

Prof. Ing. Raffaele Campanella
E-mail: raffaele.campanella@yahoo.it
335 211609

INDUSTRIAL PLANTS 2

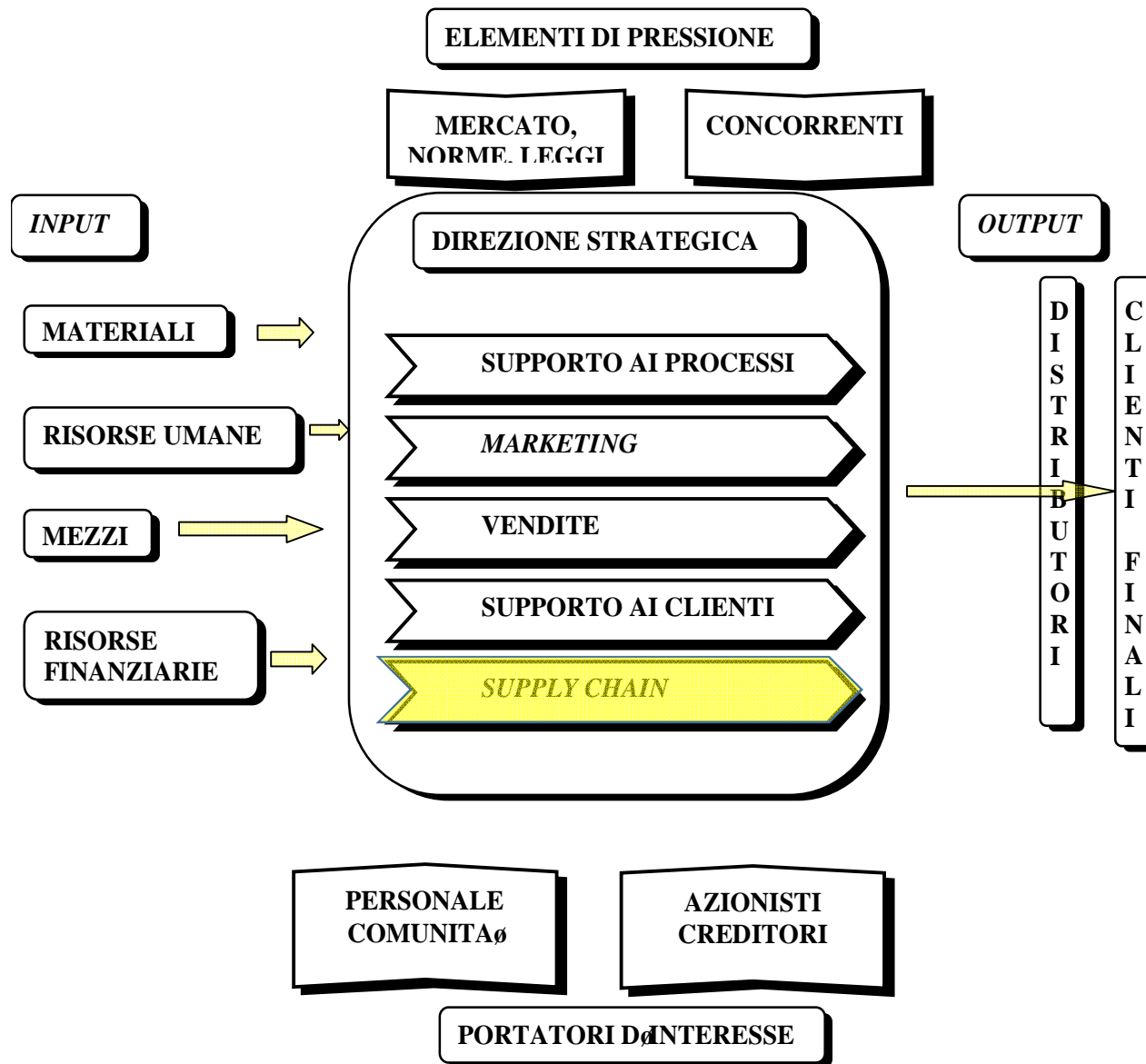
Chapter four È part 2 **Performance indicators**

DOUBLE DEGREE MASTER IN
Í PRODUCTION ENGINEERING AND MANAGEMENTÎ

CAMPUS OF PORDENONE
UNIVERSITY OF TRIESTE

PERFORMANCES MEASUREMENTS OF PRODUCTION OPERATIONS

**ONLY WHAT CAN BE MEASURED
CAN BE IMPROVED**



PROCESSES

BASE PROCESS: SUPPLY CHAIN

MAIN PROCESSES:

- “ Internal Logistic
- “ External Logistic
- “ Suppliers relationships
- “ Operations
- “ Quality Assurance
- “ Safety and Environment
- “ Technology and Investments



PROCESSES

MAIN PROCESSES: Technology and Investments

SECONDARY PROCESSES

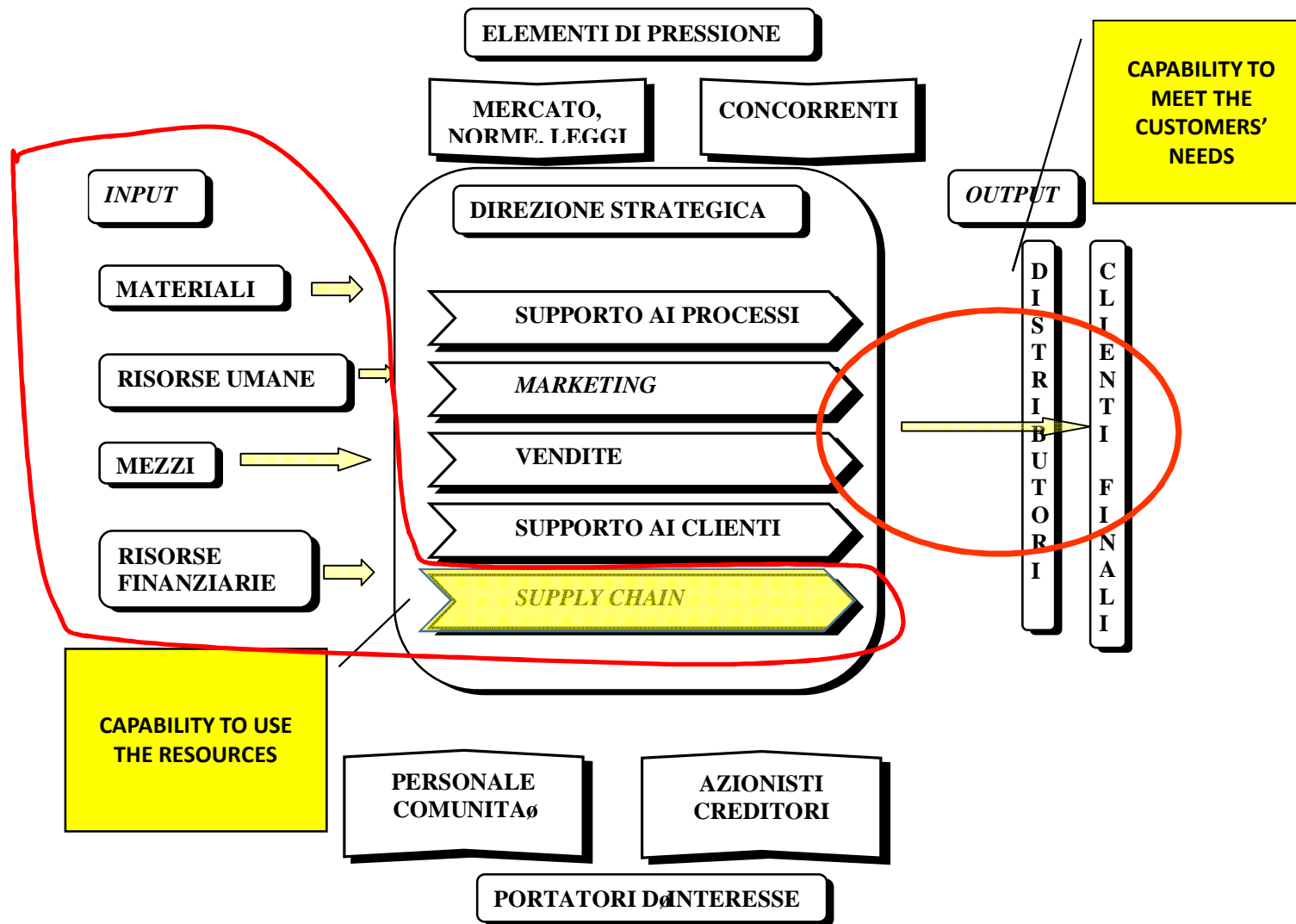
- Activities:

