Scenario Analysis for Emergency Inventory Prepositioning of Medical Supplies

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Introduction (1)

- There are more than 7,000 disasters occurred with over 2.6 million people reported to be affected by these disasters and almost half of this number was reported to have lost their life between 1999-2008. The cost in total exceeded one trillion dollars.
- 80% of action to overcome disaster lies on logistics efforts . A delay in the humanitarian logistics could be fatal.


ORAL
REHYDRATION SALTS
Each sachet contains the equivalent of:
Sodium Chloride 3.5 g
Potassium Chloride 1.5 g
Trisodium Citrate dihydrate 2.9 g
Glucose Anhydrous 20.0 g
DIRECTIONS
Dissolve in ONE LITRE of drinking water.
To be taken orally.
Infants - over a 24 hour period.
Children - over an 8 to 24 hour period.
according to age or as otherwise
directed under medical supervision.
CAUTION: DO NOT BOIL SOLUTION
MANUFACTURER: Jianas Bros. Packaging Co.
Kansas City, Missouri, U.S.A.


Doxycycline
Capsules
actavis
Doxycycline
Capsules
100
mg
8 capsules
For oral use

Introduction (2)

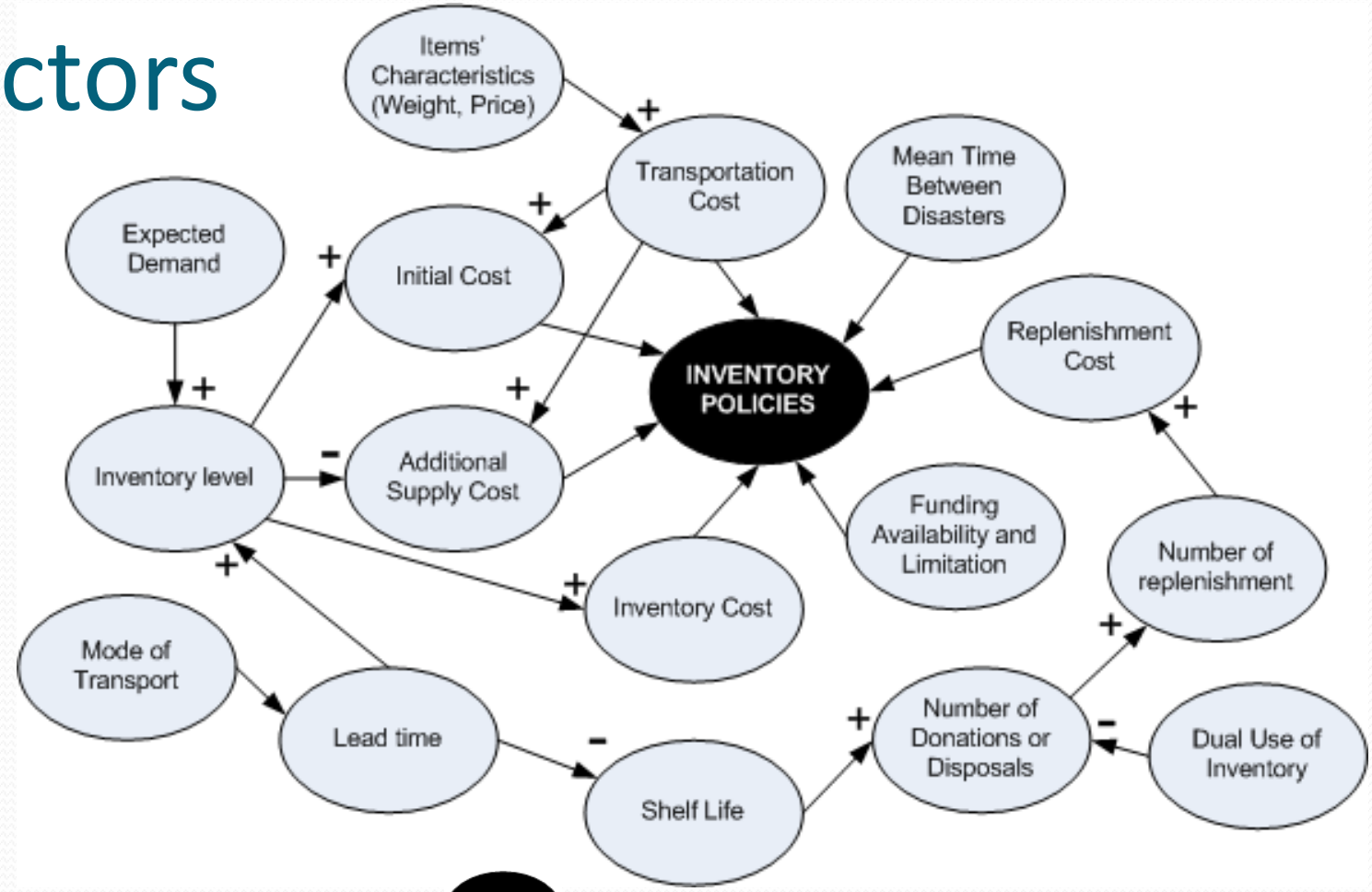
- The first 72 hours of a disaster relief effort are critical as the chance for survival beyond that time window decreases drastically .
- Keeping an inventory of emergency supplies in strategic locations can improve
  1. time response to disasters,
  2. capacity use during relief operations,
  3. effectiveness of the relief chain

