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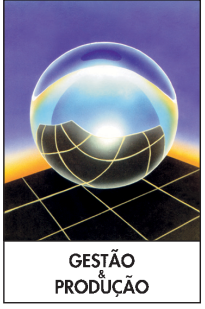

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Coordination mechanisms in humanitarian operations management: a conceptual model of a simulator and a proposal for a humanitarian logistics game

Mecanismos de coordenação em gestão de operações humanitárias: modelo conceitual de simulador e proposta de jogo de logística humanitária

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Abstract: Humanitarian supply chain management mainly involves logistics decisions that must be made before, during and after a disaster and is one of the standard challenges that relief agents must address. This study developed a conceptual model of an organizational simulator to analyse logistics decisions and proposed a humanitarian logistics game using this model that allows humanitarian relief managers and students to observe disaster scenarios and to experience in context decision making. Methodologically, bibliographic research served as the basis for developing the conceptual model and for proposing the game. Both the model and the proposed game were applied to two case studies involving relief efforts against hunger to validate their usage. The model's viability and usefulness in training were validated, and its support for decision-making management in humanitarian operations was confirmed.

Keywords: Humanitarian logistics; Disasters; Operations management; Business game; Humanitarian game.

Resumo: *A gestão da cadeia de suprimentos humanitária envolve que decisões sejam tomadas antes, durante e depois que um desastre acontece, e esta tomada de decisões trata-se de um dos grandes desafios que agentes humanitários devem encarar. O presente estudo desenvolve um modelo conceitual de simulador organizacional para análise de decisões logísticas e, a partir deste modelo conceitual, propõe um jogo logístico humanitário direcionado a permitir que gestores e estudantes de operações humanitárias observem e vivenciem a tomada de decisão nos contextos de desastres. Como metodologia, a pesquisa bibliográfica foi utilizada como base para desenvolvimento do modelo conceitual e para a proposta de jogo humanitário. O modelo conceitual e a proposta de jogo foram aplicados, para validação, a dois estudos de caso relacionados ao combate a fome. A viabilidade e uso do modelo conceitual e do jogo em treinamentos foram validados, assim como sua utilização no suporte a tomada de devisão em gerenciamento de operações humanitárias.*

Palavras-chave: *Logística humanitária; Desastres; Gestão de operações; Jogo de empresas; Jogo humanitário.*

1 Introduction

The occurrence of disasters requires the mobilization of a variety of humanitarian organizations to help affected populations. In particular, hunger is a type of disaster that results from a combination of factors, such as political decisions, conflicts, refugee crises, environmental exploitation (affecting agricultural infrastructure), social conditions, poverty, high population density, natural factors (such as drought) and socioeconomic factors. These interwoven factors can lead to challenging complexities in seeking to define the origin of hunger (WFP, 2013).

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Between 1900 and 2013, more than 25,000 natural and complex disasters around the world were registered in the *Emergency Management Disaster Database* (EM-DAT), and these disasters added up to more than 5 trillion dollars in damage (EM-DAT, 2013). According to EM-DAT, hunger is considered a complex disaster because it is related to other types of disasters, such as refugee crises (EM-DAT, 2013).

Famine is divided into subtypes by level of severity, such as Severe Acute Malnutrition (SAM), and is understood as a major cause of death worldwide for children under five years old. Every year, approximately 20 million children are affected by and suffer from famine and lack of proper food, leading to millions of deaths (WHO, 2007). In Africa, many organizations seek to combat hunger, including specific programs to help children, such as Action Against Hunger (ACF-USA, 2013), Save the Children (Save the Children, 2013), World Food Program (WFP, 2013), United Nations Children's Fund (UNICEF, 2013) and Adventist Development and Relief Agency (ADRA, 2013), among others. In Brazil, some hunger-oriented charity programs have been implemented by the government (such as the "Zero Hunger Program") and by non-governmental organizations to regularly help feed hungry people (Brasil, 2010).

According to Thomas & Mizusjima (2005), humanitarian logistics involves the processes of planning, implementing and controlling efficiency; managing cost-efficient flows; warehousing; and moving goods, materials and information from their origin to their point of consumption, all for purposes of helping beneficiaries. In other words, humanitarian logistics aims to help the distribution of relief supplies to hungry people, thus contributing to the goals of humanitarian organizations.

Humanitarian logistics supply chain management must operate in the face of enormous diversity and a great number of entities undertaking action (including governmental bodies, non-governmental organizations, military units, civil society organizations and humanitarian organizations) (Tomasini & Van Wassenhove, 2009) and also handle large flows of supplies (Day et al., 2012). According to Bui et al. (2000), no organization has the capacity to serve the entire contingent of victims, which requires the collaborative action of humanitarian organizations. These collaborative actions promote and integrate the relief operations that help victims, enhancing the effectiveness of the assisting organizations.

Collaborative actions are considered among the greatest challenges in humanitarian logistics, as they typically involve persistently high-risk situations and diverse organizational methods. According to Charles et al. (2010), the increasing occurrence of disasters is testing the humanitarian system's reaction capabilities, particularly the abilities of different actors to work together. Humanitarian operations depend on how humanitarian actors decide to develop their own activities, which may be at the individual level (decentralized) when the actor makes decisions about its own supply chain or collaborative (centralized) when actors jointly make operational decisions for multiple partners (Akhtar et al., 2012; Balcik et al., 2010; Kovács et al., 2010).

Business games are defended as a feasible alternative instrument to analyse the process of decision making and to evaluate the effects of collaborative and non-collaborative decisions (Bertazzo, 2014). According to Mury (2002), business games simulate decision-making exercises to train participants (Mury, 2002), and according to Sauaia (2013), business games may be used as management laboratories in creating an environment for management education and research and as an approach to deepen the education / learning process.

