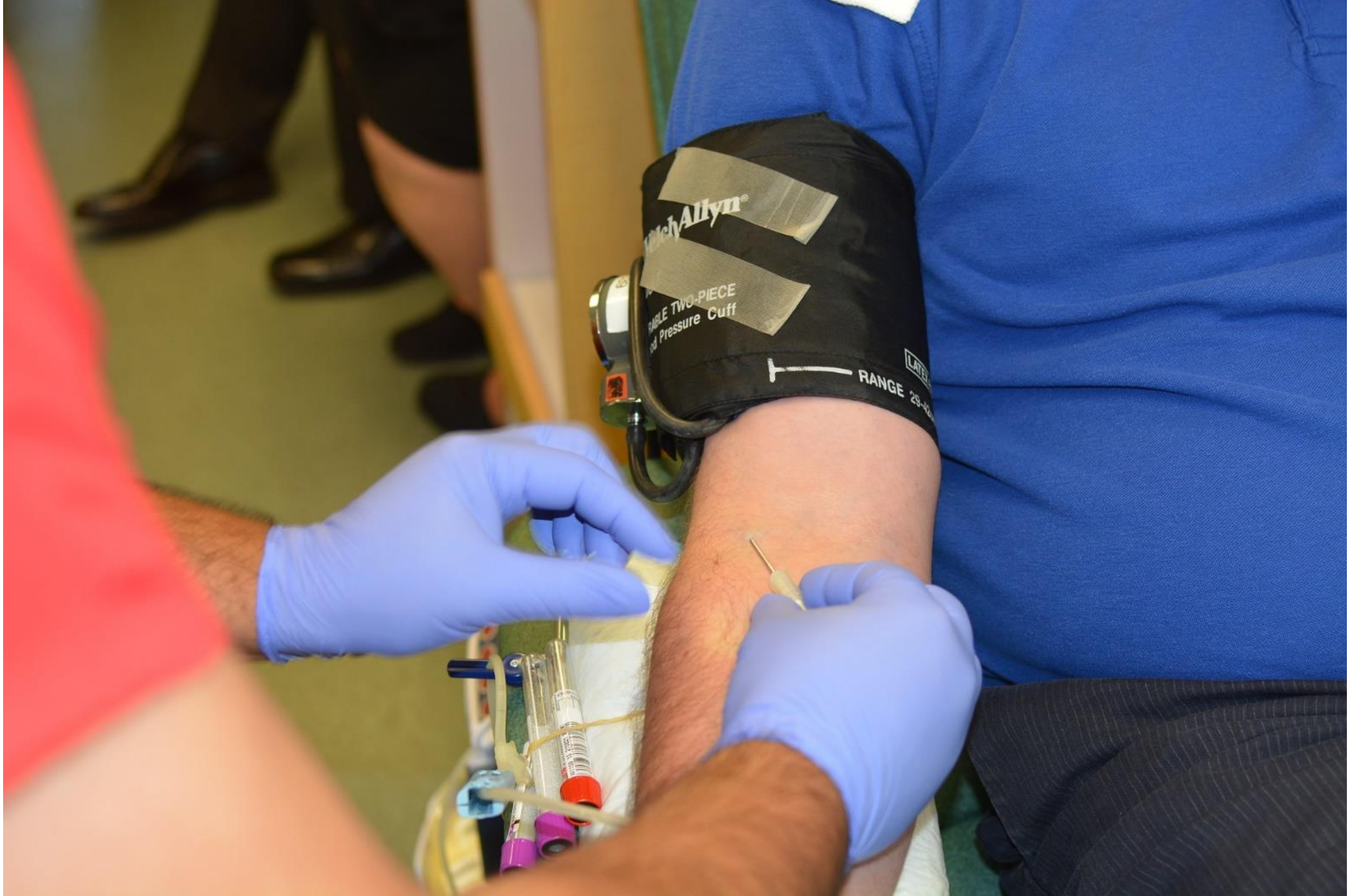
Tecnologías para la Sincronización de Superhéroes

Seminar of the PhD in Mathematical Engineering- Universidad EAFIT

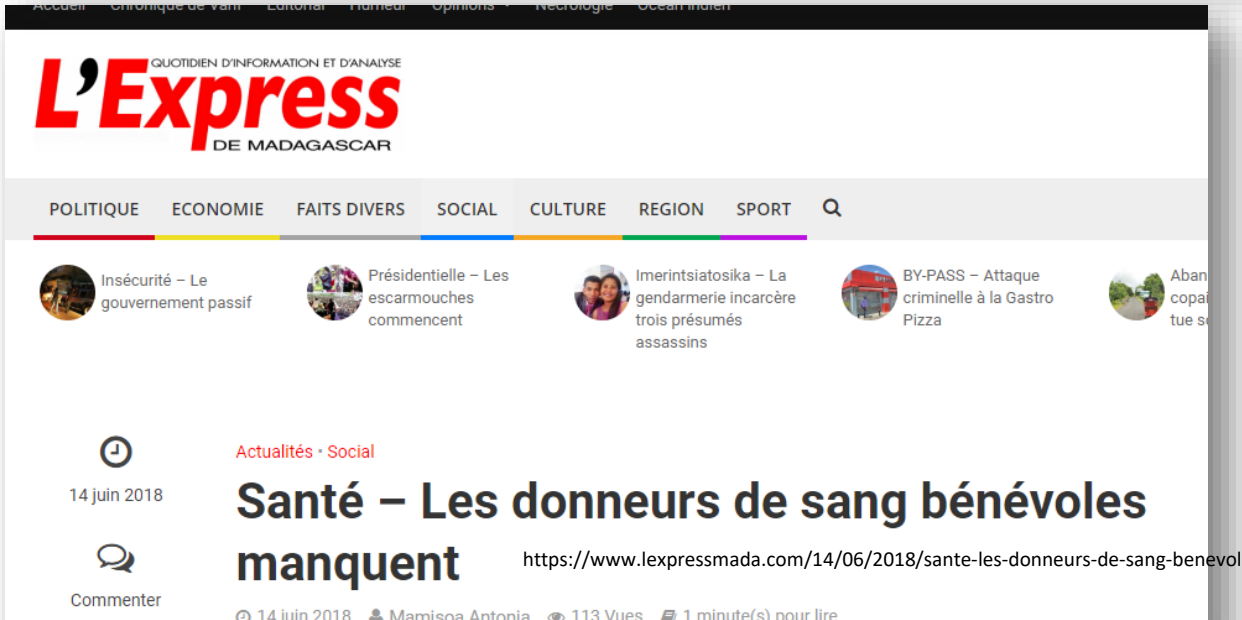

RABLE TWO-PIECE
od Pressure Cuff
RANGE

Alrededor del mundo

https://news4sanantonio.com/news/local/blood-donations-needed-for-recent-trauma-accident-patients-q

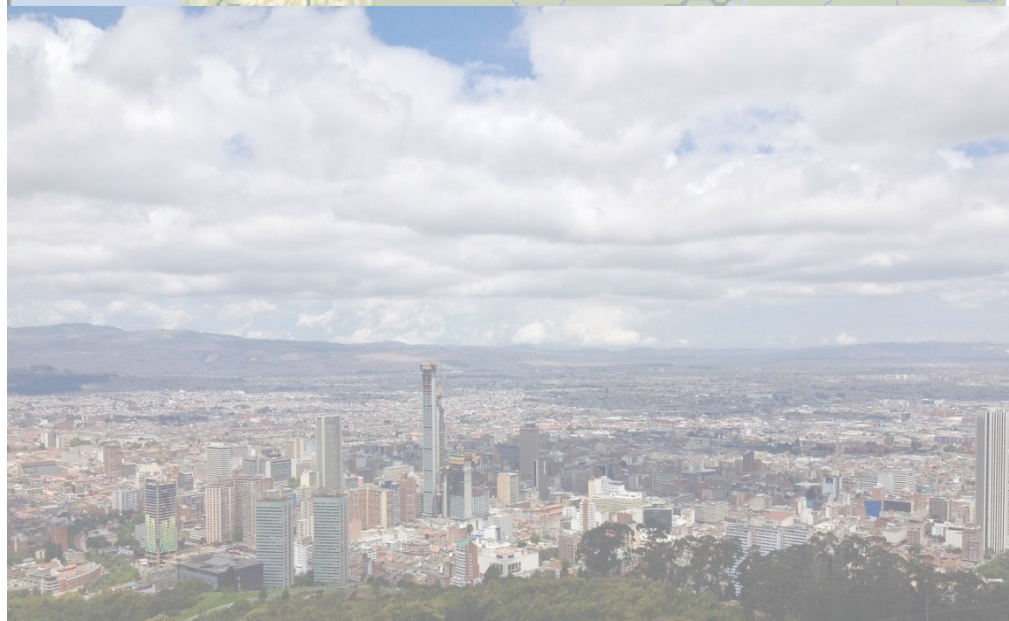
https://www.ins.gov.co/Noticias/Paginas/todos-los-dias-se-necesitan-donantes-de-sangre-en-colombia.aspx

http://www.elmundo.com/noticia/Se-necesitan-donantes-de-sangre-Ocon-urgencia/364663



https://www.lexpressmada.com/14/06/2018/sante-les-donneurs-de-sang-benevoles-manquent/

DATOS ACTUALES: Colombia

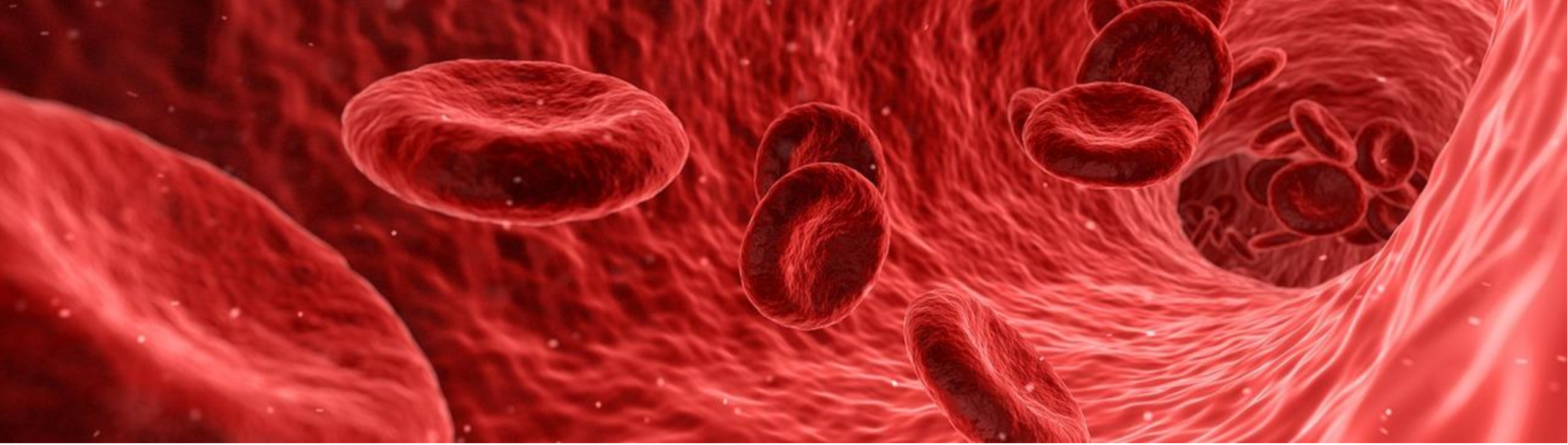


- ✓6.5 donantes por cada 1.000 habitantes.
- ✓ **META:** entre 20 y 25 donantes por cada 1.000 habitantes
- ✓ 39 bancos de sangre reciben menos de 5.000 unidades de sangre al año.

LOS RETOS

Reto # 1: ¿Y donde están los donantes?

SOURCE: www.toutenkamion.com/en/mobile-units/blood-donation.html



Reto # 2:
¿Toda la sangre es igual?

