 2004	**Mass sanitation 20** 14 MT; 90m^3	Provide basic sanitation facilities (latrines, vector control and solid waste disposal) for up to 20,000 beneficiaries. Hygiene promotion programs central: Community participation in the immediate aftermath of a disaster ensures sustainable and incremental	

[6]A Water Truck and Distribution Module and a specialized WATSAN Module were deployed for the first times in October and December 1996, respectively.

			improvements in environmental health.	
Health	**April 1999**	**Referral Hospital** 60MT; 350m^3; 15–20 staff	First-level field hospital, providing referral-level multi-disciplinary care to a population of up to 250,000 people. This is the biggest health ERU and can replace a normal hospital with inpatient capacity ranging from 75 to 150 beds, providing surgery, limited traumatology, anaesthesia, internal medicine gynaecology, obstetrics and paediatrics. By combining two units, the capacity can be doubled.	All facilities and equipment come in color-coded boxes. Includes: Surgical Module with medical equipment to establish an operating theatre; Surgical Supply Kit with disposable equipment necessary for treating 100 surgical patients for 10 days, e.g. catheters, syringes, compresses and gloves; Hygiene Module equipped for gathering, heating, storing, testing and distributing water, e.g. generator, water tank and purifying equipment; Technical Module with equipment for electricity, e.g. mobile generators, cable and lighting equipment.
	March 1996	**Basic Health Care** 18MT; 90m^3; 5–8 staff	Provide immediate basic curative, preventive, and community health care for up to 30,000 beneficiaries.	All facilities and equipment come in color-coded boxes. Does not function as a hospital but has a 20 overnight bed capacity for observation referring serious cases to a hospital. Additional modules can be sent later upon request.
	Aug. 2008	**Rapid Deploy-ment Hospital** 10MT; 90m^3; 8–10 staff	Can deploy within 48 hours of alert and offers medical and surgical interventions such as triage, first aid, and medevac, as well as limited medical/surgical care, including an outpatient department.	All facilities and equipment come in color-coded boxes. Modified and lighter version of the Referral Hospital. A 10-bed capacity is also available.
Relief	**Dec. 2004**	4–6 staff	Support the host NS to undertake relief assessments, targeted beneficiary selection. Assist in the set-up for food and NFI distributions, and compiling relief distribution statistics. Can also assist in the setting up of camps and works closely with the logistics ERU.	Staff carry their personal equipment only, sometimes a case component (for distribution of cash instead of items) can be added.
Base Camp	**Dec. 2003**		Provide host NS and IFRC/ICRC staff engaged in emergency operations with appropriate living and working conditions. Three different sizes of camp, providing accommodation for 30, 40, or 60 people, but can be scaled up or down upon request.	Tented accommodation, conditioned for hot and cold climates, toilets, hot showers, recreational facilities, a kitchen, offices, administrative, IT/communication, and coordination facilities in locations where these are not available for RCRC staff.

Table 1: Standards and modularity in literature review

	Standards	**Modularity**
Physical	*Product* standardization [26, 33, 34, 61] *Packaging* standardization [26, 33, 34, 49, 61], standard *boxes* [36] Standard relief *items* [45, 46, 54, 57, 61] Standardized *kits* [12, 14, 26, 46] Items *catalogues* [15, 19] Standard *selection* of relief goods [19, 46] Standardization for *equipment* [5, 15] Standard *infrastructures* for commodity management [28], *warehouse* standardization [22] *Telecommunication* standards [20]	Modular design of *packages of products* [8, 34] Modular *products* [30, 34] Modular *kits: survival* kits [7, 8] *hygiene* kits [14] *Procurement* modules [14]
Organisational	**Service** *Service* standardization [15, 61] **Human resources** Standardized *training* [4, 13, 34, 46] *certification* [13], *handbooks* [55] Standardization of *language* [26] Common standard of *cross-functional skills development* [4, 13] *Community-wide skills* standards [34] **Information system** Basic logistics *information* standards [29] Standardized structure of *information sharing* [48] *communication protocols* [44] *Track and trace* standard [17] Standardised *information system* [42] **Performance measurement** Standard *indicators* (to measure performance) [1, 3] and *metrics* [20] Standard *measurement systems* [52] *Accountability* standards [12, 20] **Process, procedures, tools and practices** *Process* standardization [9, 22, 31, 33, 47, 58, 61] Standard (operating) *procedures* [5, 11, 15, 28, 48, 57, 62] Standards in humanitarian *practice* [21] Standard *methodology* in project management [24] Standard set of *tools* (logistics guidelines) [31, 34, 55] Standard (logistics and SCM) *techniques* [4, 9, 34] Standards of *quality* [32] *Ethical procurement* standards [52]	**Service** Modular design of *services* [8] **Human resources** Standard *training* modules [34] **Process** Modular *processes* and/or supply chain *structures* [30]

