Advanced Improvable Pull System

Documents

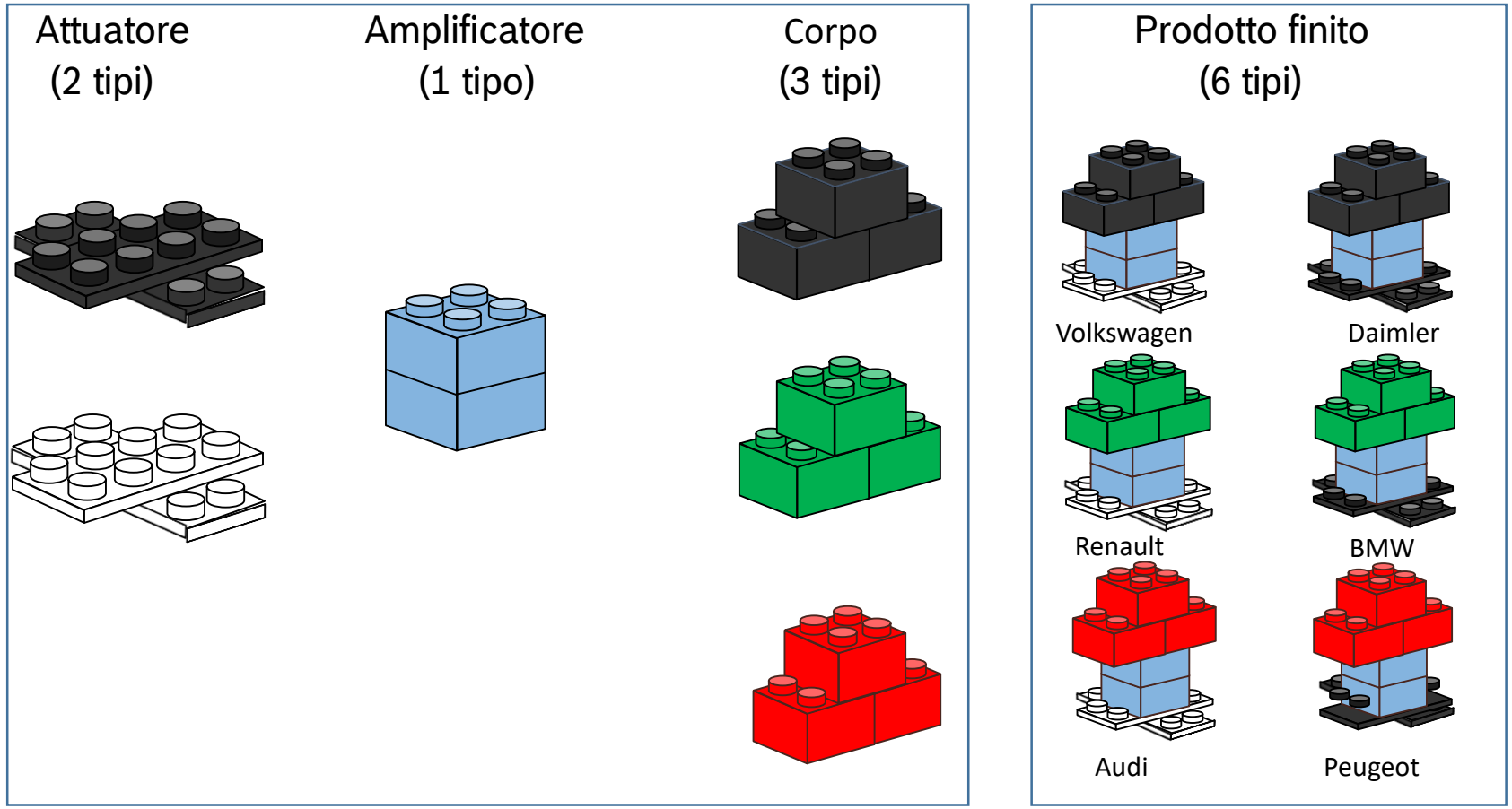
Co-funded by the Erasmus+ Programme of the European Union

The European Commission support for the production of this publication does not constitute endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein

Pull System

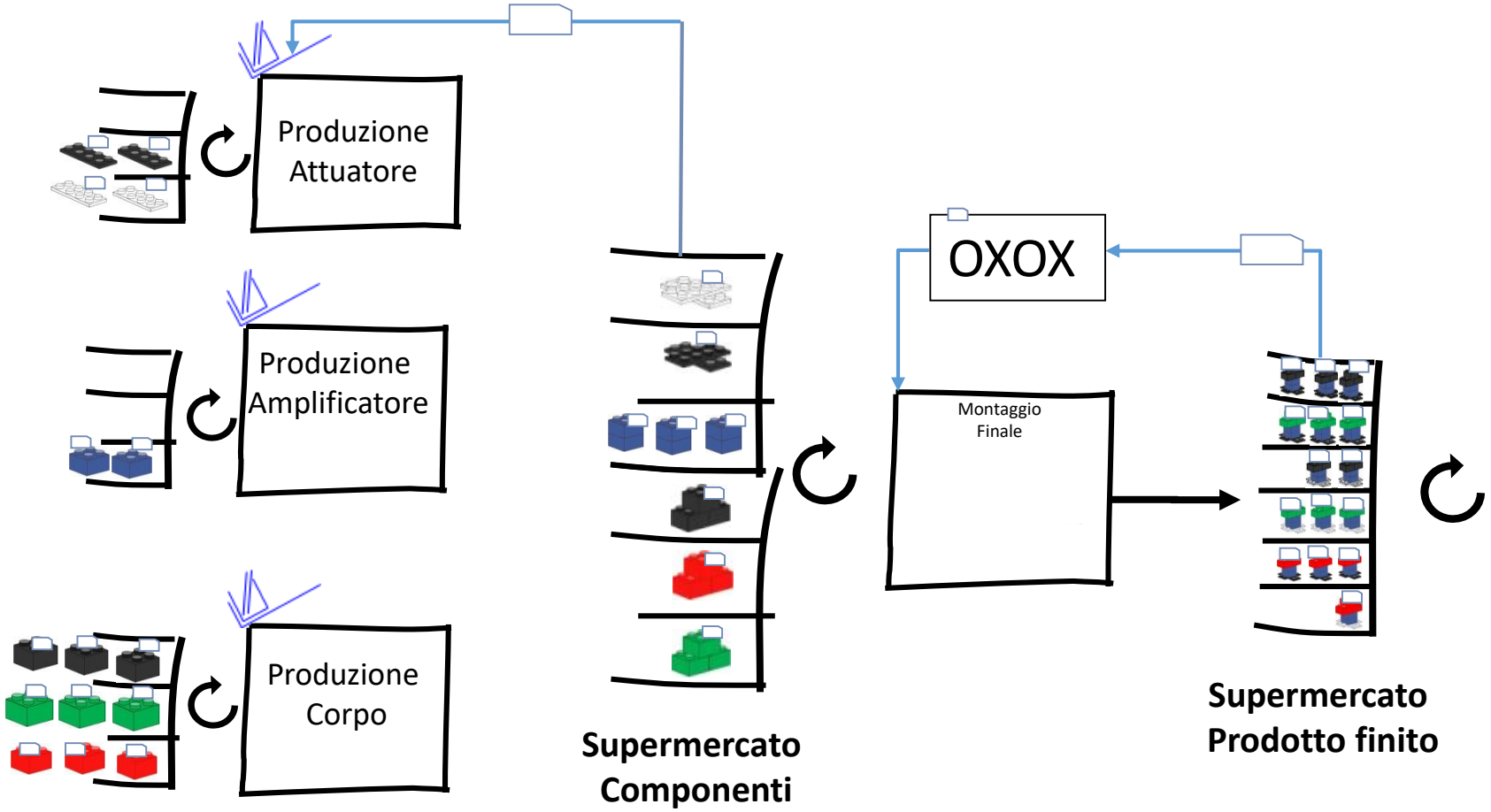
Componenti e Prodotti

➔ CRI3: production and final assembly



Pull System

Value Stream



Pull System
Steps to implement leveling:

1. Define pacemaker process (decided: final assembly)
2. Define **planning leveling period**
3. Define runner and exotics with ABC (volume) and XYZ (pick up regularity) (defined: all types are runners)
4. Analyze customer call-off behavior (done: customers prognosis quality is excellent)
5. Capacity analysis to define **number of maximal possible change overs (Step 5a) – verify supply ability of pre-processes (Step 5b)**
6. Definition of **EPEI** for each runner
7. Definition of **production lot size** per runner
8. Definition of **leveling production plan (8-a) and sequence (8-b)**
9. Calculation of **required decoupling (K-spot analysis and ReLoWiSa)**
10. Design of **heijunka board: distribution of lot sizes (10-a) and definition of daily setup of SA1 on overflow (10-b)**

Pull System

Customer Request

Step 2-3

customer pick-up per working day (number of kanbans)