Tipos de Sangre

TABLA DE COMPATIBILIDAD ENTRE TIPOS DE SANGRE								
RECEPTOR	DONANTE							
	O-	O+	A-	A+	B-	B+	AB-	AB+
O-	✓	✗	✗	✗	✗	✗	✗	✗
O+	✓	✓	✗	✗	✗	✗	✗	✗
A-	✓	✗	✓	✗	✗	✗	✗	✗
A+	✓	✓	✓	✓	✗	✗	✗	✗
B-	✓	✗	✗	✗	✓	✗	✗	✗
B+	✓	✓	✗	✗	✓	✓	✗	✗
AB-	✓	✗	✓	✗	✓	✗	✓	✗
AB+	✓	✓	✓	✓	✓	✓	✓	✓

Fuente: http://pormasdonantes.blogspot.com/2013/01/arrancando-el-ano.html

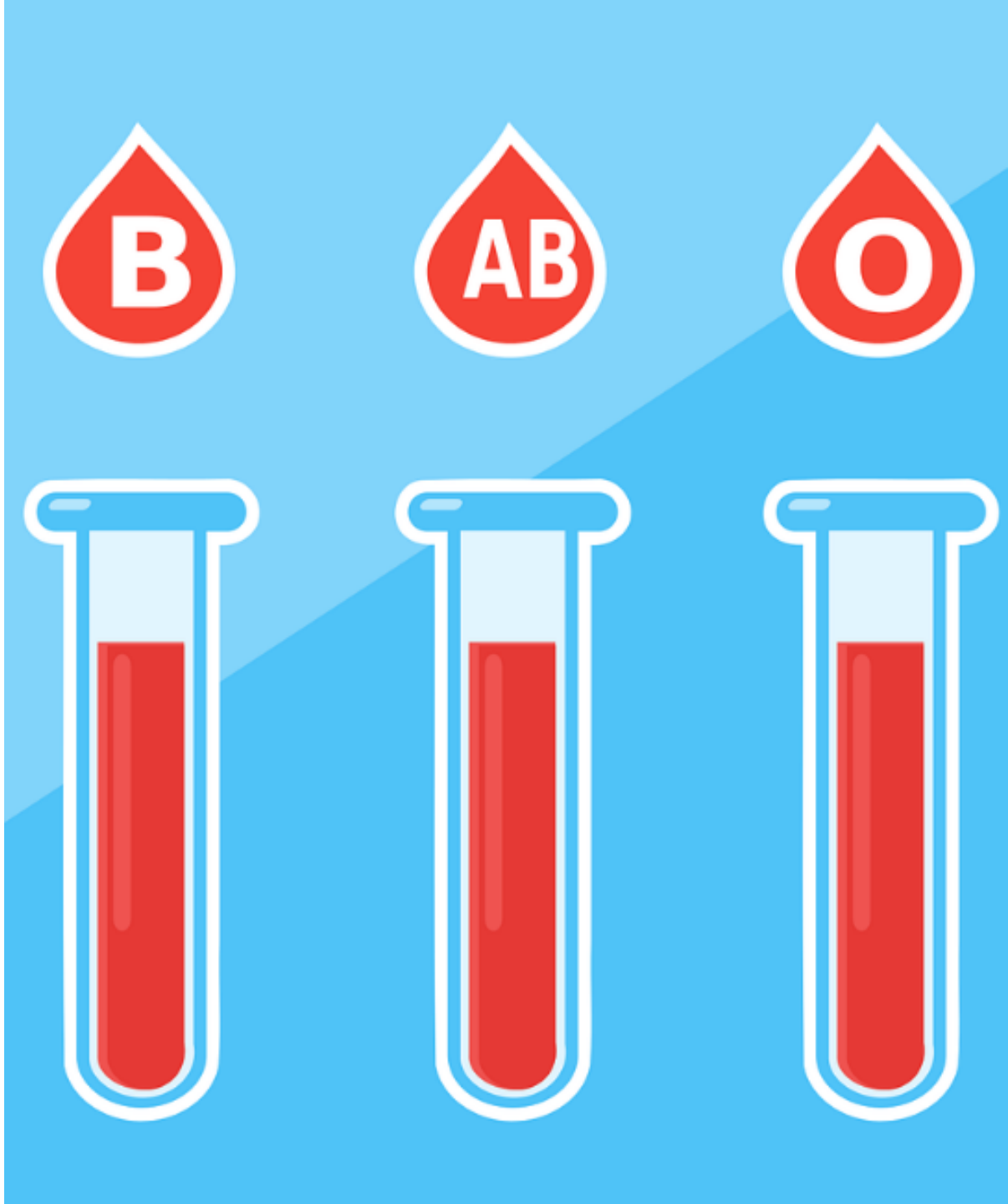
- Otras pruebas de compatibilidad
- Requerimientos de la “edad” de la Sangre

Reto #3:
¿Toda la sangre es entregada a los pacientes que la requieren?

No!

Tipo de Producto	Vida útil
Plaquetas	5 días
Sangre completa	21-31 días
Glóbulos rojos	42 días
Plasma	1 año
Crioprecipitado AHF	1 año

Reto #4: ¿Cómo hacen las bolsas de sangre para llegar hasta los pacientes ?

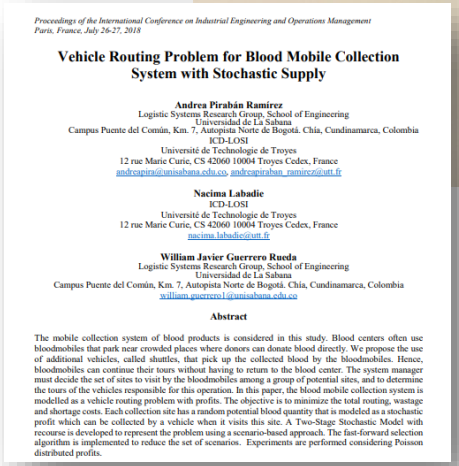


LOGÍSTICA

LA SOLUCIÓN

Universidad de La Sabana

Alianzas internacionales e investigación



Proceedings of the International Conference on Industrial Engineering and Operations Management
Paris, France, July 26-27, 2018

Vehicle Routing Problem for Blood Mobile Collection System with Stochastic Supply

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Abstract

The mobile collection system of blood products is considered in this study. Blood centers often use bloodmobiles that park near crowded places where donors can donate blood directly. We propose the use of additional vehicles, called shuttles, that pick up the collected blood by the bloodmobiles. Hence, bloodmobiles can continue their tours without having to return to the blood center. The system manager must decide the set of sites to visit by the bloodmobiles among a group of potential sites, and to determine the tours of the vehicles responsible for this operation. In this paper, the blood mobile collection system is modelled as a vehicle routing problem with profits. The objective is to minimize the total routing, wastage and shortage costs. Each collection site has a random potential blood quantity that is modeled as a stochastic profit which can be collected by a vehicle when it visits this site. A Two-Stage Stochastic Model with recourse is developed to represent the problem using a scenario-based approach. The fast-forward selection algorithm is implemented to reduce the set of scenarios. Experiments are performed considering Poisson distributed profits.

COLOMBIA
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La Sabana

Patrocinado por:

FEDER
Fondo Europeo de Desarrollo Regional

Whole Blood Collection and Component Processing

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Motivation

Don du sang : face au risque de pénurie, il y a urgence

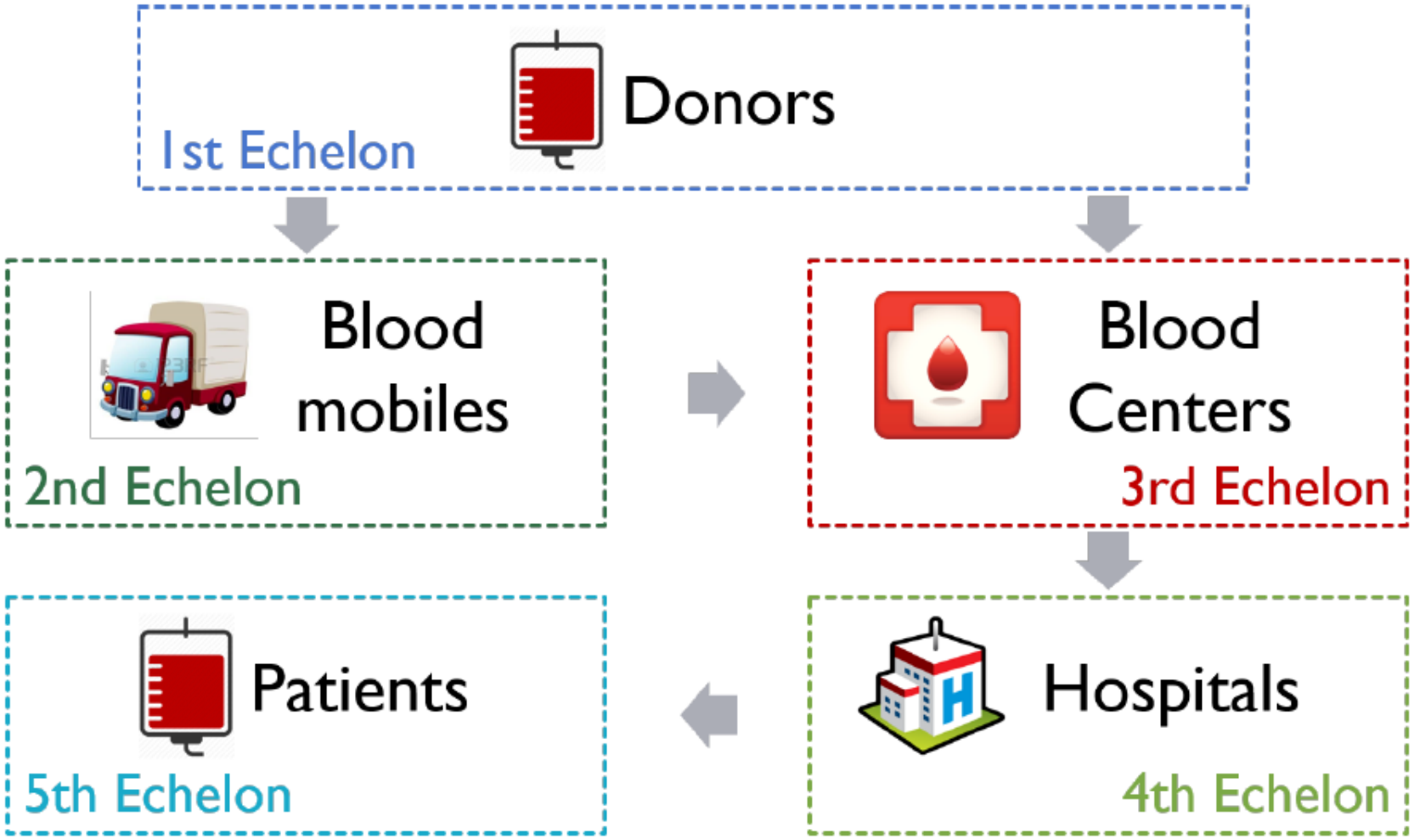
Société | J-C M.B. | 09 avril 2018, 12h57 |

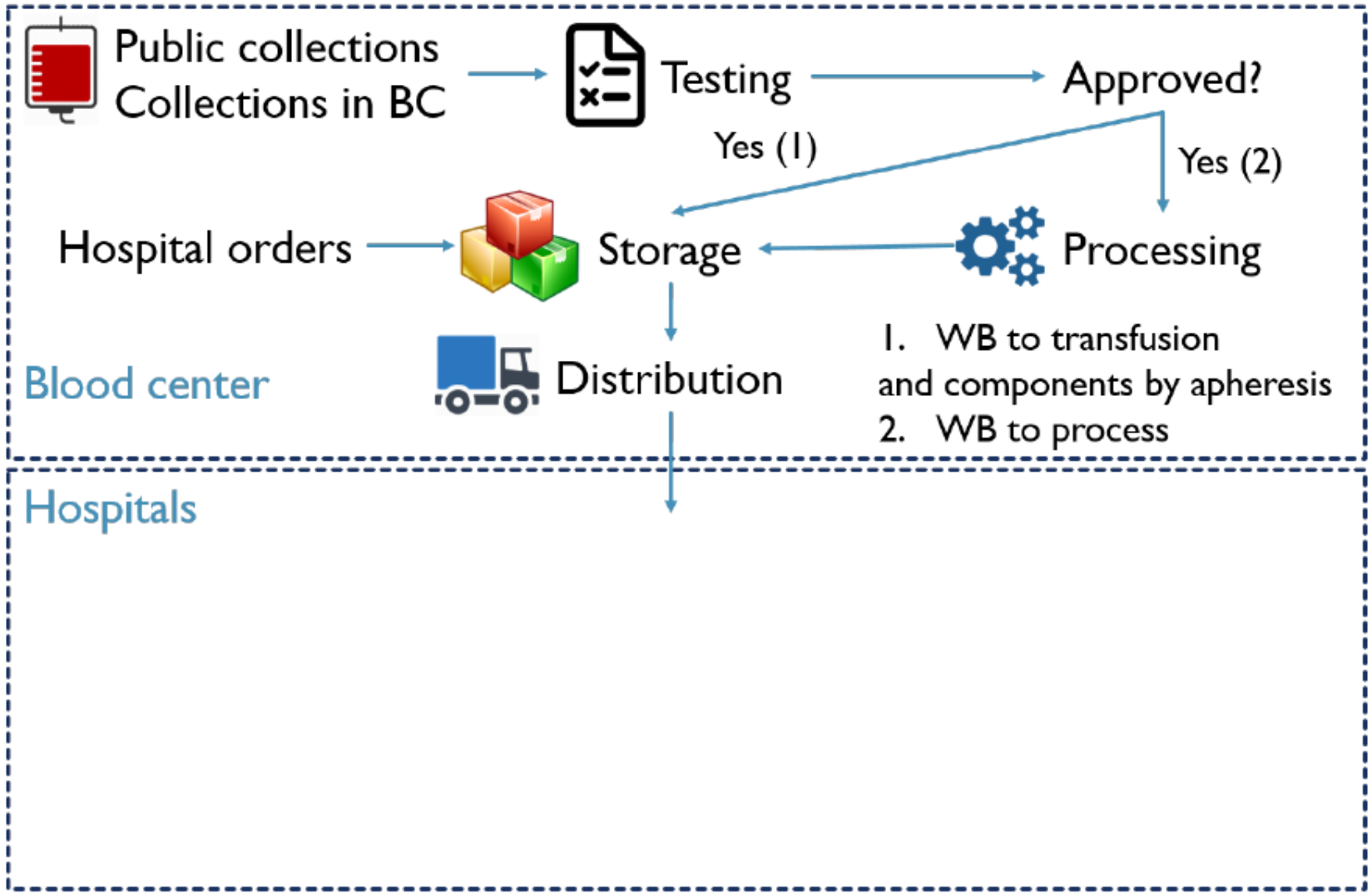
10000 dons de sang sont nécessaires chaque jour pour répondre aux besoins des malades. (Illustration) LP/Arnaud Dumontier