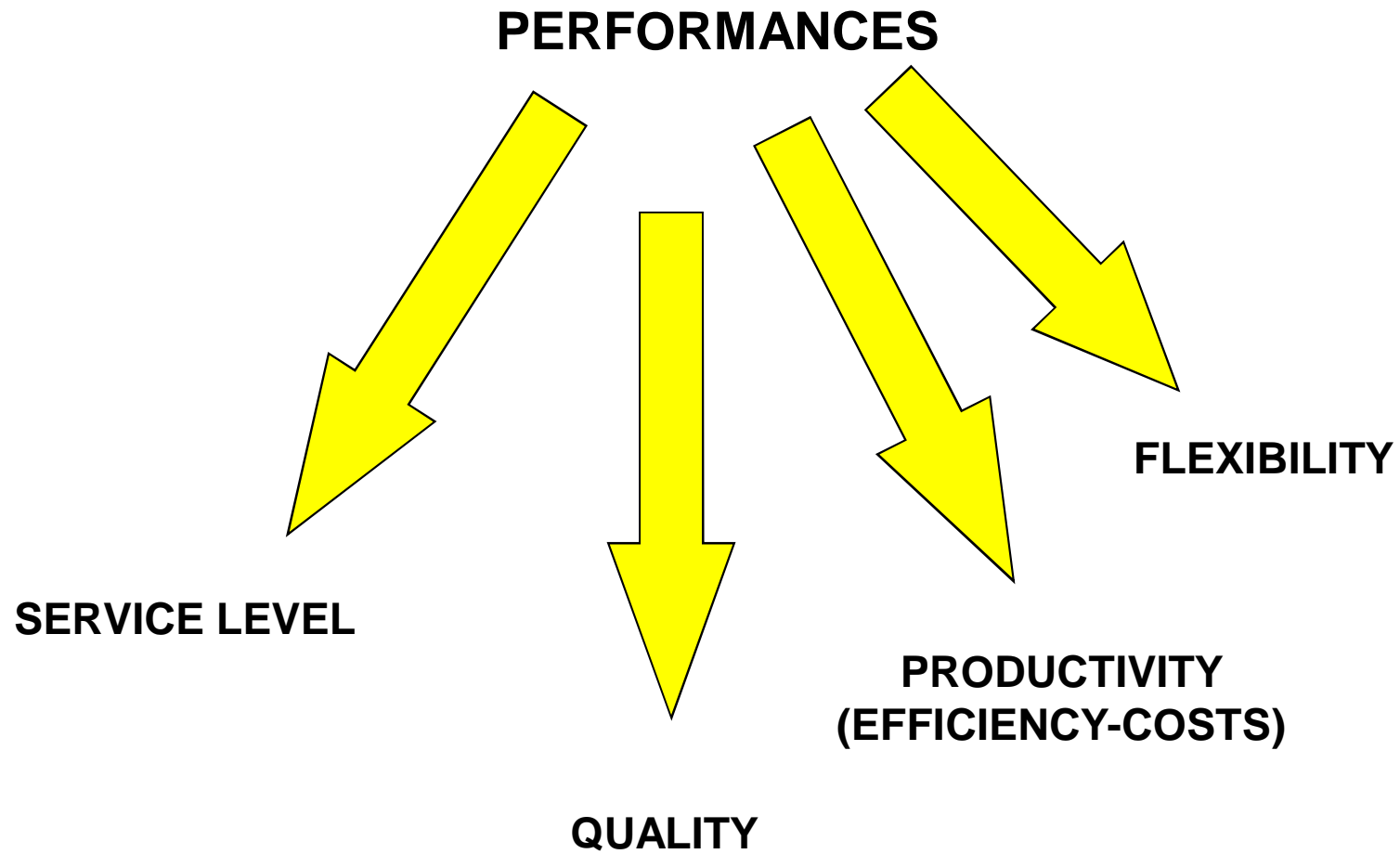
1. Investment
 - 1.1 Project feasibility
 - 1.2 Project management

2. Production Technology
 - 2.1 Technological requirements Analysis
 - 2.2 Technological know-how management

3. Production support systems
 - 3.1 IT requirements Analysis
 - 3.2 IT know-how management

4. Machines and Plant Management
 - 4.1 Service and spare parts management
 - 4.2 Maintenance management
 - 4.3 Asset Management







Capability to use the resources

- Workforce use efficiency
- Materials use efficiency
- Asset use efficiency
- Financial resources use efficiency
-

PERFORMANCES

Capability to meet the customers' demands

- Product design quality (product reliability)
- Techn. Specifications compliance
- Failure rate by the customers
- Manutenibility
-
- Delivery speed
- Delivery punctuality
- Delivery completeness
- Ability to keep promises
- Delivery flexibility
- Time to market
- Customers support
-
- Lead time
- Flexibility to volume variation
- Flexibility to mix variation
- Flexibility to product type variation
-

Productivity

Quality

Service

Flexibility

MATERIALS USE EFFICIENCY



MATERIAL CONTROL

Total stock **Giacenze totali** = Giacenze mat. Prime + Giacenze componenti + Giacenze Mat. Ausiliari + Semilavorati +/- Differenze inventariali.