This study proposes a conceptual model of an organizational simulator and business game to be used as an instrument in the analysis of decision-making processes in training environments depicting humanitarian relief scenarios. The study focuses on slow-onset disasters (regular and emergency demands), in line with the famine situation application of the case study. The models proposed here are also suitable for application during sudden onset disasters (emergency demand), as supply chain management is similar in both cases. Consequently, the model can be applied in experimental scenarios of many types of humanitarian supply chains, permitting collaborative action among actors.

The development of the conceptual model and the proposed humanitarian logistic game were used as the base methodology for the theoretical background, and two case studies were used for evaluation purposes.

The first step of this research was a theoretical investigation that identified and analysed the coordination mechanisms used by humanitarian organizations in disaster situations, focusing on the analysis of logistics operations, coordination mechanisms among actors and performance indicators. The next step was to identify the theoretical background of business games to understand the importance of the use of games in analysing the decision-making process. The third step was developing a theoretical model of an organizational simulator to serve as the basis for the next phase, the proposed humanitarian business game. To evaluate the conceptual model for the simulation and the humanitarian business game, the model was applied to two case studies that involved hunger-oriented relief efforts, one in Africa and the other in Brazil.

The structure of the remainder of this paper is as follows: section 2 describes the theoretical basis; section 3 elaborates the conceptual model for the

simulation and the proposal of the humanitarian business game; section 4 describes the application in the case studies; and section 5 provides the conclusions of the study.

2 Theoretical background

This section presents the theory related to humanitarian logistics and business games.

2.1 Humanitarian logistics

Similar to a corporate supply chain, the humanitarian supply chain has the following main logistics steps: supply, transportation, inventory prepositioning, intermediate warehousing (or secondary distribution points), and local distribution points (Balcik et al., 2010). The dominant costs are related to transportation, warehousing, distribution and management (Akhtar et al., 2012).

Useful indicators for evaluating the performance of humanitarian supply chain management include the following: resources, to manage total logistics costs (Beamon & Balcik, 2008; Beamon & Kotleba, 2006; Schulz & Heigh, 2009); outputs, to manage the coverage of attempting the beneficiaries (Beamon & Balcik, 2008; Davidson, 2006); and flexibility, to manage the capability of attempting beneficiaries (Beamon & Balcik, 2008). The coverage indicator has the more humanitarian characterization. The use of performance indicators enables humanitarian organizations' decision-making results to be evaluated. A process may occur independently, when each humanitarian organization makes its decisions regarding resource allocation among the operations of acquisition, transportation, warehousing and management of its own supply chain (Balcik et al., 2010); conversely, it may occur in a centralized manner, i.e., when a company or one of the actors assumes control of decision making for the organizations with whom they are associated. Balcik et al. (2010) consider that partnerships may be established using vertical (between partnerships of different layers of supply), horizontal (between chain links) and lateral techniques (combining and sharing resources with competitors and partners) (Simatupang & Sridharan, 2002).

2.2 Games

This section presents information related to the main concepts of business games and their application to business logistics and to humanitarian logistics.

2.2.1 Business games

The business game can be understood as an attempt to provide know-how to executives and decision makers in a simulated environment in which managers analyse the results of their own decisions in a specific scenario. According to Andlinger (1958), the business game scenario allows an individual to develop decision-making abilities without taking losses.

Tanabe (1977) expands the concept of business games for three objectives: training (development of decision-making abilities), teaching (transmitting specific knowledge) and / or researching (using the scenario as a lab for analysing the variables).

In the educational environment, Rosas & Sauaia (2006) indicate that business games generally are elaborated to expose the student to a business case, provide experience in an educational environment and to reveal preliminary information to comprehend the context in which they will act. Thus, Rosas & Sauaia (2006) present a case to gamers as experiential dynamics, in which they assume strategies, make decisions and insert them into a simulator that processes data and generates a results report. In the educational environment, this report is analysed by students focusing on the observation of the causes and effects of their decisions.

2.2.2 Games in business logistics

According to Ornellas (2005), in the process of teaching-learning, business games fit in as a method of simulation in which training is inserted into a pre-determined environment that must be the nearest possible to reality. The following games (and features) were identified by Ornellas:

- LOG: Supplies, inventory, p roduction, distribution and marketing;
- *Log Advanced*: Production planning, transportation management, investment in advertising and price and warehouse planning;
- *Forecast Game*: Production quantities;
- *Logistic game* (LOGA): Location of distribution centres, capacity sizing, regular decisions about supplies, production, distribution price and advertising;
- *Beer Game*: Quantity of storage flows by the chain and bullwhip effect;
- BR LOG: Decides the location and dimensions of (long- and short-term) distribution centre and factories;
- *International Logistics Management Game* (ILMG): Each gamer defines his own role (firm or market) and stipulates an objective or logistics sub-plan. Decisions are made regarding marketing, production, transportation, investment,

acquisition, selling and movement of material and insurance;

- Supply Chain Game: Simulation of the main activities of a supply chain;
- *Supply Chain Management Simulator* (SUCH): Acquisition of supplies, quantity of production, production velocity, demand estimations, determination of warehouse space, selection of model, allocation of product in the market and programming of sales promotion;
- CAPS *Logistics*: Distribution of products (quantity, location, routes, vehicle and driver);

The differences among these games involve the simulation of many types of functions, specific or general, related to supply chain. As a common point, the use of these games aims to train or qualify people.