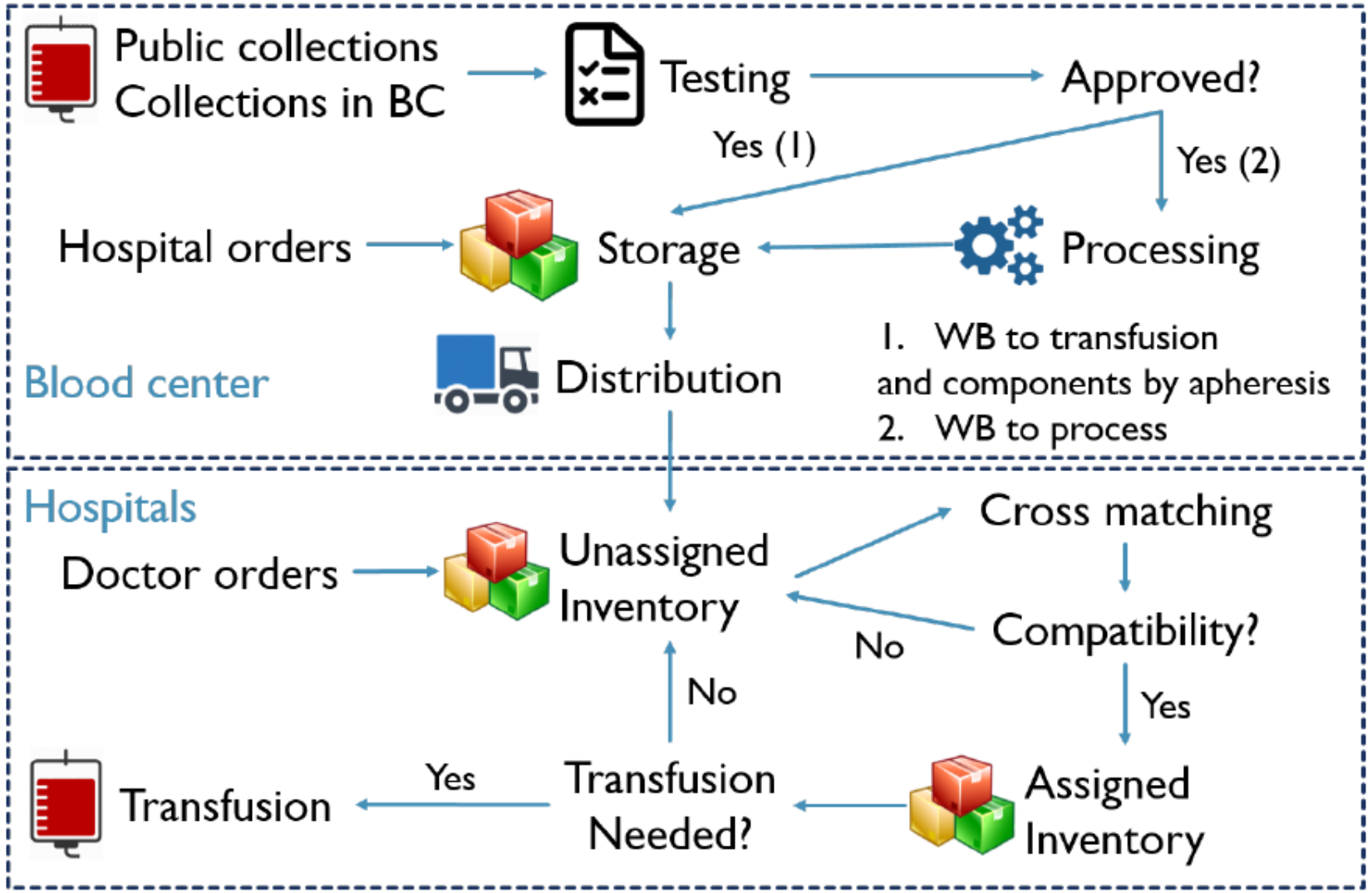
Source: [1]

- The blood is necessary for medical treatments.
- Shortage may cause deaths and complications in treatments.
- Wastage is undesirable considering the scarcity of blood and costs.

Blood Supply Chain




Public collections
Collections in BC
Testing
Approved?
Yes (1)
Yes (2)
Hospital orders
Storage
Processing
Blood center
Distribution
1. WB to transfusion
and components by apheresis
2. WB to process
Hospitals


Public collections
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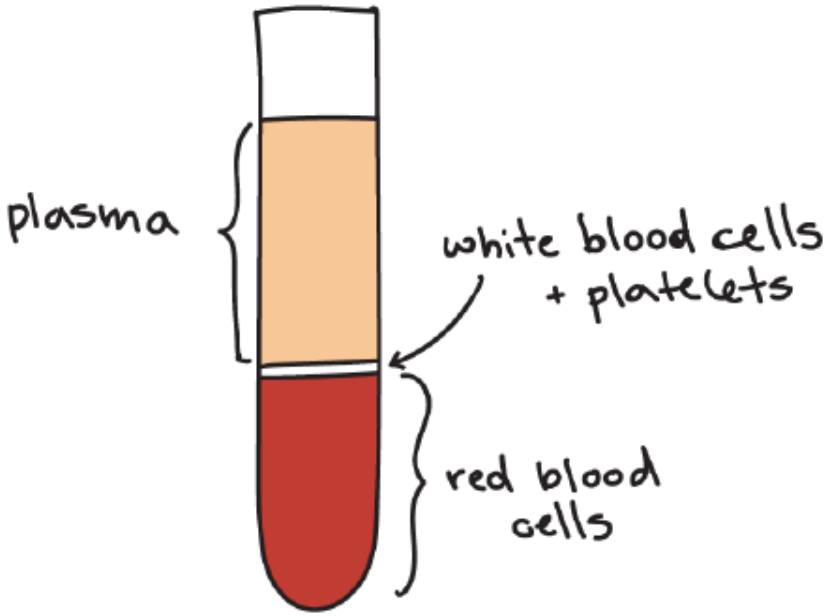
Approved?
Yes (1)
Yes (2)
Hospital orders
Storage
Processing
Blood center
Distribution
1. WB to transfusion and components by apheresis
2. WB to process
Hospitals
Doctor orders
Unassigned Inventory
Cross matching
Compatibility?
No
No
Yes
Transfusion
Yes
Transfusion Needed?
Assigned Inventory

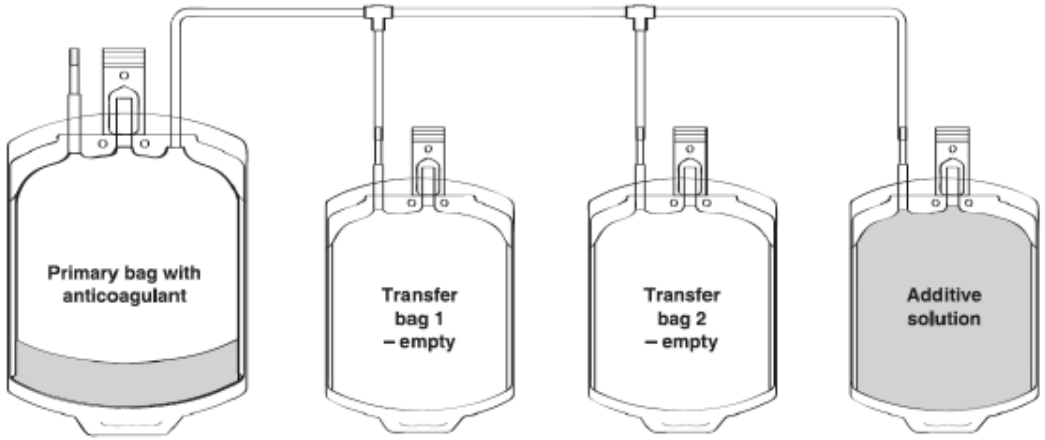
Blood Components

Components from Whole Blood (WB):

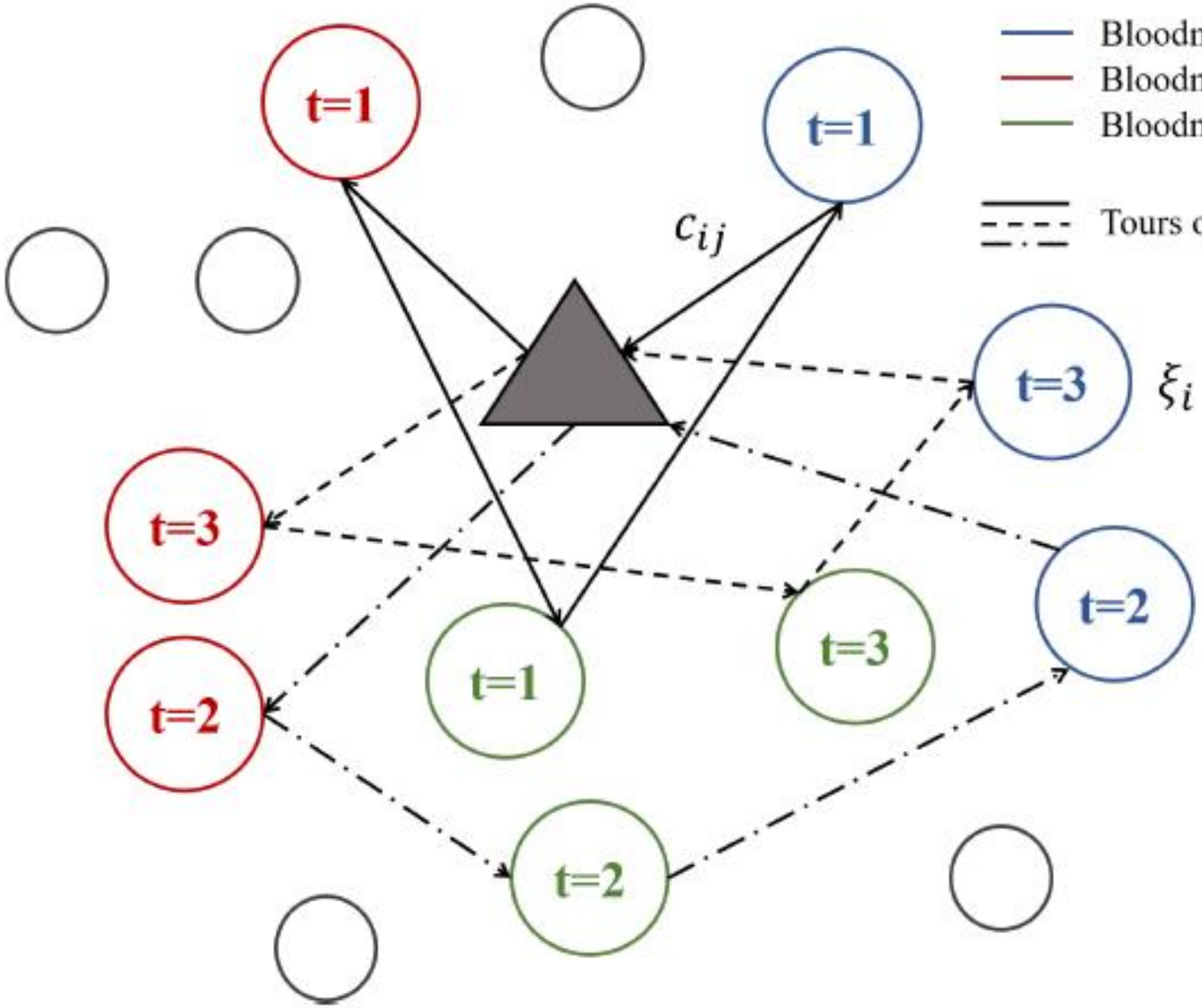


- Plasma
- Buffy coat: Platelets (PLT) and White Blood Cells (Leukocytes)
- Red Blood Cells (RBC)

Blood Bags



- Closed/aseptic blood bag system. [1].
- One fixed bag with anticoagulant: primary bag.
- Two possible additional types of bags: transfer or satellite bag and bag with additive solution [2].
- The system include in-line filters to remove leukocytes [2].



Bloodmobile 1
Bloodmobile 2
Bloodmobile 3

Tours of shuttle

Bloodmobiles

Problem Description I

- $G = (V, A)$: a graph. Let A be the set of arcs.
- $V = \{1, ..., N\}$: set of nodes.
- $V' = V \backslash \{1, N\}$: potential sites to visit.
- Nodes 1 and N : Blood Center (BC).
- p_i : collection potential associated to the time window $[e_i, l_i]$ of $i \in V$, with $p_1 = 0$ and $p_N = 0$.
- s_i : service time at the node i.
- $K = \{1, ..., B\}$: set of bloodmobiles with capacity QK.
- $F = \{1, ..., S\}$: set of shuttles with capacity QF.
- $R = \{1, 2\}$ set of possible routes by shuttles. The first one represents the "noon" tour. The second one means the tour at the end of the period.

Problem Description II

- $H = \{1, ..., T\}$: the planning horizon.
- $H' = H \backslash \{T\}$: Considering that the period T is used to end the route of the bloodmobiles.
- q_t : desired collection level at the period $t \in H$ with $q_T = 0$.
- $q'_t \leq q_t$: quantity of products that have to be delivered at BC before the time BC_{max} with a maximum age T_{max}.
- c_{ij} : travel time of each arc $(i, j) \in A$
- ζ : cost per unit of time.
- μ and σ : wastage and shortage cost per unit respectively.
- γ : penalty cost per unit of time that shuttles arrive after the end of the BC time window.

Goal

1. Tours of bloodmobiles to collect the desired level q_t each period t.
2. Tours of shuttles at "noon" to collect the demand q'_t.
3. Tours of shuttles at the end of the day to pick up the products from bloodmobiles and deliver them to the BC.

Variables I

Routing variables

- b_{ijkt} : 1 if the bloodmobile k travels from node i to node j in period t, 0 otherwise.
- x_{ijfrt} : 1 if the shuttle f in the route r travels from node i to node j at period t, 0 otherwise.

