A consideration of the relevance of lean supply chain concepts for humanitarian aid provision

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Abstract: Supply chain activities connected with providing humanitarian aid (HA) are often treated as a series of discrete activities. The view that each aspect should be seen as part of a continuum has not generally been a priority, often leading to large amounts of waste (McGuire, 2001). Much of the theory underpinning commercial supply chain processes is similar, although not necessarily directly transferable to HA due to a variety of factors including funding, employment, location, political and physical instability, a lack of logistics knowledge and the urgency inherent in emergency situations. This paper addresses the notional applicability of lean logistics techniques such as value chain analysis (VCA) to the requirements of HA supply chains, discussing the theoretical basis for its use and how it could be used to improve efficiency and effectiveness. The paper concludes that there is significant scope for the application of such techniques which could have a fundamental bearing on how HA supply chains are implemented.

Keywords: humanitarian aid; lean logistics; VCA; value chain analysis; assessment.

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1 Introduction

In any crisis situation, for example drought, earthquake or war, logistics and supply chain activities connected with providing HA are vital to the effective provision of relief to affected populations. Yet in many recent crises situations, logistics continues to be an area that is not as well managed or resourced as it might be. Thomas (2005) commenting on the SE Asian tsunami states, "logistics is the most under-recognised and under-resourced part of humanitarian organisations… the focus is on the frontline and not the backroom that facilitates the frontline". This is underlined by the findings of a Fritz Institute survey (2005) which concluded that "traditionally, infrastructure is not the focus of donations".

The view often taken by those involved in HA is that the importance of logistics and supply chain activity has not yet been fully recognised. The existence of supply chains are often taken for granted until they do not function correctly and goods do not arrive at the right place and the right time (McGuire, 2001). In HA, environments logistics is often treated as a series of discrete activities disconnected from each other. This is in part reflected in the literature related to such activities which cover the range of humanitarian issues such as procurement, international transport or local distribution, but which treat logistics as a sub-category of each issue rather than as a separate activity in its own right (Pettit and Beresford, 2005). In contrast, a fundamental concept in modern logistics and supply chain management is that a single logic should be used to create an overall plan for the supply chain (Taylor, 1997).

The view that each aspect of delivery should be seen as part of a continuous supply chain has not generally been a priority in HA systems and this has almost certainly led to large amounts of waste in terms of the actual aid reaching those requiring it; the time spent on trying to resolve problems by individuals who could probably be better utilised elsewhere; and on the financial resources required to get the aid to the end point of the chain. This is exemplified in work undertaken by Beresford and Rugamba (1995; see also Beresford, 1998) which highlights wastage rates of up to 30% in aid delivery in the aftermath of the Rwandan Civil War in 1994–1995.

It is worth recognising that much of the theory underpinning the processes which facilitate the movement of goods and materials in commercial business is similar, although not necessarily directly transferable. As Oloruntoba and Gray (2002) highlight, there is an extensive literature on business logistics in developed countries but very little on logistics in developing countries and less again on HA logistics in either emergency or development situations. The models which do exist are not easily transferable to HA situations due to a variety of factors including funding, employment, location, political and physical instability, the lack of logistics knowledge in many affected regions as well as the urgency inherent in emergency situations.

HA logistics is 'often the largest and most complex element of relief operations' (UNDP, 1993) and in order for successful supply chains to be devised, there is a requirement for a clear understanding of the problems and issues involved. Tovia (2006), having analysed the emergency response to hurricane Katrina in New Orleans, comments on the overall approach (which covered governmental, military and NGOs and which included HA provision), that "in spite of the differences and similarities (between commercial and emergency logistics) the best practices that have been demonstrated in corporate logistics have not been applied to emergency logistics". There are a variety of

techniques which have been used to try and understand the dynamics of commercial supply chains but there has been little attempt to do so for HA supply chains. This paper therefore discusses the theoretical application of the VCA technique and seeks to highlight the major differences and requirements which need to be resolved in order to provide effective HA supply chain solutions. The individual components of VCA are discussed and an overall assessment of how it might work in practice is provided.