2.2.3 Games in humanitarian logistics

In humanitarian scenarios, there are many initiatives that simulate emergency situation challenges, presenting difficulties, disaster victims' necessities and humanitarian actors' behaviour during operations. For example, the Games for Change website releases games that simulate some conflict situations (Games for Change, 2013):

- *Endgame Syria*: simulates the complexities of civil war in Syria;
- *On the Ground Reporter*: Darfur: the gamer assumes the role of a reporter, simulating the challenges in foreign localities during conflicts and several infrastructural difficulties;
- *Darfur is Dying*: Simulates the refugee experience in Darfur, Sudan;
- *Against All Odds*: Simulates the challenges of refugees.

In addition, the next two games reproduce logistics operations of distribution supplies:

- *Inside the Haiti Earthquake*: The gamer assumes the role of a survivor, humanitarian actor or journalist during the post-earthquake period in Haiti;
- *Food Force:* The gamer must distribute items from the United Nations World Food Program (WFP) in emergency crises.

In turn, the *Humanitarian Crisis Game* is a board game that re-creates crisis situations and the activation of humanitarian operations, such as safe development, distribution of supplies, infrastructure and accessibility. The game dynamics simulate cluster actions and functions. During play, unpredictable crisis situations occur (PAXSims, 2013).

In Brazil, the Civil Defense developed an online course in a game format for elementary schools in which the students can live in risk situations. The course teaches students to identify and act in various risk situations, such as landslides, floods, storms, domestic accidents and other situations (São Paulo, 2013).

Academically, games in humanitarian logistics are a subject less explored, but a few studies have been identified. In 2015, studies on the subject were stimulated, and a special edition regarding humanitarian games included three studies published by the *Journal of Humanitarian Logistics and Supply Chain Management* (Suarez, 2015). According to Suarez, as a general matter, these contributions defend the use of games for training and development of abilities for decision makers in the humanitarian logistics environment.

- Özpolat et al. (2015): The *Greatest Good Donation Calculator (GGDC)* was developed in partnership with the *Center for International Disaster Information* (USAID). In this game, donors visualize deficiencies and problems created by cash donations;
- Gralla et al. (2015): Game for practice response activities. The simulation uses exercises of the WFP as its basis;
- Tint et al. (2015): Brings the element of "entertainment" by promoting the development of abilities such as agility, flexibility, collaboration, decision, spontaneity and affectivity.

3 Conceptual model for simulation and proposal of humanitarian logistics game

As described in the methodology, a solid theoretical background was used as a base to develop the conceptual model of the simulator and the proposed humanitarian logistics game. This bibliographic research permitted factors involved in humanitarian logistics scenarios to be identified and showed how these factors can be used in the business game context.

The development of the conceptual model of the organizational simulator required the elaboration of a

conceptual scheme with the main variables involved, including identifying a humanitarian supply chain actor and justifying the development of the conceptual model for Simulation of this research. The proposal for a humanitarian logistics game was then presented.

The description of the humanitarian logistics conceptual model for simulation and the proposal for a humanitarian logistics game follows the scheme shown in Figure 1, which represents actors, partnership types, decisions and possibilities of group formation.

The proposal for a humanitarian logistic game used as the basis for the conceptual model for simulation.

3.1 Conceptual model for simulation

The conceptual model for simulation has four main variables: (i) actors, (ii) logistics steps, (iii) decisions and (iv) performance indicators. The factors' descriptions are interrelated.

3.1.1 Participating actors in the humanitarian scenario

The actors in a humanitarian supply chain include the following:

- Local Humanitarian Actor (LHA);
- Humanitarian Coordinator Actor (CHA);
- Transportation Logistics Provider;
- Warehousing Logistics Provider;
- Suppliers;
- Donors;
- Beneficiaries.

The main actors of this supply chain, responsible for decision making and considered in the proposal for a Humanitarian Logistic game, are the LHA and the CHA. These actors are responsible for interacting with other actors, raising funds from donors, collecting information regarding demand, suppliers and logistics providers and making decisions. In the model, humanitarian actors can perform in an individual or decentralized manner, and they establish vertical partnerships with logistics service providers (represented by Group 1).

In this situation, which considers decentralized scenario decisions, only LHAs make decisions, and there is no CHA participation.

In the second option, the humanitarian actor may act in a collaborative or centralized manner and establish vertical partnerships with logistics service providers and horizontal partnerships between LHAs and the CHA (represented by Group 2). In this scenario, the CHA is responsible for making decisions in supply chain management.

It is important to highlight that the difference between both groups is the coordination mechanism used that involves LHAs and the CHA, while the