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	sum	avg
VW	6	3	1	5	8	5	3	3	7	5	6	2	7	8	7	5	6	1	6	6	3	3	3	5	7	5	5	1	5	5	142	5
Renault	4	7	4	5	3	4	6	5	8	4	9	5	4	3	5	8	4	3	7	6	3	4	0	6	5	5	7	5	5	3	147	5
Daimler	2	2	2	2	1	2	2	2	2	2	3	3	1	1	2	2	1	2	1	2	3	1	2	3	1	3	1	2	2	2	57	2
BMW	2	3	1	2	1	2	2	3	2	2	3	2	3	2	2	2	1	2	2	2	2	2	2	1	2	3	2	1	3	1	60	2
Audi	0	1	1	1	1	2	1	2	0	1	1	1	1	1	1	1	1	1	1	0	1	2	1	1	1	1	1	1	1	1	30	1
Peugeot	1	1	2	1	1	1	1	1	1	1	1	1	2	0	1	1	1	2	0	1	1	1	1	1	1	1	1	1	1	0	30	1
total	**15**	**17**	**11**	**16**	**15**	**16**	**15**	**16**	**20**	**15**	**23**	**14**	**18**	**15**	**18**	**19**	**14**	**11**	**17**	**17**	**13**	**13**	**9**	**17**	**17**	**18**	**17**	**11**	**17**	**12**	**466**	**16**

customer demand in number of kanbans

Week	CW1	CW2	CW3	CW4	CW5	CW6	sum	avg
VW	23	23	30	24	21	21	142	24
Renault	23	27	26	28	18	25	147	25
Daimler	9	10	10	8	10	10	57	10
BMW	9	11	12	9	9	10	60	10
Audi	4	6	5	4	6	5	30	5
Peugeot	6	5	5	5	5	4	30	5
total	**74**	**82**	**88**	**78**	**69**	**75**	**466**	**78**

customer demand in pieces

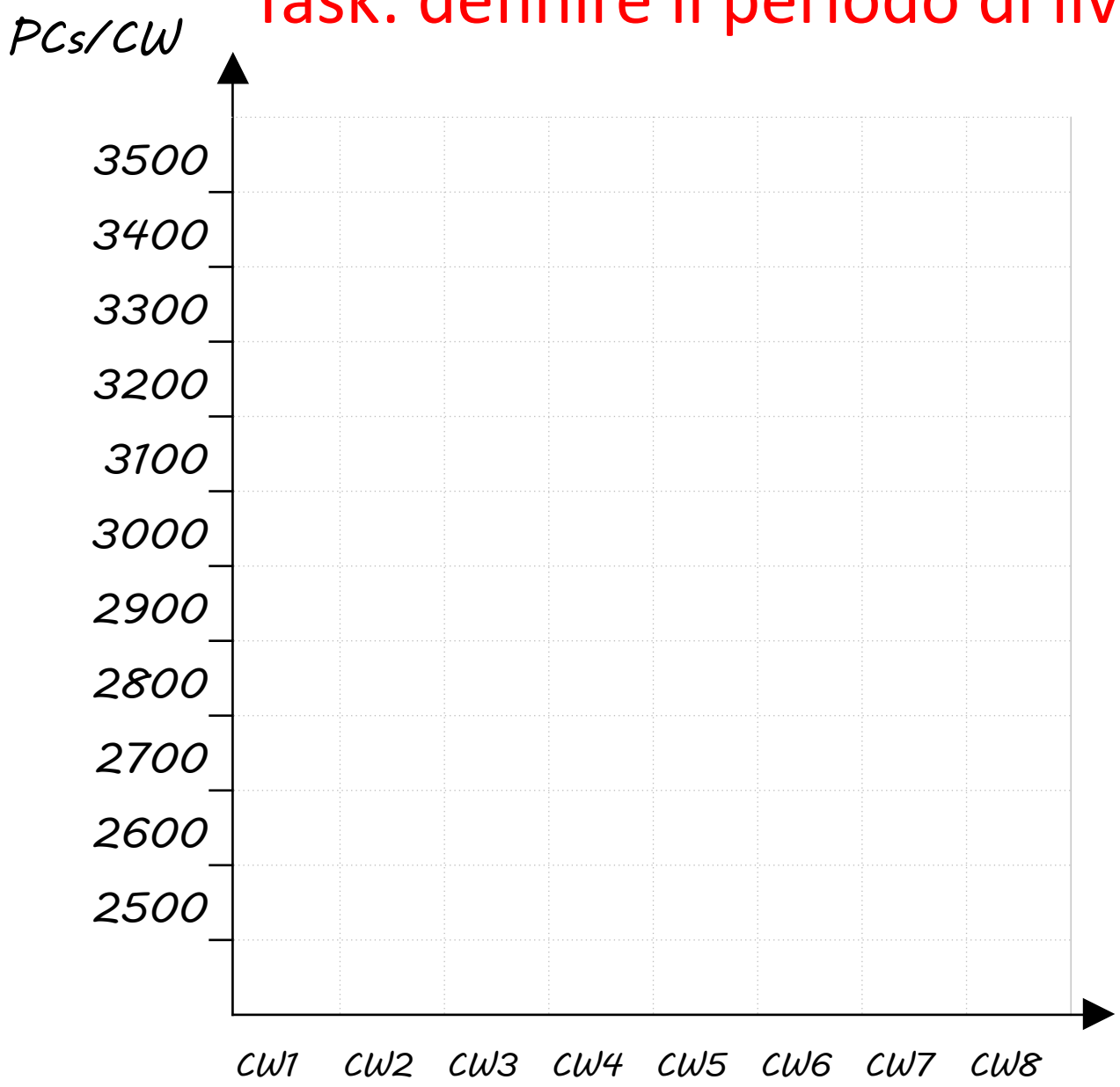
CW1	CW2	CW3	CW4	CW5	CW6	sum	avg/week
920	920	1200	960	840	840	5680	947
920	1080	1040	1120	720	1000	5880	980
360	400	400	320	400	400	2280	380
360	440	480	360	360	400	2400	400
160	240	200	160	240	200	1200	200
240	200	200	200	200	160	1200	200
2960	**3280**	**3520**	**3120**	**2760**	**3000**	**18640**	**3107**