Rolling average stock **Giacenza media *rolling*** =
$$\frac{\text{Somma delle giacenze degli ultimi dodici mesi}}{12}$$

Monthly std. cost **Costo standard mensile** = costo standard dei prodotti versati a magazzino nel mese di riferimento.

Rolling average std. cost **Costo standard medio *rolling*** =
$$\frac{\text{Somma dei costi std mensili degli ultimi dodici mesi}}{12}$$

Actual turnover Index **Indice di Rotazione puntuale** =
$$\frac{\text{Costo standard medio *rolling*}}{\text{Giacenza totale mensile}}$$

Average turnover Index **Indice di Rotazione media** =
$$\frac{\text{Costo standard medio *rolling*}}{\text{Giacenza media *rolling*}}$$

MATERIALS CONTROL

Stock Level Actual Value	Dic	Gen	Feb	Mar	Apr 00	May 00	Jun 00	Jul 00	Aug 00	Set 00
RAW MATERIAL	530	541	644	654	589	674	554	646	646	935
COMPONENTS	3276	3169	3487	3613	3828	4008	3833	3869	4167	3649
AUXILIARY MATERIAL	65	70	71	72	59	54	60	58	62	74
SEMIFINISHED GOODS	610	611	629	752	706	628	595	554	679	679
Inventory Differences	-314	-317	-322	-328	-328	-339	-345	0	0	-40
Total Stock Level	4167	4074	4509	4763	4854	5025	4697	5126	5554	5297
STK3 STD MONTLY	2744	2532	3701	4312	3699	4762	5253	4699	2329	4004
STK3 STD ROLLING	37700	38176	38957	39766	39400	40921	42592	43227	43707	44454
STOCK LEVEL ROLLING	4640	4521	4458	4396	4366	4371	4385	4472	4605	4691
TO/RATE Punctual	9,05	9,37	8,64	8,35	8,12	8,14	9,07	8,43	7,87	8,39
TO/RATE Average	8,12	8,45	8,74	9,05	9,02	9,36	9,71	9,67	9,49	9,48



Material
differencies
from standard
value

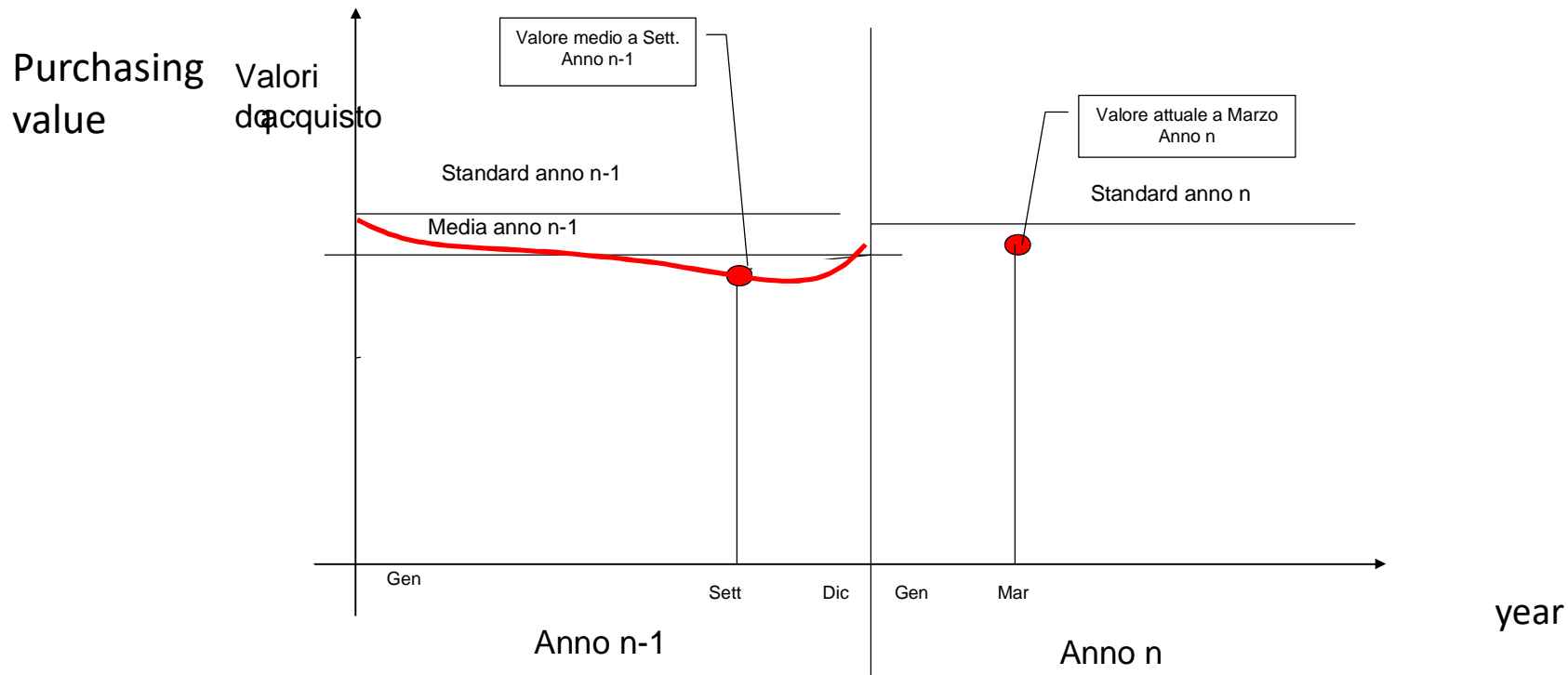
STANDARD VALUE DIFFERENCE

SCOSTAMENTO DEI MATERIALI DALLO STANDARD				
VALORE Ö	Mese n	Mese n+1	Mese n+2	Mese n+3
Ragg. 01	MATERIE PRIME	Raw materials		
ACQEFF	1656609	3512844	5107556	6558118
STDACQ	1678759	3631978	5236570	6702629
SCOST.	-22150	-119134	-129014	-144511
%	-1,32	-3,28	-2,46	-2,16
Ragg. 04	MATERIALI AUSILIARI	auxiliary materials		
ACQEFF	17273	39118	57582	76798
STDACQ	17895	40278	59200	79348
SCOST.	-622	-1160	-1618	-2550
%	-3,48	-2,88	-2,73	-3,21
Ragg. 06	CONTO LAVORAZIONE	Subcontracted work		
ACQEFF	7263	20189	26277	34440
STDACQ	7745	21585	28127	36422
SCOST.	-482	-1396	-1850	-1982
%	-6,22	-6,47	-6,58	-5,44
TOTALI	total			
ACQEFF	1681145	3572151	5191415	6669356
STDACQ	1704399	3693841	5323897	6818399
SCOST.	-23254	-121690	-132482	-149043
%	-1,36	-3,29	-2,49	-2,19



