Inventory Control Policies for Humanitarian Logistics Supply Chain

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Abstract: The distribution of seed and tools definitively represents one of the most important interventions to guarantee disaster relief in developing countries. Several different approaches have been experimented: direct distribution, organization of seed fairs and, recently, attempts to restart a commercial sector of agriculture goods also have been pursued. Both the first and the last of these approaches imply the purchase and distribution of agriculture items, with the overall goal of providing populations with the right quantity of materials, minimizing the associated costs. Thus, it is important to adopt the proper inventory control policy in order to control the flow of goods between the various echelon in the supply chain . In this paper, for each product category, several multi-echelon polices are presented and tested through simulations. Moreover, a model that minimizes the overall inventory cost, including transportation administration and perishing cost is also presented. Context parameters are derived from a case of a project implemented by F.A.O. in North Uganda.

Keywords: Emergency operations, Humanitarian logistics, Supply chain management, Inventory management

1. Introduction

Emergency Agriculture Aid (EAA) is gradually arousing interest among Supply Chain Management researchers; indeed, the trend of investment in this field is increasing, especially as an effective mean of supporting farmers in poor areas on top of food provision actions (Hauge, Sperling, & Remington, 2004). The main objective is contributing in terms of food security, that is to provide those agricultural primary goods (seeds, fertilizer, etc.) needed from the specific population, adequate to the climatic region, during sowing time and, moreover, rapidly and in the correct quantities (Cooper, Osborn, & Sperling, 2003). This is mainly pursued by intergovernmental (IGO) and non-governmental organizations (NGO), that have to cope with these problems finding solutions at a sustainable cost. This is properly the challenge of logistics research, inside the specific application scope named Humanitarian Logistics.

In spite of the acknowledgement of the importance of logistics method in the field, the greatest part of the activities related to design and organization of humanitarian supply chains are often performed in a unstructured way; improvement opportunities in EAA, along with the resulting social and economic growth, may thus be within reach through the application of quantitative methods or of those coming from Operations Management and Industrial Engineering studies (Cooper, Sperling, & Remington, 2008). This paper focuses on the validation of Industrial Inventory Control Policies within an innovative EAA methodology, in order to show the effectiveness of Operations Management techniques applied to Humanitarian Logistics Supply Chain.

For example, as far as seed distribution is concerned, the choice of the most appropriate logistic model depends on context characteristic, which is related to:

- purchasing channels (formal seed system vs local seed system);
- seed security constraints (seems availability, accessibility, utilization);
- emergency complexity (acute crisis or chronic crisis).

Farmers get seeds through two different purchasing channels: the *formal seed system* and the *local seed system*. The first is characterized by private companies, government agencies or humanitarian agencies that provide certified seeds – i.e. their variety and quality standards are granted (Louwaars, 1994). This system plays a strategic role for the development in the long run because it allows the introduction of new seeds varieties that can increase production and thus ensure greater food security (Sperling & Remington, 2006). On the contrary, the local seed system is made up by informal channels through which farmers receive seeds of uncertain quality and variety: by the way of an example, local markets, previous crops or loans from other farmers (Almekinders & Louwaars, 1999). However, seed security must be granted, anyway: each farmer must be able to acquire enough seeds to survive.

The Seed Security Framework is thus composed by three elements:

- seeds availability: the presence of enough crop when it is necessary;
- accessibility: capacity in terms of purchasing power to obtain the necessary seed;
- utilization: availability of standard quality seeds.

At last, a third important aspect is related to the complexity of emergencies. Two types of situations should be distinguished: acute crisis - due to short-lasting events, like the loss of a crop - and chronic crises - marginalized population due to social, economical, environmental or political events. In the first case population endogenous capacity allows a slow recovery of food security (Figure 1), in the second it is necessary the intervention of humanitarian agencies to prevent desperate case of poverty (Figure 2).

