# HOW DOES THE BEER DISTRIBUTION GAME HELP US TO UNDERSTAND HUMANITARIAN SUPPLY CHAINS?

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**Abstract**

This research seeks to establish the effects of variations in material flow under Push and Pull inventory strategies in the humanitarian supply chain. It examines the extent to which the Bullwhip Effect impacts upon a humanitarian supply chain and considers forecasting within the humanitarian supply chain to determine what can be done to mitigate against this effect.

**Keywords**

Humanitarian; Supply Chain; Bullwhip Effect; Material and Information Flow.

## Introduction

This year's conference theme is 'Planning for Uncertainty – Creating Supply Chain and Logistics Systems Resilient to Global Change'. This is quite a pertinent theme given recent political events but it is equally relevant when considering the wide and expanding field of Humanitarian Logistics. By its very definition, planning for humanitarian interventions is full of uncertainty: in terms of the skill sets needed to be effective on the ground; in terms of location, terrain and surviving infrastructure; and in terms of what and where assistance is required, to mention but a few. In a logistic context, planners and practitioners must grapple with uncertainty in designing and operating an appropriate and resilient supply chain with its associated logistic systems. Considerations include how to overcome ethical, cultural and moral challenges; how to deal with bureaucracy, political influences and unrest; how well the humanitarian supply chain functions in terms of delivering 'need' rather than 'want'; and how it influences behaviours to protect the reputation of the organisation and thereby protecting the future flow of donations and other forms of aid.

By taking an inductive approach, this research seeks to use exploratory methods to establish the effects of variations in material flow under Push and Pull inventory strategies in the humanitarian supply chain. It examines the extent to which the Bullwhip Effect impacts upon a humanitarian supply chain and considers forecasting within the humanitarian supply chain to determine what can be done to mitigate against this effect.

## Literature Review

The literature which has contributed to this research is drawn from a wide range of sources. In addition to the many articles published in international journals such as the Journal of Humanitarian Logistics and Supply Chain Management and the International Journal of Physical Distribution and Logistics Management, books, operational reports and conference papers have guided this research. The literature has also offered some conflicting views, particularly in the definition of the customer, where, for example, Tatham and Hughes (2011) allude to a 'final customer', while Shiffling and Piecyk (2014) suggest that the customer can be found all along the supply chain. Oloruntoba and Gray (2006) seem to corroborate Christopher and Tatham (2011) but do not go so far as a definition. The literature also confirms some rather uncomfortable truths regarding supply chain ownership and control, the role and influence of donor organisations and the flow of materials and information. Sandwell (2011) is quite explicit when he refers to donors demanding that their aid is directed to a particular beneficiary group, often in a manner that undermines the strategic aid plan. He reflects the frustration experienced by strategic and logistic planners. Meanwhile, Maxwell, *et al* (2012) reveal perceptions,

gaps and challenges regarding corruption in humanitarian assistance, much of which had already been identified on the ground and published in the ODI report by Willetts-King and Harvey (2005). In addition to highlighting the importance of coordination in humanitarian relief operations, Altay (2008) looks at how Non-Governmental Organisations (NGOs) conduct contingency planning in areas of the world where assistance is most likely to be needed; the importance of coordination and the need for efficient passage of information is highlighted by both Akhtar, *et al* (2015) and Tomasini and Van Wassenhove (2009). The need for frameworks to be developed to assist logistic practitioners is acknowledged by Overstreet, et al (2011), D'Haene (2015) and Carroll and Neu (2009), but attention is drawn to the issues of control and ownership by Kovacs and Spens (2009), MacLachlin and Larson (2011) and Christopher and Tatham (2011). An aspect of inventory strategy which is more important in the humanitarian supply chain than in the commercial world is that of Push and Pull logistics; Oloruntoba and Kovacs (2015) look at this in some detail and Chandes and Pache (2010) consider this in the wider context of NGO reaction and collective action.