STANDARD VALUE DIFFERENCE

DIRECT MATERIALS DIFFERENCE											
TOTALE	VALORE D'ACQUISTO PROGRESSIVI					VALORI DI ACQUISTO				MESE: 3	
	VALORE MEDIO ANNO N-1	VALORE MEDIO A SETTEMBRE ANNO N-1	STD ANNO N	STD N/MEDIA N-1	STD N/MEDIA SETT. N-1	STD	ATTUALE MESE 3/STD	DELTA	ATTUALE MESE 3/ MEDIO ANNO N-1	ATTUALE MESE 3/ MEDIA SETTEMBRE N-1	
0	20.142.000	20.118.000	20.437.000	1,46	1,59	5.805.819	(1,53)	(89)	0,07	0,20	





material
management
000 €

MATERIALS CONTROL

Actual

Actual

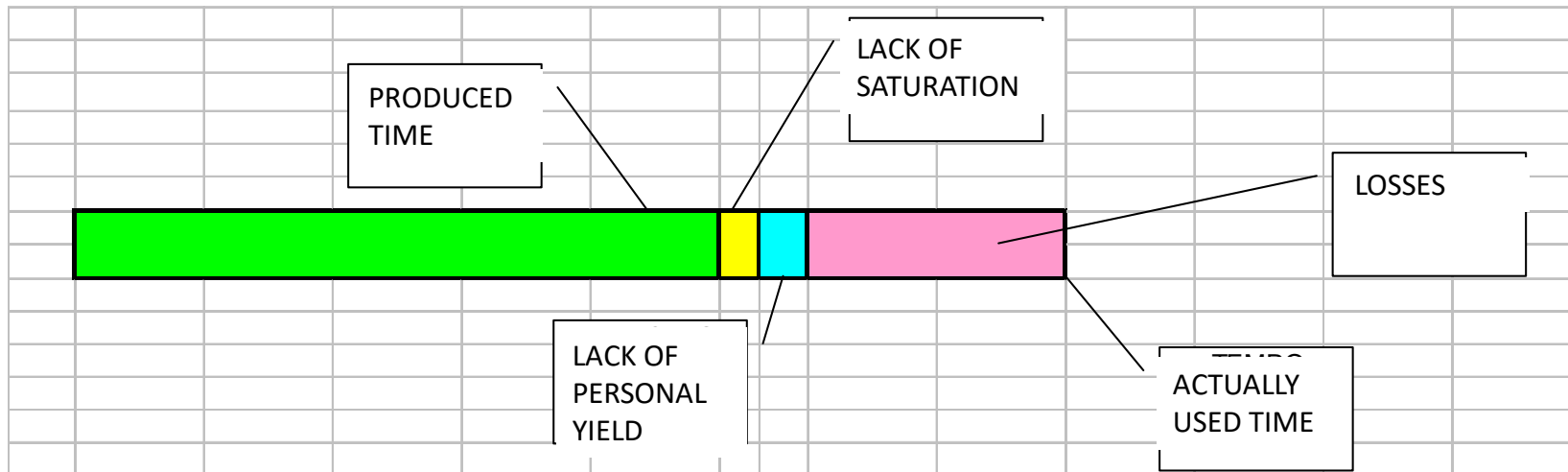
Direct
material
prices

Direct
material
utilization

	Gestione dei materiali (migliaia di p)	Budget Anno n		Consuntivo progressivo mese i-1		Budget progr. Mese i-esimo		Consuntivo progressivo mese i-esimo	
	Valore dei materiali	20252		18855		17210		21519	
Prezzi dei materiali diretti	Delta prezzi	-273	-1,3%	-112	-0,6%	-205	-1,2%	-166	-0,8%
	Oneri aggiuntivi			23	0,1%			48	0,2%
	Differenza Acquisto/Fatturazione			132	0,7%			-90	-0,4%
	Costi standard mancanti			29	0,2%			29	0,1%
	Prezzi d'acquisto mancanti			1	0,0%			1	0,0%
	TOTALE DELTA PREZZI	-273	-1,3%	72	0,4%	-205	-1,2	-179	-0,8%
Utilizzo dei materiali diretti	Cattivo Utilizzo			133	0,7%			154	0,7%
	Analisi del Valore/Cambio metodo	-145		-227	-1,2%	-109	-0,6%	-288	-1,3%
	Transcodifica			88	0,5%			56	0,3%
	Altre differenze di consumi			442	2,3%			614	2,9%
	Variazione di magazzini (causali)			59	0,3%			55	0,3%
	Vendita di materiali			-91	-0,5%			-85	-0,4%
	TOTALE DELTA UTILIZZO	-145	-0,7%	404	2,1%	-109	-0,6%	506	2,3%
	TOTALE GENERALE	-418		476		-314		327	

EFFICIENCY OF WORKFORCE UTILIZATION

EFFICIENCY AND PERSONAL YIELD CONCEPTS



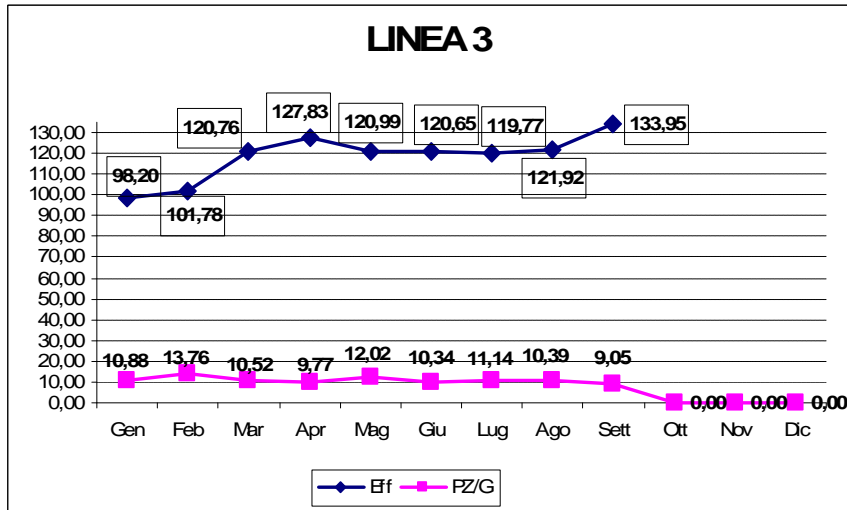
$$R = \frac{+}{+ +}$$

$$E = \frac{+}{+ + +}$$

PRODUCED TIME + MS

ACTUALLY USED TIME

DIRECT WORKERS EFFICIENCY



$$E_{d1} = \frac{\sum_1^n (+)_i}{\sum_1^m A_i + B_1} = \frac{\sum_1^n (P_i \times T_{base\ i})}{\sum_1^m (Nop_i \times O_{li})}$$

$$E_g = \frac{\sum_1^n (P_i \times T_i)}{\sum_1^m (Nop_i \times O_{pi})}$$

$$E_{d2} = \frac{(P_i \times T_{cor\ i})}{(Nop_i \times O_{li})}$$



DIRECT WORKFORCE LOSSES

- Repairs along the assembly line
- Repairs out of the assembly line
- Completion for lack of materials
- Transformation along and out of the line
- Possible operations for small problems
- Set up
- workers training
- change of model
- Variation to the preferred cycle
- Machine, equipment and plants problems
- Indirect not forecast activities
- Workplace cleaning
- Start-up of new activities
- Stop for lack of materials
- Stop for lack of energies
- Stop for failure of machines
- Inactivity for exceeding workers
- Stop for lack of workers
- Waiting for Quality assurance approval