Inventory for Emergency Prepositioning

- Definition

  Strategic positioning of inventory in the relief area in preparation for disasters to improve the response and efficiency of the relief aid. It needs to be managed by taking into account the key factors affecting it

Inventory Policies Influencing Factors



Legend:

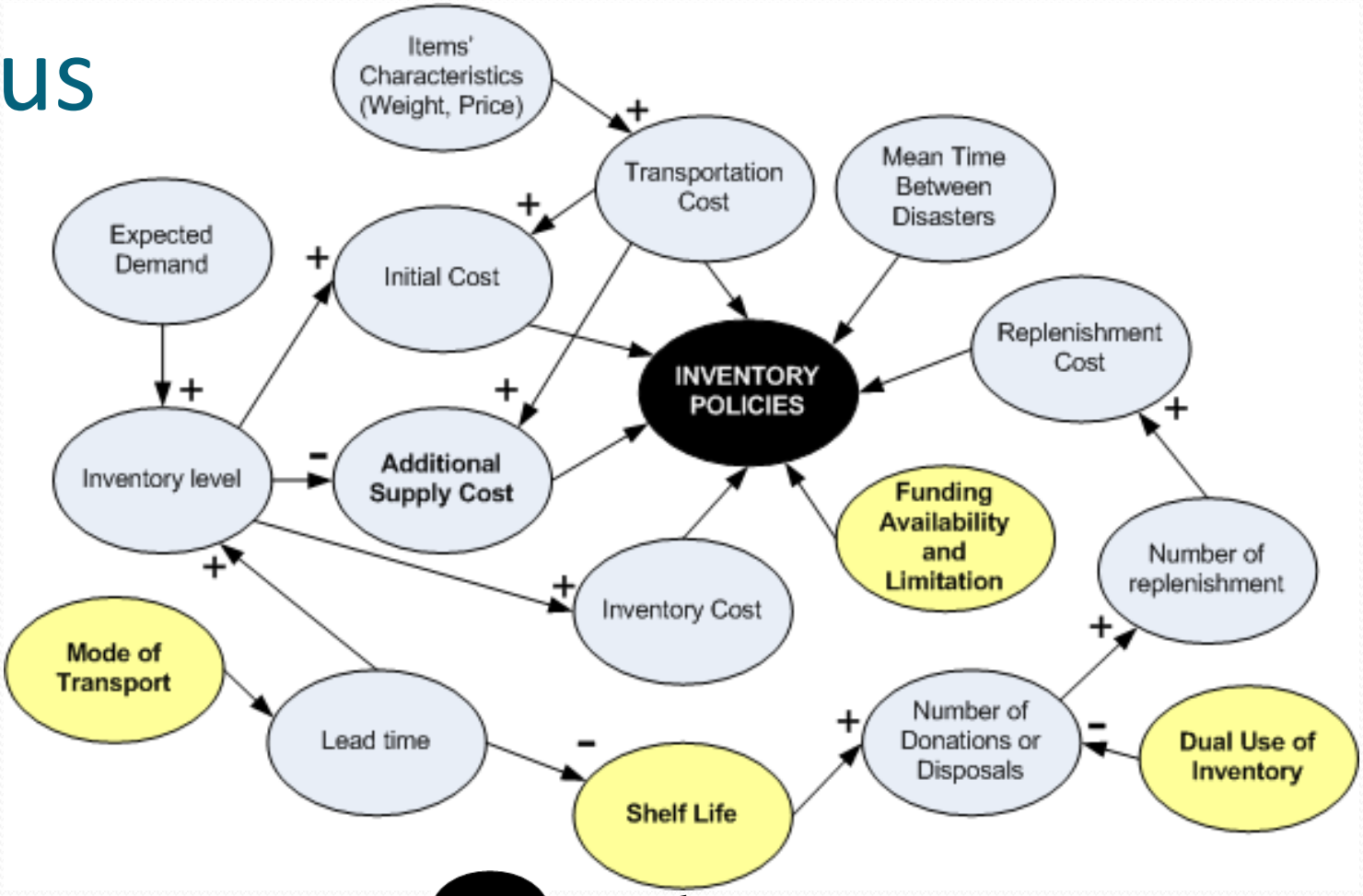
= Influencing Factor

= Goal

= Direction of Influence

+/- = Relation between factor, whether proportional (+) or inversely proportional (-)

Inventory Policies Influencing Factors Focus



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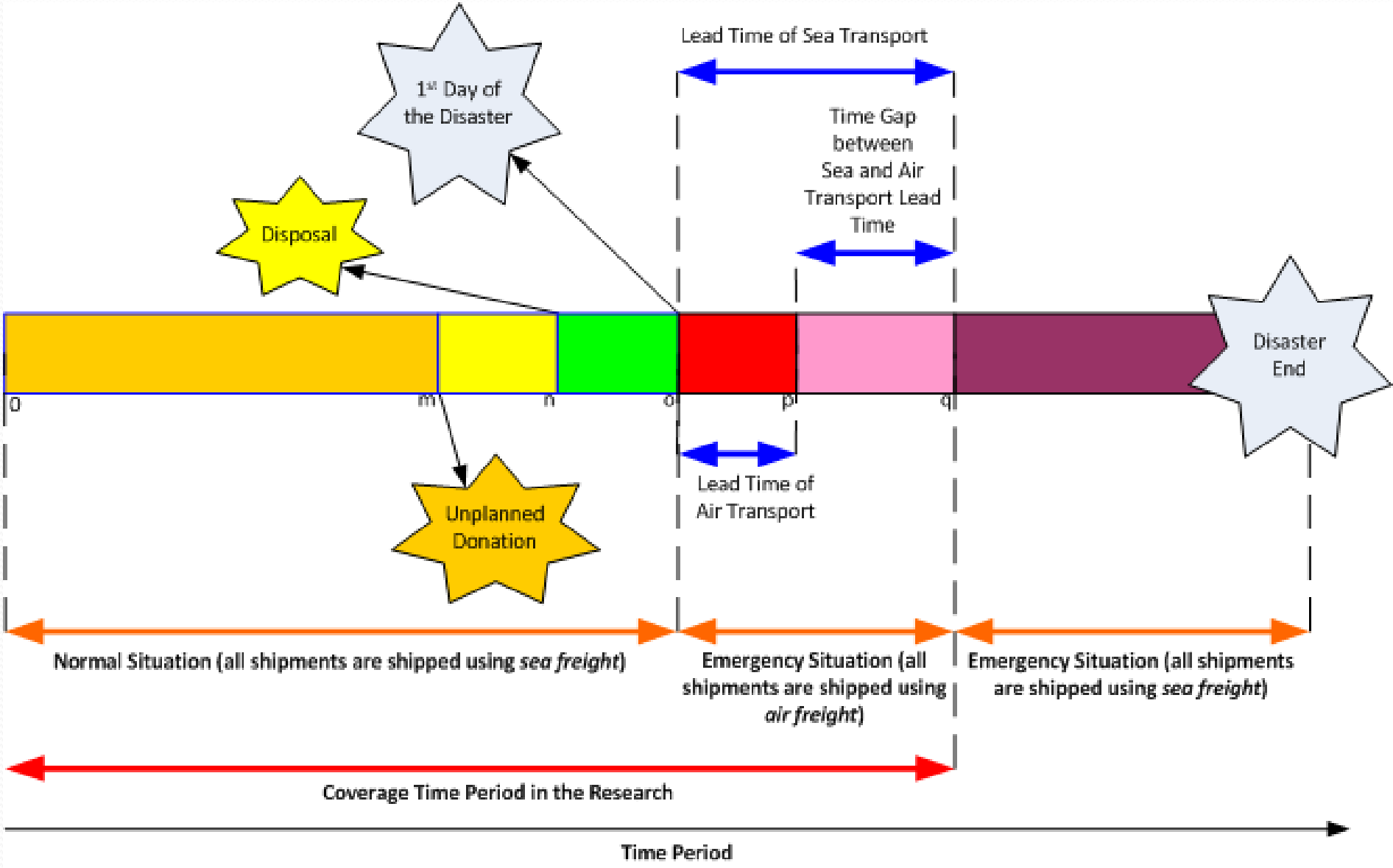
Scope

