

TIME-DEPENDENT ANALYSIS OF OPERATIONAL AVAILABILITY IN NON- REPLENISHABLE SPARE PARTS SCENARIOS

FUSARO (NA) – 14/05/2025

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Case Study Overview

Scope & Objective

This presentation delves into the critical analysis of **Operational Availability (Ao)** for a sample system installed on several naval units, specifically focusing on scenarios involving **non-replenishable spare parts**: this system is subject to **non-mitigable obsolescence**, meaning it cannot be updated using alternative components.



Scope

Given an initial stock level and fixed boundary conditions, as well as various operational scenarios, evaluate the time-domain operational availability of the system and identify potential weaknesses in the support system.



Objective

Understanding these dynamics is crucial to identify the maximum achievable **Logistic Horizon** of the system given a required Ao and an initial spare parts stock level.



Analysis Approach

Tools & Hypothesis

The analyses have been performed using the **SIMLOX Tool**.

- Allows detailed analysis about the performance of the System (i.e. **Primary** and **Support** System) in the time domain;
- Makes it possible to obtain fairly realistic estimates of the operational efficiency of the systems and any weak points in the support system.

General Calculation Assumptions



System Configuration – limited to only the component parts affected by obsolescence



Criticality – each component considered **mission critical**



Spare Parts Stock – current stocks supplied (non-replenishable as per assumption above)



Number of Simulation – 1000



Simulation Duration – 18 years, selected to effectively observe the decline in availability over time for the sample subsystem



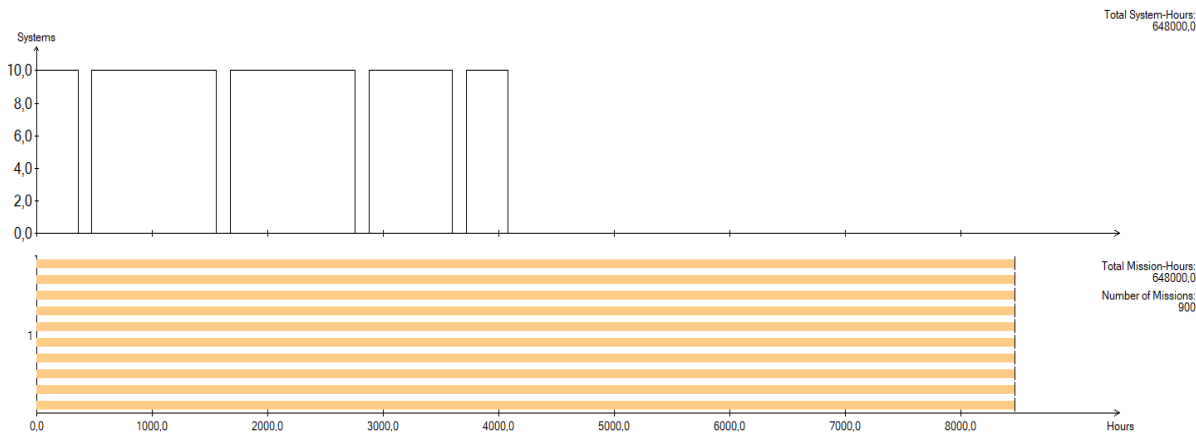
Tool Modelling

Mission Profile

Firstly, the tool's modelling focuses on the deployment framework, which defines the operational context and requirements of the naval units where the sample system is installed.



Total PAS [days]	150
AOR [hours]	3600



Defined Mission Profile

- **Period at Sea (PAS)** of 15, 30 and 45 days;
- **Port periods** of 5 days between each PAS;
- Total PAS days equal to the **Annual Operating Requirements (AOR)** of the sample subsystem.



Tool Modelling

Support Organization (1/3)

The logistical and organizational structure is a critical component in ensuring the operational efficiency and readiness of naval units. For this use case we considered:

Naval Units



10 operational units that rely on the support provided by the **Central Stock Site** to maintain their readiness and effectiveness.

Central Stock Site



- Location where **all customer stocks** are stored;
- Provides services to the naval units;
- **Not directly connected** to the naval units;
- Linked to the 'Station' referred to as **Port**;
- Not involved in the replenishment of stocks from the industry.

Port



- Represents all potential ports where the Naval Units may be located within the mission profile;
- It is not possible to deliver supplies at the Port for any operational restorations.