DIRECT WORKFORCE LOSSES ANALYSIS

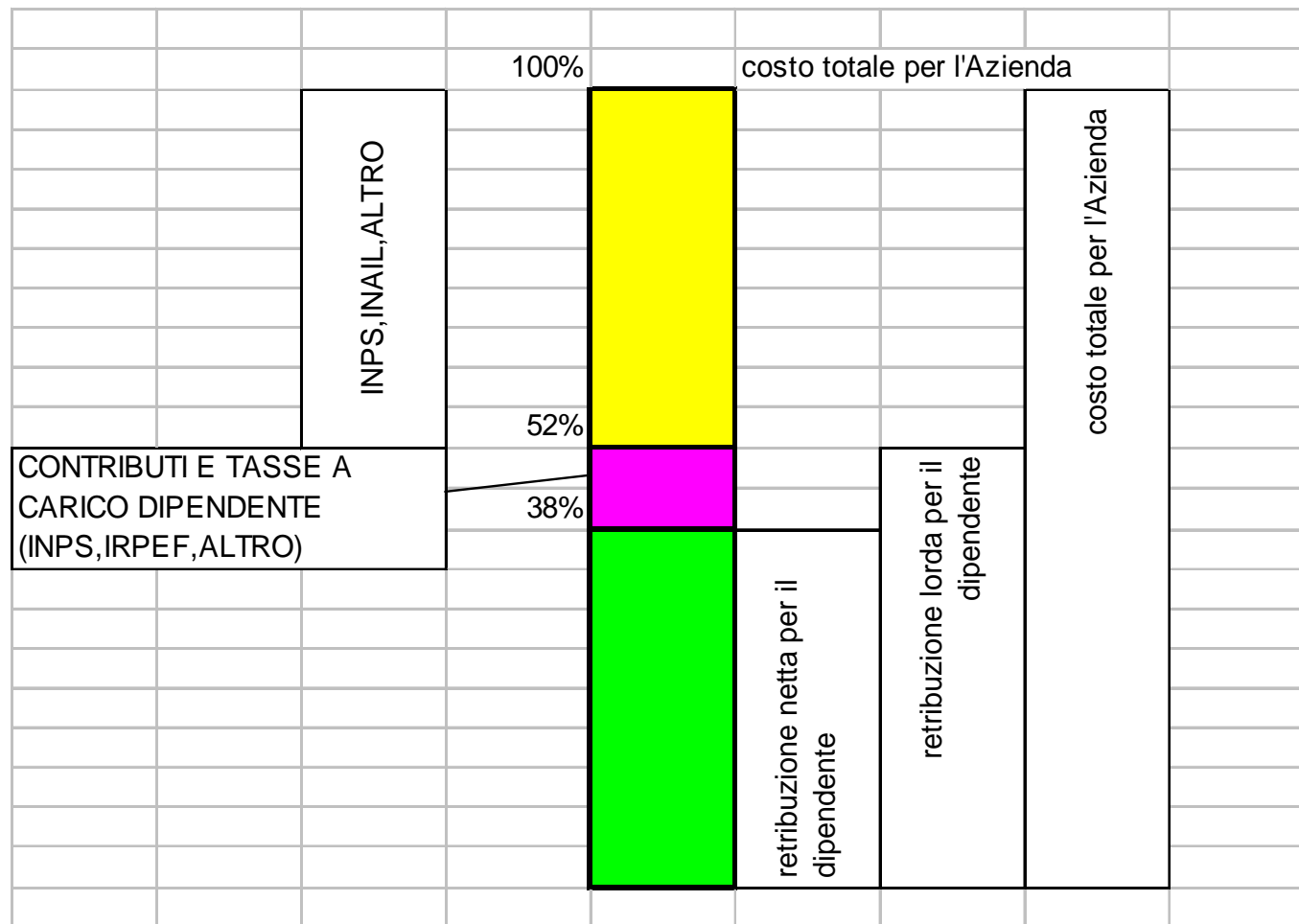
	PERDITE SETTEMBRE							
	LINEA 1	LINEA 2	LINEA 3	LINEA 4	LINEA 5	LINEA 6	CESTI+GOMME	PREPARAZIONE
Recupero in linea		80	8	24	160	70		
Recupero fuori linea		50		24	80	32		
Mancanza materiali (ACQ)	32	80	10	20	400	100		
Mancanza materiali interni		20			150	80		
Operaz. non a ciclo		190	12	24	50	80	20	50
Attrezzamento						5		450
Trasporto					80	10	32	194
Imp./ macch./ attrezz. difettoso		30		4	40			
Addestramento	64	40						40
Manutenzione reparto								
Avv. nuove produzioni								
Errori di progettazione								



DIRECT WORKERS HOURS

DAYS PER YEAR	GG ANNO		365				
		SABATI	-52				
		DOMENICHE	-52				
		ALTRE FESTIVITA'	-5				
AVAILABLE DAYS	GG DISPONIBILI		256	GG/H RETRIBUIBILI (T)			(T)
		FERIE	-20				1
		PERMESSI	-13				(2+3)
WORKING DAYS	GG LAVORABILI		223	GG A CONTRATTO			
		ORE GIORNO	8				
WORKING HOURS	ORE LAVORABILI		1784	ORE A CONTRATTO			(A)
		ASSENTEISMO A CARTELLINO	5%	MALATTIA			(B)
PRESENCE (PAID) HOURS	ORE PRESENZA (PAGATE)		1695	PRESENZA EFFETTIVE			(C)
		ASSENTEISMO CONTRATTUAL	1%	ASSEMBLEE			(B1)
		SOSTE CONTRATTUALI	1%	PAUSE TURNO			(D)
HOURS REALLY AVAILABLE FOR PRODUCTION	ORE LAVORABILI (LAVORATE)		1659	DISPONIBILI PER LA PRODUZIONE			(E)
		COSTO ORA PAGATA= COSTO TOTALE AZIENDA/ORE PAGATE					
		COSTO ORA LAVORATA= COSTO TOTALE AZIENDA/ORE LAVORATE					