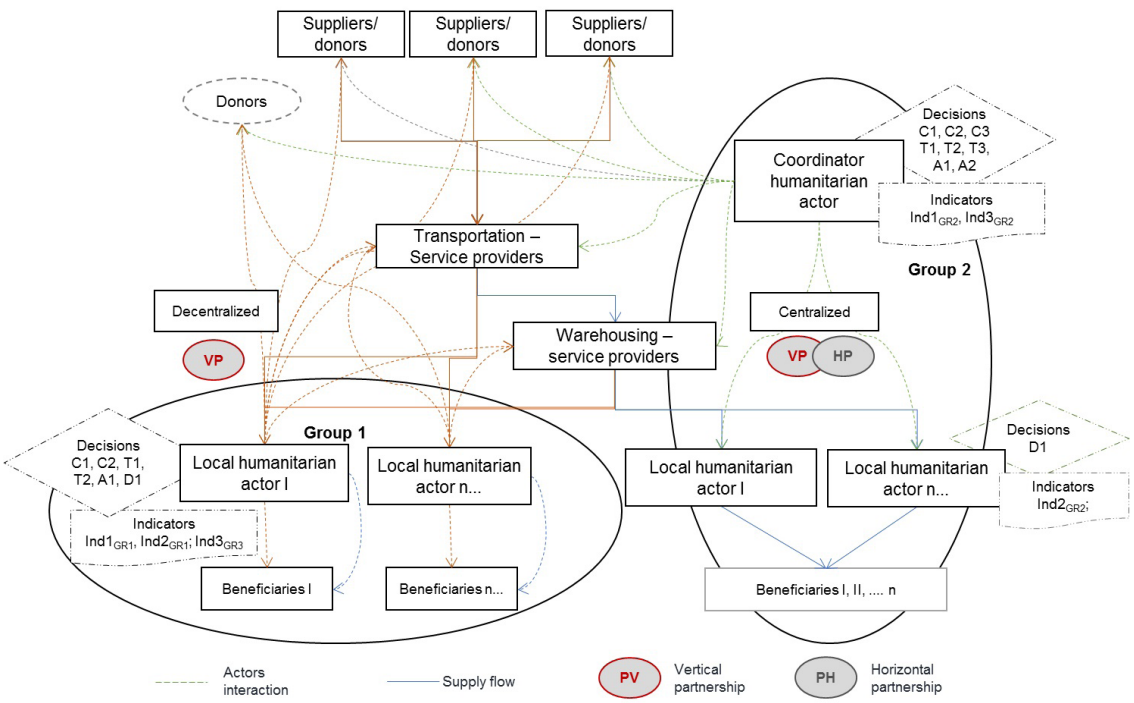

Figure 1. Diagram for the conceptual model for simulation of coordination mechanisms. Source: Bertazzo (2014).

other actors are the same (donors, beneficiaries and logistics service providers).

3.1.2 Stages and decisions

The necessary decisions in humanitarian logistics operations management are related to the logistics steps of a common supply chain. In this manner, the type of decisions made, the description of decisions, the information required and a code for the decisions used for identification in the model are provided in Chart 1.

The decisions made by Group 1, which represents the decentralized coordination mechanism, are C1, C2, T1, T2, A1 and D1. In this group, LHAs are responsible for decisions to manage their own supply chain and attempt to satisfy their own beneficiaries' demand. Local demand may be identified by LHAs individually, thereby making duplicated need identification possible, where beneficiaries located in the area of one LHA also seek help in other regions and from other agencies, thus duplicating donations.

The decisions made in Group 2, which represent centralized coordination mechanisms, are C1, C2, C3, T1, T2, T3, A1, A2 and D1. In this scenario, the LHAs are no longer responsible for raising funds with donors but remain responsible for identifying beneficiaries' demand and for direct contact with beneficiaries; thus, they remain responsible for analysing local demand and deciding how many supplies (D1) to solicit from the CHA.

The remaining decisions are made by the CHA, which evaluates possibilities and includes collaboration in logistics activities, such as acquisition in large quantities to provide for more than one LHA, associated with the transport of products in collaborative freights and warehousing service providers (characterizing horizontal partnerships).

Decisions made by the CHA define the way that the coordination of logistic activities will involve vertical or horizontal partnerships for contracts of service provided or collaborative contracts between organizations. With collaborative contracts, the CHA can mobilize the purchase of greater quantities of supplies to meet total demand for all the organizations, and the same may occur for contract transportation and warehousing.

3.1.3 Performance measures

As humanitarian actors (LHAs and CHAs) are responsible for making decisions, their decisions must be evaluated by measures that permit the analysis and monitoring of activities.

Donors, in turn, are responsible for releasing resources that fund the operations. In the model, these actors analyse the measures associated with supply chain management. The performance indicators considered in the model are as follows:

- Total logistics costs;
- Attendance covering;
- Attendance capacity.

3.2 Proposal for a humanitarian logistics game

The proposal for a humanitarian logistics game aims to apply to situations faced by humanitarian organizations by focusing on collaborative or competitive actions

Chart 1. Framework of humanitarian logistic game decision.

Decision type	Code	Decision to be made	Required information
Acquisition	C1	From which supplier to buy	Price of items from each supplier Supply capacity by period Demand
	C2	How much to buy	
	C3	Collaboratively buy with another agent	
Transportation	T1	Which carrier / modal contract	Transportation costs
			Transportation capacity by period
	T2	Quantity to transport	Transportation time from supplier to local agent or from warehouse to local agent
	T3	Whether to share transportation	
Warehousing	A1	How much to stock in each period	Item's shelf life
	A2	Local or collaborative warehousing	Warehousing cost
			Warehousing capacity by period
Demand	D1	How much supply required	Number of beneficiaries, item quantity by person

Source: Bertazzo (2014).

among organizations, and particularly on abilities related to managing logistics functions, classified as a process game, as long as – according to Belhot (1997) – it replicates those situations confronted by humanitarian organizations.

This game proposal is also classified as a functional game, which, according to Keys (1977), focuses on the management of an organization's logistics functions. The logistics functions that are used correspond to acquisition, transportation and warehousing roles, which are represented in the scheme of the conceptual model for simulation, presented above.

The proposal of a game for supply chain management in humanitarian scenarios associates elements of business logistics games with characteristics of humanitarian scenarios, focusing on decisions that involve and promote cooperation among humanitarian organizations.

3.2.1 Base model

Developing this game proposal is associated with the conceptual model of simulation and the conceptual model of business games of Rosas & Sauaia (2006), resulting in the base model of the humanitarian game shown in Figure 2.