1 box = 1 NPK = 40 pezzi

Periodo di livellamento: ____ settimane

Step 2: Definition Leveling Period

Task: definire il periodo di livellamento



Day1: Round 1

- 1 week
- 2 weeks
- 3 weeks
- 4 weeks

	CW1	CW2	CW3	CW4	CW5	CW6
1 week	2960	3280	3520	3120	2760	3000
2 weeks (avg.)	3120	3120	3320	3320	2880	2880
3 weeks (avg.)	3253	3253	3253	2960	2960	2960
4 weeks (avg.)	3220	3220	3220	3220		

Pull System

Dati

Task: Calcolare il numero di ore disponibili per la produzione e C.O.

- Dati– **Media OEE del periodo precedente, senza C/O**
  - Montaggio finale: 84 % (24h*84/100)=
  - Produzione attuatore: 76 %
  - Produzione Amplificatore: 68 %
  - Produzione Corpo: 80 %

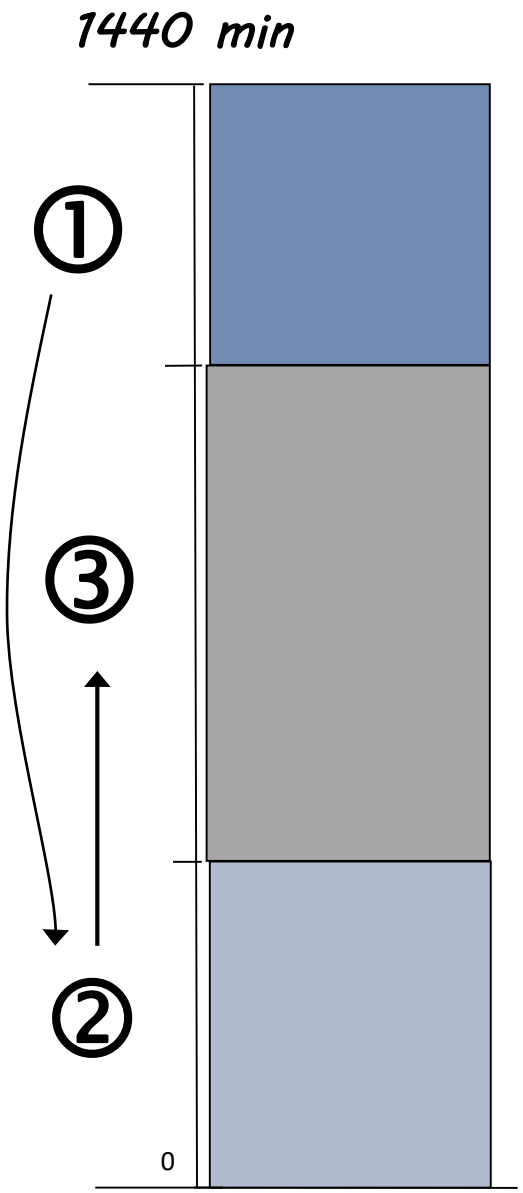
- POT 24 h
- Tempo di cambio tipo 60 min
- Tempo ciclo/pz 1.5 min
- NPK 40 pz = 1 h production

Step 5: Capacity analysis Task: Calcolare il numero di C.O. possibili

Step 5A: Define n° of change-overs (Per day)

	CW1	CW2	CW3	CW4	CW5	CW6
1 week	2960	3280	3520	3120	2760	3000
2 weeks (avg.)	3120	3120	3320	3320	2880	2880
3 weeks (avg.)	3253	3253	3253	2960	2960	2960
4 weeks (avg.)	3220	3220	3220	3220		

(3120+3120)/10= 624 Pz/g



1440 min **Final Assembly**

1) OEE-loss w/o change over:
POT: 1 _____
- POT * OEE: 2 _____
= OEE-Loss 3 _____