WORK COST ANALYSIS



INDIRECT WORKFORCE CONTROL

ANALISI MANODOPERA INDIRETTA anno n				gennaio		febbraio		marzo		aprile		
		Ore a ciclo dirette	201.354	14.287		30.291		48.057		61.300		
		BDG	% prestiti su ore dirette	Ore prestiti	% prestiti su ore dirette	Ore prestiti	% prestiti su ore dirette	Ore prestiti	% prestiti su ore dirette	Ore prestiti	% prestiti su ore dirette	
da	a	Descrizione	anno n									
c.d.c.	c.d.c.	c.d.c.										
18673	18219	PERS/ COSTI COMUNI	1.500	0,7%	56	0,4%	127	0,4%	143	0,3%	143	0,2%
18673	18224	PERS/ VIGILANZA		0,0%		0,0%	198,5	0,7%	198,5	0,4%	198,5	0,3%
18673	18621	GESTIONE MATERIALI	3.800	1,9%	896	6,3%	1174	3,9%	1519	3,2%	2116	3,5%
18673	18630	INGEGNERIA DI PROCESSO	200	0,1%	47	0,3%	90	0,3%	134	0,3%	181	0,3%
18673	18631	OFF. MANUTENZIONE	800	0,4%	182	1,3%	217	0,7%	288	0,6%	288	0,5%
18673	18641	OFFICINA MODELLI	100	0,0%	24	0,2%	24	0,1%	66	0,1%	98	0,2%
18673	18643	ASS. QUALITA'	800	0,4%	31,5	0,2%	42,8	0,1%	62,8	0,1%	81,3	0,1%
18673	18683	INDIRETTI DI MONTAGGIO	1.800	0,9%	0	0,0%		0,0%		0,0%		0,0%
18673	18670	FABBRICAZ. UFFICIO	0				332,8	1,1%	725	1,5%	1094	1,8%
		Totale prestiti	9.000	4,5%	1.236	8,6%	2.205	7,3%	3.136	6,5%	4.199	6,8%
		TOTALE GEN.LE PRESTITI	9.000	4,5%	1.236	8,6%	2.205	7,3%	3.136	6,5%	4.199	6,8%
		ORE INDIRETTI	52.036	25,8%	3.243	22,7%	6.667	22,0%	10.706	22,3%	13.990	22,8%
		TOTALE IND. + PRESTITI	61.036	30,3%	4.479	31,4%	8.872	29,3%	13.842	28,8%	18.189	29,7%

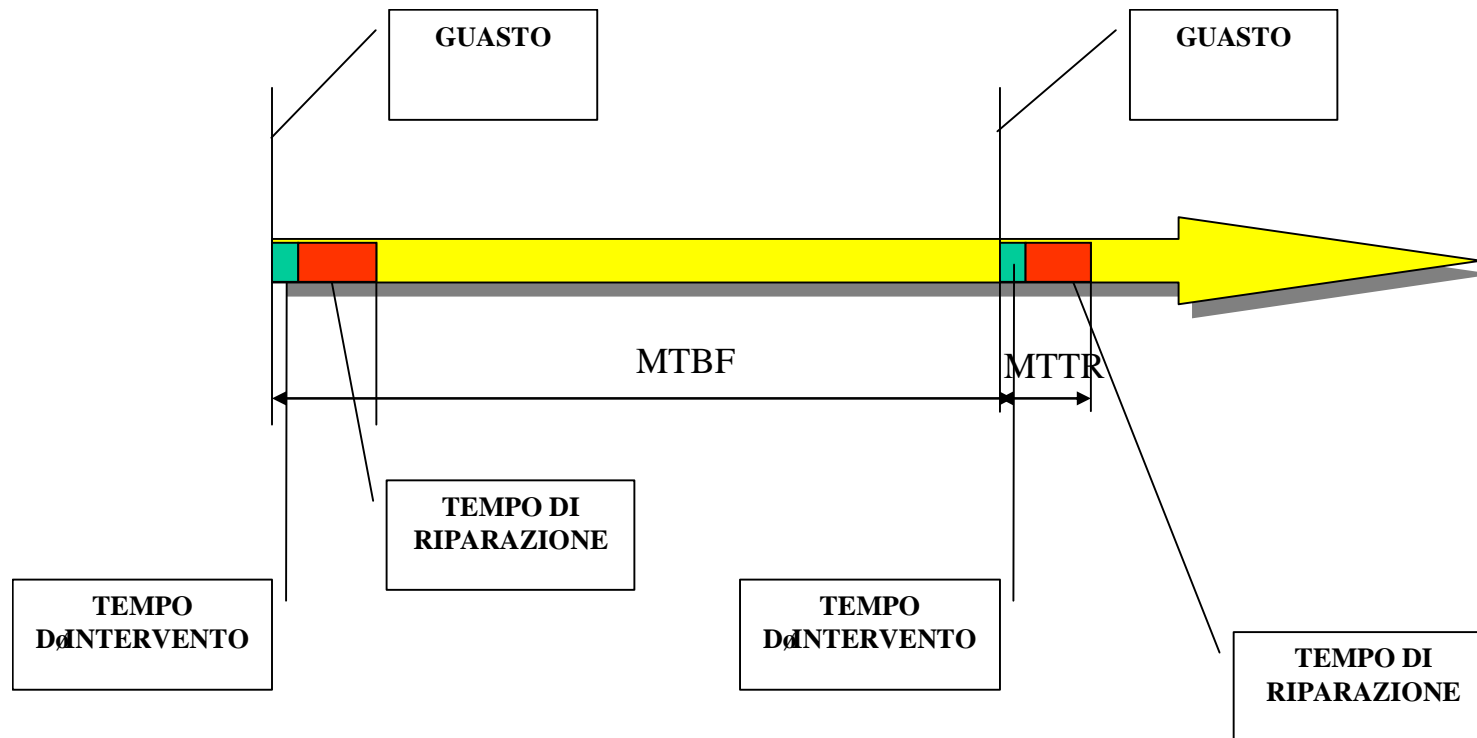
EFFICIENCY OF THE MACHINES UTILIZATION

OEE È OVERALL EQUIPMENT EFFECTIVENESS



$$OEE = DC \times E/D \times F/E = F/C$$

MAINTENANCE INDEXES



MAINTENANCE INDEXES

MAINTENANCE WORKFORCE

MAINTENANCE STRUCTURE

MAINTENANCE OVERALL COSTS

MAINTENANCE MATERIAL COSTS

SPARE PARTS TURNOVER

SPARE PARTS TOTAL VALUE

MAINTENANCE CONTRACT VALUE

MTBF

MTTR

AVAILABILITY

Å -

PRODUCT DEVELOPMENT EFFICIENCY

- Percentage of turnover from new products.
- Percentage of turnover dedicated to product development.
- Respect for product costs.