The humanitarian case used involves a humanitarian supply chain that permits the participants to experience logistics decisions made in disaster situations (presented in Chart 1).

The **strategy** assumed by gamers and the **decisions** that must be made depend on the group that each gamer is part of (Group 1 or Group 2), following the scheme of Figure 1. Group 1 represents the decentralized coordination mechanism, in which participants (assuming the role of LHA) are responsible for managing the supply chain autonomously. Group 2 represents the centralized coordination mechanism in which participants (assuming the roles of LHA and CHA) select one of the members to act as a CHA and make the decision for the group. Thus, Group 1 assumes the "competitive" strategy and Group 2 the "collaborative" strategy.

After choosing the strategy, the gamers must make decisions and insert them into the computing simulator, which processes data and outputs reports to present the results of decisions and performance measures. In this manner, participants can evaluate the cause-effect relation of decisions made and results obtained.

The gamers that adopt the decentralized coordination mechanism strategy (Group 1) assume the role of LHAs and make decisions C1, C2, T1, T2, A1 and D1. Gamers that adopt the centralized coordination mechanism strategy (Group 2) may assume the role of LHAs or CHAs. The gamers that assume the role of LHA must make decision D1, and those that assume the role of CHA make decisions C1, C2, C3, T1, T2, T3, A1 and A2.

The necessary information (Chart 1) for making decisions is shared with the responsible gamers. In this manner, the participants in Group 1 have access to information necessary for their decisions (C1, C2, T1, T2, A1 and D1). In the case of Group 2, the participants receive information related to decisions they are responsible for; thus, the LHA has the information related to demand, and the CHA has additional information. In the latter group (Group 2), it is essential that participants share information; in other words, LHAs must share information with CHAs.

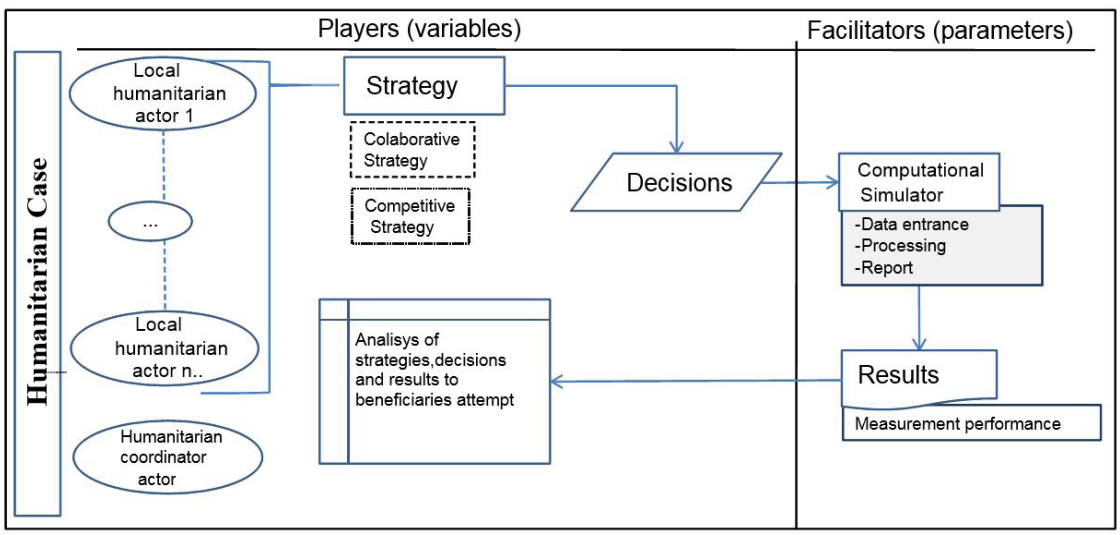

Figure 2. Base model of humanitarian game. Source: Adapted by Rosas & Sauaia (2006).

3.2.2 General dynamics

The conceptual model of the humanitarian game is presented in Figure 3.

In this model, both groups are evaluated with regard to different dynamics but with a final and unique result, which simulates competitive and collaborative decisions and enables a comparison between the decisions and results of each group. The number of gamers in Group 1 and in Group 2 must be the same, varying in a range from 1 to n (J=1, 2, ..., n).

3.2.3 Group 1 dynamics – decentralized coordination

1) The gamers (Gamer 1, Gamer 2, ..., Gamer n) assume the role of LHAs and receive information about the **humanitarian case** demand to make **decisions** (C1, C2, T1, T2, A1, D1).

2) The gamers (individually) analyse information and make **decisions** to manage their own supply chain and to attempt to meet their beneficiaries' demand.

3) Each gamer inserts the **decisions** into the **computational simulator** and receives **partial results** ($Ind1MD_I$, $Ind2MD_I$, $Ind3MD_I$; $Ind1MD_{II}$, $Ind2MD_{II}$, $Ind3MD_{II; ...;}$ Ind1MDn, Ind2MDn, Ind3MDn)

a. Ind1: supply chain management costs.

b. Ind2: attendance rate, the ratio between the number of people who have their needs met and the number of people that need help during a determined period.

c. Ind3: attendance capability for each gamer. The logistics capabilities that the chain supports (CapFCS – provision; CapPSTCS – transportation; or CapPSACS – warehousing) are represented by the capability of the minor value.