Assumption

The end of the Mission Profile is considered as the earliest time to restore operations through available stocks; The tool modelling foresees a transport time of the parts from the Central Warehouse to the Port 'station' equal to AOR/2; assuming that the failure occurs in the middle of the mission profile, on average the restoration will occur only at the end of the mission profile and not at intermediate ports.





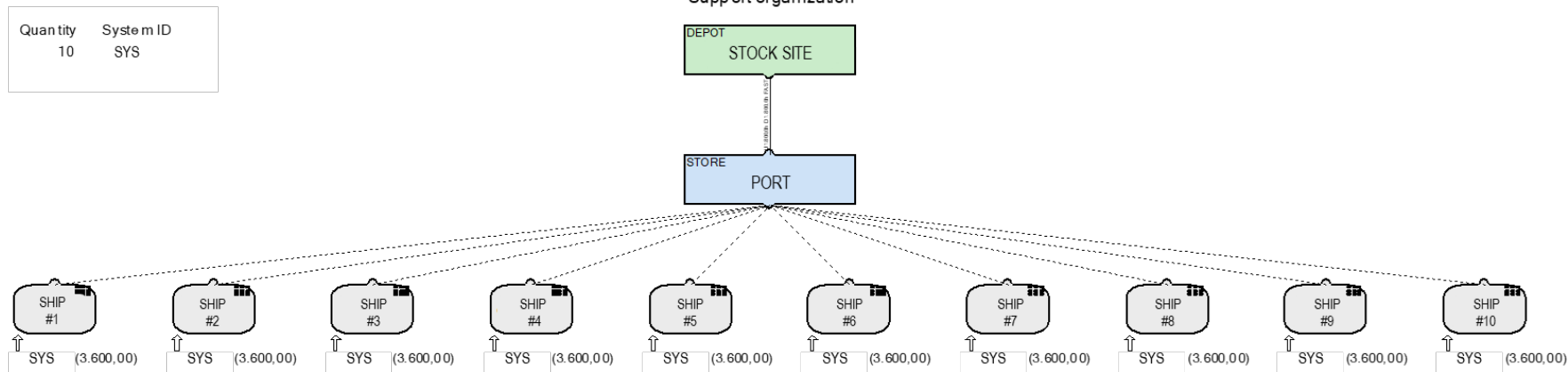
Tool Modelling

Support Organization (2/3)

STID	MSTID	TFRMS	TTOMS
Station identifier	Mother station identifier	Time from mother station	Time to mother station
		[Hours]	[Hours]
PORTO	MAG CENTRALE	1800,0	1800,0