Time variables

- τ_{ifrt} : Start of the service at node i by the shuttle f in the route r at period t.
- β_{ft} : Delay of shuttle f at the end of period t.

Variables II

Quantity variables

- y_{ifrt} : Collected units at node i by shuttle f in the route r at period t.
- w_{it} : Units associated with wastage, not collected at node i in period t.
- d_t : Units of unsatisfied demand (deficit), associated with shortage, in period t.
- d'_t : Units of unsatisfied demand q'_t in period t.

Objective function

$$\text{Min} \quad \zeta \cdot \left(\sum_{i=1}^{N-1} \sum_{j=2}^{N} \sum_{k \in K} \sum_{t \in H} c_{ij} \cdot b_{ijkt} + \sum_{i=1}^{N-1} \sum_{j=2}^{N} \sum_{f \in F} \sum_{r \in R} \sum_{t \in H'} c_{ij} \cdot x_{ijfrt} \right)$$

$$+\sigma \cdot \sum_{t \in H'} (d_t + d'_t) + \mu \cdot \sum_{i=2}^{N-1} \sum_{t \in H'} w_{it} + \gamma \cdot \sum_{f \in F} \sum_{t=1}^{T-2} \beta_{ft} \qquad (1)$$

Constraints I

Bloodmobiles are located at the BC at the beginning of the planning horizon,

$$\sum_{j=2}^{N} b_{1jk1} = 1; \quad \forall k \in K \tag{2}$$

Available bloodmobiles,

$$\sum_{i=1}^{N-1} \sum_{j=2}^{N} \sum_{k \in K} b_{ijkt} \leq |K|; \quad \forall t \in H' \tag{3}$$

Bloodmobiles return to the BC at the end of the planning horizon,

$$\sum_{i=1}^{N-1} b_{ijk(T-1)} = b_{jNkT}; \quad \forall j \in V', \forall k \in K \tag{4}$$

Constraints II

Flow conservation of each bloodmobile tour,

$$\sum_{i=1}^{N-1} b_{ijkt} = \sum_{i=2}^{N} b_{jik(t+1)}; \quad \forall j \in V', \forall k \in K, \forall t \in H' \tag{5}$$

$$\sum_{i=1}^{N-1} b_{iNkt} = \sum_{i=2}^{N} b_{1ik(t+1)}; \quad \forall k \in K, \forall t \in H' \tag{6}$$

Each potential site is visited at most once in the planning horizon,

$$\sum_{i=1}^{N-1} \sum_{k \in K} \sum_{t \in H'} b_{ijkt} \leq 1; \quad \forall j \in V' \tag{7}$$

Constraints III

Available quantity to pick up in a period and capacity of bloodmobiles,

$$p_i \cdot \sum_{j=1}^{N-1} \sum_{k \in K} b_{jikt} - w_{it} \leq QB; \quad \forall i \in V', \forall t \in H' \tag{8}$$

Option 1 for the collected units in the first route of shuttles,

$$y_{if1t} \leq \tau_{if1t} \cdot \frac{p_i}{l_i - e_i} \leq QB; \quad \forall i \in V', \forall f \in F, \forall t \in H' \tag{9}$$

Description

The uncertainty in the number of available blood unit in a potential site is formulated using a Two-Stage Programming Model. It is considered that ξ_i represents the profit of each site i, $\forall i \in V$, with a specified probability distribution and a finitely number of realizations. According to the realizations of ξ_i, the scenario set Ω is considered, where $\omega = (\xi_1^\omega, , \xi_N^\omega)$, $\forall \omega \in \Omega$ and their associated joint discrete probabilities $\mathbb{P}(\omega) = \prod_{i=1}^{N} \mathbb{P}(\xi_i^\omega)$, $\forall \omega \in \Omega$.

Parameters

- ξ_i^ω instead p_i : available units to be collected at site $i \in V$ for the scenario $\omega \in \Omega$.
- $prob_\omega$: the probability associated with each scenario $\omega \in \Omega$.

Variables

The variables y_{ifrt}, w_{it}, d_t and d'_t associated to second-stage decisions are replaced by,

- y^{ω}_{ifrt} : Collected units at node i by shuttle f in the route r at period t in the scenario ω.
- w^{ω}_{it} : Units not collected at node i at period t in the scenario ω.
- $d_{t\omega}$: Units of unsatisfied demand at period t in the scenario ω.
- $d'_{t\omega}$: Units of unsatisfied demand q'_t at period t in the scenario ω.

Objective function

We replace the objective function 1 by the following,

$$\text{Min} \quad \zeta \cdot \left(\sum_{i=1}^{N-1} \sum_{j=2}^{N} \sum_{k \in K} \sum_{t \in H} c_{ij} \cdot b_{ijkt} + \sum_{i=1}^{N-1} \sum_{j=2}^{N} \sum_{f \in F} \sum_{r \in R} \sum_{t \in H'} c_{ij} \cdot x_{ijfrt} \right)$$

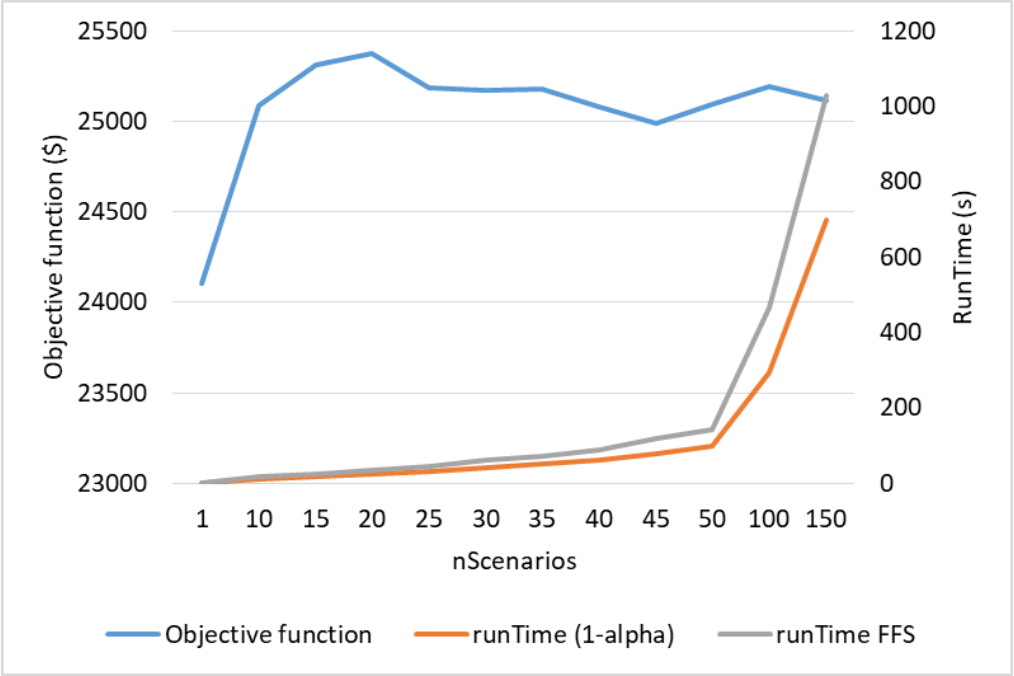
$$+ \sum_{\omega \in \Omega} prob_{\omega} \cdot \left[\sigma \cdot \sum_{t \in H'} \left(d_t^{\omega} + d'_{t\omega} \right) + \mu \cdot \sum_{i=2}^{N-1} \sum_{t \in H'} w_{it}^{\omega} \right] + \gamma \cdot \sum_{f \in F} \sum_{t=1}^{T-2} \beta_{ft} \quad (37)$$

Preliminary Results:

Instances for 10 nodes, 3 periods, 3 blood mobiles and 1 shuttle are solved to optimality within 5 min computations (regular laptop)

Scenario reduction

The number of scenarios to consider affects importantly the CPU time (Fast forward selection method)



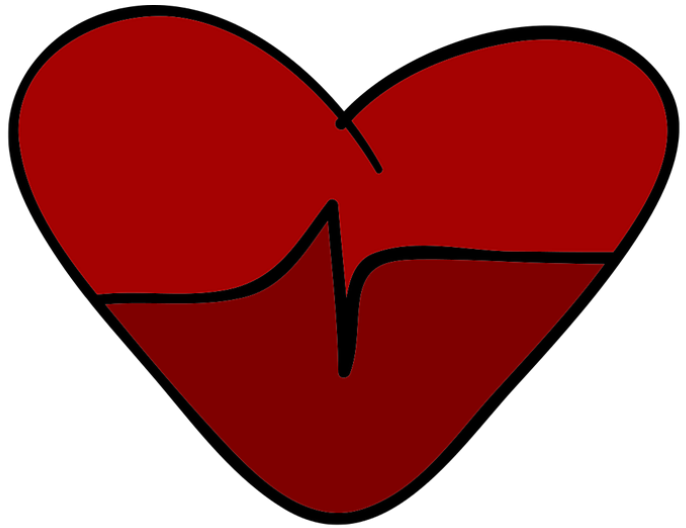
Current Research:

- Approximating better the donations through the day.
- Metaheuristics for the MIP model

Mi invitación

- ¡Donar sangre salva vidas!

  ¡Una persona puede salvar 3!



- Unirse a la red de investigadores y sponsors
  - Derecho, Medicina, Enfermería, otros
  - william.guerrero1@unisabana.edu.co

- Usuarios de la plataforma

#losbuenossomosmas

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¿Dónde están los héroes?

Inventory routing model with social cost for humanitarian logistics

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Seminar of the PhD in Mathematical Engineering- Universidad EAFIT

Chía, November 26th 2018

Universidad de La Sabana

Outline

1. Introduction
2. Problem Definition
3. Results
4. Conclusions and future works

1. Introduction

Global interest: **Damages could have been reduced with improvements in logistic operations** (Costa, Campos and Bandeira, 2012).

logistics is the most expensive part of humanitarian operations, exceeding **80% of total costs** (Tatham & Kovács, 2010).

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Humanitarian Logístics definition

- ✓ **Delivering the proper aid, in the right place at the right time,** in a similar way to traditional supply chains (Tomasini & Van Wassenhove, 2009) (Ertem, Buyurgan, & Rossetti, 2010)

- ✓ Delivery time vs Cost.

- ✓ The shortage is more expensive in humanitarian logistics than in commercial logistics. **This may mean the loss of a life.**

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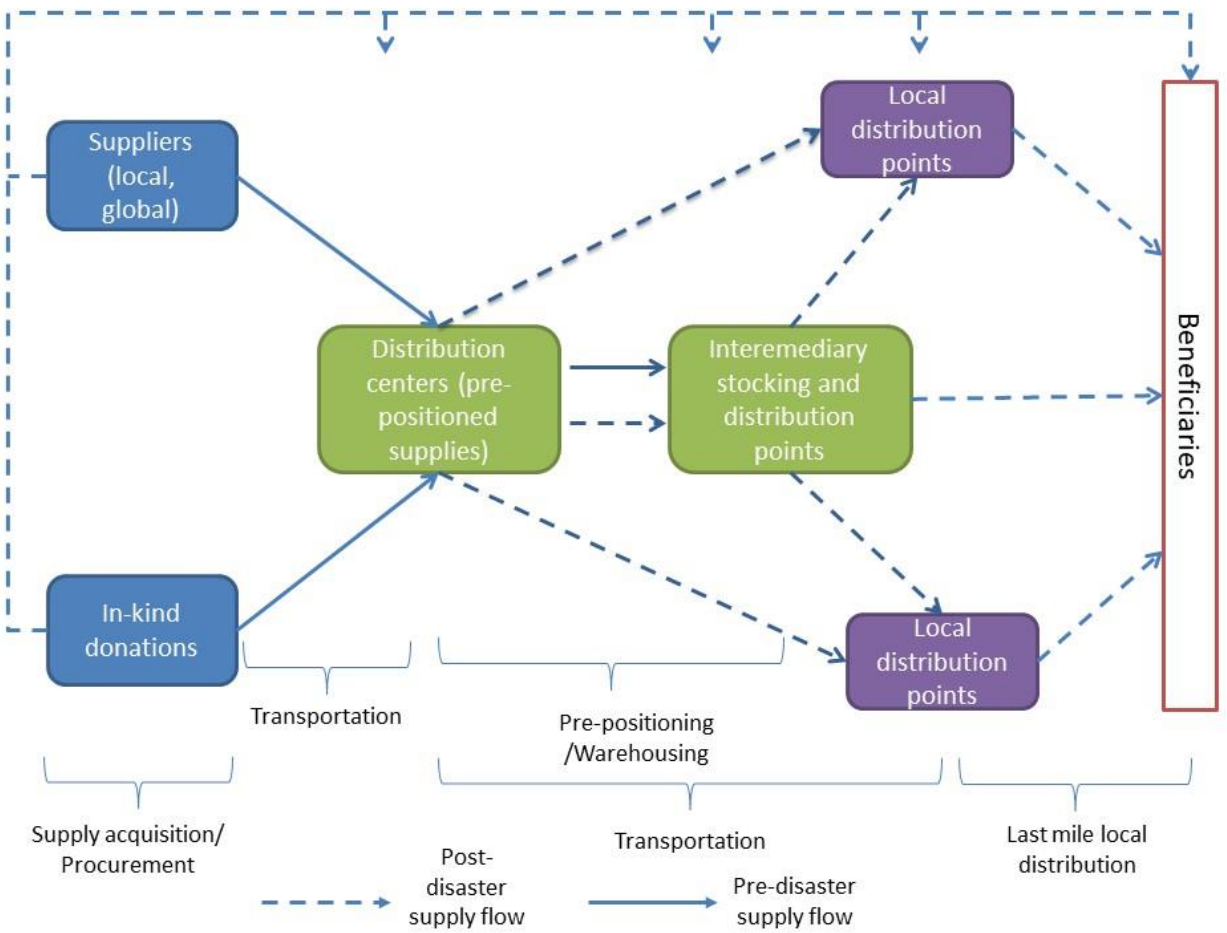
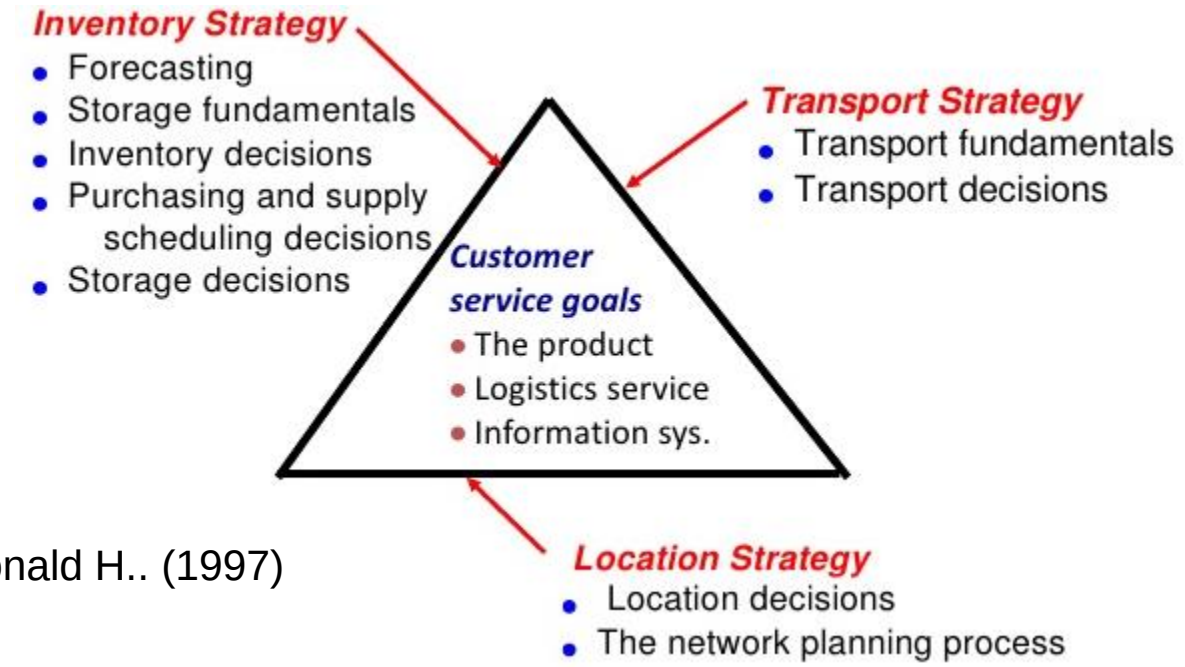
1. Introduction