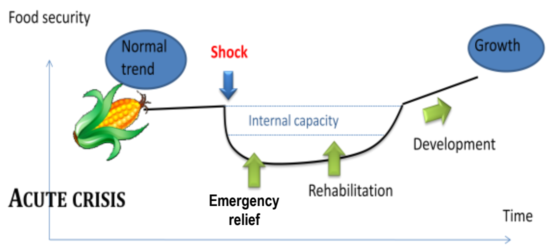

Figure 1. Food security trend in acute crisis

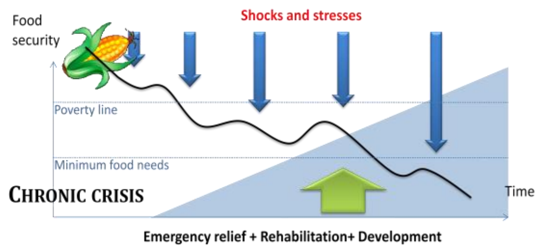

Figure 2: Food security trend in chronic crisis

So far, two main different approaches have been adopted: Direct Seed Distribution (DSD) and Seed Vouchers and Fairs (SVF). In the former, seeds and agricultural tools are directly distributed to communities, thus focusing on seed availability (Cooper, Sperling, & Remington, 2008). In the latter, an ad hoc market place is established in order to facilitate access to seeds from farmers, thus focusing on seed accessibility: farmers are provided with special vouchers by which tools and seeds can be purchased from certain retailers.

Despite both of these methodologies were conceived for the application during acute crisis, in past times they have been applied even in chronic crisis contexts, with poor results. In this paper a new logistic model suitable for supply chain management in chronic crisis contexts is also presented: *Vouchers for Work - Input for Vouchers* (VfW-IfW) is an innovative approach, validated in two different projects coordinated by FAO (Food and Agricolture Organization) in Nord Uganda - Africa, that is candidated to represent an effective type of action for such situation where the main problem is the availability of agricultural products from the formal seed system. The beneficiaries of the project are involved in construction activities, such as public works, in order to obtain vouchers that can be used to buy agricultural products sold by private retailers.

The aim is to reach two specific targets:

- establishing a private self-reliant distribution system of agricultural products, sustainable over time;
- helping farmers to access agricultural products by providing purchasing power through a voucher method.

Retailers represent the last level of a multi-level supply chain coordinated by the organizations that are in charge of the whole project. In these premises, service level - in terms of punctuality and seed availability - is critical: farmers dissatisfaction may cause their withdrawal from the project. As a result, replenishment lead time and stock levels management result to be the main leverages to act on in order to pursue system optimization. Due to the lead time constraints originating from the specific application context, in this paper, for each product category, several multi-echelon policies are presented and tested through simulations in order to carry out an assessment of their logistic performance. Moreover, a model that minimizes the overall inventory cost, including transportation administration and perishing cost is also presented.

2. VfW-IfW methodology

Vouchers for Work - Input for Vouchers (VfW-IfW) approach can represent a suitable solution for chronic emergencies situations caused, for example, by conflicts or natural disasters. In these circumstances, three main problems may block the potential recovery of agricultural activities:

- inadequate rural infrastructures: roads, wells, markets, etc;
- lack of funds to restart trading and production activities;
- absence of private initiatives for the delivery of agricultural products to farmers.

To be able to act simultaneously on all these three problems, VfW-IfW methodology has been founded with three targets:

- building of critical infrastructures, realized by project beneficiaries that are rewarded with vouchers;

- supporting the development of a private distribution system for agricultural products by which beneficiaries can exchange received vouchers;
- training on growing technique, to increase the quality and the results of harvests.

The goal is to develop a trading system that allows local communities to sustain themselves, leveraging on growing technique learning and on the presence of quality seeds. The following figure represents the various players involved and the flow of both goods and vouchers in each phase of intervention.

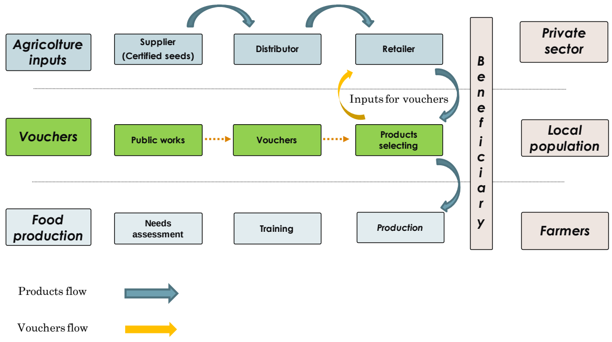

Figure 3: Products and vouchers flow

As an hypothesis, in the start-up phase of the project, neither distributors nor retailers have the economic capacity to buy a variety and quantity of products which is sufficient to satisfy their demand. For this reason the humanitarian organizations responsible of the project grant them a credit. The input dealers play, therefore, a passive role within a supply chain which is fully coordinated by the organizations. These establish both supply and materials management policies in order to minimize costs and to ensure a high service level, given that a dissatisfaction of project beneficiaries would cause the failure of the intervention.