2 Humanitarian logistics and supply chain management

The terms 'logistics' and 'supply chain management' are often used interchangeably and in practice there is no universally accepted definition of either term. An early definition of logistics was provided by the US Council of Logistics Management in 1986: "the process of planning, implementing, and controlling, the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements" [Council of Logistics Management, quoted in Johnson et al. (1998)]. In effect, logistics being seen as a coordinated approach to managing the whole supply chain for a product from raw material acquisition to delivery of finished product to the end user.

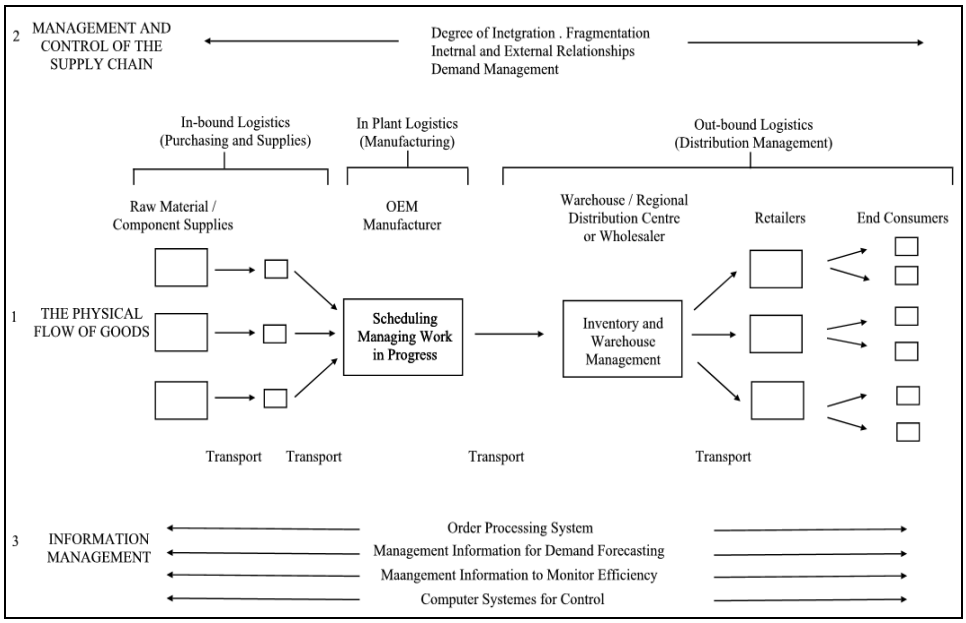
In recent years, there has been a tendency to make a distinction between logistics and supply chain management. By 2006, the Council of Logistics Management had been restyled as The Council of Supply Chain Management Professionals and defined supply chain management as:

> "Encompassing the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers and customers. In essence, supply chain management integrates supply and demand management within and across companies" (www.csmp.org, 2007).

This statement reflects an increasing appreciation of the wider organisational and control issues involved in supply chain management beyond the management of the flow goods and information. The model proposed in Figure 1 (Taylor, 1997) summarises three key aspects of supply chain management and highlights the typical scope and activities included in many commercial supply chains.