- We limit ourselves to the following situation:
  - To-country distribution only up to emergency prepositioning point
  - Transport to country by sea or air

CASE STUDY - MÉDECINS SANS FRONTIÈRES (MSF)

Inventory of ringer lactate for cholera emergency response at zimbabwe

Illustration



Issues to Consider in Case Study: 1. Mode of Transport (1)

- How transport modalities can affect the inventory:
  1. Mode of transport determine the quantity of inventory for emergency prepositioning
  2. The quantity will be equal to the number of items needed to cover the demand during the order to delivery time

Issues to Consider in Case Study: 1. Mode of Transport (2)

Air Transport

- Delivery time is short → inventory quantity ($Q_{Min,Air}$) is relatively small
- Initial cost is low
- Cost related to replenishment due to donation or disposal is low
- Cost to fill in the gap between lead time of sea and air (additional supply cost) high due to emergency situation

Sea Transport

- Delivery time is high → inventory quantity ($Q_{Min,Sea}$) is relatively big
- Initial cost is high
- Cost related to replenishment due to donation or disposal is high
- No additional supply cost to fill in the gap between lead time of sea and air

Issues to Consider in Case Study: 2. Funding Availability

- Inventory policies must not exceed the budget allocated for the emergency prepositioning to have replenishment before the disaster happen
- The funding can be only used for stocking ringer lactate only

Issues to Consider in Case Study: 3. Shelf Life

- Medical items have relatively short shelf life
- In this case, the item can also be donated to the other party. Based on the regulation, donated items must reach the destination of donation at least 6 months before expired.
- Items with short shelf life will have high number of disposal due to obsolescence
- The bigger number of disposal or donation, the bigger the cost related to this activities

Issues to Consider in Case Study: 4. Dual Use of Inventory

- Medical items such as Ringer Lactate require some form of rotation of emergency prepositioning stock to prevent obsolescence
- MSF implements dual use of inventory, their continuous aid work (e.g. malnutrition and vaccination program) can use the oldest disaster relief items for emergency prepositioning and replace the used items with a new ones.

Trade-off in Inventory for Emergency Prepositioning

- There is a trade-off between replenishment cost and additional supply cost.

High Inventory Level

- High number of replenishment
- High replenishment cost
- Low additional supply cost or even 0 (zero)

Low Inventory Level

- Low number of replenishment
- Low replenishment cost
- High additional supply cost

Method (1)

- We have been able to determine the effective inventory policies of ringer lactate for cholera emergency response at Zimbabwe
- An effective inventory policies in emergency prepositioning has to be able to minimize costs while satisfying demands without exceeding the budget allocation and incorporate the issues mentioned before

Method (2)