The central role of the community is an innovative concept: in the traditional methodologies – DSD or SFV - humanitarian organizations decide autonomously the varieties, quantities and time for the distribution of the products, basing on their perception of the population needs. In this way there is a non negligible probability of unsatisfying real beneficiaries' preferences. However, the change originating from the introduction of the new VfW-IfW approach generates a strong increase in the project complexity, considering that the need to apply quantitative methods for the optimization of supply and materials management in each level of supply chain arises. In this paper, referring to the project being carried out in North Uganda, a three levels supply chain is considered (Figure 4) and a model for the optimal order quantities determination is presented.

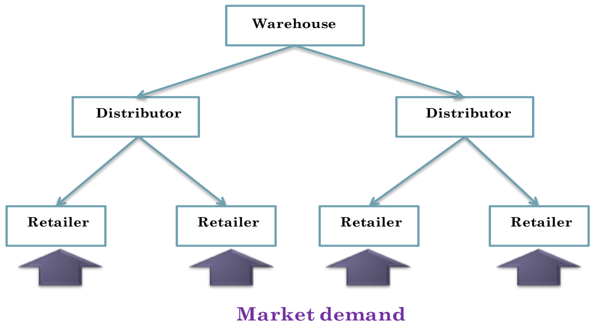

Figure 4: Supply chain structure

The goal is to minimize supply costs and inventory costs. For each product class, several multi-echelon policies have been tested through simulation in order to carry out an assessment of their logistic performance.

3.Optimal order quantity determination

The proposed model is based on several assumptions that reflect project constraints:

- build up rate is considered known and constant;
- the lots are entirely delivered at one time;
- purchase costs are constant and not influenced by economies of scale (thus are not considered in the model);
- holding costs quantify the risk of a bad investment because of perishable goods. Opportunity cost is considered equal to zero because the capital devoted to the project could not be eventually used for alternative investments;
- it is not possible to identify and reject perished products because of lack of adequate tools for materials quality control.

The first three of these hypotheses can be brought back to the well known Wilson and Harris inventory management and lot sizing models. In the model the following parameters are also defined:

- C_{ua}: administrative cost incurred for each order issued;
- C_d: perishing cost - it is related to beneficiaries dissatisfaction due to perished products. In this model it is estimated as (at least) twice the price of each product because the beneficiary should however buy again the same goods thus doubling his expenses;
- *TH*: planning period - expressed in days;
- *DT*: maximum perishing time - it represents the service life of a product which means that after this period the 100% of materials perishes. It obviously depends on the type of goods and on the environmental conditions in the warehouses. This parameter is estimated by the project responsible on the base of his experience.

- α' (t): distribution function of perishing probability, with 0≤*t*≤*DT*. It represents the probability that one unit of product perishes at time t. Its trend depends either on the type of goods or on the environmental conditions in storage;
- α(*t*): cumulative distribution function of perishing probability - with 0≤*t*≤*DT*. It is computed to be equal to

$$\alpha(t) = \left({}^{t}/_{DT}\right)^{n} \quad (1)$$

where the parameter *n* represents a shape factor (Nahmias, 1982). This parameter depends on the type of goods and on the environmental conditions in storage as well.

The inputs variables are listed below:

- *Q*: replenishment quantity;
- $C_{lo}(Q)$: ordering cost - It is characterized by two components: the first one is fixed for each order (C_{ua}), the second depends on carried quantity $C_t(Q)$;
- *D*: total demand expected in the planning period *TH*;
- *I*(*t*): inventory level at time *t*;

The optimal size of order quantity *Q** minimizes the total supply costs *CT*(*Q*) given by the sum of ordering costs and holding costs. Hence, the total cost function becomes:

$$CT(Q) = C_{lo}(Q) * D/Q + IDP(Q) * C_d * D/Q \quad (2)$$

where *IDP* is the amount of inputs perished in a batch coverage period. It is determined by considering the cumulative amount of perished inputs at time t:

$$\int_0^t I(x) * \alpha'(x) * dx \text{ with } 0 \le t \le \frac{Q}{\bar{d}}. \quad (3)$$

Assuming a constant inventory build-up rate, the total cost function can be written like:

$$CT(Q) = [\, C_T(Q) + C_{ua}\,] \cdot \frac{D}{Q} + D \cdot \left(\frac{Q}{\bar{d} * DT}\right)^{n} \cdot \frac{1}{n+1} \cdot C_d \quad (4)$$

Minimizing the *CT*(*Q*) function for any possible value of the market demand, it is possible to find the optimal lot size *Q**.