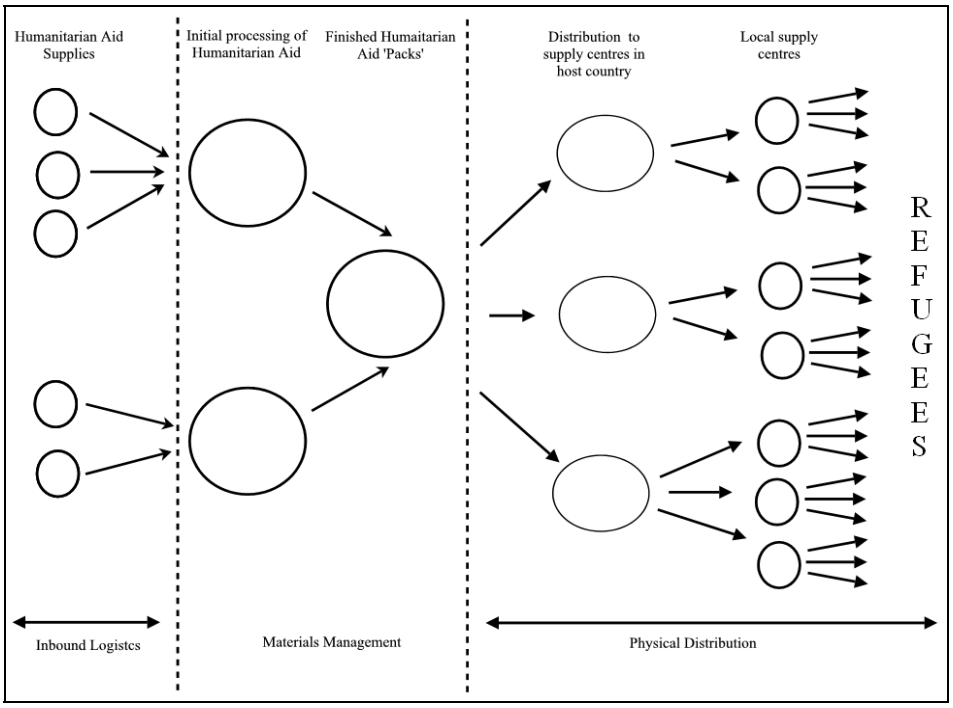
While supply chains in any context have the same overall objective, i.e., to move goods through the chain from source to point of delivery, there are significant differences between commercial supply chains and those used for HA. In commercial chains, manufacturing activity is often at the fulcrum of the chain. In HA chains, the fulcrum is more likely to be a materials management function managed by an aid agency, in which multiple supplies are coordinated and or aid packs produced. Figure 2 details the broad structure of the flow of goods through an HA supply chain. Further differences, as discussed by Oloruntoba and Gray (2002), are that HA generally operates in a context of voluntary contributions of finance and labour, that the 'end consumers' are people who will not be party to any commercial transaction, that final delivery will be in countries without any established logistics community or infrastructure (conceivably no functioning transport infrastructure), that governments and the military may be involved at a significant level and the environment may be both politically and militarily unstable.

Figure 1 The supply chain management model



Source: Adapted from Taylor (1997).

Figure 2 Flow of HA



Source: Authors

Drawing on the above statements, the following tentative definition of HA logistics is proposed: "the adoption of a single logic for the planning, implementation and control of the efficient, effective flow and storage of humanitarian aid and related information from the point of donation or acquisition to the point of distribution for the purpose of the effective provision of aid to refugees". Humanitarian logistics organisations could also benefit from the wider adoption of supply chain management perspective by taking into account the need to:

- manage demand through the supply pipeline
- manage relationships with channel intermediaries
- manage relationships with other agencies that are involved in the provision or control of aid within the context of a disaster.

The literature concerning commercial supply chain management is considerable and often related to specific industries, reflecting the fact that a logistics or supply chain solution for a car manufacturer (Kiff, 1997; Holweg and Bicheno, 2001; Neto and Pires, 2005; Waller, 2005) may not be directly transferable to, for example, the meat industry (Zokaei and Simons, 2005) or the grocery sector (Potter et al., 2003). There is also the view that this extends to the HA supply chain where the direct transfer of concepts applicable to such situations is not directly relevant (Oloruntoba and Gray, 2002). It may, however, not be the case that commercial logistics approaches are inapplicable in HA situations. Until, however, approaches tested in the commercial environment are applied to HA supply chains, their applicability will remain under discussion. The remainder of this paper thus highlights some key commercial logistics concepts derived from lean principles and best practices and makes initial comment as to the extent to which these may be applicable in a humanitarian context.

The perceived lack of direct transferability of commercial logistics and supply chain solutions is exacerbated by the lack of technical logistics knowledge which exists in many aid agencies as there are insufficient number of experienced logisticians working in the HA community. This was most recently highlighted by the Fritz Institute (2005) in a survey undertaken in the aftermath of the Asian tsunami. This scarcity impacted on the functioning of the relief effort and had wider consequences as logisticians were reallocated from other assignments. The lack of logisticians had other impacts notably in the area of assessment and planning. The Fritz Institute survey (2005) highlighted the fact that only 58% of organisations had such people in their assessment teams ultimately leading to problems in the supply chain at a later date as choke points had not been addressed properly.