**The Challenge**

Until recently, humanitarian logistics was not necessarily recognised as a specific, niche discipline; instead, it was viewed by many as an application of commercial, or even military logistic thinking to a humanitarian relief operation. Van Wassenhove (2006) reflects of this situation and notes the 'fire-fighting mentality' (p.476) of certain commercially trained logistic managers who view humanitarian logistics as merely the movement of material and equipment from a point in the developed world to a point of need somewhere in the developing world. Overstreet, *et al* (2011) recognise that humanitarian logistics, and the design of humanitarian supply chains in particular are fundamentally different from those of commerce, and this is reflected in the development and proliferation of educational courses at institutes, colleges and universities. However, we are not yet at the stage where all humanitarian logisticians and humanitarian operations planners have been educated in this relatively new discipline. Gralla, *et al* (2015) suggest that there is a case for 'developing the logistic skills of both new and experienced practitioners' (p.115). The majority are schooled in commercial logistics and have to adapt by themselves when presented with humanitarian logistic challenges in the field, a situation acknowledged by the World Food Programme (WFP) Logistic Cluster (2015b) in their 2016-2018 Strategy paper.

**The Research**

Published academic articles, evaluation reports from past humanitarian logistic operations and observations by the researcher have been used to inform the development of a model similar to the Beer Distribution Game developed by Forrester (1958) to understand where uncertainty is generated in humanitarian supply chains through variations in commodity demand. The primary case studied in this research is the response to the 2014/15 Ebola Crisis in Guinea, Sierra Leone and Liberia.

The humanitarian supply chain is complex in terms of ownership, control and information flow, but importantly, the 'customer' in a commercial supply chain is quite different from the customer in a humanitarian supply chain. The Beer Game, a widely-understood example of illustrating the demand and forecasting fluctuations within a commercial supply chain, is based on the principle that the customer places a demand on the supply chain and that this demand can vary in volume, depending on the appetite of the customer and their ability to fund larger volume purchases. Nienhaus (2002) explains that this demand creates a reaction by the wholesaler, bottler and brewery in the manufacture and distribution of bottled beer and that the game helps determine if, where, and to what degree changes in customer demand creates uncertainty and over- or under-supply in the supply chain.

Starting with the customer and working backwards, it is possible to map logically the four principal elements of the supply chain, reflecting Forrester's Brewery, Bottler, Wholesaler and Retailer. For the

purposes of this research, the Donor organisation is viewed as the Brewery, the initial source of the required materials, equipment or funding. The International NGO (INGO) parent organisation, often located in Europe or the USA, is seen as the Bottler, acting strategically as well as operationally, and being the sole point of contact of the Brewery. The country office of the INGO organisation acts as the Wholesaler, often located in the capital city of the stricken country. The Retailer is the local NGO working with subject matter experts at the point of need, and in a position to relay the demand from the expert to their NGO country office. This then leaves the question we started with: who is the customer?

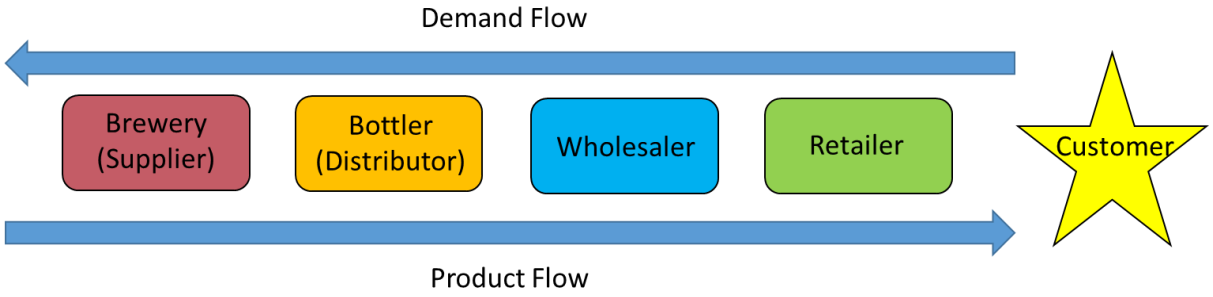


Figure 1. The Elements of the Beer Distribution Game. Adapted from Forrester (1958).

Beaman and Balcik (2008) explain that the key decision-makers within the humanitarian supply chain are the donors who are funding the operation and that many NGOs regard the donor as the customer in the humanitarian supply chain. In commercial supply chains, the end recipient decides what supplies they require, and fulfilment can be easily evaluated by monitoring the receipt of these supplies. However, in humanitarian operations, as supplies are determined by external assessments of the needs of the beneficiary, evaluating fulfilment becomes more difficult, as additional analysis must be undertaken to determine if these needs have been met by the supplies provided. Importantly, they note that unlike commercial supply chains, humanitarian operations are not judged on their speed and costs, but rather by their impact.