- The steps taken to determine effective inventory policies are as follow:
  1. Map the business process of the emergency prepositioning in MSF,
  2. Identify the factors or issues that affect the decision in emergency prepositioning
  3. Identify the possible scenarios
  4. Create a scenarios selection model to determine the effective inventory policies
  5. Data collection
  6. Use the data into the model

Scenarios (1)

- Every single scenario proposed in the model, presents a set of inventory policies as follow:
  1. Inventory level
  2. Order quantity
  3. Review and replenishment policy
  4. Transportation policy

Scenarios (2)

- The scenarios are identified based on:
  1. Mode of transport – two types of stock levels
  2. Options to dealt with obsolescence issue – dispose or donate

Scenarios (3)

No.	Scenario	Inventory Level	Transport Mode	Decision to Dispose or Donate
1	A	$Q_{Min,Sea}$	Sea Transport	Donate
2	C	$Q_{Min,Sea}$	Sea Transport	Dispose
3	E	$Q_{Min,Air}$	Air Transport	Donate
4	G	$Q_{Min,Air}$	Air Transport	Dispose

Scenario Selection Model (1)

- The model will be divided into six steps as follow:

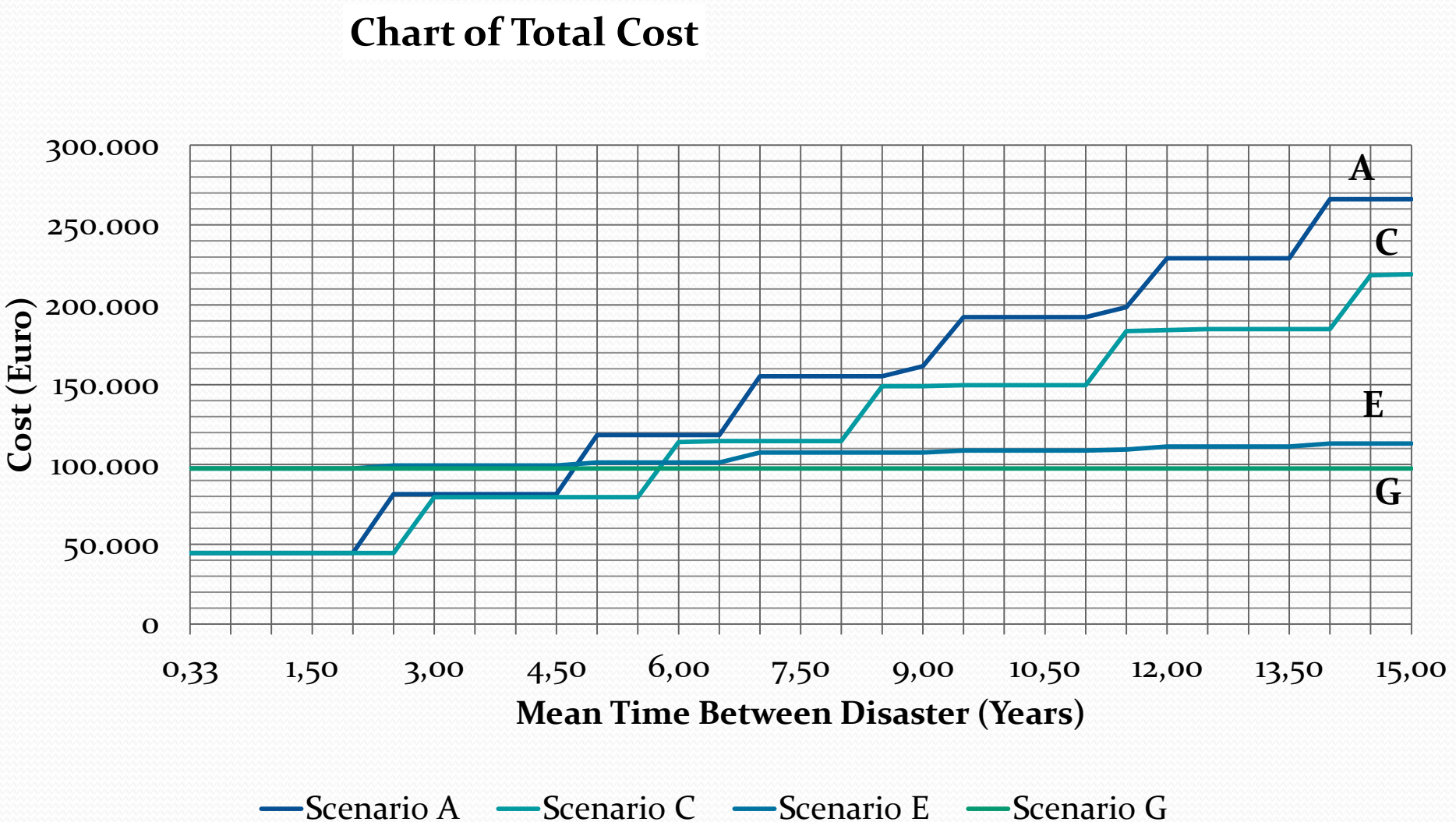
1. *Step 1* - Collect the necessary values of the parameters
2. *Step 2* - Define actual shelf life.
3. *Step 3* - Calculate the frequency and the items quantity of the donation or disposal per mean time between disasters.
4. *Step 4* - Calculate total cost.
5. *Step 5* - Identify disposal or donation replenishment cost.
6. *Step 6* - Conduct break even analysis and execute decision making.