3 Defining HA supply chain management aims

A starting point for any supply chain management improvement initiative must be a clear definition of the aims and objectives and what is trying to be achieved. In a commercial setting, these would typically fall into three broad areas:

- the provision of an appropriate level of customer service
- minimising supply chain costs commensurate with achieving the desired level of service

- developing a supply chain that is designed to be flexible in order to be able to adapt to unforeseen changes in markets or supply sources (Taylor, 1997).

It is suggested that all three of these broad aims are pertinent in the context of the HA operations and in order to achieve these aims there has, over the last ten years, been an increasing interest in a variety of commercial sectors (e.g., automotive, aerospace, retail, healthcare and agri-foods) in the application of lean principles (Womack and Jones, 1996) to the improvement of supply chain operations. The techniques of value stream management (Hines et al., 1998) and VCA and improvement (Taylor, 2005) have been developed as methods to apply lean principles and other aspects of supply chain best practice to the improvement of commercial supply chains. (VSM and VCA can in practice be regarded as synonymous approaches.) In this paper, it is suggested that (VCA) may provide a useful framework with which to consider some of the key aspects of supply chain management in HA settings. VCA involves the following key elements:

- defining what is 'value' from the customer (or recipients) point of view
- analysing both end user demand and demand dynamics within the supply chain with a view to proactively managing demand
- measuring supply chain lead times with the objective of time compression
- managing inventory with the aim of having the right amount of inventory in the right place with in the chain and in the right form
- identifying waste in the chain in terms of non-value adding activities with a view to reducing the cost of supply chain operations
- reducing product waste and losses through the chain.

In order to understand the application of these principles to HA supply chains each aspect is now considered.

3.1 Understanding customer value or recipient need

The first objective of a commercial supply chain operation, as stated above, is to provide an appropriate level of customer service. This is often simply stated as providing the right product in the right place at the right time. In the context of VCA, this is reflected in the first of the lean principles (Womack and Jones, 1996) which is: 'understand what is 'value' from the point of view of the end consumer of the product or service'. Commercial companies are becoming increasingly sophisticated in defining the customer's 'value' proposition. This will be different for every supply chain but will include a variety of elements ranging from product types, packaging requirements, delivery quantities, frequency and reliability, through to a range of after sales support issues. Market research is increasingly used to ensure that the 'value' proposition is clearly understood and specified from the customer's point of view, rather than from the view point of the company.

The above concepts are relevant to HA supply chains, because although the value in such chains is not expressed in commercial terms or outputs, there is still 'value' to be extracted from the chain. Value in an HA context relates to ensuring that the correct products are distributed to the right people at the right time. Thus blankets, for example,

will have a relatively low value if the refugee population already have a sufficient number. Conversely, a post-disaster region may be affected by a variety of disease and illness and medical supplies may have a relatively high value. Providing the correct form of aid to meet immediate needs is a critical part of any aid operation. Unfortunately, there are many examples of inappropriate aid being supplied in many relief scenarios, whilst desperately needed equipment or supplies are either not provided or cannot get through aid pipelines which are choked by unneeded items (Pettit and Beresford, 2005).

In the HA environment, 'needs assessment' is the equivalent to commercial market research. Therefore, an important part of improving HA supply chain performance is to improve the approaches to, and accuracy of, needs assessment exercises. A further complicating factor is that aid organisations tend to carry out independent needs assessments exercises, often in a fairly ad hoc manner, which in itself can contribute to the confusion in the early stages of a disaster. This duplication of effort was clearly evident at the beginning of the Asian tsunami crisis when there were estimated to have been as many as 400 separate organisations involved in the aid effort, many of which undertook independent needs assessment (Perry, 2006) which in itself contributed to the chaos.

A further and important dimension of value in HA is the need to understand value from the perspective of the donors of aid as well as the recipients. HA supply chains are perhaps unique in that both 'customers' and 'suppliers' must each have their 'value' needs addressed in order to maintain engagement. Lean tools for measuring the effectiveness of supply chain performance may be able to make a significant contribution to enhancing donor confidence.