Support organization

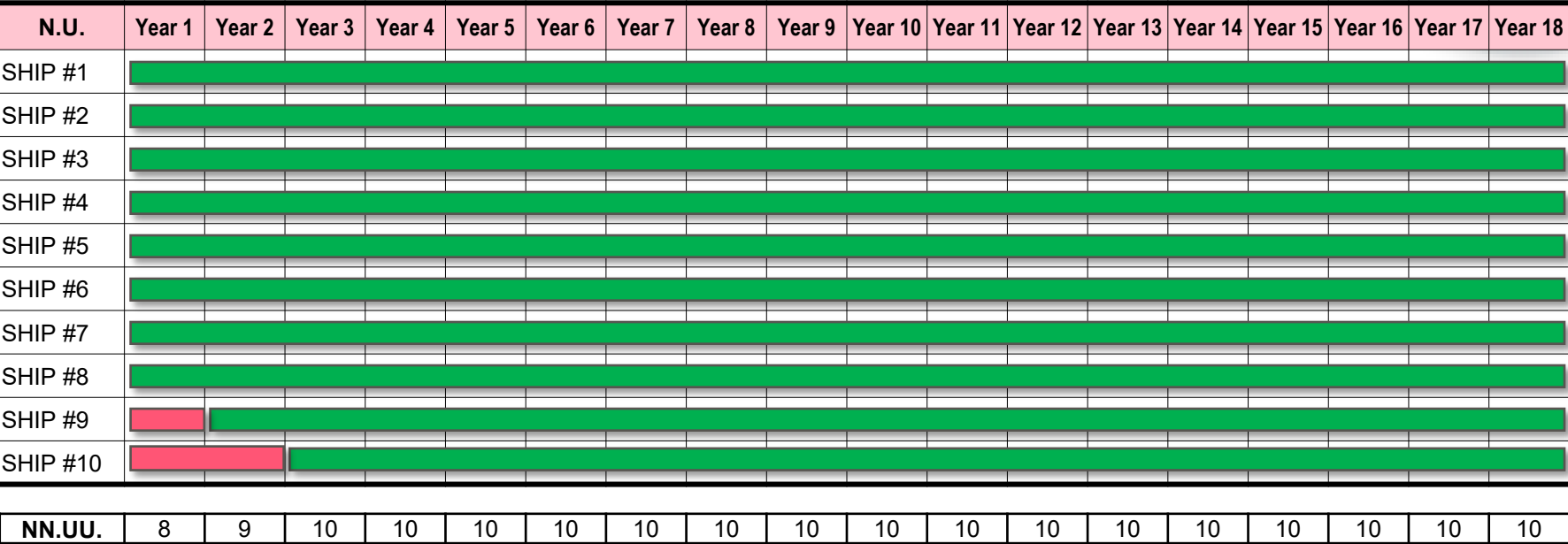




Tool Modelling

Support Organization (3/3)

All 10 NN.UU. are operational for the entire 18 years interval, with the exception of **ships #9** and **#10**, which become operational in second and third year, respectively.





Tool Modelling

Management of “Outside”

To implement this delayed entry-into-service for ships #9 and #10, the 'System Transfer' table in SIMLOX was configured as follows.

“**System Transfer**” table to schedule delayed entry-into-service for individual ships.

UFID and **UTID** the source and destination of the system transfer (here using **<OUTSIDE>** as the external “depot”).

TFTIME to schedule the year of entry-into-service

Ship 9 becomes operational at the start of Year 1;
Ship 10 at the start of Year 2

	UFID	UTID	SID	TFTIME	TFQTY	TFDT	NOTE
	Unit or station from identifier	Unit or station to identifier	System identifier	Transfer time	Transfer quantity	Transfer delay time	User note
				[Years]		[Hours]	
1	SHIP9	<OUTSIDE>	SYS	0.0	<1>	<0.0>	
2	SHIP10	<OUTSIDE>	SYS	0.0			
3	<OUTSIDE>	SHIP9	SYS	1.0			
4	<OUTSIDE>	SHIP10	SYS	2.0			



Case Study Data Input

Obsolete Item Inventory and Logistics Parameters

The following is the list of obsolete parts for the sample system, including the applicable system **AOR**, the **MTBF** value, the **installed quantity** per naval unit, and the **customer's stock** on hand.

System	LRU Name	MTBF [h]	Cust. Stock lv.	QTY installed x N.U.
SYS	item #1	50120	10	6
SYS	item #2	12353305	2	2
SYS	item #3	12455	16	2
SYS	item #4	32281	15	2
SYS	item #5	32326	5	2
SYS	item #6	27584	2	4
SYS	item #7	27945	12	9
SYS	item #8	300000	6	9
SYS	item #9	18317	11	2
SYS	item #10	23228	5	2
SYS	item #11	48246	8	7
SYS	item #12	58306	4	2
SYS	item #13	652707	7	2
SYS	item #14	28689	10	2
SYS	item #15	110109	5	2

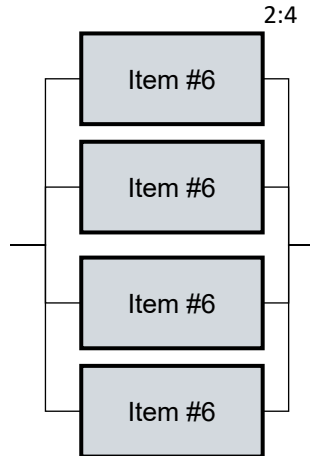
System	LRU Name	MTBF [h]	Cust. Stock lv.	QTY installed x N.U.
SYS	item #16	80348	29	2
SYS	item #17	80348	0	2
SYS	item #18	80348	0	2
SYS	item #19	104579	6	2
SYS	item #20	95785	2	2
SYS	item #21	72463	4	2
SYS	item #22	96153	2	2
SYS	item #23	96153	1	2
SYS	item #24	26667	4	2
SYS	item #25	50100	6	2
SYS	item #26	48543	3	2
SYS	item #27	85690	5	2
SYS	item #28	25000	4	2
SYS	item #29	200601	4	4
SYS	item #30	66979	1	2



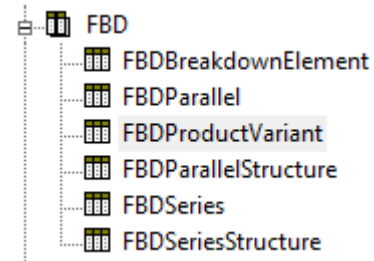
Case Study Data Input

Redundancy Characterization

Item #6 is configured with redundancy. The input data used to model this redundancy configuration within SIMLOX are provided below.