Table 2: Challenges of using standards and modularity for integration and flexibility

Element	Issues	Examples	Sources[7]
Ability of available standards and modules to fit with local context	Types of disasters	Better fit with typical disasters like earthquakes and typhoons than epidemics	17, 26, Y
		Better fit with big than small and medium disasters	6, 15, 26
		Originally better fit with larger population centers than moving/scattered populations (this has changed)	15
		Parts of health modules too sophisticated for the beneficiary needs	4, 14
	Physical aspects	Infrastructural constraints	14, 17, 26
		Scattered populations, geographic spread, and complexity	8, 14, B, E
		Urban disasters	C
	Cultural aspects	Language barriers	6, 15, B, C
		Differing practices in hygiene, health, and logistics	15, 26
	Organi-zational aspects	Better fit with weaker than stronger NS	28, B, E
		Lack of status agreement	B, E
		Does not use existing systems and local capacity	6, 15, 19, B, C, E
		Lack of knowledge of local context/procedures	14, 15, 26
	Overall aspects	Locals perspective is lacking in RTEs	28
		Lack link between global, regional, local teams	C, H
		Fairness: All NS should be allowed to deploy ERUs, not only strong/experienced ones	6
		Visibility: Politics rather than technical capability and needs determine deployments; e.g., NS that need to deploy to get funding and media attention	15
Lack of standards or knowledge in use of standards	Lack of training	In what are the standards	4, 14, 15, 17, 28
		In using the standards	14, B
		Too infrequent deployments	4, 15
		In management, including systemic thinking	4, 15, 19, 21, 28;
	Lack of/ incomplete standards	Missing hand-over protocols and procedures	6, 28, C, E
		Unclear division of work between finance, logistics, procurement	28, Y
		Unclear division of work between the ERUs of the same type and between different types	5, 18, 19, 25, 26 B, E
		Different approaches in ICRC and IFRC	26, 28
		Lack of security plans/checklists	4, B,T
	Lack of sequencing/ standard procedures	Poor sequencing of the order in which types of ERUs arrive; e.g., logistics vs. relief and health	4, 26, S, Y
		Modules should be packaged and marked even more systematically to account for situations where priorities must be made in terms of order (e.g., due to lack of transport capacity). One solution could be start-up boxes vs. more sophisticated equipment	4, 14, 17
	Need to adapt existing standards	For Ebola: Adapted a Cholera Treatment Center by choosing from the list of available items in warehouse	26
		There may be situations where items specified in the emergency catalogue are simply not available when needed	17

[7]For the sake of anonymity, interviews are numbered, see appendix 2. The letters refer to reports listed in Appendix 2.

Further development of modules	Additional modules	Watsan with health ERU; e.g., for Ebola, cholera	4, 26, 28, T
	Additional functions in modules	Procurement function	8, 17, 19
		Beneficiary communications	Y
		Epidemiologists, GIS data management	Y
		Cold chain and incinerators	C
	Adapting competen-cies to fit with modules	Logistics for different types of health ERU; e.g., mobile teams, cholera treatment	T
		Generalists who can fill multiple functions include logistics, administration, finance, procurement, technical maintenance; i.e., a 'multi-skilled' delegate	17, E
	Adapting existing modules	Watsan modules in smaller units	15, B, Y
		Smaller base-camp modules	E
		Smaller and more modular ERU teams, equipment and ways of working	6, 15, B, E

