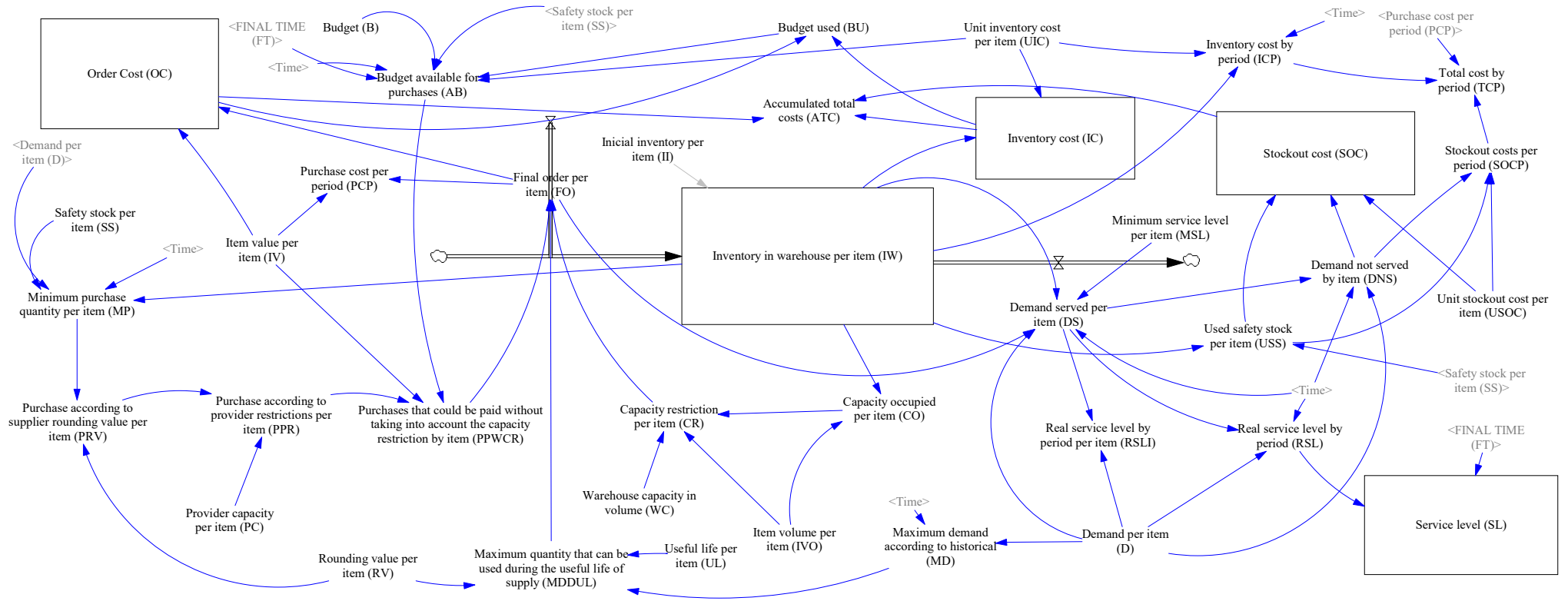


Flow chart



Health care supplies (i)	VED classification	Input data										Output data
		Safety stock (SS)	Initial inventory (II)	Useful life (UL)	Inventory cost (UIC)	Stock out cost (SOCP)	Service level (MSL)	Volume (VO)	Rounding value (RV)	Price (IV)	Supplier capacity (PC)	"Optimum" safety stock
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2	Vital	2	2	10	1367	41022	100	6438	1	13674	4	1
3	Vital	57	57	10	44	1311	100	1980	1	437	494	36
4	Vital	21	21	3	1129	33855	100	2366	1	11285	620	9
5	Essential	74	74	10	19	378	90	518	25	189	200	65
6	Vital	173	173	11	3	102	100	377	1	34	49410	76
7	Vital	56	56	10	221	6624	100	1980	1	2208	776	29
8	Vital	74	74	6	45	1356	100	419	1	452	225	49
9	Vital	25	25	6	178	5340	100	419	1	1780	440	16
10	Essential	74	74	6	201	4016	90	491	1	2008	980	25
11	Vital	74	74	10	98	2940	100	504	10	980	589	28
12	Vital	22	22	10	56	1683	100	639	1	561	279	15
13	Desirable	11	11	10	392	5885	85	1279	1	3923	132	1
14	Vital	64	64	6	86	2583	100	2138	1	861	1480	35
15	Essential	11	11	10	42	844	90	1176	1	422	100	3
16	Vital	41	41	3	165	4950	100	2393	1	1650	138	20
17	Vital	148	148	10	2	54	100	50	1	18	4000	49
28	Vital	74	74	10	39	1161	100	405	5	387	700	44
19	Vital	74	74	13	22	648	100	378	25	216	200	77
20	Vital	74	74	10	17	513	100	2116	10	171	704	63
21	Vital	74	74	13	58	1731	100	914	1	577	9140	25

Health care supplies (i)	Demand (D)								Statistical values for demand			
	time period 0	time period 2	time period 3	time period 4	time period 5	time period 6	time period 7	time period 8	Standard deviation	Mean	Minimum	Maximum
1	0	151	174	177	137	177	156	179	19,5	160	130	179
2	0	3	3	3	3	3	3	3	0,0	3	3	3
3	0	143	165	168	130	168	148	169	18,5	152	123	169
4	0	51	59	60	47	60	53	61	6,6	54	44	61
5	0	183	214	201	177	212	190	222	20,7	195	162	222
6	0	427	499	469	413	495	443	518	48,3	455	378	518
7	0	141	163	166	128	166	146	167	18,3	150	122	167
8	0	183	214	201	177	212	190	222	20,7	195	162	222
9	0	61	71	67	59	71	63	74	6,9	65	54	74
10	0	183	214	201	177	212	190	222	20,7	195	162	222
11	0	183	214	201	177	212	190	222	20,7	195	162	222
12	0	52	61	57	51	61	54	63	5,9	56	46	63