4) The **partial results** are transformed into **group results** ($Ind1_{GR1,}$ $Ind2_{GR1,}$ $Ind3_{GR1}$).

a. $Ind1_{GR1}$: the cost of the entire supply chain, therefore, the sum of all gamers' supply chains. As there are *n* gamers (j=I, II, ..., n) and *n* supply chains (cs=I, II, ..., n), $Ind1_{GR1}$ equals the sum of indicator 1 of the gamers ($Ind1MD_I$, $Ind1MD_{II}$, ..., $Ind1MD_n$).

b. $Ind2_{GR1:}$ the average performance of decision gamers in the measure related to attendance rate. As there are *n* players (j=I, II, ..., n) and *n* supply chains (cs=I, II, ..., n), $Ind2_{GR1}$ equals the average of the indicator 2 of all players ($Ind2MD_I$, $Ind2MD_{II}$, ..., $Ind2MD_n$).

c. $Ind3_{GR1:}$ the attendance capability average of each player, in other words, the average of how many people the supply chain can provide for in a determined period. As there are *n* players (j=I, II, ..., n) and *n* supply chains (cs=I, II, ..., n), $Ind2_{GR1}$ equals the average of indicator 3 of all players ($Ind2MD_I$, $Ind2MD_{II}$, ..., $Ind2MD_n$);

5) The **group results** are amplified by factors from 0.0 to 1.0 attributed to each indicator (P1, P2 e P3). The factor strains are delegated by the game director,

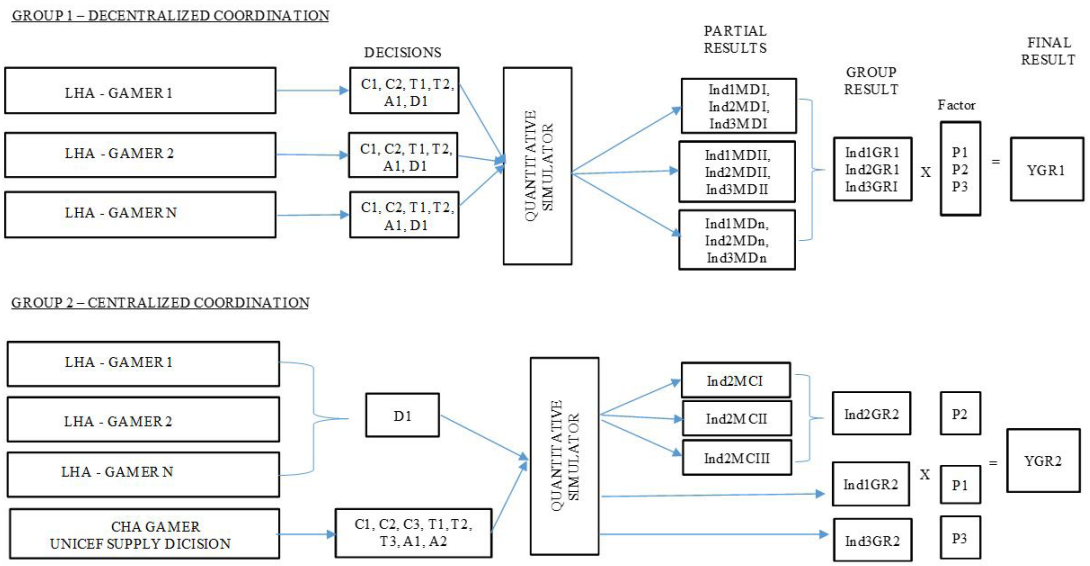

Figure 3. Conceptual model of the humanitarian logistics game. Source: Adapted from Bertazzo (2014).

according to the case study objectives. The final result comes from the equation: $Y_{GR1} = Ind1_{GR1}$ x P1 + $Ind2_{GR1}$ X P2 $_+$ $Ind3_{GR1}$ X P3.

3.2.4 Group 2 dynamics – centralized coordination

1) The players (Player 1, Player 2, ... Player n-1) assume the role of LHAs, and one of the players assumes the role of the CHA. The players with the LHA roles receive information about the **humanitarian case** needs for making **decisions** related to their responsibility (D1). The CHA role player receives information about the **humanitarian case** needs for making **decisions** related to his responsibility (C1, C2, C3, T1, T2, T3, A1, A2).

2) In a collaborative group, LHA players share information with the CHA, which analyses information and makes **decisions** to manage the supply chain and attempts to meet the demand of all the LHAs' beneficiaries.

3) Each player inputs the d**ecisions** they are responsible for into the **computational simulator**. The players playing the LHA role obtain the **partial results** ($Ind2MC_I$, $Ind2MC_{II}$, ..., $Ind2MC_{III}$).

a. Ind2: the attendance rate, the ratio of the number of people the organization attempted to serve and the number of people that demand attendance in a determined period.

4) The **partial results** of the LHAs are transformed in **group results** ($Ind2_{GR2}$).

a. $Ind2_{GR2:}$ the average performance of all players of the indicator related to the attendance rate. Considering n players (j=I, II, ..., n) and *n* supply chains (cs=I, II, ..., n), $Ind2_{GR1}$ equals the average of indicator 2 of all players ($Ind2MC_I$, $Ind2MC_{II}$, ..., $Ind2MC_n$).

5) The results of the CHA are the **group results** for the indicators ($Ind1_{GR2}$ and $Ind3_{GR2}$):

a. $Ind1_{GR2}$: the total cost of the supply chain, i.e., the sum of management costs of all players that represent LHAs. Considering that there are n-1 LHAs (j=I, II, ..., n-1) and *n*-1 supply chains (cs=I, II, ..., n-1), $Ind1_{GR2}$ equals the sum of indicator 1 for all players ($Ind1MC_I$, $Ind1MC_{II}$, ..., $Ind1MC_n$).

b. $Ind3_{GR2:}$ the average of the attendance capability of the entire chain in attempting to meet the demands of all the groups of beneficiaries from LHAs. This figure equals $Ind3_{GR2} = (CAPmax_I + CAPmax_{II} + ... + CAPmaxn) / n$.