3) POT: 7
- OEE-loss: 8 _____
- Net prod. Time 9 _____
= C/o capacity 10 _____
/ time per C/o 11 _____
= no. of max. C/O 12 _____

2) no. of parts to produce/day: 4 _____
* cycle time 5 _____
= NPT 6 _____

0

Pull System

Capacità ed abilità del rifornimento

Quante volte al giorno dobbiamo effettuare un C.O. al pacemaker? Decisione:

Step 5b

4

Situation at the pacemaker (final assembly):	
Planned Operating Time (POT):	1440
- OEE-loss:	
- Change Over Time:	
= Net production time (NPT):	
/ Cycle time per piece (in min/pc)	1.5
= max. number of pieces per day	
= max. number of k per day	

Task: Calcolare il numero di pz/g con 4 C.O.

Are the preprocesses able to produce the daily quantities of each type?	Amplifier module	Actuator module	Body Production
Number of types	1	2	3
(1) POT (min)	1440	1440	1440
OEE w/o change over losse	68%	76%	80%
(2) OEE-loss (min)	461	346	288
No. of C/o per day	0	2	3
Time per C/o (min)	60	60	60
(3) C/O-Capacity (min)	0	120	180
= NPT (1) - (2) - (3)	979	974	972
/ Cycle time	1.5	1.5	1.5
= pieces / day			

Quanti pezzi potremmo produrre al giorno con una perdita di OEE determinata e un numero deciso di cambi?

Dati

Task: Calcolare l'OEE con C.O.

- Pianificazione della capacità: **Media OEE del periodo precedente,**

	senza C/O	**con C/O (NPT/POT)**
– Montaggio finale:	84 % = 20 h	(4 C.O.)
– Produzione attuatore :	76 % = 18,2 h	(2 C.O.)
– Produzione Amplificatore :	68 % = 16 h	(0 C.O.)
– Produzione Corpo :	80 % = 19,2 h	(3 C.O.)
– POT	24 h	

- Tempo di cambio tipo 60 min
- Tempo ciclo/pz 1.5 min
- NPK 40 pcs = 1 h production
- Target OEE ≠ Valore base OEE per la pianificazione della capacità (riferimento: periodo precedente)
- Nessuna fluttuazione del cliente non pianificata

Step 6: Definition of EPEI

Task: Calcolare richiesta media giornaliera

Customer	Average Daily customer Demand [pcs/day]	Change Over [Av·/day]	EPEI	NPK
VW*				40
Renault				40
Daimler				40
BMW				40
Audi				40
Peugeot				40
Total				

*Esempio VW = (920+920)/10 =184

Step 6: Definition of EPEI

Task: Definire Leveling Pattern

Step 7:

Average N° of cards/day

Customer	Demand in cards/day
VW*	
Renault	
Daimler	
BMW	
Audi	
Peugeut	
Total	

Step 8a:

Leveling production Plan

Customer	Day 1	Day 2	Day 3	Day 4
VW				
Renault				
Daimler				
BMW				
Audi				
Peugeut				
Total				

*Esempio VW = (184/40) =4,6

Step 9: Calculation of required decoupling

Task: Calcolare il Kspot

period

Renault	1	2	3	4	5	6	7	8	9	10
Initial Stock in supermarket	0	-4								
+ Planned Production of previous day (availble at day +1)		5								
- Customer Withdrawal of current day	4	7								
= Theoretical Stock in Supermarket after customer withdrawal	-4	-6								
Initial Kanbans in Overflow	0	-5								
+ kanbans from Customer Withdrawal previous day		4								
- kanbans for Planned Production of next day	5	5								
= Kanbans in overflow after fixing pattern for next day	-5	-6								
Needed Kanban and location:	Supermarket (**Kspot 2**):				+ Process (**Kspot 1**):					
	+ Overflow (**Kspot 3**):				= Total					

period

BMW	1	2	3	4	5	6	7	8	9	10
Initial Stock in supermarket	0	-2								
+ Planned Production of previous day (availble at day +1)		0								
- Customer Withdrawal of current day	2	3								
= Theoretical Stock in Supermarket after customer withdrawal	-2	-5								
Initial Kanbans in Overflow	0	-4								
+ kanbans from Customer Withdrawal previous day		2								
- kanbans for Planned Production of next day	4	0								
= Kanbans in overflow after fixing pattern for next day	-4	-2								
Needed Kanban and location:	Supermarket (**Kspot 2**):				+ Process (**Kspot 1**):					
	+ Overflow (**Kspot 3**):				= Total					