LRU Name	MTBF [h]	Redundancy (m:n)	Cust. Stock lv.	QTY x N.U.	Criticality
item #6	27584	2:4	2	4	Y

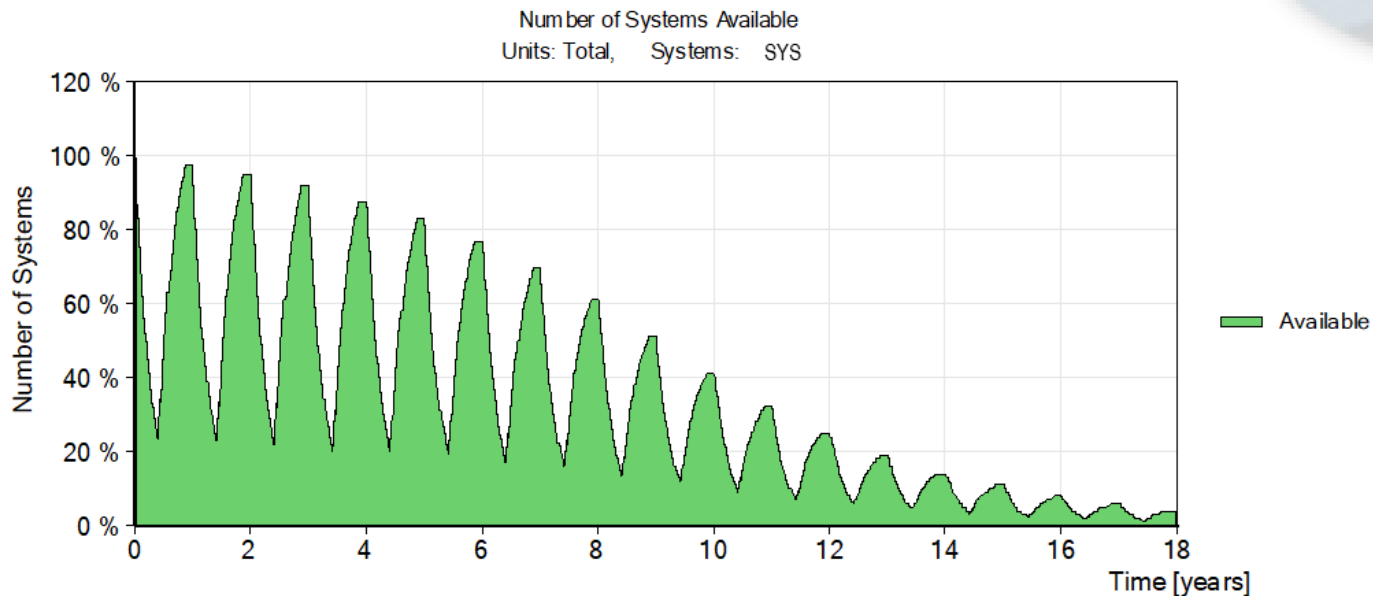




Case Study Results

Operational Availability over Time

The graph below illustrates the trend of operational availability over time. Given the strict maintenance conditions (restoration of parts at the end of the entire mission profile), the availability for each year varies from a maximum value (at the beginning of the mission profile) to a minimum value (at the end of the mission profile).



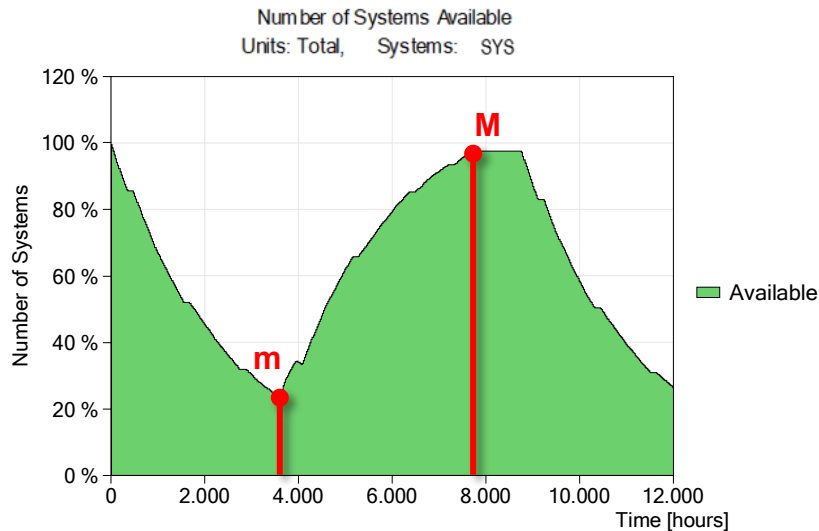


Case Study Results

Local Minimum Focus

The local minimum (**m**) occurring along the entire operational availability curve takes place at the end of each mission of 3600 operative hours (onboard repairability inhibited).