Note: the model has been built based on deterministic variables due to the availability of historical data, complexity, purpose and time constraint.

Scenario Selection Result (1)

No	Variables/ Parameter	Value			
		Scenario A	Scenario C	Scenario E	Scenario G
1	Average Disposal or Donation Replenishment Cost (Euro)	21,464	13,537	1,725	No Increase
2	Mean Time between Occurrence of Disposal or Donation Replenishment (Year)	1.75	1.50	2.00	No Increase
3	Accumulative Expected Budget in the Mean Time between Occurrences of Disposal or Donation Replenishments (Euro)	26,250	22,500	30,000	15,000
4	Gap Between Expected Budget with Average Disposal or Donation Replenishment Cost (Euro)	4,785	8,963	28,275	15,000

Scenario Selection Result (2)



Scenario Selection Result (3)

- Scenario C is more preferable than any others scenario up to MTBD equal to 5.65 years
- Scenario G is more preferable than any others scenario after 5.65 years MTBD

Scenario Selection Result – Sensitivity Analysis (1)

- Lead time of transportation mode

  The lead time of transportation mode will affect three aspects as follow:

  1. The actual shelf life of the items → changes in replenishment costs
  2. Inventory level → changes in inventory costs
  3. The time difference between sea and air lead time → changes in emergency procurement costs

Scenario Selection Result – Sensitivity Analysis (2)

- Funding availability

  Currently, there are no scenarios exceed the funding limit. If the funding is smaller than the current condition, there is a possibility that scenario C exceed the limit thus it cannot be chosen.

  Therefore, Scenario A is more preferable than any others scenario up to MTBD equal to 4.78 years and the preference will go to G afterwards

Scenario Selection Result – Sensitivity Analysis (3)

- Shelf Life

  The increase in the shelf life of the items will reduce the number of donations or disposals or at least reduce the quantity per disposals or donations due to the affect of regular consumption. Therefore, the increase in the shelf life of the items will increase the likelihood of sea transport to be chosen.

  The effect of decreasing of shelf life of the items is the other way around than if there is an increase

Scenario Selection Result – Sensitivity Analysis (4)

- Dual use of inventory

  The increase the consumption of regular programs will reduce the number of donations or disposals or at least reduce the quantity per disposals or donations. Therefore, the changes in the regular consumption will increase the likelihood of sea transport to be chosen.

  The effect of the reduction in regular consumption is the other way around than if there is an increase

Conclusion

- There is no absolute winner. The scenarios will be overlapping each other at some points. The preferences will change on those points.
- Sea transport is more preferable in a short MTBD. In this case, the MTBD of cholera in Zimbabwe is less than a year, therefore sea transport should be chosen
- Disposal always generates lower cost than to donate. However, there are some other factors that influence the decision to donate or dispose, such as political aspects.

Suggestion for Further Researches

- Multi items
- Stochastic and analytical model
- More details in dual use of inventory
- Calculate and put into account causalities cost