3.2 Managing demand

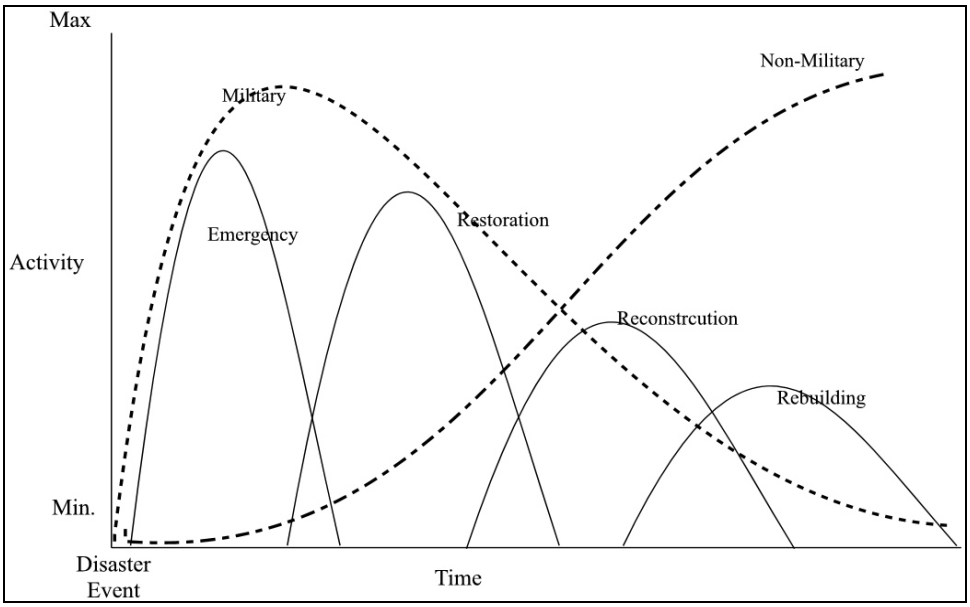
Demand management is increasingly recognised as a key element in the management of commercial supply chains. This starts with an understanding of the end consumer demand but also requires the management of demand dynamics along the chain. Commercial supply chains are complex, rarely being in the remit of any single organisation and having no single point of control. They are dependent on volatile demand signals and forecasts which may or may not be accurate. The supply chain system as a whole is often made up of a number of sub-systems which optimise their own performance to satisfy the demand of their immediate customer but probably without coordination with the rest of the supply chain (see e.g. Christopher and Towill, 2001; Beresford et al., 2005).

If demand levels were constant, assets utilised along the supply chain could be accurately planned for and consistently utilised. However, this is almost never the case and demand can fluctuate considerably due to economic, cyclical, trend or random reasons whilst demand amplification effects (Forrester, 1958) in the supply chain frequently exacerbate swings in demand. Increasing attention is being given to developing approaches to more effectively control and manage demand within commercial supply chains, as it is recognised that the variability in demand creates major difficulties for supply chain operational efficiency in terms of resource requirements (e.g. people, machines, vehicles), inventory levels and service level achievement (Taylor, 2000). Although there is currently no published evidence, it is likely that demand amplification effects will occur within the HA supply chains to the detriment of chain efficiency and the levels of service provided to recipients. Although demand patterns and

signals in HA scenarios are likely to be more chaotic and difficult to understand than in commercial chains, it is nevertheless suggested that attention to demand management could play an important part in improving aid provision.

A further complicating factor in the context of a humanitarian emergency is that demand arises when a crisis event occurs and subsequently develops through several phases. These have been detailed by Haas et al. (1977) and more recently by Pettit and Beresford (2005) and are illustrated in Figure 3. When a crisis occurs, there will be an immediate need for the emergency provision of a wide range of goods and materials; medical, food, clothing, tents, blankets, etc. There will therefore be a demand surge at the beginning of any crisis as HA organisations assess the situation and commit resources to it. In the longer term, once the initial problems generated by the crisis have been stabilised the long term aid situation will develop, as the crisis moves into the restoration, reconstruction and rebuilding phases. Demand should then be more predictable and agencies should be able to plan a more constant schedule to meet this demand. The latter situation will still, however, suffer demand fluctuations for a variety of reasons depending on the type of crisis which has occurred. In a wake of a military conflict, this may be due to renewed hostilities and further displacement of people, in a natural crisis such as an earthquake there may be aftershocks which destroy further infrastructure and thereby increase the difficulties of a population to obtain food and water. Nevertheless, it is suggested that demand management approaches developed in the context of commercial value chain analysis may be able to go some way towards proactively managing and stabilising demand in humanitarian scenarios rather than just accepting and trying to react to chaotic demand signals (Taylor, 2005). If this could be achieved, it would in turn facilitate improved efficiency of supply chain operations.