4.Inventory models

The availability of stock gives the possibility to reduce the response time to the customer, but this generates an holding cost that in VfW-IfW project is considered equal to the goods perishing cost $C_{d.}$ The application of Operation Management quantitative methods aims at achieving a good trade-off between service level and operating costs, and this leads to an increase in efficiency of the whole project.
Considering that, in North Uganda, accessibility areas from each retailers are quite distinct, it is assumed only a vertical flow of products within the supply chain, which means that products exchange among retailers or distributors is not possible and an univocal allocation of beneficiaries and retailers is determined.
Products are thus divided in three different classes in dependence on their perishing trend. In this way the most appropriate inventory policy for each class can be applied.

Class	Description
Class K	Single-growing perishable goods
Class M	Multi-growing perishable goods
Class N	Not perishable goods

Table 1: Products classification

The next table summarizes the parameters that characterize each supply chain actor.

Class	Description
$\bar{d}_i$	Mean value of the demand for each actor *i*
$\sigma^2_{d_i}$	Variance of the demand
$\overline{LT}_i$	Mean value of the supply lead time for each actor *i*
$\sigma^2_{LT_i}$	Variance of the supply lead time

Table 2: Model parameters

For each product class, several inventory look-back policies are presented, defining three decision variables for each supply chain actor:

- Reorder level - *LR*
- Replenishment quantity - *Q*;
- Safety stock – *SS.*

4.1 Inventory policy for class N products

Installation stock, based on a “two-bin” policy, is applied to product class *N*. For this type of goods, perishing costs are negligible. This results in the fact that the order quantity is not determined to minimize $CT(Q)$ but to reduce the number of orders (*D*/*Q*) and, meanwhile, the complexity of the project. For this reason an installation stock policy is presented: the amount of needed information is not dispersed within supply chain and a replenishment order for *Q* units is launched when one of two bins gets exhausted. Safety stock is computed according to the classical Hadley & Within model (Hadley & Whitin, 1963).
Table 3 summarizes *LR*, *Q* and *SS* values in the installation stock policy based two bin policy.

Level SC	Reorder level	Order quantity	Safety stock
Warehouse	$LR_w = \bar{d}_w \cdot \overline{LT}_e + SS_w$	$Q = \bar{d}_w \cdot \overline{LT}_e + SS_w$	$SS_w = k\sqrt{\sigma^2_{LT_e} \cdot \bar{d}^2_w}$
Distributor	$LR_{d_i} = \bar{d}_{d_i} \cdot \overline{LT}_{d_i} + SS_{d_i}$	$Q = \bar{d}_{d_i} \cdot \overline{LT}_{d_i} + SS_{d_i}$	$SS_{d_i} = k\sqrt{+\sigma^2_{LT_{d_i}} \cdot \bar{d}^2_{d_i}}$
Retailer	$LR_{r_j} = \bar{d}_{r_j} \cdot \overline{LT}_{r_j} + SS_{r_j}$	$Q = \bar{d}_{r_j} \cdot \overline{LT}_{r_j} + SS_{r_j}$	$SS_{r_j} = k\sqrt{\sigma^2_{d_{r_j}} \cdot \overline{LT}_{r_j} + \sigma^2_{LT_{r_j}} \cdot \bar{d}^2_{r_j}}$

Table 3: *N1* inventory policy : two-bin

4.2 Inventory policy for class M products

Installation stock based ROL (Re-Order Level) policy is applied to product class *M*. When the on-hand inventory level falls below a certain replenishment point - *LR* - a replenishment order for a certain quantity *Q** is generated. This leads to minimize the total costs $CT(Q)$. The installation stock policy is preferred if compared to the echelon policy because of the continuous inventory monitoring needed by ROL policy. Table 4 summarizes *LR*, *Q* and *SS* values in an installation stock based ROL policy.