(Balcik, Beamon, Krejci, Muramatsu, & Ramirez, 2010)

Introduction



Ballou, Ronald H.. (1997)

Problem Definition

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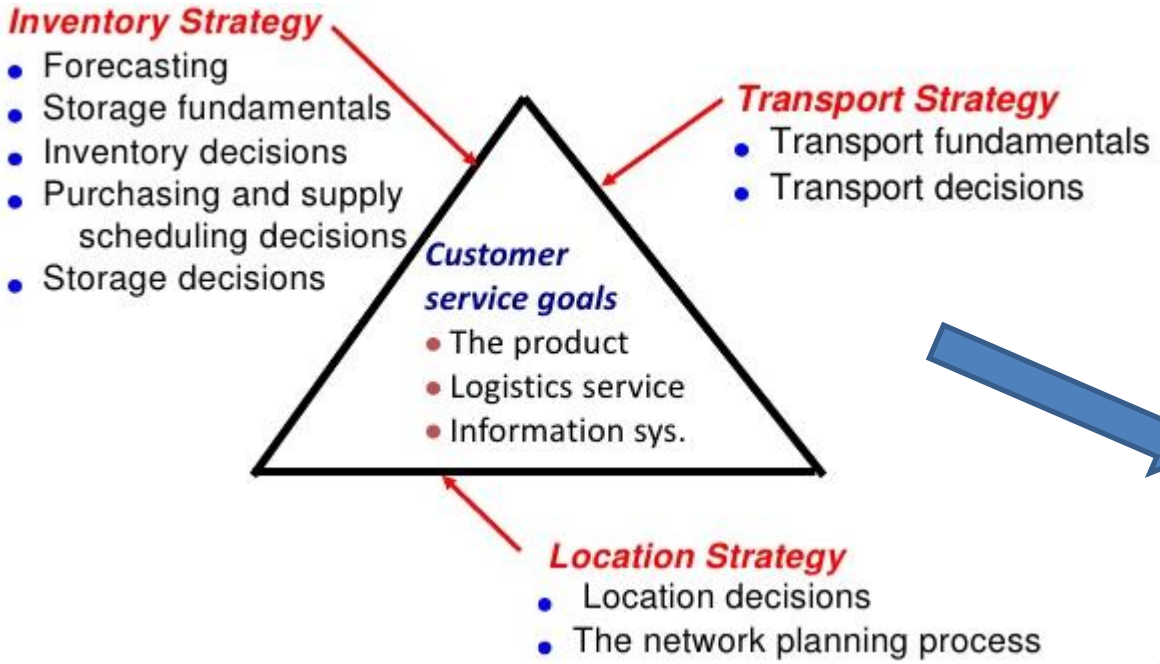
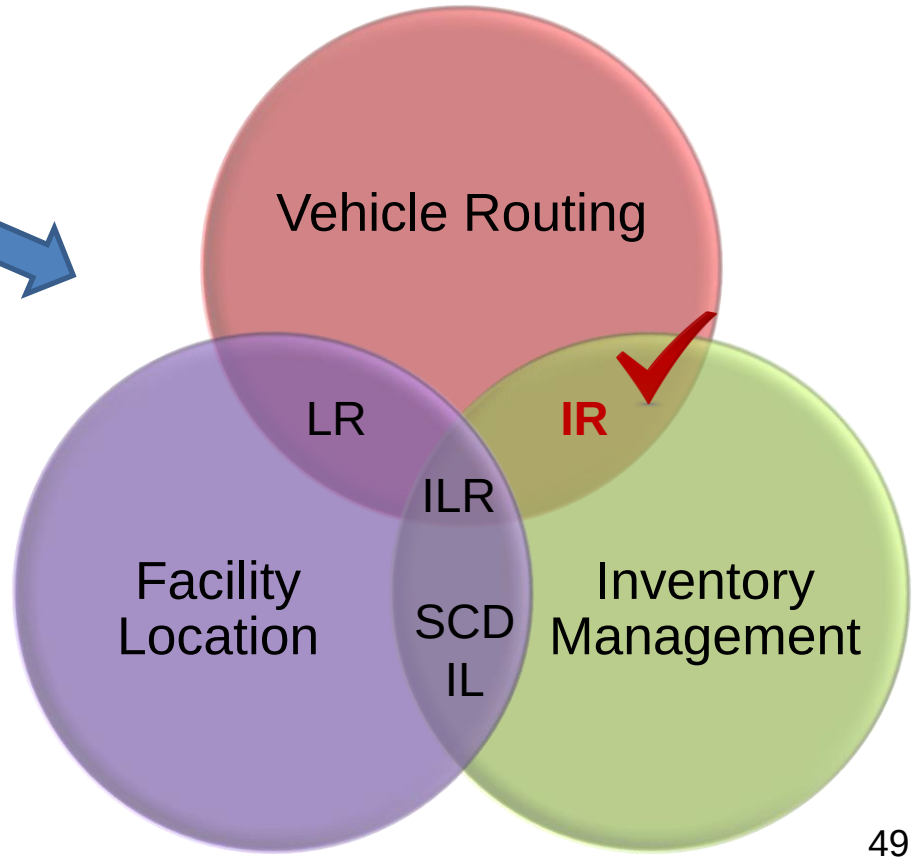


Ballou, Ronald H.. (1997)



Problem Definition

The mathematical model has been inspired from the literature (Archetti et al., 2007) and (Pérez-Rodríguez & Holguin-Veras, 2015).

The main contributions of this mathematical model proposed are:

- ✓ **Model the situation where shortages of aids (kits) are allowed and penalized.**
- ✓ **Include a deprivation cost function associated with the number of consecutive days with significant shortages of kits.**

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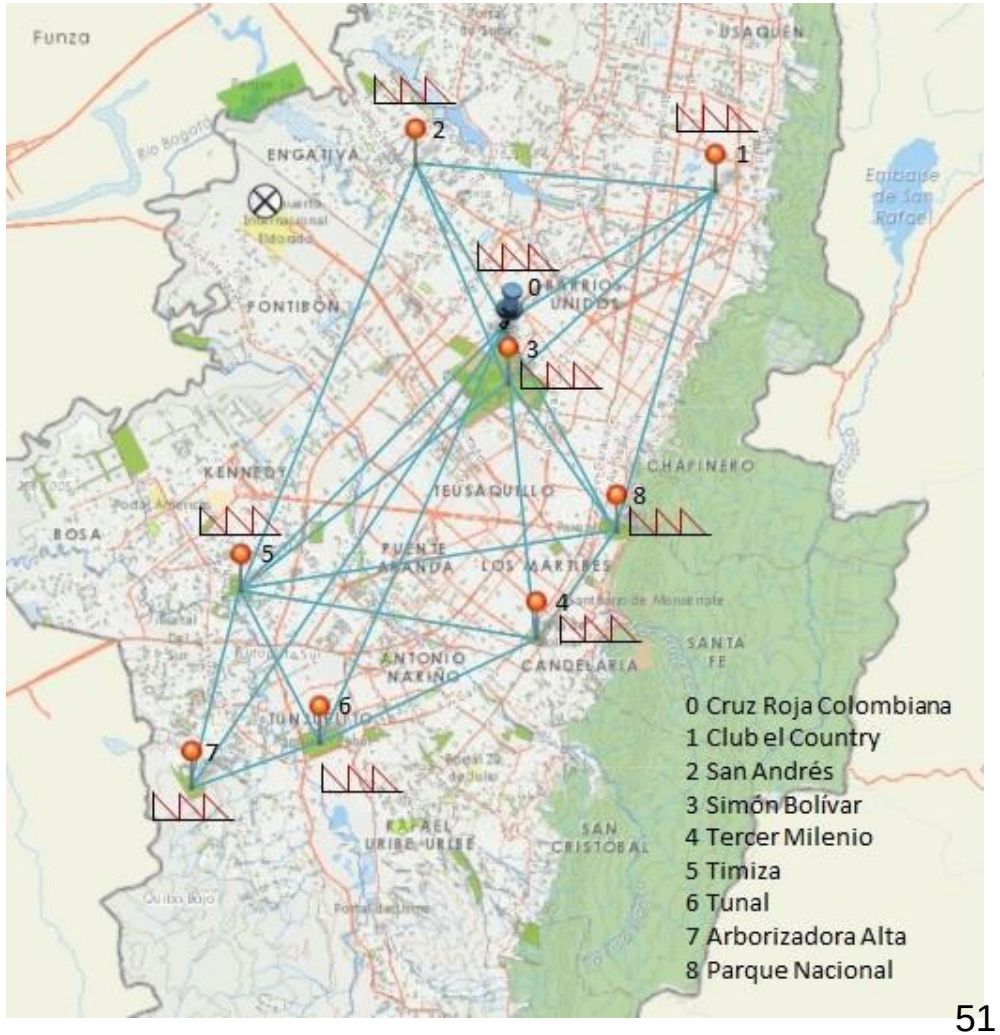
Problem Definition