Figure 3 A suggested model of emergency recovery



Source: Pettit and Beresford (2005) refined from Haas et al. (1977).

3.3 Time compression

Time compression has become a key objective of most commercial supply chains. This involves reducing the cycle time in the supply chain by speeding up both physical and information flows (Towill, 1996). It has many benefits including increased forecast accuracy (Stalk and Hout, 1990), reduced demand amplification (Towill, 2005), faster response to market changes, and reduction of uncertainty which allows supply to respond more closely to changes in demand. In the HA environment, time compression is a critical issue, and indeed it could literally be a matter of life and death in many situations.

A central feature of VCA is the careful mapping and measurement of the time taken within a supply chain from receipt of a customer order to delivery of the product to the customer. Value stream maps not only measure the total order cycle time, but clearly identify how the time accumulates through the chain and importantly where unnecessary delays occur both in the movement of the physical product and of the information which is required to trigger product flows. It is therefore suggested that the adoption of value chain mapping techniques could prove beneficial in the analysis of existing HA supply chains and in the planning supply chain structures for future unknown events.

A key requirement in achieving time compression is the employment of time-based key performance indicators (KPIs). This has not been a priority for HA organisations although it is an area which could benefit such organisations in executing their functions. KPIs relevant to an HA supply chain could include:

- the time from onset of disaster to completion of needs assessment exercise i.e., specification of immediate needs
- the time from communicating immediate product requirements to receipt of first aid deliveries
- the time to ramp up supply chain activity to provision of adequate levels of aid to meet ongoing need.

The above relate to measures of the overall supply chain performance. It would also be useful to develop time-based measures for the individual elements of the supply chains shown in Figure 2, i.e., inbound logistics, materials management, international transport, distribution within the host country etc.

3.4 Inventory management

In commercial supply chains over recent years, there has been a very significant emphasis on reducing inventory levels. There have been strong commercial incentives to do this as companies have started to recognise the true costs of holding inventory (including capital costs, warehousing, insurance, obsolescence damage/deterioration, etc.) as well as the pressure to adopt just-in-time delivery systems.

Issues pertaining to the levels of inventory in HA supply chains are important and as such need careful planning and consideration (as indeed it does in commercial chains), as inadequate levels of inventory could significantly reduce the capability to respond particularly in the event of rapid onset disasters. Inventory in an HA scenario relates to the stocks of aid goods held by agencies or moving through the HA supply chain. Reductions of inventory while useful, cannot form the sole objective of an HA supply chain, particularly for emergency response, as buffer stocks will be required to meet such

situations. Where longer term aid is being provided there may be scope to reduce stocks provided that consistent supplies can be secured. Achieving a balance between availability and inventory maintenance is therefore an issue which aid agencies have to address. Assessment of potential demands for HA supplies together with knowledge of supplier lead times and reliability are the starting point for determination of inventory levels. Beyond that, it is suggested that major aid agencies could beneficially develop closer relationships with key suppliers to work together towards shortening lead times of supply, as well as jointly agreeing demand forecasts.

A common misconception is that lean systems should operate with little or no inventory, as all inventories is considered to be waste. In fact, this is not the case as in both theory and practice, true lean systems aim to operate with an 'appropriate' amount of inventory to cover both variability in demand and supply. A key concept in lean is that managers work to reduce those variabilities and if successful can subsequently safely reduce inventory levels. Understanding this approach will be particularly pertinent in the context of HA where lack of availability of aid could be life threatening.

A further issue for consideration in HA is the location of inventory around the globe. A number of major aid agencies including UNICEF are moving towards the development of strategic warehouses in proximity to areas that are deemed to be high disaster risk, rather than holding inventory at one central location to service the whole globe. An additional concept currently being postulated is that of 'sea-basing' whereby some inventory is 'warehoused' in ships which are able to deliver that aid at relatively short notice when a crisis occurs (Tatham and Kovacs, 2007).