Level SC	Reorder level	Order quantity	Safety stock
Warehouse	$LR_w = \bar{d}_w \cdot \overline{LT}_e + SS_w$	Q^*_w	$SS_w = k\sqrt{\sigma^2_{LT_e} \cdot \bar{d}^2_w}$
Distributor	$LR_{d_i} = \bar{d}_{d_i} \cdot \overline{LT}_{d_i} + SS_{d_i}$	Q^*_{di}	$SS_{d_i} = k\sqrt{+\sigma^2_{LT_{d_i}} \cdot \bar{d}^2_{d_i}}$
Retailer	$LR_{r_j} = \bar{d}_{r_j} \cdot \overline{LT}_{r_j} + SS_{r_j}$	Q^*_{rj}	$SS_{r_j} = k\sqrt{\sigma^2_{d_{r_j}} \cdot \overline{LT}_{r_j} + \sigma^2_{LT_{r_j}} \cdot \bar{d}^2_{r_j}}$

Table 4: *M1* inventory policy: ROL

Similarly to *N1* case, safety stock is computed according to Hadley & Within model where *k* is a decision variable related to service level, and should be set by the project responsible.

4.3 Inventory policy for class K products

Class *K* products are characterized by a high perishing trend. Minimizing the overstock of the whole supply chain is very important to limit both inventory cost and buyers' unsatisfaction due to purchase of unsuitable goods. On the other hand, an over-reduction of stock may generate a of service level loss, which may influence project success.
In order to achieve a good trade off among these factors, three different inventory policies are presented (Table 5):

- model *K1*: echelon stock based (*s*,*S*) policy (Zipkin, 2000) for the first level of the supply chain - warehouse - and installation stock based ROL policy for the others - distributors, retailers;
- model *K2*: echelon stock based (*s*,*S*) policy for the first level of the supply chain and installation stock based policy for the others, with re-order level and decreasing ordered quantities as time passes;
- model K3: single period inventory policy - so called "newsboy problem" (Arrow K.A, 1951).

In models *K1* and *K2* the echelon stock policy leads to the minimization of total costs in a centralized supply chain. An effective implementation of this policy requires strict coordination among all actors within the supply chain. However, in a context lacking in adequate means of communication and data sharing, as North Uganda is, an echelon inventory policy renders continuous inventory review almost impossible to set in practice. For this reason, (*s,S*) policy is applied at warehouse level: inventory level is periodically verified so the average values for cycle stock and safety stock increase due to a higher re-order lever with respect to that used in *ROL* policy. In order to balance this negative effect, an installation stock based ROL policy is applied at the others supply chain levels.
K2 model differs from *K1* in determining the order quantity size. Ordered quantities start decreasing after time *t**, which is determined by the project responsible. In this way, at the end of the sowing season, stock decreases.
In the *K3* model the single period inventory policy is applied because of shorter life cycle of class *K* products. At the beginning of the sowing season only one order is launched, and *Q* instead of *Q*-1 units are ordered if the average benefits (*b*) are greater than the average losses (θ); thus it is necessary to quantify the benefits related to a single unit of product in the project.

Using the North Uganda project data, for each euro invested in a class *K* product the system earns, on top of obviously one euro of quality goods:

- one euro of construction works;
- 15 cent earned by retailers and distributors;
- one euro related to capacity training.

Hence it is possible to assume that average benefit is equal to:

$b = 3{,}15 \cdot c$

where *c* is the single product price. On the contrary the average losses are equal to perishing cost, that is:

$\theta = C_d$ with $C_d = 2 \cdot c$

The size of the order launched by the warehouse is equal to:

$$Q^1{}_w = inv.norm\,(1 - 0{,}388; \bar{d}_w; \sigma_{d_w}) \qquad (5)$$

At last, an installation stock based ROL policy is applied at the others supply chain levels.