## Analysis

### The Customer

The first step in developing this model is to analyse and define who the customer is, what role they play and how much influence they have on the humanitarian supply chain. The Beer Game relies on the Lysons and Farrington (2006) definition of the customer as 'simply the recipient of the goods or services that result from all the processes and activities of the supply chain' (p.92) because the customer is the consumer; however, this is not necessarily the case in the humanitarian context. The consumer will be the family left without shelter after the earthquake, the baby suffering from malnutrition or the young man who has contracted Ebola. But these individuals cannot be the customers in the humanitarian version of the Beer Game because while they place a demand on the supply chain, sometimes without knowing it, they cannot influence the meeting of that demand.

If we extrapolate the logic of Nienhaus (2002) that the customer is the individual that places a demand for a specific item, in the humanitarian logistics paradigm the customer must actually be an appropriately experienced or qualified Subject Matter Expert (SME). This is the person on the ground, closest to the disaster, who has oversight of the local needs. This person may be a doctor, nutritionist or other professional capable of determining what aid is actually needed, to whom it must be directed, where, when and in what quantities. This person will be able to inform the supply chain, interact with the supply chain and act as the final link between the supply chain and the actual consumer. Howden (2009) depicts this person in his humanitarian supply chain flows model and refers to it as the person engaged in 'monitoring and evaluation'.

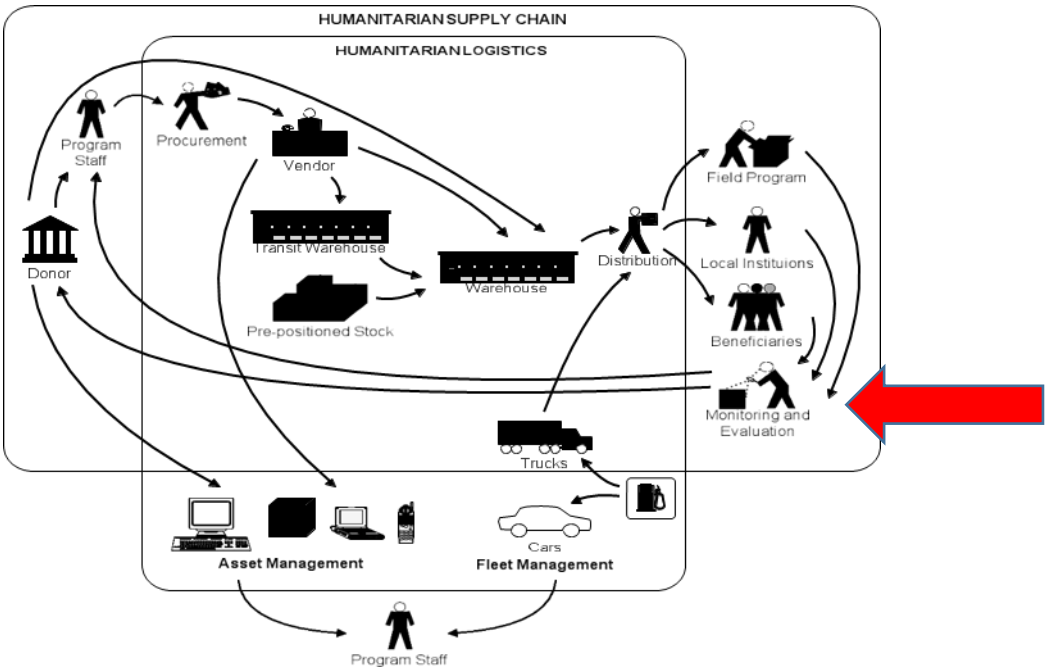


Figure 2. Humanitarian Logistics and Humanitarian Supply Chain Flows. Howden (2009).

**Commodity Control Interface**

Humanitarian supply chains can become increasingly complex once commodities have crossed the international interface to enter a country receiving aid assistance. When more than one aid agency is involved, a number of individual supply chains are often established, catering for the needs of each specific NGO. MSF (2016) Supply Annex shows that this was the case during the Ebola Crisis. Many donors provide a single commodity which, as Logistics Cluster (2015b) recognises, will run through individual supply chains to the in-country headquarters offices of the lead NGOs. It is at this point that collaborative working starts, and is the point where in-country NGOs come to appreciate the holistic priorities of the aid programme in addition to the priorities of their specific project. In classic PRINCE2 terms, this is the point where project management is superseded by programme management, with the WFP's Logistics Cluster acting in a similar manner to a Programme Board. The interface between the individual NGOs and the collaborative envelope of the Logistics Cluster is where NGOs are most likely to relinquish control over commodities to address priorities outside their sphere of influence.