6) The **group results** are applied by factors (strain) from 0.0 to 1.0 given to each indicator (P1, P2 and P3). The strain factor is delegated by the game director (teacher, for example), based on the study's case objectives. The final result equals $Y_{GR2} = Ind1_{GR2}$ x P1 + $Ind2_{GR2}$ X P2 $_+$ $Ind3_{GR3}$ X P3.

3.2.5 Final result

To evaluate the final game result and winners, the process of evaluation takes the following steps:

1) Presentation of the **decisions** made by the group, **partial results** and **final results**.

2) As the objective of the chain is to serve the beneficiaries, supply chain management must be analysed in terms of the performance of each of the humanitarian actors focusing on the general beneficiaries' attendance.

3) Analysis of the cause-effect relation between the assumed strategies, the decisions made and the results obtained.

4 Case study

To evaluate the conceptual model for simulation and to propose the humanitarian logistics game, it was applied to two case studies described in advance.

4.1 Description of the cases

One of the ways to combat hunger and severe acute malnourishment in children in the Horn of Africa adopted by humanitarian organizations, such as UNICEF and Doctors Without Borders, is the distribution of ready-to-use therapeutic foods (RUTF), including Plumpy'Nuts, a product made from peanut butter, sugar and dried milk. Plumpy'Nuts is the main type of RUTF purchased by UNICEF and distributed to treat malnourished children (Swaminathan, 2009).

In Brazil, a case study was undertaken of two food banks in São Paulo city, the NGOs Banco de Alimentos *(Food Bank*) and Associação Prato Cheio (*Full Plate Association*). Both are non-governmental initiatives that focus on providing food and fighting against waste, promoting educative action and expanding actions and knowledge regarding the real problem of hunger in society (Associação Prato Cheio, 2014; Banco de Alimentos, 2014). The description of this study of food banks is presented by aggregating data from both types analysed organizations to see that the method of both organizations is similar, with minor differences highlighted in the text.

4.2 Application analysis of the conceptual model

Chart 2 presents the factors considered in the conceptual model for simulation and the application in both case studies.

The tactical planning level of logistics steps in the conceptual model for simulation allows suppliers and transportations and warehousing service providers to be married.

It remains necessary to make decisions about buying quantities from each supplier or hiring service providers. Finally, it must be determined whether the resources used will meet the demand of only one region (or local humanitarians organization) or more regions (many local humanitarian organizations).

The same humanitarian actors in both chains (donors, suppliers, service providers and humanitarian actors) involved in the logistics steps are part of and influence the decisions made by LHAs and CHAs.

In Case Study 1, the LHA represents the local humanitarian agencies, and the CHA represents the UNICEF Supply Division. In Case Study 2, the LHA represents the beneficiaries' entities that help beneficiaries directly, and the CHA represents the food bank.

The differences identified between both case studies and the conceptual model developed are situated in terms of acquisition and warehousing activities. The logistics steps of acquisition and warehousing in Case Study 1 are similar to those in the conceptual model, whereas, in Study 2, there are no decisions related to food acquisition in the supply and warehousing step because the food banks do not negotiate food purchases. Thus, the organization depends on direct donations of food

Chart 2. Comparative betwen conceptual and study case models.

		Conceptual model	***Plumpy'Nuts***	**Food Bank**
Logistics steps		Supply		
		Transportation		
		Warehousing		Not applied
Decisions	Supply	*C1		Not Applied
		*C2		
		†C3		
	Warehousing	*A1		Not Applied
		†A2		
	Transportation	*T1		*T1
		*T2		*T2
		†T3		†T3
	Demand	*D1		*D1
		†Emergency Non-emergency		Non-emergency
Humanitarian actors		Donors	General public, companies, government, NGOs	
		Suppliers	Nutriset/ others	Grocery store, municipal stores, farmers
		Transportation service providers	Scan Logistics, Kuehne+Nagel, DHL	Organization or outsourcing
		Warehousing service providers	NGO implementor / Distribution central	
		Local humanitarian actors	Implementer NGO	Charitable institution
		Coordinator humanitarian actor	Supplier Division of UNICEF	Food bank
		Beneficiaries		
Measures		Total cost		
		Attendance covering		
		Maximum attendance capability		
*		Local Humanitarian Actor		
†		Local and Coordinator Humanitarian Actor		

Source: Bertazzo (2014).

and does not store food because the food is collected and distributed in the same day.

The conceptual model points to ordinary and emergency demand as possibilities. As both studies fight hunger, a slow-onset natural disaster, regular demand is identified in both cases. The food banks do not face emergency demands, in contrast to the Plumpy'Nuts case.

4.3 Analysis of coordination mechanisms

The potential of centralized and decentralized actions was identified in both cases. The decisions related to acquiring vertical partnerships, including selection of suppliers and definition of quantities for purchase, and horizontal partnerships, including collaborative acquisition with other organizations. These types of decisions are not applied to the food bank case because there is no supply acquisition.

Decisions related to storage involve selecting warehouse and storage quantities in each pre-determined period. This decision is also not applicable to the food bank, as there is no storage of food; the cycle of receiving, processing and distribution of supplies occurs all in one day. Partnerships may be vertical, such as contracting a warehousing service provider, or horizontal, involving more than one humanitarian organization.

Decisions in transportation include selecting the service provider through vertical partnerships, contracting services, and / or horizontal partnerships, with the help of more than one organization.