Inventory policy K1			
Level SC	***Reorder level***	***Order quantity***	***Safety stock***
Warehouse	$LR_w = \bar{d}_w \cdot (\overline{LT}_e + T) + SS_w$	$LO_{wc} = Q^*{}_w + LR_w$	$SS_w = k\sqrt{\sigma^2_{LT_e} \cdot \bar{d}^2_w}$
Distributor	$LR_{d_i} = \bar{d}_{d_i} \cdot \overline{LT}_{d_i} + SS_{d_i}$	$Q^*{}_{d_i}$	$SS_{d_i} = k\sqrt{+\sigma^2_{LT_{d_i}} \cdot \bar{d}^2_{d_i}}$
Retailer	$LR_{r_j} = \bar{d}_{r_j} \cdot \overline{LT}_{r_j} + SS_{r_j}$	$Q^*{}_{r_j}$	$SS_{r_j} = k\sqrt{\sigma^2_{d_{r_j}} \cdot \overline{LT}_{r_j} + \sigma^2_{LT_{r_j}} \cdot \bar{d}^2_{r_j}}$
Inventory policy K2			
Level SC	***Reorder level***	***Order quantity***	***Safety stock***
Warehouse	$LR_w = \bar{d}_w \cdot (\overline{LT_t} + T) + SS_w \text{ if } t < t^*$ $LR_w{}' = LR_w \cdot \left(\frac{TH-t}{TH}\right)$ $\text{if } t^* < t < TH$	$LO_{wc} = Q^*{}_w + LR_w$ $LO_{wc}{}' = LO_{wc} \cdot \left(\frac{TH-t}{TH}\right) + U(TH) \cdot L4L(T)$	$SS_w = k\sqrt{\sigma^2_{LT_e} \cdot \bar{d}^2_w}$
Distributor	$LR_{d_i} = \bar{d}_{d_i} \cdot \overline{LT_{d_i}} + SS_{d_i}$ $\text{if } t < t^*$ $LR_{d_i}{}' = LR_{d_i} \cdot \left(\frac{TH-t}{TH}\right)$ $\text{if } t^* < t < TH$	$Q^*{}_{d_i}$ $Q^*{}_{d_i} \cdot \left(\frac{TH-t}{TH}\right) + U(TH) \cdot L4L(T)$	$SS_{d_i} = k\sqrt{+\sigma^2_{LT_{d_i}} \cdot \bar{d}^2_{d_i}}$
Retailers	$LR_{r_j} = \bar{d}_{r_j} \cdot \overline{LT_{r_j}} + SS_{r_j}$ $\text{if } t < t^*$ $LR_{r_j}{}' = LR_{r_j} \cdot \left(\frac{TH-t}{TH}\right)$ $\text{if } t^* < t < TH$	$Q^*{}_{r_j}$ $Q^*{}_{r_j} \cdot \left(\frac{TH-t}{TH}\right) + U(TH) \cdot L4L(T)$	$SS_{r_j} = k\sqrt{\sigma^2_{d_{r_j}} \cdot \overline{LT}_{r_j} + \sigma^2_{LT_{r_j}} \cdot \bar{d}^2_{r_j}}$
Inventory policy K3			
Level SC	***Reorder level***	***Order quantity***	***Safety stock***
Warehouse	Single batch at the beginning of the sowing season	$Q^1{}_w$	
Distributors	$LR_{d_i} = \bar{d}_{d_i} \cdot \overline{LT}_{d_i} + SS_{d_i}$	$Q^*{}_{d_i}$	$SS_{d_i} = k\sqrt{+\sigma^2_{LT_{d_i}} \cdot \bar{d}^2_{d_i}}$
Retailer	$LR_{r_j} = \bar{d}_{r_j} \cdot \overline{LT}_{r_j} + SS_{r_j}$	$Q^*{}_{r_j}$	$SS_{r_j} = k\sqrt{\sigma^2_{d_{r_j}} \cdot \overline{LT}_{r_j} + \sigma^2_{LT_{r_j}} \cdot \bar{d}^2_{r_j}}$

Table 5: Inventory policies class K products

5.Simulation and results analysis

The models presented in the previous sections have been tested with Enterprise Dyanamics Studio® simulation software to study their logistic performance in terms of both service level and inventory cost. In this step, *N1* model was excluded from the analysis due to the low criticality of this type of products: they are characterized by negligible perishing cost so high service levels are easily reachable. Other models are tested on two cases with different supply lead time values (long/short) in order to analyze the corresponding performance variation. Each simulation is characterized by 10 runs of 1 year length.

The logistic performances of the models is measured with two indexes:

- service level: it is computed like the average queue waiting time at retailers level;
- inventory cost: it is assumed to be equal to perishing cost.

Analyzing simulation results it is possible to classify models by perishing cost: model *K2* achieves the lowest values, followed by model *K3*, *K1* and *M1*. This confirms some theory assumptions regarding models performances:

- installation stock policy - model *M1* - generates a greater amount of wasted products than the echelon one - model *K1*,*K2*,*K3* - within the whole supply chain;
- model *K2* achieves lower perishing cost than *K1* because ordered quantity starts to decrease near the sowing season end. This allows to decrease the amount of unsold products which perish between two consecutive sowing seasons. As supply lead time increases, this effect raises.
- model *K3* generates greater perishing cost with respect to those of model *K2* because a single order is placed at the beginning of sowing season and the average stock increases according to perishing probability.