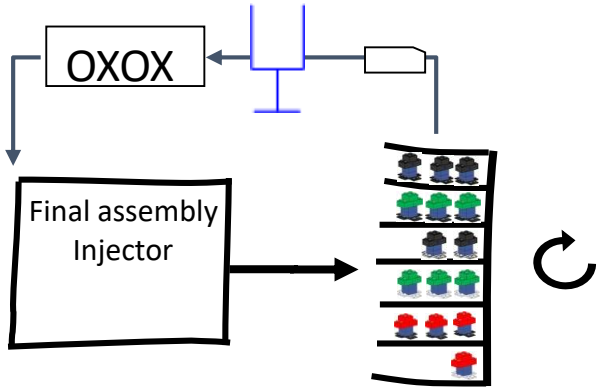
Step 9: Calculation of required decoupling

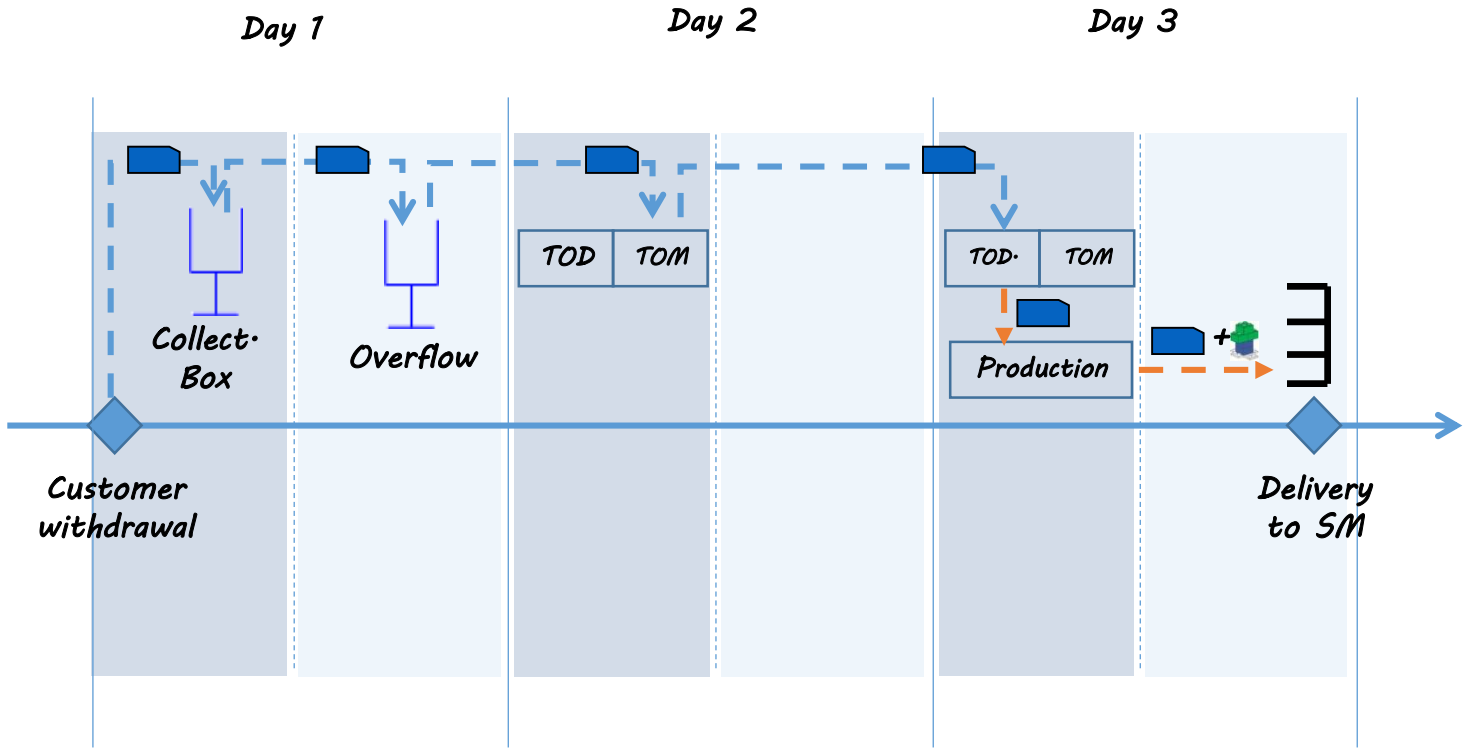
Task: Calcolare RTLoop; RE di Renault

(RELOWI)

Step A: Define RE

(N° of cards to cover the Replenishment Time → Rt loop





Rt loop= _____

$$Re = \frac{RTLoop \times Pr}{POT \times NPK}$$

Re= _____ = Kanban

Step 9: Calculation of required decoupling

Step B: Define LO (RELOWI)
(N° of cards needed to complete lot size)

LO = 0

Step C: Define WI (RELOWI)
(N° of cards needed to cover the planned customer peaks)