3.5 Reducing waste and cost in supply chain operations

Cost reduction and efficiency improvement are key targets for all commercial supply chain operations. An increasing number of firms are using value chain mapping techniques to analyse their processes and identify the value adding and non-value adding activities. In commercial chains, it is common to find that less than 5% of steps are 'value adding', whilst 90% of steps are 'non-value adding' in that they incur costs but provide no benefit to the customer (Hines and Taylor, 2000).

Typical examples of waste in commercial chains include too much product handling in factories and warehouses, unnecessary storage locations, unnecessary movement of product between storage locations, dealing with excess inventories or writing off obsolete inventory. If within commercial chains such levels of waste occur, it is suggested that systematic mapping of HA chains which are generally less well planned and less stable would be likely to uncover many opportunities to reduce non-value adding activities. This would highlight opportunities to reduce the costs, as well as possibilities to compress lead times and increase responsiveness. Systematic process mapping also highlights non-standard work practices which are likely to be prevelant in many HA chains because of their ad hoc nature. Identification of best practice for any operation and the introduction of 'standard work' is another key objective of a lean system. However, it is acknowledged that achieving such improvements will present many challenges that are not necessarily encountered in commercial chains.

3.6 Identifying product losses along the supply chain

An obvious aspect of waste in humanitarian supply chains is the loss of product between donor and recipient. There are many reasons for this ranging from theft, misappropriation, poor tracking and control, as well as product deterioration or spoilage. A clear objective for any aid operation is to ensure that as much as possible, the aid products reaches the intended recipients and does not 'seep' from the supply pipeline. Interestingly, recent detailed studies using VCA techniques in the UK agri-food chains have identified that in many commercial food chains there is significant product loss or wastage between product sources at farms and the retail outlet/end consumer. In some, fresh produce chains detailed only 50% to 60% of harvested product reach the end consumer (Food Chain Centre, 2007).

If this is an issue in the context of quite sophisticated commercial chains, it is likely to be a significant issue in humanitarian chains which are typically longer, less tightly controlled and operating in chaotic environments. Indeed, as described earlier, a study conducted by Beresford and Rugamba (1995) found that as much as 30% of aid was lost from the supply chain during the post Rwandan civil war era.

It is therefore suggested that an important KPI for HA supply chains should be an assessment of the percentage of donated aid reaching the intended recipients, although it is again acknowledged that in practice, this may be difficult to accurately measure. Equally important however would be the use of value chain mapping techniques to pinpoint where along the chain losses or waste occur and importantly the reasons for the occurrences. Elimination of losses from the supply chain will require the use of systems to track and trace product flows and inventory. However, the Fritz Institute survey (2005) highlighted the lack of up-to-date technologies for tracking and tracing aid in the supply chain and pointed out that only 26% of aid agencies have access to track-and-trace software.

The adoption of approaches developed in commercial chains to identify, quantify and reduce product losses from supply chains could be a major benefit in HA environments. Indeed for many aid agencies, evidence of improved proportions of product reaching the recipients could provide a vital element in securing further funding from donors.

4 Conclusions

4.1 The applicability of VCA elements to HA supply chains

There is a clear need for HA supply chains to be improved and it is suggested that the use of VCA techniques may be one approach which would be of use in this context. Each of the six elements outlined earlier are relevant in an HA context and in light of the discussion in the previous section, it is pertinent at this point to summarise the relevance of each aspect of the discussion and these are shown in Table 1. The components of VCA shown in Table 1 and their applicability to HA are not intended to provide complete coverage of the approach but indicate the relevance of such an approach in an HA context.