The second performance measure index - service level - gives an opposite result: model *M1* achieves the lowest average queue waiting time at retailers level, followed by model *K1*, *K2*, and *K3*.

Figure 5 and Figure 6 point out a qualitative models classification in terms of both performance measure indexes as lead time varies.

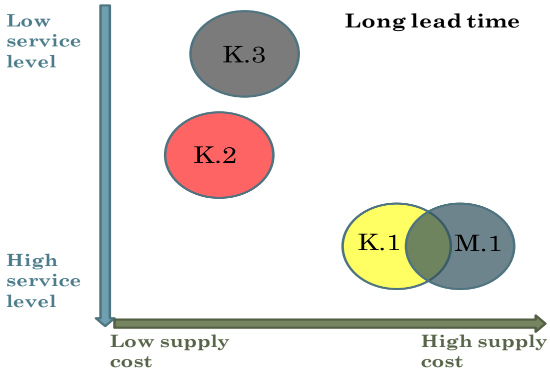

Figure 5: Comparison between logistic performance of models with long LT

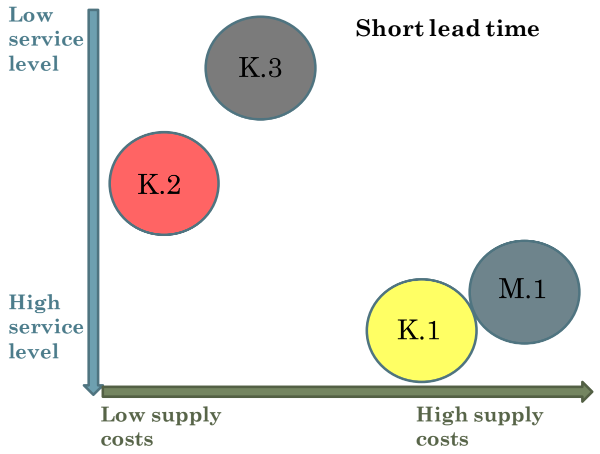

Figure 6: Comparison between logistic performance of models with short LT.

K1 and *M1* models achieve high service level but high supply costs as well; on the contrary *K2* and *K3* models achieve both low supply cost and low service level. *K2* model performs always better that *K3* because, given a certain supply cost, the former achieves a higher service level either with short or long lead times.

6.Conclusions

This paper focuses on the validation of Industrial Inventory Control Policies within an innovative EAA methodology, in order to show the effectiveness of Operations Management techniques applied to Humanitarian Logistics Supply Chain.

Up to now, two main different logistic approaches have been applied in order to guarantee seed accessibility in poor countries through the Emergency Agriculture Aid multi-level supply chain: Direct Seed Distribution (DSD) and Seed Vouchers and Fairs (SVF). Despite both of these methodologies were conceived for the application during acute crisis, in past times these have been applied even in chronic crisis contexts, with poor results. In this paper a new logistic model suitable for supply chain management in chronic crisis contexts is presented, the so-called *Vouchers for Work - Input for Vouchers* approach (VfW-IfW). In this methodology service level is critical because farmers dissatisfaction may cause their withdrawal from the project and a consequent failure. The availability of seeds stock obviously gives the possibility to reduce the response time to the customer, but it may generates high holding cost, due to perishable goods. Hence, for each product category, several multi-echelon policies are presented and tested through simulations in order to carry out an assessment of their logistic performance. From simulation results it has been found that dealing with single-growing perishable seeds, either with short or long supply lead times, in case of service level optimization, an echelon stock based policy for the warehouses and an installation stock based standard re-order level policy for the retailers, generally achieves the best logistic performance; while in case of supply cost optimization better performances are reached if ordered quantities are decreased as time passes. On the other side, dealing with multi-growing perishable goods, either with short or long supply lead times, a standard re-order level stock based policy applied both to all supply chain levels allows to reache high service level with acceptable costs.

Despite it is anyway clear that the approach choice depends on the strategic decision of giving more importance to service level or to supply costs, in this paper it has been shown that the application of Operation Management quantitative methods – especially those in the field of Inventory Management and Stock Control – aiming to achieving a good trade-off between service level and supply costs can provide an effective support to intergovernmental and non-governmental organizations in managing these complex multi level-supply chains.

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