Task: Calcolare Wi

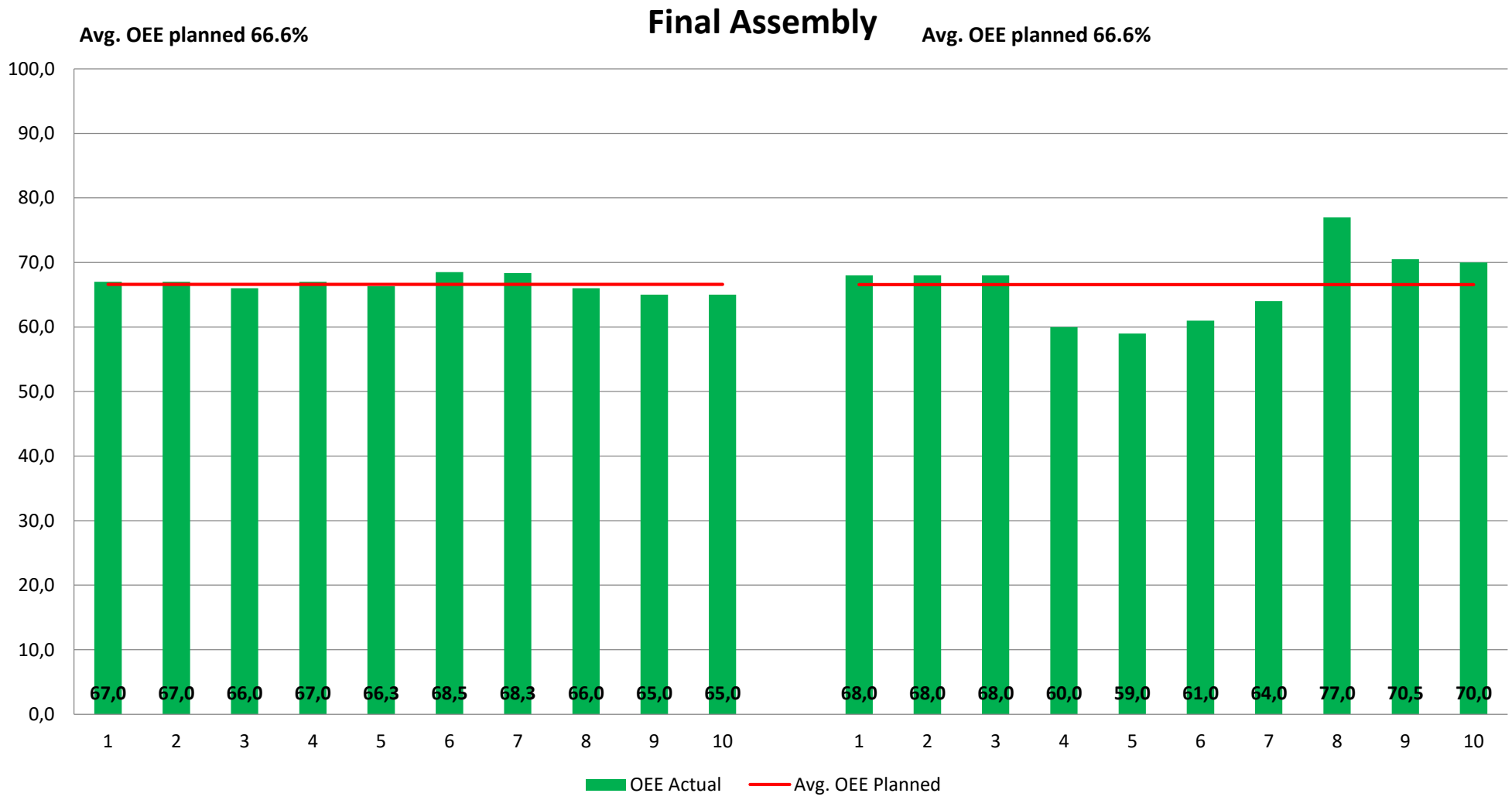
WI=Kspot tot-Re-Lo

Process Kspot 1=5	Total Number of kanbans required for the planned set-up 19	Kanbans covering **Replenishment time (RE)**
SUPERMARKET Kspot 2=6		Kanbans covering **Lot Size formation (LO)**
OVERFLOW Kspot 3=8		Kanbans covering **Planned customer withdrawal peaks (WI)**

WI=_____

SA_1: Calcolo per SA1 pacemaker

(Own Fluctuation)