In the conceptual model and in the two case studies, a mixed coordination mechanism with vertical and horizontal partnerships is possible.

4.4 Analysis of the humanitarian logistic game

Related to the proposal of the conceptual model of the humanitarian logistic game, two types of roles were possible: the LHA or CHA. These decisions are similar to the conceptual model for simulation, and the game decisions applied to the UNICEF case are equivalent to those in the conceptual model. The strategies of the game refer to the decentralized coordination mechanism (competitive) and to the centralized coordination mechanism (collaborative). The differences between the applications of the conceptual model and the case studies are the decisions related to acquisition and warehousing, which, following the decentralized conceptual group from the scheme, are only possible in the UNICEF case, as shown in Chart 3.

Shared acquisitions were identified for the Plumpy'Nuts and food bank study cases. In the Plumpy'Nuts case, the humanitarian actors acquire the products directly from suppliers (vertical partnership) in which each local partner may buy to meet his own supply and demand, or a coordinator actor may buy to meet the demand of many organizations (horizontal partnerships).

This type of partnership was identified at the Full Plate Association and Food Bank. As there is no product acquisition, there was also no vertical partnership in the food banks' acquisition operations.

Sharing supply acquisition facilitates the hiring of transportation and warehousing service providers through previous contracts with suppliers that stipulate where the items are collected and delivered, by means of acquisition or donation.

Therefore, there is the possibility of cost reduction by increasing the power of negotiation in the case of Plumpy'Nuts.

The collaborative model of food bank management might be expanded to the acquisition of non-perishable foods, attempting to provide people with this type of products also. This situation is possible because the products are more durable and easier to store, and this measure would stimulate partnerships with other business institutions that are interested in issues such as sustainability and humanitarianism. In both cases of logistics acquisition, the use of centralized or decentralized coordination mechanisms is feasible.

When LHAs are associated and permit the CHA to make decisions (e.g., UNICEF Supply Division and Brazilian partner food banks), this actor has more power to negotiate the provision of services such as transportation and warehousing. In other words, one service provider (transportation or warehousing) may be contracted (vertical partnership) to meet the demands of many partners or associated entities (horizontal partnerships).

For warehousing operations, the local partners (decentralized mechanism) or the Supply Division (centralized mechanisms) can establish vertical partnerships by hiring service providers to serve more than one local partner by supply division (horizontal partnerships). For charity entities and food banks, whose products are perishable, there is no need for warehousing services.

In addition to warehousing operations, local partners/supply divisions and charity entities / food banks can contract service providers for transportation (vertical partnership) to meet their own demand, using the decentralized coordination mechanism; or to meet other local partner / charity entities' demand by the supply division/food bank (horizontal partnership)

Chart 3. Comparative of mechanisms aplied in the case study.

		Competitive strategy / decentralized mechanism			**Collaborative strategy / centralized mechanism**					
		Conceptual model	**UNICEF**	**Food banks**	**Conceptual models**		**UNICEF**		**Food banks**	
Decision type	Code	LHA	Local Partnerships	Charity entities	LHA	CHA	Local Partnerships	Supply Division	Charity entities	Food banks
Aquisition	C1	X	X	Not applicable		X		X		Not applicable
	C2	X	X			X		X		
	C3					X		X		
Transportation	T1	X	X	X (road)		X		X		X (road)
	T2	X	X	X (road)		X		X		X (road)
	T3					X		X		X
Warehousing	A1	X	X	Not applicable		X		X		Not applicable
	A2					X		X		
Demand	D1	X	X	X	X		X		X	

Source: Bertazzo (2014).

using the centralized coordination mechanism. It was observed that the transportation service providers can be commercial or philanthropic and need not necessarily involve forming vertical partnerships in the transportation operations of food banks.

During the analysis of the case studies herein, some decisions of the UNICEF Plumpy'Nuts supply chain were not applied to the food banks, as the latter do not realize some operations of warehousing and product acquisition. However, it was verified that the proposed game can be used realizing the adaptations necessary for the types of decision making.

5 Conclusions

This study aimed to comprehend the logistics decisions related to disaster situations for those affected and then to develop a conceptual model of an organizational simulator and a proposed humanitarian relief logistics game. Therefore, the considered analysis factors involved identifying the following: actors; decisions; the relevant performance measures for humanitarian supply chain management (including issues related to costs and quality of humanitarian attendance); supply chain structure; and the means by which partnerships and cooperation can be constructed among humanitarian relief actors.

The results of the analysis of the conceptual model's application in the case studies verified that the centralized coordination mechanism is the most utilized in both studies, with the centralized actor in each case being the UNICEF Supply Division (Africa) and the food banks (Brazil).

The conceptual model for the organizational simulator may serve to develop a computational model of a simulator that enables the application and quantitative verification of the cause-effect relations of actors' decisions.

Proposing a humanitarian logistics game aims to demonstrate the viability of the conceptual model of an organizational simulator associated with a disaster scenario. When required, the game proposal can be used with adaptations based on the type of decisions required and the disaster type. Thus, it can be used by humanitarian managers, students and researchers.

As this research focused on fighting hunger, it is recommended that future studies analyse sudden-onset disasters (such as hurricane or flood) and other types of slow-onset disasters (such as drought), observing the actions developed by each actor involved, the method, type and the instruments of collaboration that can be used to improve supply chain management in the case studies.

The proposed logistics game was not applied to groups of players for testing – which must be undertaken in future steps – but to case studies to demonstrate its viability in terms of application and analysis. This proposal differs from other business games by allowing testing of logistics decisions in disaster scenarios.

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