Decision Variables

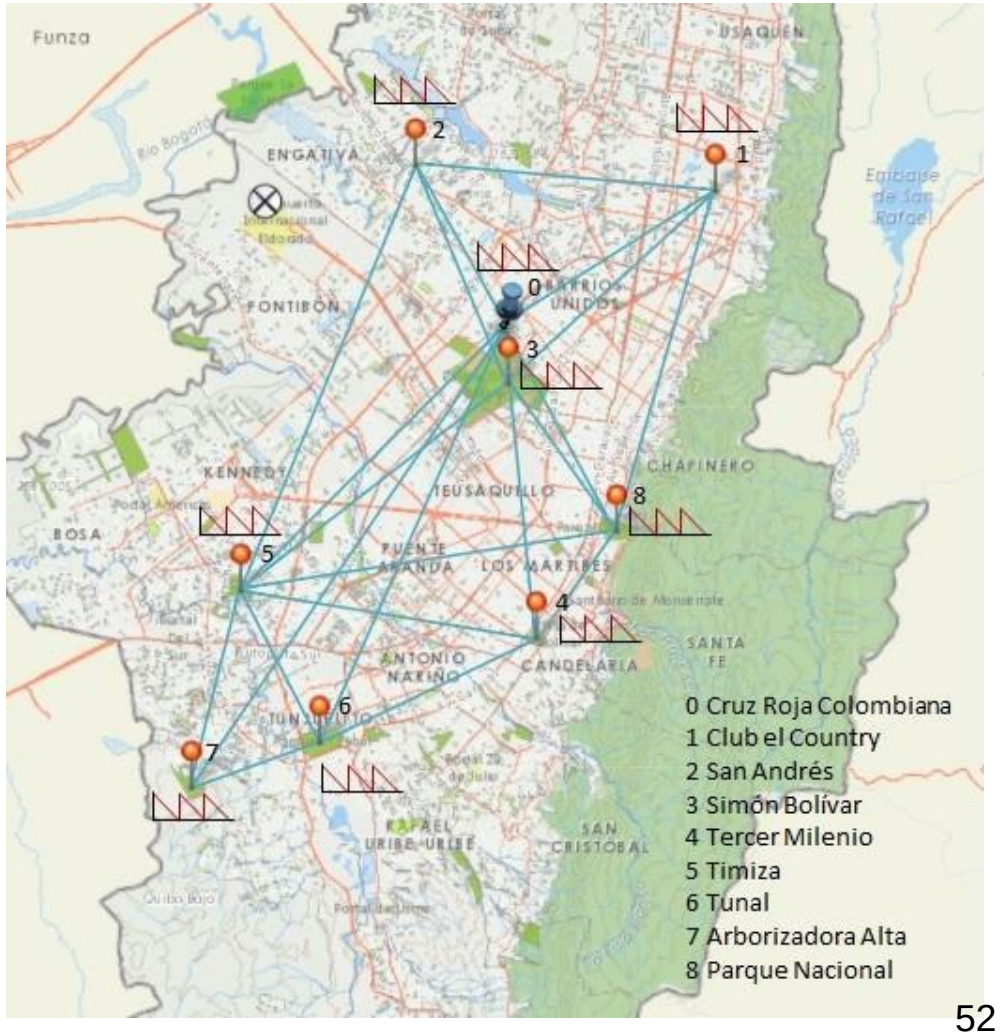
- Stock Levels
  - At Depot
  - At LDP
- Quantities delivered
- Stockouts
- Binary variables
  - Served or visited
  - Routing
  - Shortage
  - Consecutive days with Sig. Shortage



Problem Definition

Constraints

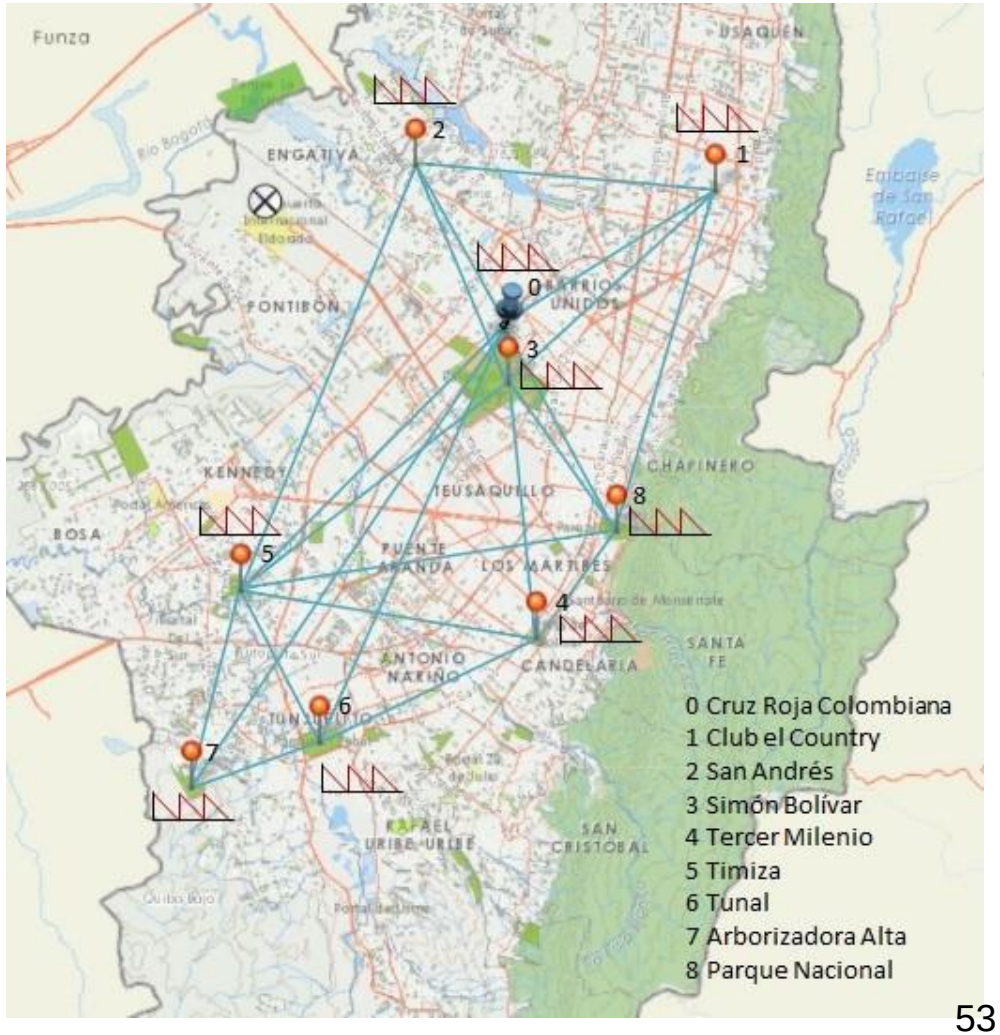
- Inventory levels
  - At depot
  - At Local distribution points
- Routing decisions
  - Single route per period
- Balance Constraints
- Significant Shortage
- Consecutive Days with significant shortage
- Capacities
  - Maximum storage
  - Vehicle



Problem Definition

Objective function costs

- Inventory Holding Cost
  - At depot
  - At local distribution points
- Transportation Cost
- Shortage cost
- Deprivation cost
  - Associated with the number of consecutive days with significant shortages of kits
  - DCF



Problem Definition

SETS

T:	$set\ of\ time\ periods\ \ T = \{1, \dots, t\}$
T':	$set\ of\ time\ periods. T' = T\ \cup \{t+1\}$
M:	$set\ of\ nodes\ representing\ local\ distribution\ points\ (LDP), M = \{1, \dots, n\}$
M':	$set\ of\ nodes\ that\ represent\ LDP\ including\ the\ depot\ \{0\} \cup\ M$
A:	$set\ of\ arcs\ (i,j) \in M'$
A':	$set\ of\ arcs\ (i,j) \in M$

PARAMETERS

C:	$Vehicle\ Capacity$
U_n:	$Maximum\ stock\ capacity\ of\ kits\ at\ LDP\ \ n\ \in M$
I_n:	$Initial\ inventory\ level\ of\ kits\ at\ LDP\ \ n\ \in M\ at\ the\ \ period\ 1$
B_o:	$Initial\ inventory\ level\ of\ kits\ at\ the\ depot$
h_o:	$Unit\ inventory\ holding\ cost\ at\ the\ depot$
h_n:	$Unit\ inventory\ holding\ cost\ at\ LDP\ \ n\ \in M$
C_{ij}:	$Transportation\ cost\ from\ node\ i\ in\ M'\ to\ node\ j\ in\ M', (i,j) \in A$
DP_{nt}:	$Demand\ of\ kits\ faced\ at\ LDP\ n \in M\ in\ \ period\ t \in T$
D_{0t}:	$Number\ of\ kits\ or\ donations\ available\ at\ the\ depot\ in\ \ period\ t\ \ \in T$
F_{nt}:	$Penalty\ cost\ for\ shortages\ of\ kits\ at\ LDP\ \ n\ \in M\ in\ \ period\ t\ \ \in T'$
γ:	$Limit\ for\ insignificant\ shortage$
BM:	$Big\ M$

Problem Definition

DECISION VARIABLES

B_t: $Stock\ level\ of\ kits\ at\ the\ depot\ in\ period\ t \in T'$

X_{nt}: $Quantity\ of\ kits\ delivered\ at\ LDP\ n \in M\ in\ period\ t \in T$

I_{nt}: $Stock\ level\ of\ kits\ at\ LDP\ n \in M, in\ period\ t\ \in T'$

Z_{nt}: $1\ if\ LDP\ n \in M'\ is\ served\ in\ period\ t\ \in T$

Y_{ijt}: $1\ \ if\ j\ immediately\ follows\ i, (i,j) \in A, in\ the\ route\ in\ period\ t\ \in T$

S_{nt}: $Shortage\ of\ kits\ at\ LDP\ n \in M, in\ period\ \ t\ \in T'$

W_{nt}: $1\ if\ there\ are\ significant\ shortage\ at\ LDP\ n \in M, in\ period\ \ t\ \in T'\ (S_{pt} \geq \gamma)$

G_{ntk}: $1\ if\ LDP\ n \in M\ , in\ period\ t \in T'\ has\ significant\ shortage\ for\ k \in T'\ consecutive\ days$

A_{ntk}: $1\ if\ LDP\ n \in M\ , in\ period\ t \in T'\ \ has\ maximum\ k \in T'\ \ consecutive\ days\ with\ significant\ shortage$

AP_{ntk}: $1\ if\ LDP\ n \in M\ , in\ period\ t \in T'\ \ there\ is\ a\ maximum\ k \in T'\ \ consecutive\ days\ with\ significant\ shortage$

V_{nt}: $Auxiliary\ variable\ for\ subtour\ elimination\ constraints$

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Problem Definition

Objective Function

Inventory Holding Cost- Depot

Inventory Holding Cost- LDP

Transportation Cost

Shortage Cost

$$Min\ Z$$

$$= \sum_{t \in T'} h_0 \cdot B_t + \sum_{n \in M} \sum_{t \in T'} I_{nt} \cdot h_n + \sum_{i \in M'} \sum_{j \in M', j<i} \sum_{t \in T} C_{ij} \cdot Y_{ijt} + \sum_{n \in M} \sum_{t \in T'} S_{nt} \cdot F_{nt}$$

$$+ \sum_{n \in M} \sum_{t \in T'} \sum_{k \in T'} AP_{ntk} \cdot (36.606 \cdot k^3 + 1764.7 \cdot k^2 + 32375 * k)$$

Social Cost

Results

Implemented in CPLEX Optimization Studio IDE 12.7.1.
Intel Core i5 4200 CPU 2.3 GHz and 4 GB RAM Laptop
One hour cpu limit

Adapted Instances from (Archetti et al., 2007) to induce stockout and the deprivation cost.
The instances have the following characteristics:

- ✓ Planning horizon: 3 days, corresponds to 72 hours (immediate response phase).
- ✓ Number of local distribution points (LDP): 5,10.
- ✓ The vehicle capacity was adjusted to 40% from the original capacity.
- ✓ The initial inventory was reduced in 50%.
- ✓ The number of kits available at the depot was reduced in 50%.
- ✓ The shortage cost was randomly generated in the interval [100,500].
- ✓ The other parameters remain the same as the original instances.

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Results

Instance	Z*	Holding cost at the depot	Holding cost at LDP	Transportation cost	Shortage cost	Deprivation cost	CPU TIME (sec)
1h_gr5	44163,41	577,80	103,30	2034	7272	34176	0,477
2h_gr5	45261,83	525,60	72,92	1994	8493	34176	0,536
3h_gr5	106428,58	753,00	234,27	2406	68859	34176	0,502
4h_gr5	61809,51	414,00	69,20	2456	24694	34176	0,297
5h_gr5	59139,06	702,00	190,75	1403	22667	34176	0,464
Average	63360,474	594,480	134,088	2058,600	26397	34176	0,455
1h_gr10	143610,54	1786,20	367,73	2862	70242	68353	951,755
2h_gr10	114679,09	1484,40	337,08	3383	41122	68353	3,803
3h_gr10	67599,06	1374,00	307,75	2805	28936	34176	5,040
4h_gr10	133389,56	1462,20	273,75	3527	59774	68353	37,956
Average	114819,563	1526,700	321,578	3144,250	50018,5	59808,750	249,639

Shortage and deprivation costs represent, on average, the 43,61% and 53,01% of the total cost.

Results

		MIP branching direction		MIP node selection strategy		MIP Gomory fractional cuts switch		
Instance	Default	Up branch selected first	Down branch selected first	Best-bound search (default)	Depth-first search	Do not generate Gomory fractional cuts	Generate Gomory fractional cuts moderately	Generate Gomory fractional cuts aggressively
1h_gr5	0,477	0,589	0,587	0,477	0,538	0,391	0,36	0,555
2h_gr5	0,536	0,529	0,701	0,536	0,433	0,498	0,379	0,363
3h_gr5	0,502	0,907	0,668	0,502	1.605	0,551	0,426	0,666
4h_gr5	0,297	0,328	0,313	0,297	0,303	0,389	0,28	0,323
5h_gr5	0,464	0,293	0,593	0,464	0,311	1.304	0,315	0,287

	MIP emphasis switch			
Instance	Balance optimality and feasibility (default)	Emphasize feasibility over optimality	Emphasize moving best bound	Emphasize finding hidden feasible solutions
1h_gr5	0,48	0,474	0,846	0,792
2h_gr5	0,54	0,242	0,723	0,532
3h_gr5	0,50	0,682	1.401	0,729
4h_gr5	0,30	0,194	0,459	0,265
5h_gr5	0,46	0,203	0,578	0,266

Conclusions and future works

- ✓ MIP model to optimize inventory and distribution considering logistical costs and deprivation cost.
- ✓ Shortages of aids (kits) are allowed, penalized as a function of the number of consecutive days with significant shortages of kits and the amount.
- ✓ Deprivation and Shortage costs are significantly representative of the total cost in humanitarian operations.
- ✓ Relief aid distribution taking advantage of capacities.
- ✓ The model ensures equitable distribution of donations.