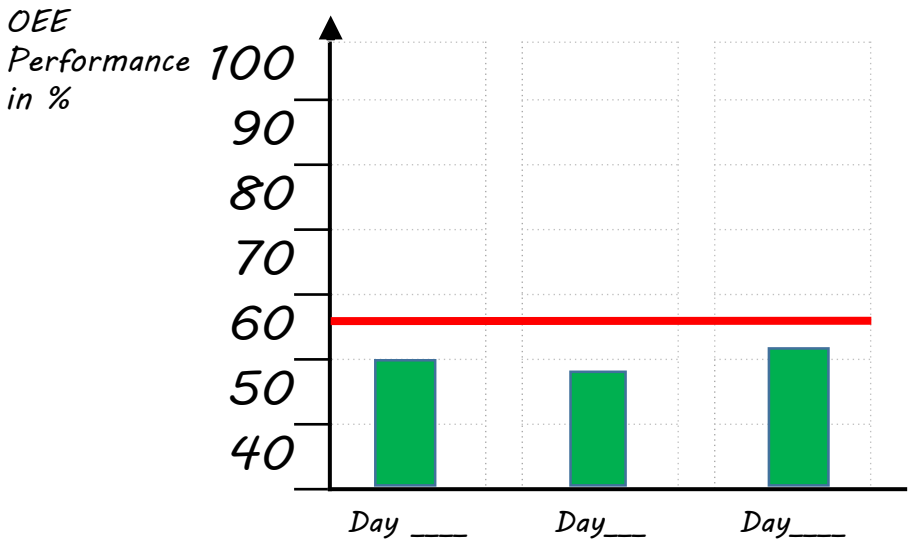
$SA_{1\ Supermarket}$: To cover negative fluctuation

Production deliver less than plan, to protect the customer, include safeties in the supermarket

Task: Calcolare Sa1 Supermercato

$SA_{1\ Supermarket}$:

1) Calculate the biggest losses cummulated in the RT_{loop}



Day___: ➔ 66,6%: 16K➔ ___: X K | X= | ➔ | Losses= ____Cards

Day___: ➔ 66,6%: 16K➔ ___: Z K | Z= | ➔ | Losses= ____Cards

Day___: ➔ 66,6%: 16K➔ ___: W K | W= | ➔ | Losses= ____Cards

2) Calculate the number of cards to cover the biggest losses in the RT_{loop}

$SA_{1\ Supermarket}$=

Day1: Round 1

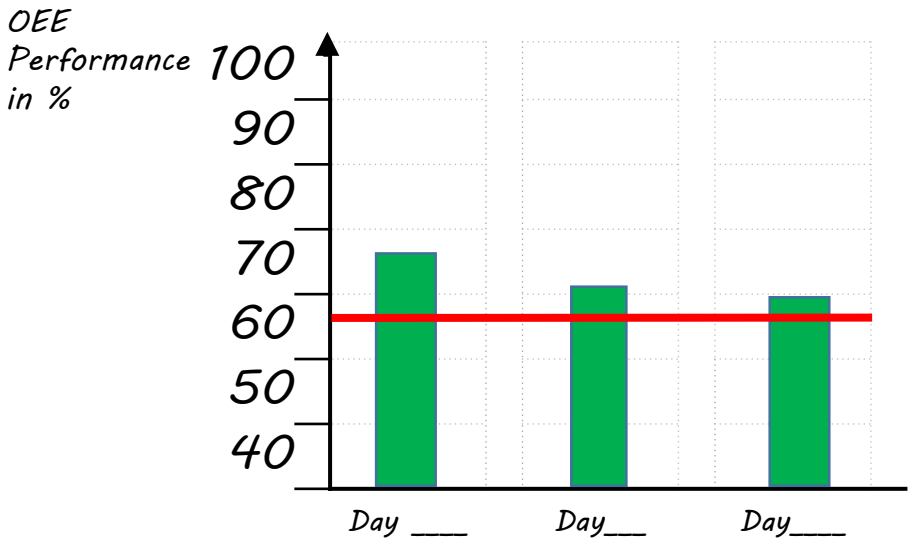
$SA_{1\ Overflow}$: To cover positive fluctuation

Number of cards tobe provide to the production when its perform better than average OEE, which was the basis to define the number of cards available daily (the aim is to support positive performance to the process)

$SA_{1\ Overflow}$:

1) Calculate the biggest performance increase cummulated in the RT_{loop}

Task: Calcolare Sa1 Overflow



Day___: ➔66,6%: 16K➔ ___: M K | M= | ➔ | Increase= _____Cards

Day___: ➔66,6%: 16K➔ ___: N K | N= | ➔ | Increase= _____Cards

Day___: ➔66,6%: 16K➔ ___: L K | L= | ➔ | Increase= _____Cards

2) Calculate the number of cards for biggest positive performance in the RT_{loop}

$SA_{1\ Overflow}$=

Step 9: Calculation of required decoupling

Task: Compilare

	Renault
RE	
LO	
WI	
SA1 (OEE)	
SA1 sup	
SA1 overflow	
SA2 (Customer)	
SA2 sup	
SA2 lev·board	
SA	
Total	