13	0	26	31	29	25	30	27	32	3,1	28	23	32
14	0	157	183	172	152	182	163	190	17,6	167	139	190
15	0	26	31	29	25	30	27	32	3,1	28	23	32
16	0	102	118	120	93	120	106	121	13,2	109	88	121
17	0	366	428	402	354	424	380	444	41,4	390	324	444
18	0	183	214	201	177	212	190	222	20,7	195	162	222
19	0	183	214	201	177	212	190	222	20,7	195	162	222
20	0	183	214	201	177	212	190	222	20,7	195	162	222
21	0	183	214	201	177	212	190	222	20,7	195	162	222

Budget (B)	27048505
Warehouse capacity (WC)	6107123
Final planning time (FT)	8

MILP formulation

Nomenclature for the mathematical programming model based on Piñeyro et al. (2018).

Index	
N	Set of supplies, with $0 < N < \infty$, with indices $i \in N$
J	Set of suppliers, with $0 < J < \infty$, with indices $j \in J$
FT	Quantity of periods in the planning horizon, $0 < T < \infty$, with indices $t, s, m \in \{0, 1, \dots, T\}$
Parameters	
WC	Total warehouse capacity in cubic centimeters
UL_i	Useful life of supply i , in number of time periods since the purchasing period inclusive
IVO_i	Volume in cubic centimeters of supply i
MSL_i	Minimum service level demanded of supply i , defined as the percentage of demand to be met
UIC_i	Unit cost to store supply i during a time period
$USOC_i$	Inventory stock out cost of supply i
II_{ii}	Initial inventory of supply i
SS_i	Safety stock of supply i
IV_{ij}	Unit price of supply i for supplier j
PC_{ij}	Maximum replenishment capacity of supply i for supplier j
RV_{ij}	Rounding quantity of supply i set by supplier j
D_{it}	Demand of supply i during time period t
B_m	Budget for a consecutive number of time periods m
cpp	Number of time periods included during the time period of budget m
Decision variables	
FO_{ijts}	Quantity of supply i to buy from supplier j during time period t to meet the demand of period s
IW_{it}	Inventory level of supply i during time period t
USS_{is}	Lacking quantity or stock out of supply i during time period s
n_{ijt}	Quantity of supply i to buy from supplier j during time period t expressed in rounding quantities
z_{its}	1 if supply i is purchased during time period t to meet the demand of time period s , and 0 otherwise