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Conclusions and future works

- ✓ Future works include considering disruptions of roads or random response times, among others features.
- ✓ Development of computational methods to solve these instances (IRP is NP-hard) (Metaheuristics).
- ✓ Real Parameters, Mocoa Case Study

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Event Analysis and research opportunities

Mocoa-Colombia Landslide

March 31st, 2017 23:00

One of the most devastating natural disaster that shocked the entire country in recent years claiming hundreds of lives

SOURCE:
https://www.elespectador.com/noticias/nacional/avalancha-en-mocoa-una-de-las-peores-tragedias-de-2017-articulo-730617

SOURCE:
https://www.elnuevosiglo.com.co/articulos/04-2017-alud-en-mocoa-una-tragedia-anunciada

Research Group Logistics Systems– Faculty of Engineering
Universidad de La Sabana, Colombia

Universidad de La Sabana

EL ESPECTADOR Martes 14 De Agosto

Avalancha en Mocoa, una de las peores tragedias de 2017

Nacional 27 Dic 2017 - 3:07 PM
Por: -Redacción Nacional

El primero de abril de este año, una tragedia azotó a la capital putumayense: una avalancha, producto del desbordamiento de tres ríos por cuenta de las incesantes lluvias, acabó con la vida de más de 300 personas.

Más de 320 personas fallecieron tras la avalancha y miles resultaron damnificadas. / Archivo El Espectador

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A closer look to the map

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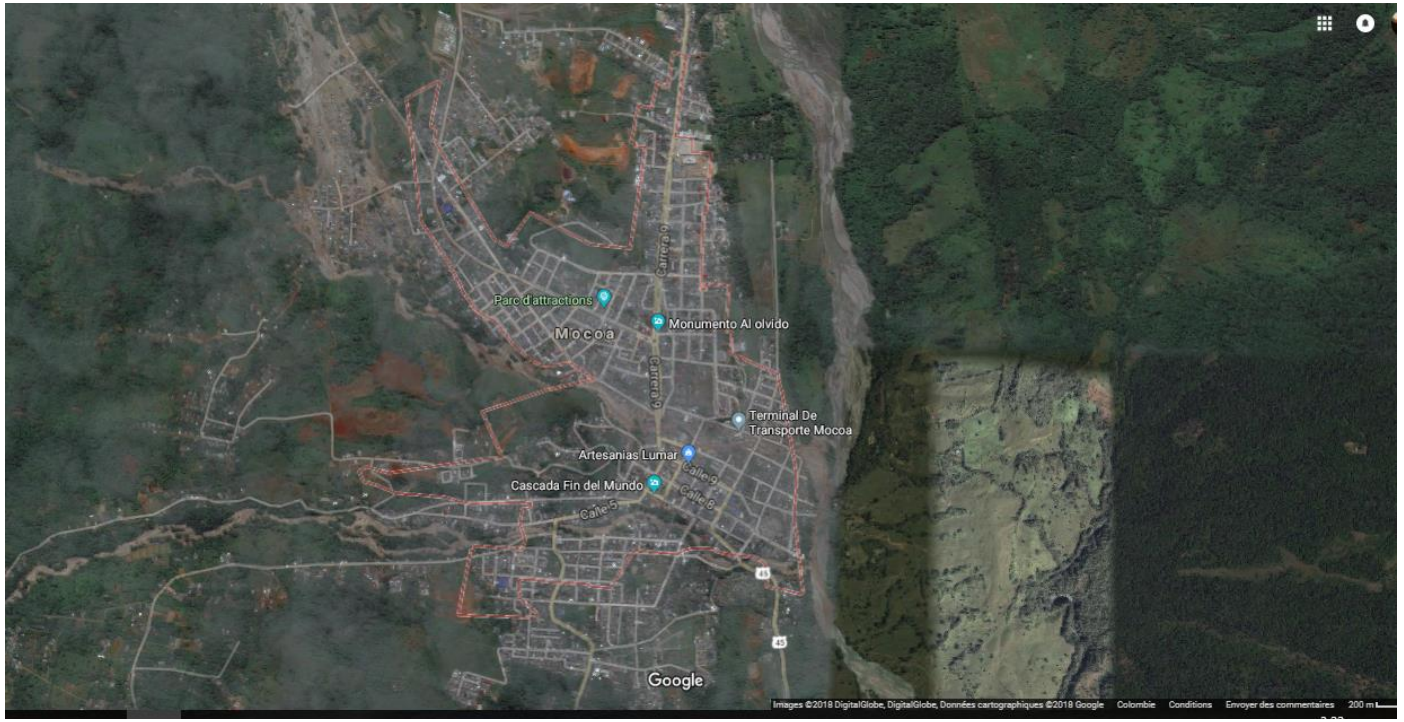

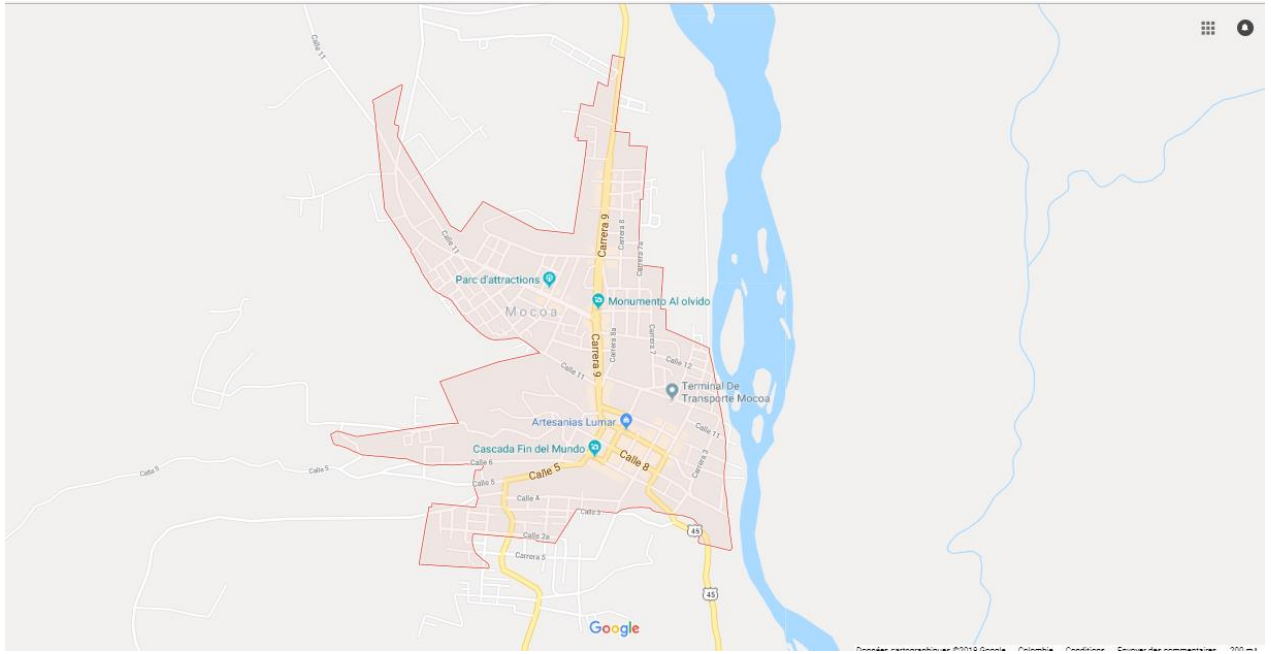

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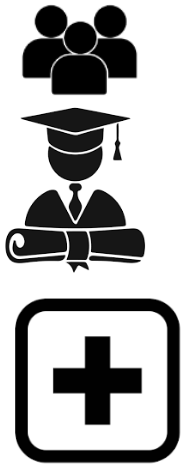
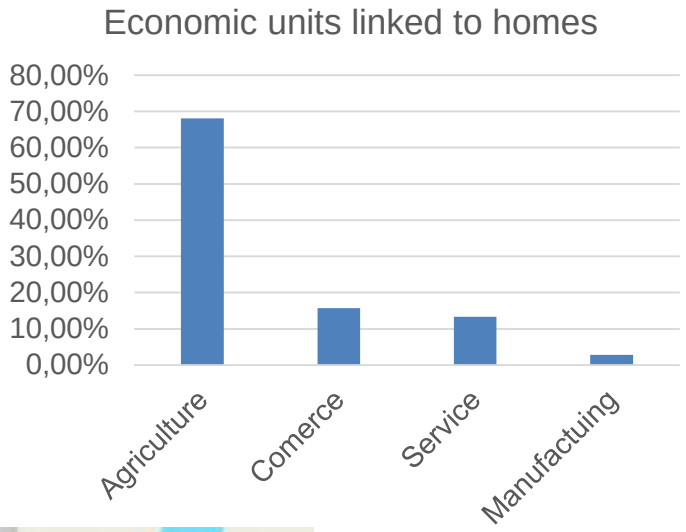
Social and Economic aspects of Mocoa



Aprox. total population 2018 - 44.631 (Dane)
Aprox. Density35/km²
Young population – Child and tenager 31.4% of total population

24 schools - 3 universities (ITP-SENA-POLITÉCNICO GRANCOLOMBIANO)

One hospital (José María Hernández) third level
Eleven health centers of low complexity



Sources: IDEAM, DANE, Perfil productivo mocoa Minitrabajo

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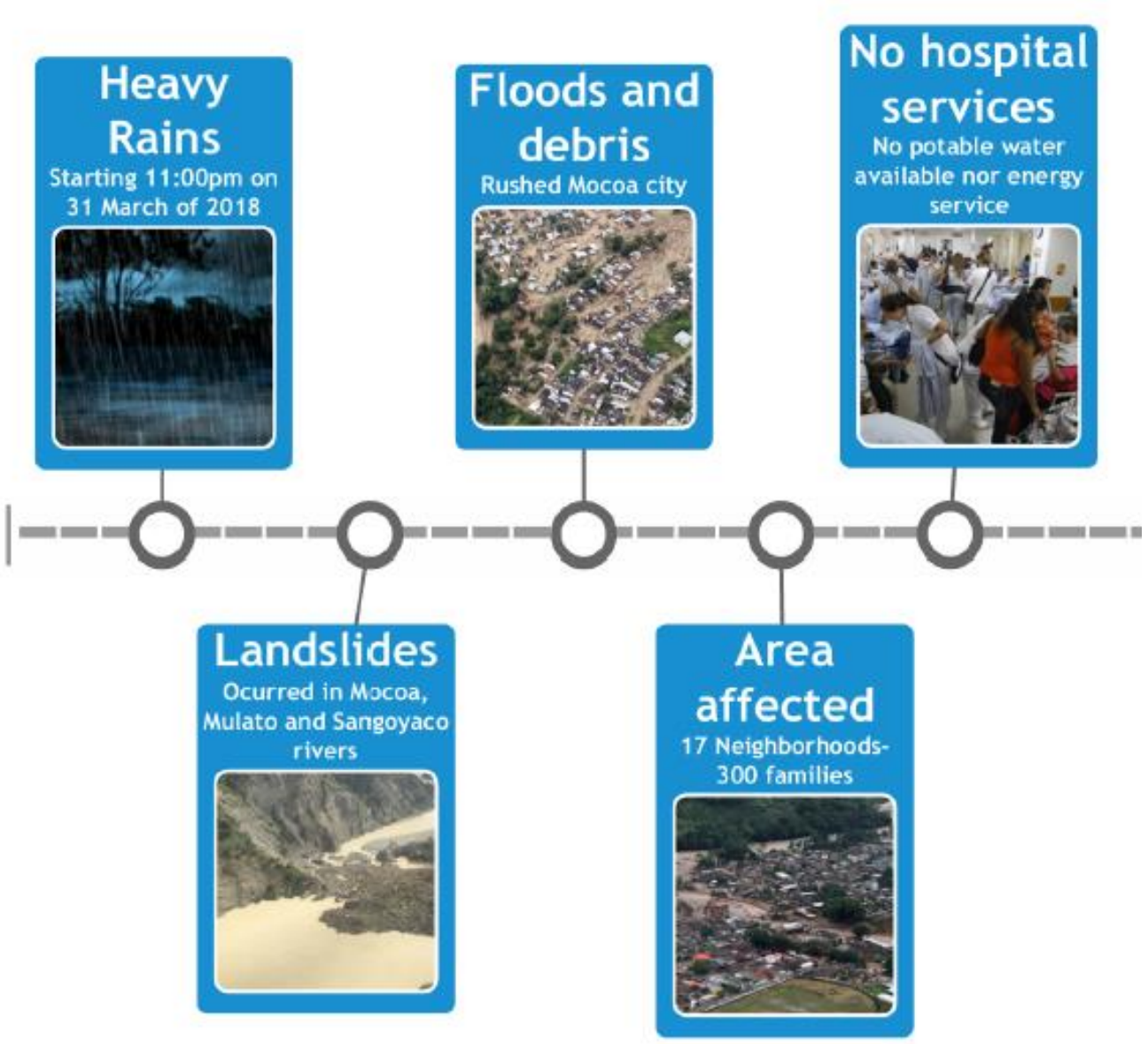
Timeline of the event