•Development cost delta% =
$$\frac{\text{Cost at the end of development}}{\text{Target specification cost}} * 100$$

- Standardization index.

$$IS = \frac{\text{Number of common codes}}{\text{Total number of codes}} * 100$$

•IS =
$$\frac{\text{total number of common uses}}{\text{number of total jobs}} * 100$$

- Product renewal rate.

$$Rp = \frac{\text{Number of new codes /year}}{\text{Total number of codes managed}} * 100$$

$$Mp = \frac{\text{number of modifications/ year}}{\text{Total number of codes managed}} * 100$$

PRODUCT DEVELOPMENT EFFICIENCY

PRODUCTIVE VOLUMES

PRODUCTIVE VOLUMES

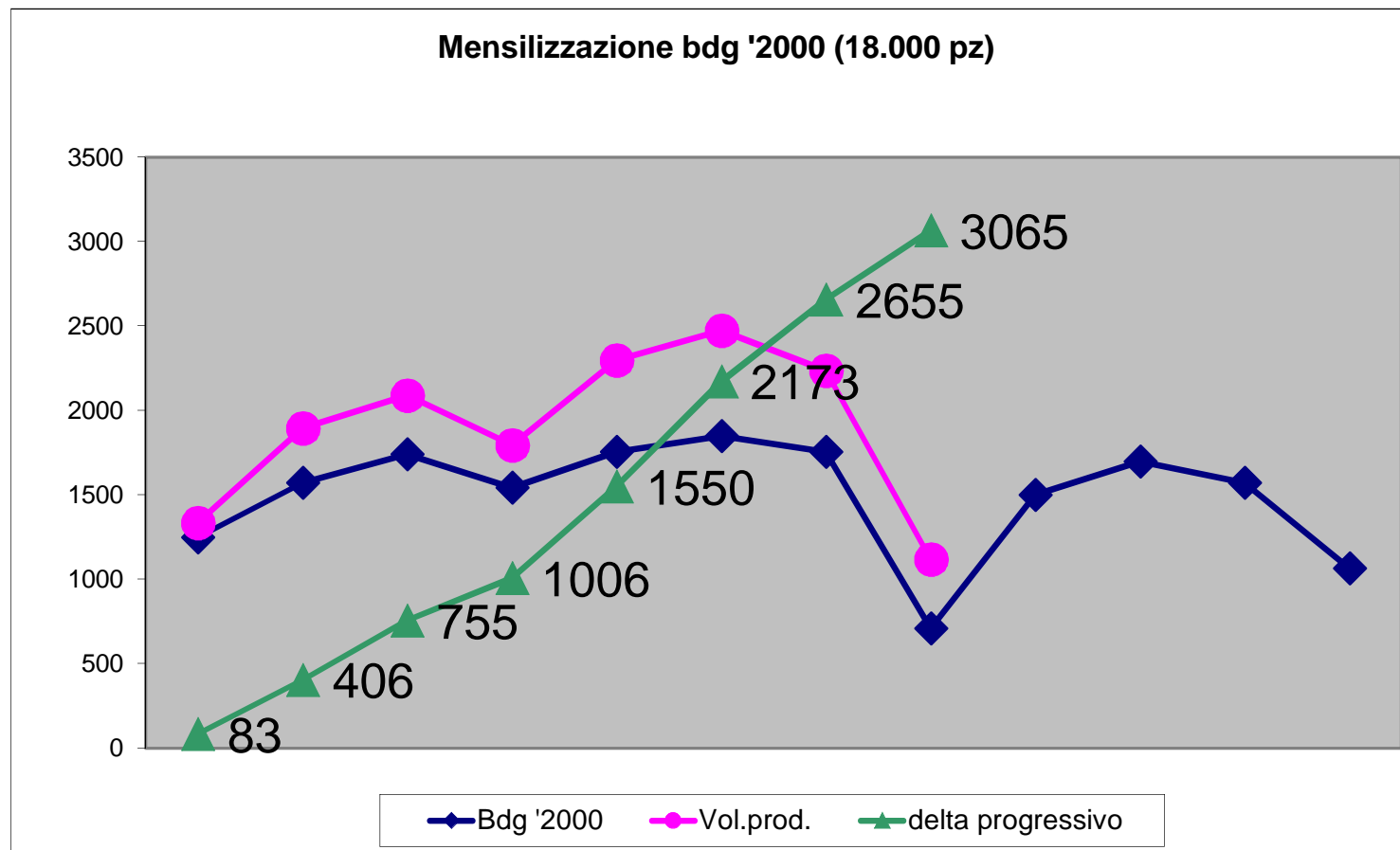
TOTAL ACCUMULATED (ALL PRODUCTS)

		J	F	M	A	M	J	J	A	S	O	N	D
A	ACT 99	1002	2387	4273	5863	7917	9679	11748	12664	14140	15768	17282	18754
B	BDG 00	998	2421	4279	5859	7968	9828	12008	12923	14480	16249	17770	18897
C	ACT 00	1280	3076	5161	6970	9167	11635	0	0	0	0	0	0
	C/A %	27,7	28,9	20,8	18,9	15,8	20,2						
	C/B %	28,3	27,1	20,6	19,0	15,0	18,4						

TOTAL PER MONTH (ALL PRODUCTS)

		J	F	M	A	M	J	J	A	S	O	N	D
A	ACT 99	1002	1385	1886	1590	2054	1762	2069	916	1476	1628	1514	1472
B	BDG 00	998	1423	1858	1580	2109	1860	2180	915	1557	1769	1521	1127
C	ACT 00	1280	1796	2085	1809	2197	2468	0	0	0	0	0	0
	C/A %	27,7	29,7	10,6	13,8	7,0	40,1						
	C/B %	28,3	26,2	12,2	14,5	4,2	32,7						

PRODUCTIVE VOLUMES



EMPLOYEES



EMPLOYEES

WORKERS ABSENTEISM						
	01/00	02/00	03/00	04/00	05/00	06/00
DIRECT	8,1%	7,6%	7,0%	7,3%	6,2%	9,3%
INDIRECT	1,0%	4,8%	2,6%	3,8%	4,0%	2,6%
AVERAGE	7,2%	7,2%	6,3%	6,8%	5,9%	8,4%
PROGRESSIVE WORKERS ABSENTEISM						
	01/00	02/00	03/00	04/00	05/00	06/00
DIRECT	8,1%	7,8%	7,5%	7,5%	7,2%	7,6%
INDIRECT	1,0%	3,1%	6,1%	6,1%	3,3%	3,2%
AVERAGE	7,2%	7,2%	6,9%	6,9%	6,6%	7,0%