The maximum local value (**M**) is reached following the scheduled stop of the N.U.

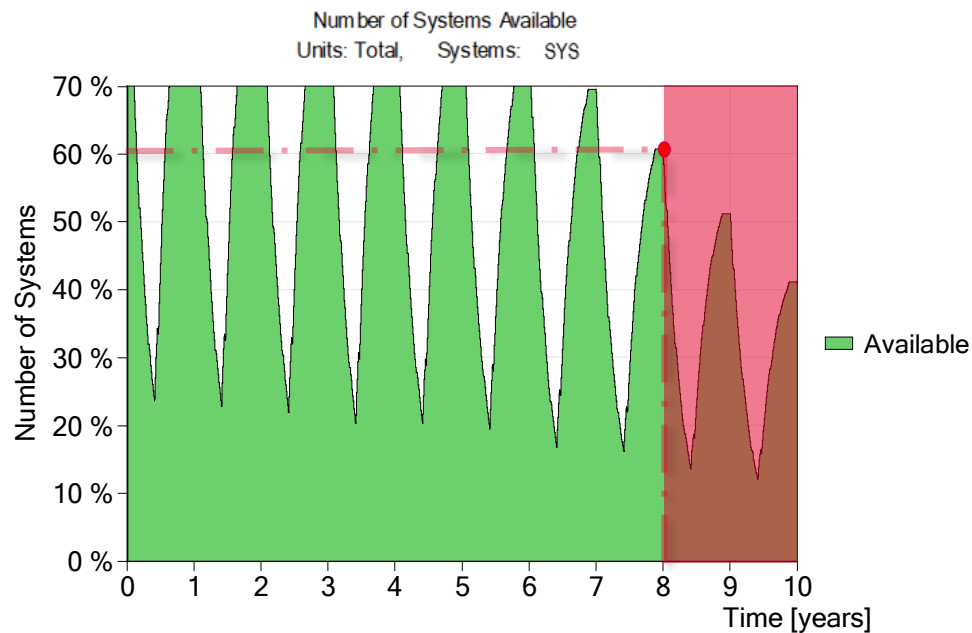




Case Study Results

Operational Availability over Time

For example, it is noted that by the beginning of the **eighth year**, the maximum value of the operational availability falls below **60%**.

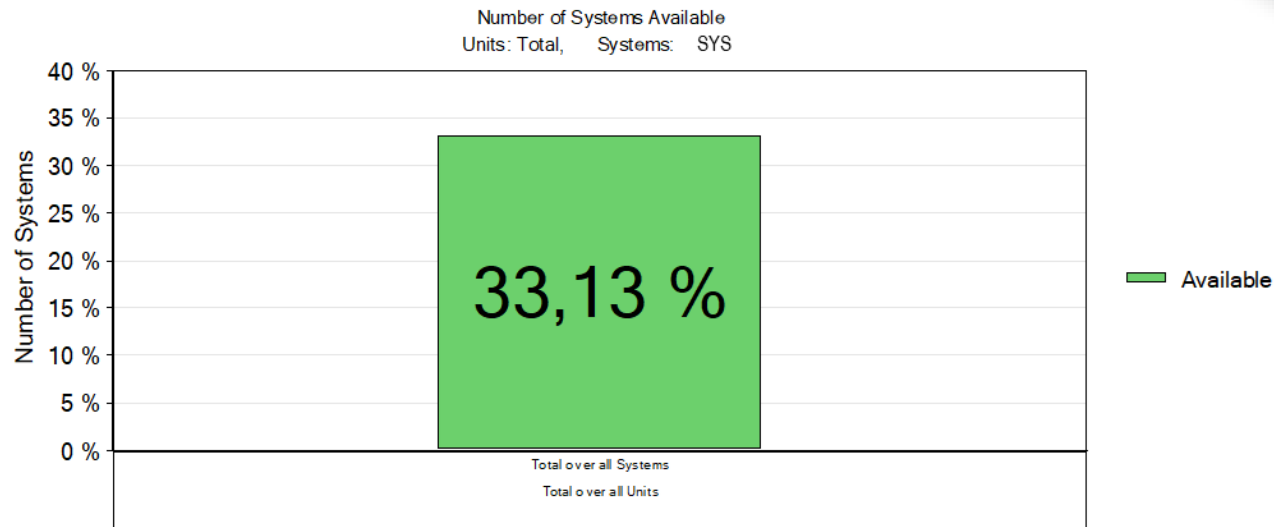




Case Study Results

Mean Operational Availability

The graph below shows the mean availability value over the 18 years considered as the simulation time.