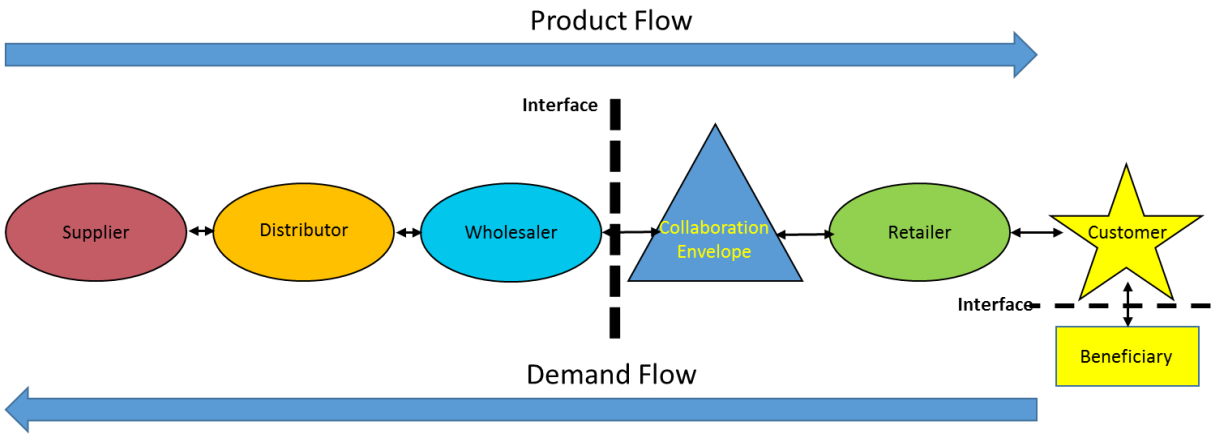


Figure 3. The Commodity Control Interface and the Collaborative Envelope.

**Customer / Consumer Interface and the Collaborative Envelope**

Even in a simple humanitarian supply chain where there is only one NGO providing all the aid, the customer will be the SME and the consumer, the beneficiary. At this point, the consumer's simple needs of medical aid, food, water and shelter are translated into a complex demand for commodities. Medicines as determined by a health professional; food and water requirements as determined by a nutrition specialist; and shelter as determined by an engineering specialist. These demands inform the supply chain of the exact nature of commodities required by the consumer and these are passed up the supply chain to the entity acting as the 'retailer'. This may be a small storage facility which may not stock the items required and therefore a demand is placed further up the chain, but in the humanitarian supply chain, this is not directly to the 'warehouse'. Between the retailer and warehouse sits the collaborative envelope: a logistics services and supply brokerage where NGOs and other aid agencies come together to coordinate disparate supply chains and collaborate in the resolving of supply chain issues for the many potential beneficiaries across the programme. As UNICEF (2014) recognises, in this forum, commodities such as rice, nutritional supplements, flour, bottled and bowser water, tarpaulin shelters and tents, disinfectants, blankets, specific medicines and medical supplies, and clothes can break out of individually stove-piped NGO and governmental supply chains and be directed towards the point of greatest need. Clearly, integrating many supply chains in this way can give rise to great complexity, but by providing alternative sources of aid, it can also contribute much to supply chain resilience. However, a pre-requisite for such a complex supply chain to work efficiently as well as effectively, there must be an effective flow of information along the entire supply chain and a supporting flow of information and guidance up to and down from individual NGO and governmental strategic decision makers. WFP (2017) and UNICEF (2014) both testify that the National Ebola Response Centre Logistics Cluster was extremely valuable in acting as the collaborative envelope for the Ebola Crisis operation, but both concur that much more development of the forum and its policies and procedures needs to take place. Indeed, WPF (2017) go as far as to suggest that 'the relevance of these [extant emergency response] policies as a trigger to initiate action has not been sufficiently established' (pp.11).

**Humanitarian Supply Chain Complexity**

In variance to the Beer Game's simple supply chain, a single humanitarian supply chain sees more than one commodity being supplied in a shared, operationally focused chain, where often, a single, identical commodity type may be supplied by more than one donor. Multiple donors may be supporting a few major NGOs, or a select few donors may be supporting a plethora of NGO organisations. Some donors may themselves be NGOs, for example, WFP.