Table 1 VCA component relevance to HA supply chains

Component of VCA	*Commercial context*	*Applicability to HA*	*Challenges*
Customer value	'End consumer value' e.g., product type, after sales support Supported by market research	'Aid recipient value' e.g., appropriate aid, right place, right time Supported by 'needs assessment'	Replacing uncoordinated ad hoc assessments with structured, measured needs assessments
Demand management	Understanding end consumer demand Developing demand management techniques	Understanding aid recipient requirements	Addressing initial crisis demand surge Reducing demand amplification
Time compression	Key objectives: reduce cycle time; increase forecast accuracy; reduce demand amplification; use of KPIs	Time compression is critical and its use could improve response times in HA	Implementation of KPIs Developing time-based measures for individual components of HA supply chains
Inventory management	Reducing inventory	Appropriate levels of inventory but not sole objective in HA context	Developing closer relationships with key suppliers Developing demand forecasting
Reducing waste and cost	Use of value chain mapping techniques to identify value adding and non-value adding activities	Reduction of non-value adding activities Identifying key areas where waste and costs are incurred	Improving stability of HA supply chains
Identifying product losses	Identifying where product losses occur	Identifying where aid losses occur	Increasing proportion of aid levels reaching recipients Implementing track and trace systems

4.2 Conclusions

The need to improve the efficiency of HA supply chains can be summarised in the following quotations:

> "The first challenge is how to manage such a flood of aid to the region and how to coordinate the activities of so many international agencies. Instead of getting relief to those who need it, the wrong supplies may easily end up in the wrong places, while the donors trip over each other in the process… OCHA, the UN Office for the Coordination of Humanitarian Affairs, is desperately short of money and trained personnel. It is currently undergoing review, ordered by Jan Egeland, to identify what is wrong with its speed and effectiveness, particularly in the light of the world's disorganised response to the Darfur crisis in Sudan. It is too early for any results" (Peel, 2005).

> "There is a lot of logistics. You can't just truck it out and drop it off. You need a warehouse. You need a distribution system. You need to locate who is in need. We are trying to put a system in place so the right people get the food" (Burke, 2005).

The discussion in this paper highlights just some of the issues that could be considered in the improvement of HA supply chain operations. With the commercial sector, there are many other approaches and techniques that are adopted in the continuing quest for improved efficiency and service performance some of which may well be relevant to HA operations. Consideration could be given to ideas such as the use of de-coupling points, separation of base and surge demand (Christopher and Towill, 2001), postponement (Christopher, 2000), transport network configuration (Dadzie, 1998) to name a few. However, agencies responsible for the delivery of aid need to have a framework with which to systematically approach the improvement of their operations and it is suggested that the VCA approach provides a usable framework with which to start the supply chain improvement process.

Even so, it is clear that VCA techniques will need to be developed and adapted in order to be applied in the context of HA operations. Compared to most commercial environments, the contexts in which HA supply chains operate have some very significant differences including the following:

- Once established, most commercial chains operate on a regular basis over protracted time period, which means it is relatively easy to observe and analyse their operations. In contrast, many HA chains and particularly those developed in response to emergencies are transitory. This will present challenges for the mapping and analysis of such chains which may only be in existence for relatively short periods in very specific environments.
- Many commercial chains take time to establish and in the early phases may not operate to optimum efficiency, but are gradually modified and improved as the business continues. Ideally, HA chains should be operating as effectively as possible from the outset. Indeed, the supply chain capability in the initial phase of a disaster may be the most critical in terms of saving lives.
- In the HA environment, there is a need to analyse the efficiency and effectiveness of chains set up to respond to specific incidents both in order to improve those chains whilst they are operating, and to more effectively plan and operate future chains that will be developed in response to new emergencies.

In spite of these difficulties and challenges, it is suggested that there is an opportunity and indeed an imperative, for those responsible for organising HA supply chain to adopt or adapt whatever best practices can be effectively drawn from the experience of commercial logistics and supply chain. In the commercial world, the drivers for supply chain improvement are competitive advantage and increased profit. The drivers for improvement of humanitarian supply chains are surely, if not more, compelling.

4.3 Further research

This paper has presented a conceptual view of the potential applicability of value chain analysis and lean principles to humanitarian aid operations. What is now required is to test these ideas in practice. It is the intention of the authors to undertake a number of

action research pilot projects with aid agencies with a view of analysing and improving specific humanitarian supply chains. In so doing, it is anticipated that adaptations of the methodologies used in the commercial sector will be required. The intention will be to develop a value stream management framework relevant to HA, as well as to provide case-based evidence of the operational efficiency and challenges of humanitarian supply chain operations.

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