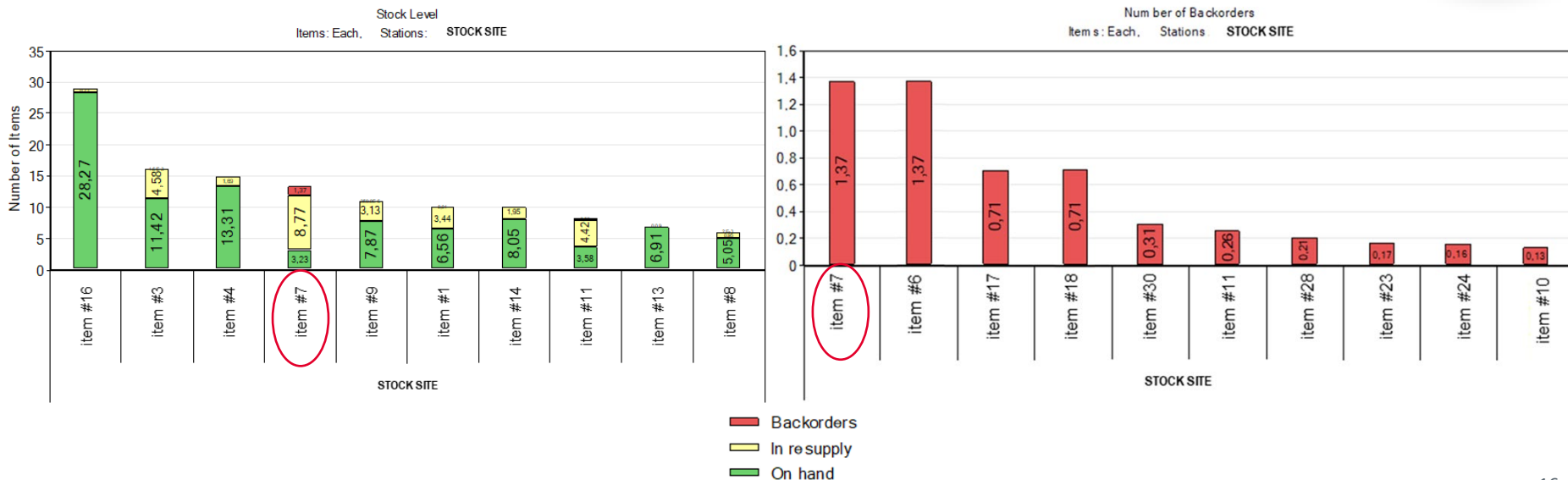




Case Study Results

Stock Level and Backorders

Graphs below show the consumption of stock and any Backorders (unfilled requests) that occurred during the simulations. For readability purposes, the figure only reports the most significant items for the output.

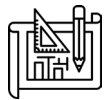




Case Study Results

Stock Effectiveness Summary

LRU Name	Cust. Stock lv.	Stock on hand	Backorders	Redundancy
item #1	10	6,56	0,01	
item #3	16	11,42	0,00	
item #4	15	13,31	0,00	
item #6	2	0,60	1,37	2:4
item #7	12	3,23	1,37	
item #8	6	5,05	0,00	
item #9	11	7,87	0,00	
item #10	5	2,71	0,13	
item #11	8	3,58	0,26	
item #13	7	6,91	0,00	
item #14	10	8,05	0,00	
item #16	29	28,27	0,00	
item #17	0	0,00	0,71	
item #18	0	0,00	0,71	
Item #23	1	0,58	0,17	
item #24	4	2,05	0,16	
item #28	4	1,94	0,21	
item #30	1	0,47	0,31	



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Year	Ao (Max)
1	100%
2	97%
3	95%
4	90%
5	86%
6	82%
7	78%
8	70%
9	61%
10	51%

It should be noted that these values are relative to the average operation over the 18 years of simulations and provide an indication of the possible priority to be considered for the acquisition of additional stocks, and do not represent the stock delta to meet an operational availability requirement.



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