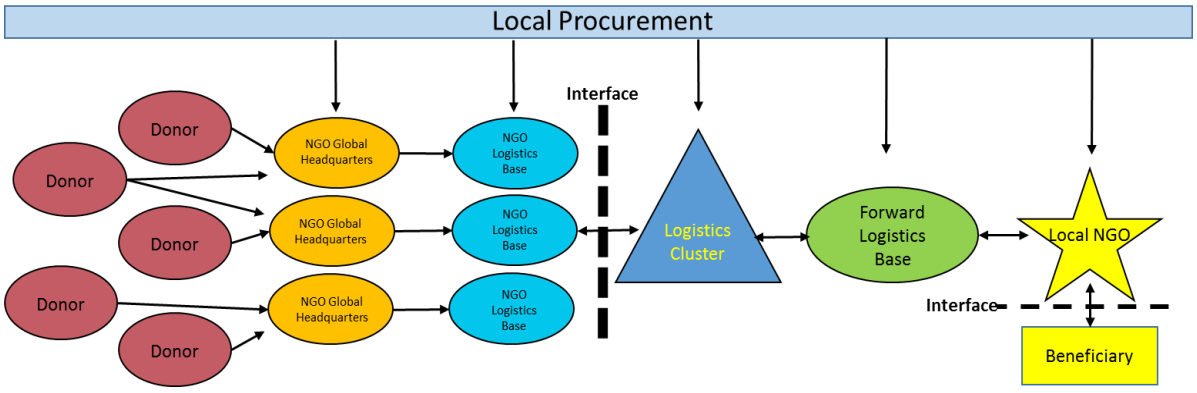


Figure 4. Humanitarian Supply Chain Complexity and Role of Local Procurement.

To ensure that such a surge does not always adversely impact on other operational priorities, the humanitarian supply chain has the advantage of local procurement: the utilisation of financial resources in the theatre of operations to buy in materials, equipment or services. This can also be used to relieve pressure on the supply chain in the event of delays or losses. NGOs will exert strategic control over their in-country offices from their global HQs, and these entities are capable of mechanising local procurement from outside the aid region. Where appropriate, they will facilitate local procurement in-country, normally for commodities to support their own local objectives, but larger NGO and International Governmental Organisations (IGOs) such as USAid and the UK's DfID will also locally procure in support of pan-programme requirements and the specific needs of smaller NGOs. However, this takes a great deal of coordination and it is in this role that the WFP's Logistic Cluster makes a significant contribution.

**Push and Pull inventories**

Push logistics as a humanitarian supply chain strategy differs profoundly from the commercial world in that there is no anticipation of demand based on long-term forecasting and inherent uncertainty. Rather, it is based on short-term, if not immediate anticipated demand where certainty is virtually assured: there is an established need. Push strategies tend to be employed early in humanitarian operations to ensure a sufficient volume of urgently required specific material is delivered to the point of need. Push tends to give way to Pull once effective supply chains have been established. The effectiveness of such supply chains is determined by the flow of information as this is the key element of Pull logistics: the ability to inform the supply chain of accurate demand. In the case of the Ebola Response in Sierra Leone, commodities were sent forward from the logistic base at Port Loko to district storage facilities where bulk was broken before being forwarded to points of need. Where items were delivered as part of multi-commodity packs, some commodities were needed and others not. Due to the frenetic work involved in forwarding materials, items which were not required were held in storage by local NGOs 'Just in Case' rather than being immediately back-loaded for redistribution. Some storage facilities began to fill with unnecessary items but the Logistics Cluster was in a position to instigate a reverse supply chain to relief the pressure on such facilities. In February 2015, the logistic effort switched from Push to Pull, and it is clear from Logistics Cluster (2015a) that the NERC Logistics Representative realised the effect of this on storage at Port Loko, and planning began to offset this.

**The Bullwhip Effect**

Due to the nature of Push logistics, commodities managed this way tend to flow relatively feely along the humanitarian supply chain. Blockages do occur where:

- Efficient air consignments are being consolidated;
- Customs delays occur at international frontiers;
- Breaking bulk occurs at principal logistics bases in preparation for onward distribution;
- Delays caused by transport issues and lack of infrastructure arise;
- Bureaucratic challenges arise, including corruption and other losses to the supply chain.