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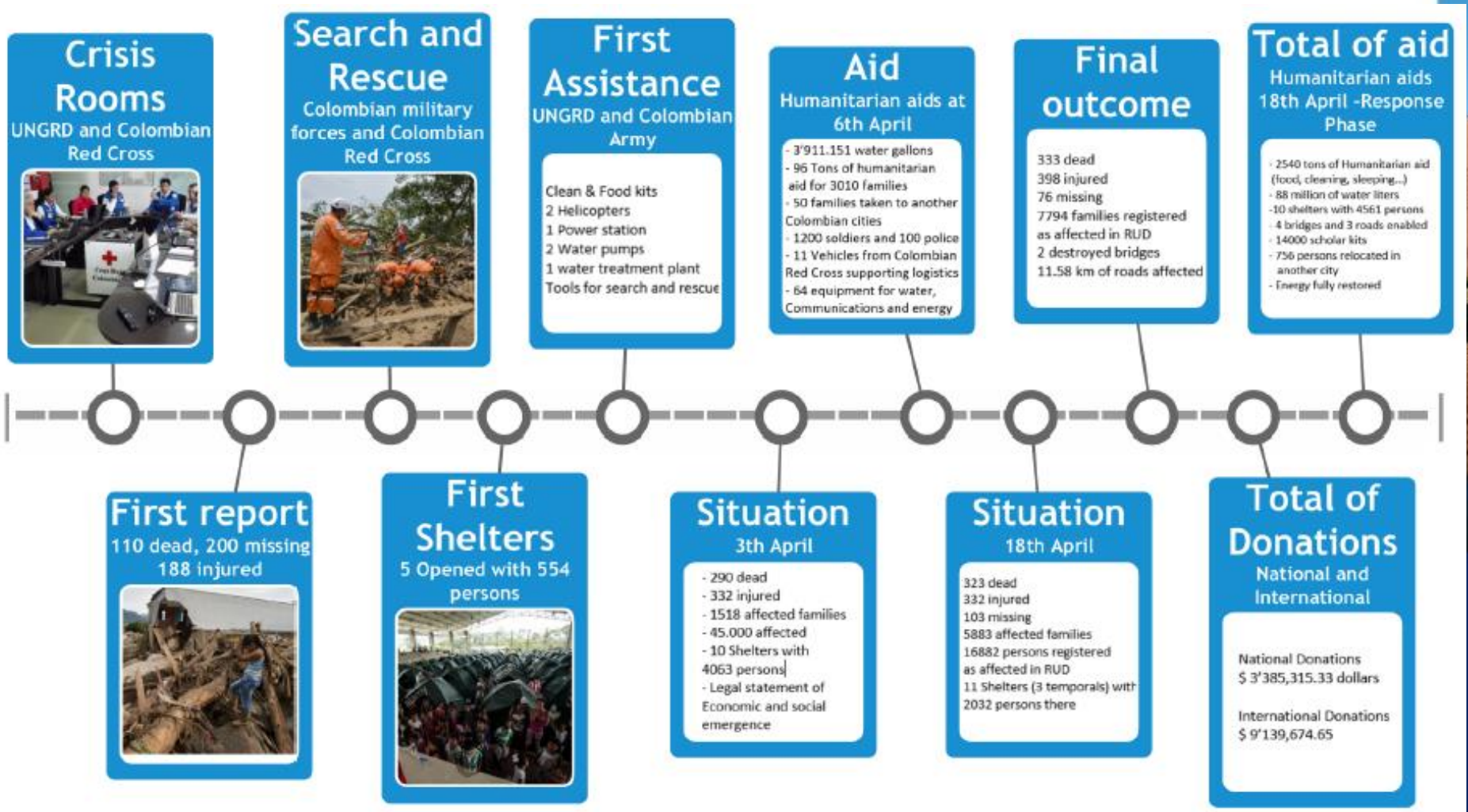
Timeline of the event in the immediate-response phase



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Case study – Mocoa 2017 Landslide

A pesar de que las ayudas no dejan de llegar, estas han resultado pocas ante la magnitud de la tragedia. Por otra parte, en algunas partes del municipio, el fluido eléctrico ya está volviendo a la normalidad.
Foto: Santiago Saldarriaga / EL TIEMPO

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OTRAS CIUDADES 03 DE ABRIL DE 2017 , 06:06 P.M.

La vida en los albergues después de la avalancha en Mocoa, Putumayo

En total, son 5 los centros de atención instalados para ayudar a los damnificados.

"Despite the humanitarian aids don't stop coming, these have been scarce for the tragedy"

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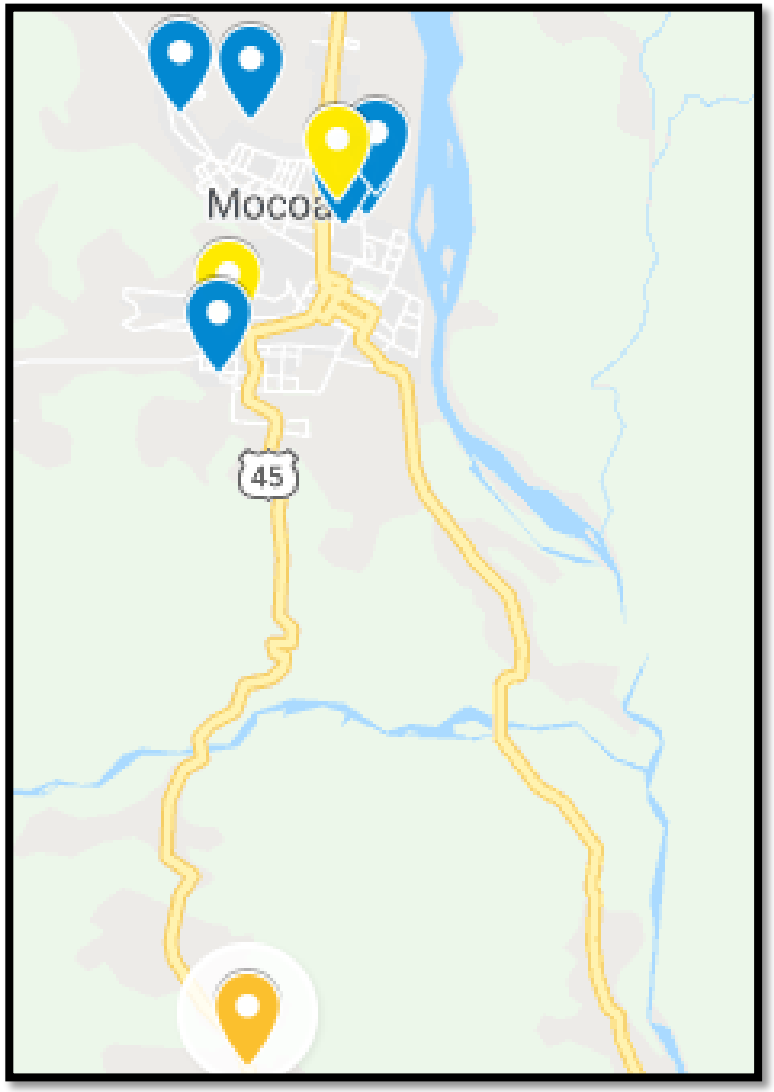
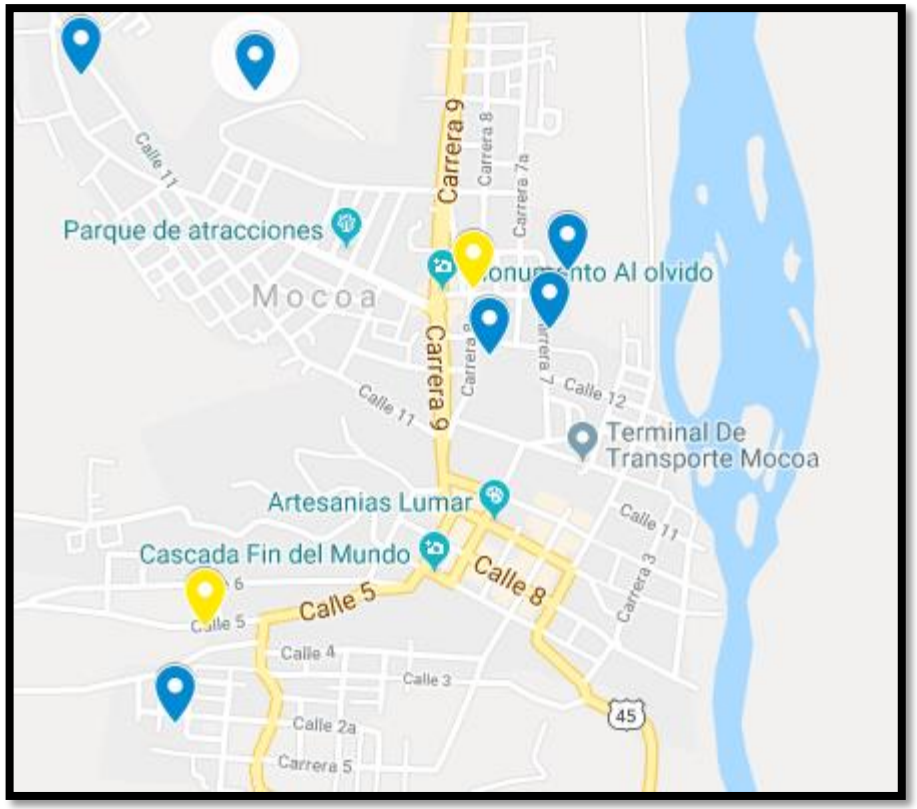
Case study – Mocoa 2017 Landslide Shelters ubication





Sources: SITREP – CRUZ ROJA COLOMBIANA and UNGRD

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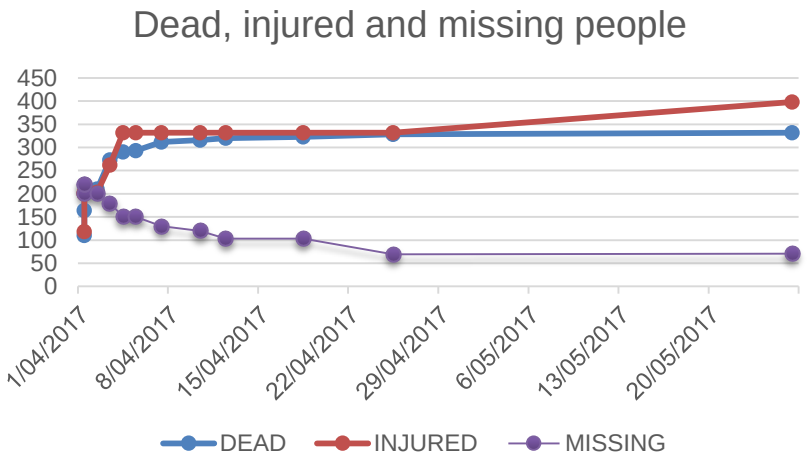
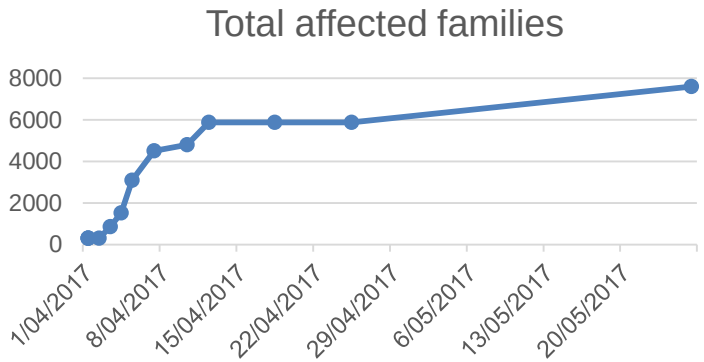
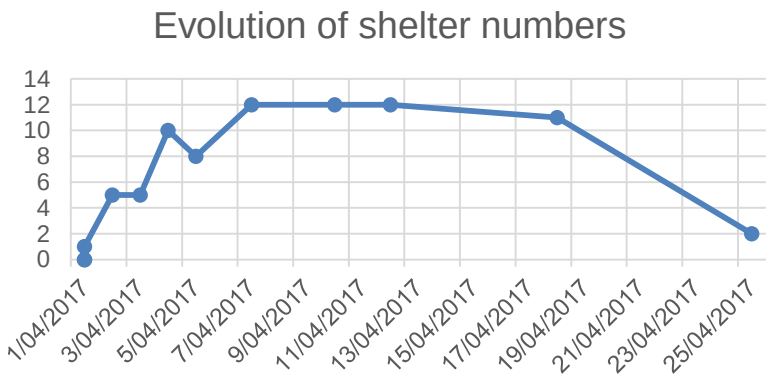
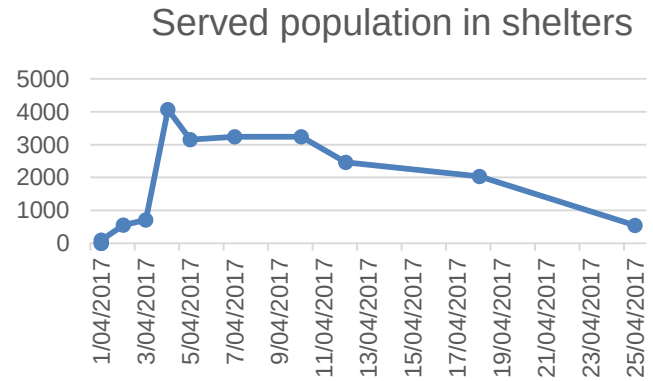
Affected people and shelters

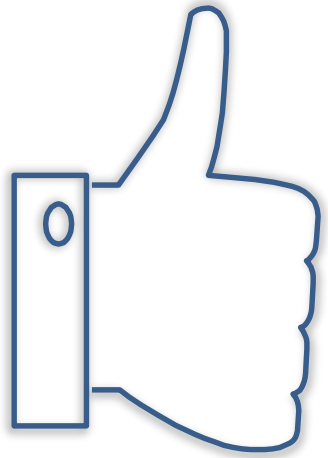








Sources: SITREP – CRUZ ROJA COLOMBIANA and UNGRD



THANKS!

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