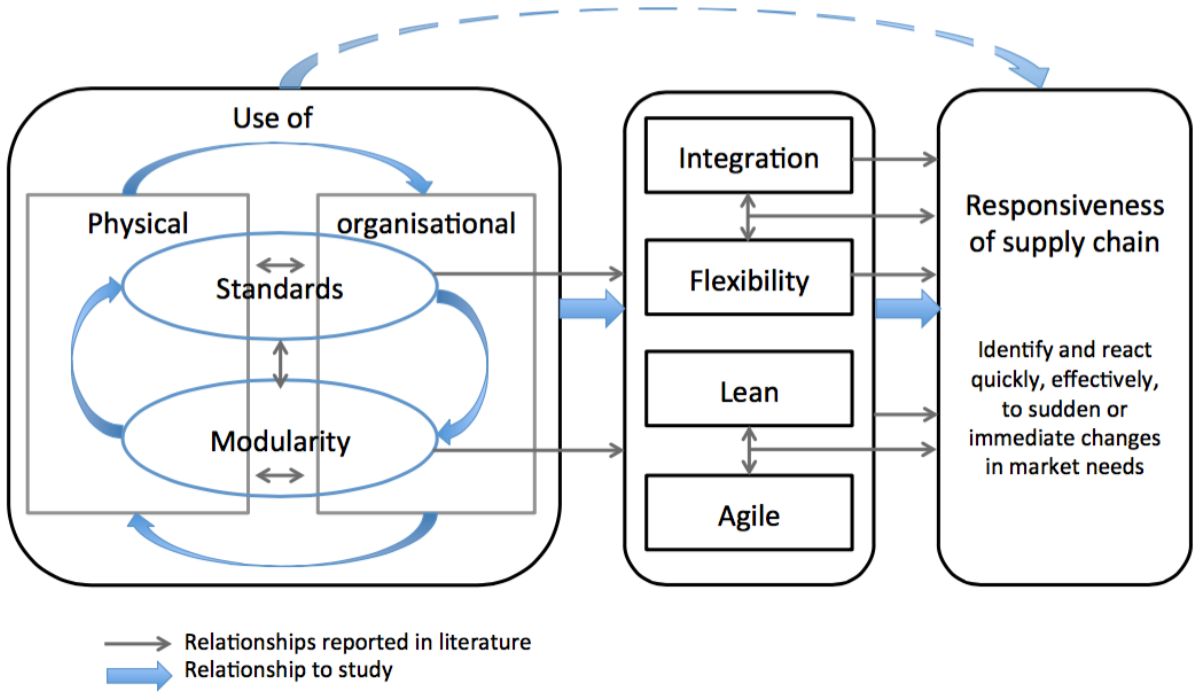

Figure 1: Conceptual framework

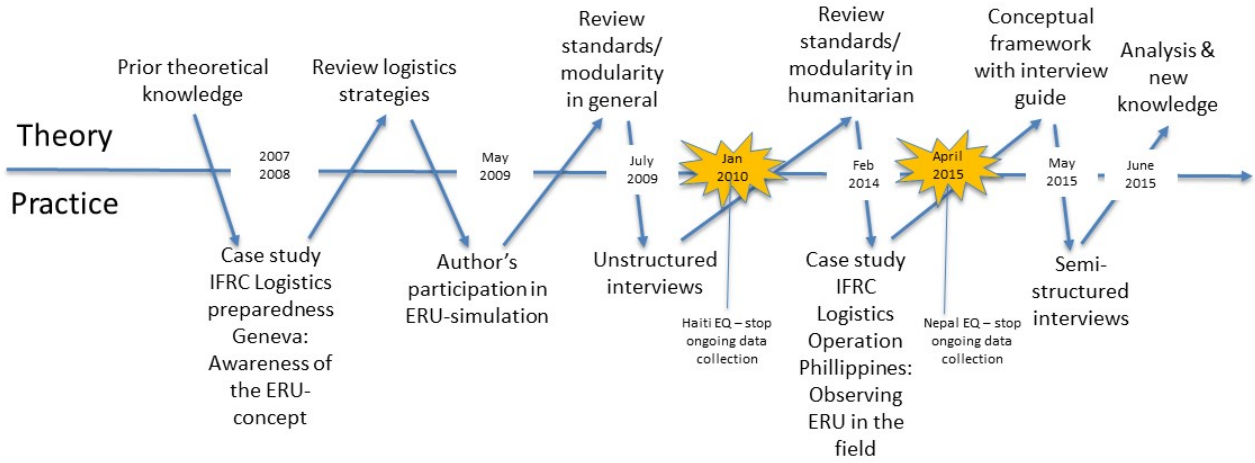

Figure 2: The abductive research process

Picture 1: The standardized and modular concept

Picture 2: Pre-positioning and deployment