However, because the flow is determined and controlled at a point close to the donor, and the supply chain support infrastructure of national ports of entry, warehousing and bulk cargo transportation is managed by the in-country NGO or Logistics Cluster, despite administrative delays intimated above, there is little evidence of the Bullwhip effect. In Push logistics, decision making for the supply of a given commodity is often made at the strategic level of the NGO, either to meet the specific aims of the NGO, or to contribute to the common good; however, the in-country staff must inform and update the global HQ of the extant requirement and the global HQ must have the capability of understanding the crisis situation in supply chain terms and be able to facilitate an effective flow of information. Given the tendency for NGOs to conduct contingency planning at a national, regional and global level and preposition stocks accordingly, and the ability to procure locally, the supply of individual

commodities is rarely an issue. However, WFP (2017) reminds us that the Ebola Crisis presented a significant challenge in this regard.

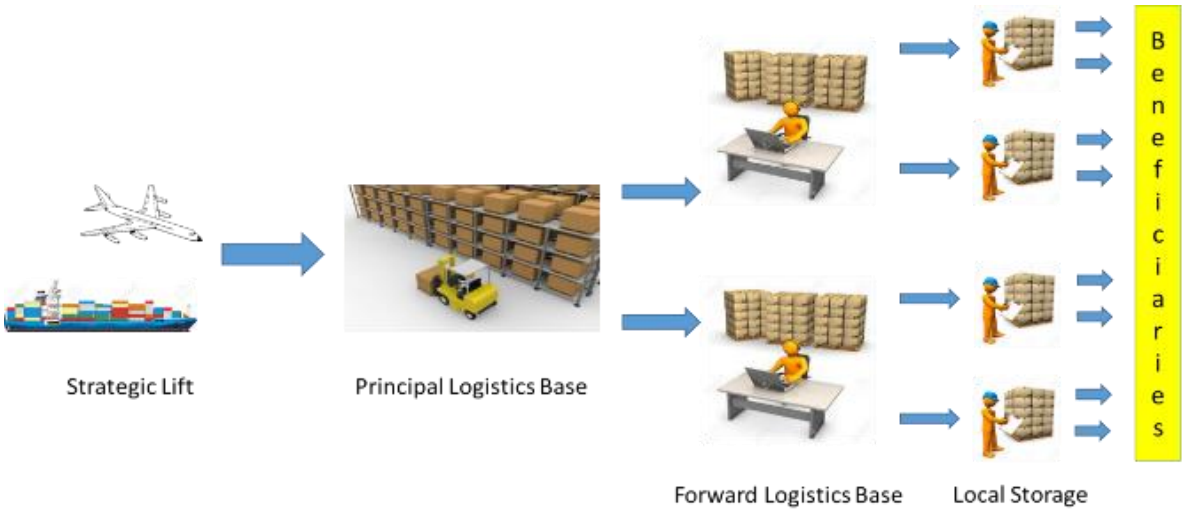


Figure 5. Flow of materials during Push inventory management strategy.

At the point when the inventory management mode switches from Push to Pull logistics, an effect similar to the Bullwhip effect is generated which affects only part of the supply chain. In humanitarian logistics, this switch creates a log-jam at the principal logistic base because commodities being pulled forward tend to move more slowly and in smaller volumes than when they are pushed. At the same time, the reverse supply chain becomes more effective for the redistribution of items required elsewhere, but all the while, donations still arrive in country. This all requires significantly larger 'rear area' storage facilities near the point of entry and a management system to coordinate the arrival of new materials, the redistribution of reserve supply chain commodities and the effective reaction to demands from frontline local agencies. At this point, the ability of the Logistics Cluster to inform strategic planners is critical to influencing the stream of donations. Donations already in the pipeline can be strategically diverted to other emergencies or restock global and regional stockpiles, thereby making more efficient use of strategic lift transport assets and avoiding waste or gratuitous reserve supply chains.