$$\text{Min} \sum_{t=1}^T \sum_{i \in I} \left(UIC_i * IW_{it} + \sum_{s=t}^{T+1} \sum_{j \in J} IV_{ij} * FO_{ijts} \right) + \sum_{i \in I} USOC_i * \sum_{s=1}^T USS_{is} \quad (1)$$

Subject to:

$$IW_{it} = IW_{it-1} + \sum_{j \in J} \sum_{s=t+1}^{T+1} FO_{ijts} - \sum_{j \in J} \sum_{r=0}^{t-1} FO_{ijrt}, \quad \forall i \in I, t = 1, \dots, T \quad (2)$$

$$IW_{i0} = II_i, \quad \forall i \in I \quad (3)$$

$$\sum_{s=1}^{T+1} \sum_{j \in J} FO_{ij0s} = IW_{i0}, \quad \forall i \in I \quad (4)$$

$$IW_{it} \geq SS_i, \quad \forall i \in I, t = 1, \dots, T \quad (5)$$

$$\sum_{s=t}^{T+1} FO_{ijts} = n_{ijt} * RV_{ij}, \quad t = 1, \dots, T, \forall i \in I, \forall j \in J \quad (6)$$

$$FO_{ijts} = 0, \quad \forall i \in I, \forall j \in J, t = 0, \dots, T, s = t + v_i, \dots, T \quad (7)$$

$$\sum_{t=0}^s \sum_{j \in J} FO_{ijts} \leq D_{is}, \quad \forall i \in I, s = 1, \dots, T \quad (8)$$

$$\sum_{t=0}^s \sum_{j \in J} FO_{ijts} \geq MSL_i * D_{is}, \quad \forall i \in I, s = 1, \dots, T \quad (9)$$

$$z_{its} + z_{iuw} \leq 1, \quad \forall i \in I; t, s, u, w = 0, \dots, T+1, \forall t < u \leq w < s \quad (10)$$

$$\sum_{j \in J} FO_{ijts} \leq D_{is} * z_{its}, \quad \forall i \in I, s = 1, \dots, T+1, t = 0, \dots, T, s \geq t \quad (11)$$

$$\sum_{t=cpp*(m-1)+1}^{cpp*m} \sum_{i \in I} (UIC_i * IW_{it} + \sum_{s=t}^{T+1} \sum_{j \in J} IV_{ij} * FO_{ijts}) \leq B_m, \quad m = 1, \dots, \frac{T}{cpp} \quad (12)$$

$$USS_{is} = D_{is} - \sum_{t=0}^s \sum_{j \in J} FO_{ijts}, \quad \forall i \in I, s = 1, \dots, T \quad (13)$$

$$\sum_{s=t}^{T+1} FO_{ijts} \leq PC_{ij}, \quad \forall j \in J, \forall i \in I, t = 1, \dots, T \quad (14)$$

$$\sum_{i \in I} IVO_i * (\sum_{j \in J} \sum_{s=t}^{T+1} FO_{ijts} + IW_{it-1}) \leq K, \quad t = 1, \dots, T \quad (15)$$

$$USS_{is} \geq 0, \quad \forall i \in I, s = 1, \dots, T \quad (16)$$

$$FO_{ijts} \geq 0, \quad \forall i \in I, \forall j \in J, t = 0, \dots, T, s = 1, \dots, T+1, s \geq t \quad (17)$$

$$n_{ijt} \in Z^+, \quad \forall i \in I, \forall j \in J, t = 0, \dots, T \quad (18)$$

$$z_{its} \in \{0,1\}, \quad \forall i \in I, t = 0, \dots, T, s = 1, \dots, T+1, s \geq t \quad (19)$$

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