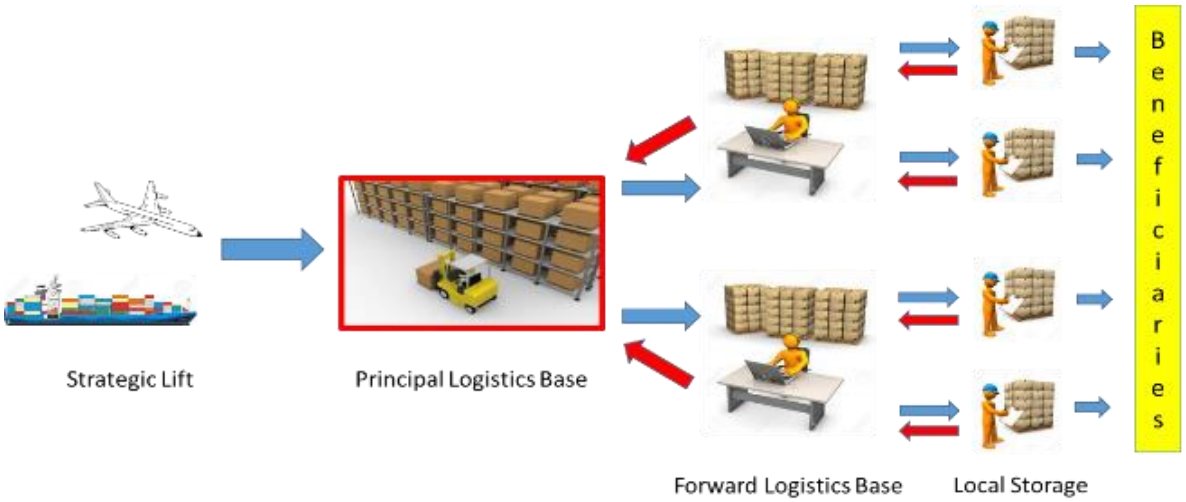


Figure 6. Flow of materials during Pull inventory management strategy.

**Discussion**

A phenomenon similar to the Bullwhip Effect therefore can occur in humanitarian supply chains but due to the complex system of donations, supply and local procurement, it tends to have less impact. Donor organisations are often well placed to meet demand surges from alternative sources and major NGOs maintain stockpiles on regional and global levels. During the initial, Push logistics phase of an operation, material flows to the point of need as fast as possible, and often the demand will outstrip supply, but this is because there is a finite volume of aid that can be initially delivered due to stock availability, transport limitations, environmental issues and access challenges. Any demand placed by the customer will only be satisfied if it is available and can be transported to the point of need. As a result and irrespective of the demand, the reactive nature of the humanitarian Push inventory supply chain will rarely result in the initiation of the Bullwhip Effect. During the subsequent Pull phase, demand surges that give rise to the Bullwhip Effect can be mitigated by routing commodities efficiently from other donors, through NGOs at international and in-country level to the Logistics Cluster, from where they can be directed to specific forward logistics bases and on to beneficiaries. This, together with the use of local procurement to relieve pressure on the supply chain requires an effective and proactive collaboration envelope, capable of maintaining information flow not just along the supply chain, but vertically between logistic practitioners in-country and strategic logistic planners in NGO and IGO global HQs.

The initiation of a Bullwhip Effect relies upon the creation of a demand on the supply chain. In the Beer Game, this demand is reflected by an order for a single commodity placed by a customer who understands the nature and value of the commodity. The customer will not accept or reorder the commodity if it fails to satisfy or costs too much. The customer is a decision maker who discerns whether they want the item and what they are prepared to pay for the item. The beneficiary of emergency aid performs neither of these functions; rather, it is the local subject matter expert that makes these decisions on behalf of all beneficiaries with his/her sphere of influence. There is, however, another customer role within the supply chain, namely the donor who initially purchases the commodities that enter the supply chain. The role played here, however, is not that of humanitarian supply chain customer, but commercial supply chain customer who disposes of the commodity by passing it to the humanitarian supply chain. There are moral, prestige and political aspects to this second transaction, but this research contests that the donor is not the humanitarian customer, but the humanitarian supplier.

**Conclusion**

The Beer Game was developed to allow students to understand the effects of order variations on, and the ability to forecast demand within, a commercial supply chain. While accepting that humanitarian supply chains are profoundly different from those of the commercial world, by understanding the role of each game element, and in particular the role of the customer, it is possible to map the Beer Game across to a humanitarian supply chain. Humanitarian supply chains operate both Push and Pull strategies, depending on the nature and maturity of the relief operation, and the likelihood of the Bullwhip Effect occurring differs in each mode. There is a propensity for it to occur more often in Pull logistics, the mode closest aligned to the commercial philosophy of the Beer Game. By examining the levers available to stakeholders within and outside the collaboration envelope, this research shows that the Bullwhip Effect, where it manifests itself in the humanitarian supply chain, differs from that evident in the Beer Game, but provides understanding of where demand surges may occur and how the effects might be mitigated.

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