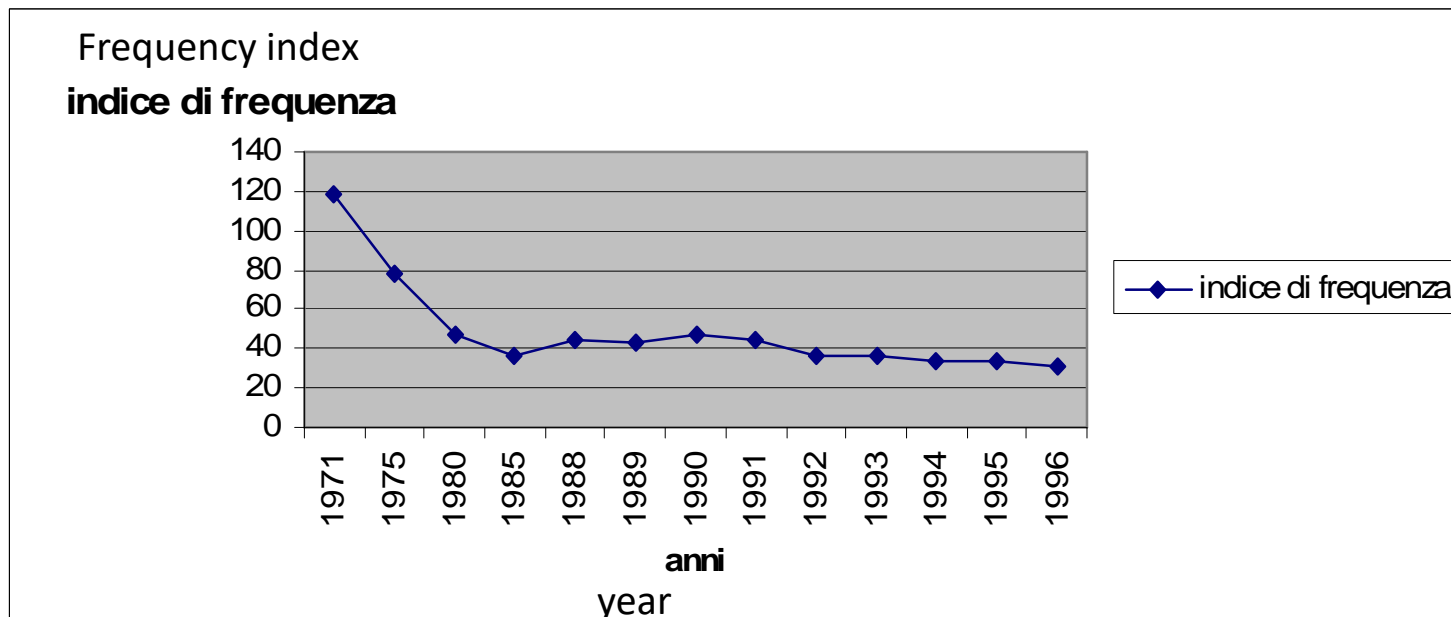
EMPLOYEES

SITUAZIONE ORGANICI		GIUGNO											
C.d.C.	UNITA'	ORGANICO AL 30.06.2000						BDG					
		DIR	IMP	EQ	OP		TOT	DIR	IMP	EQ	OP		TOT
					D.	I.					D.	I.	
10601	DIVISION DIRECTOR	1	1				2	1	1				2
10602	PR. PLANNING		1				1	1	1				2
10603	IN. SALES						0						0
10605	R&D	1					1	1					1
16111	COG		1				1		1				1
16213	PERSONALE		1				1		1				1
16620	DISTA	1					1	1					1
16621	GESTIONE MATERIALI		8			6	14		8			6	14
16622	ASS. QUALITA'		2			5	7		2			4	6
16630	ING. PROCESSO		5				5		4				4
16631	MANUTENZIONE					3	3					3	3
16640	PROGETTAZIONE		11				11		12				12
16641	LABORATORIO		1			5	6		1			5	6
16670	FABBRICAZIONE		4				4		3				3
16671	PREPARAZIONE				15		15				16		16
16674	MONTAGGIO				105		105				76		76
		3	35	0	120	19	177	4	34	0	92	18	148

SAFETY

number of Injuries

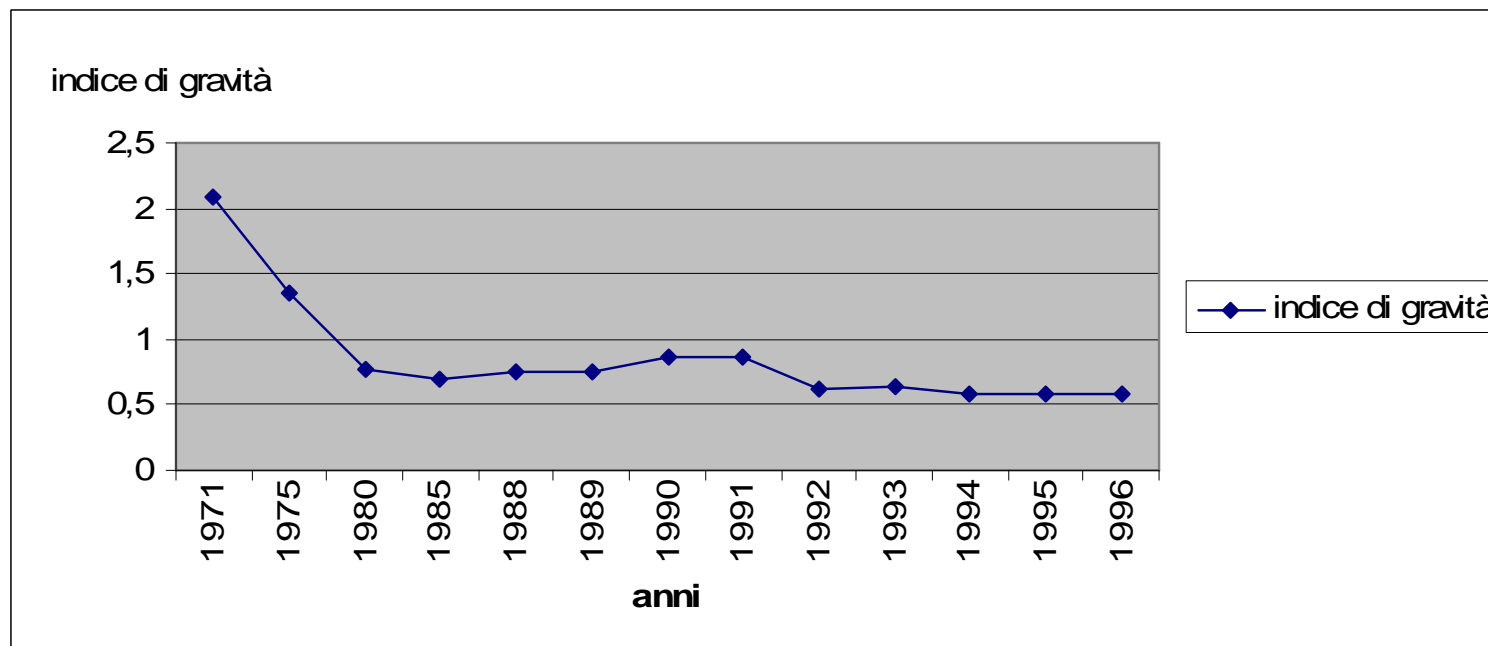
$$\text{I.F.} = \frac{\text{-----}}{\text{Worked hours}} \times 1.000.000$$



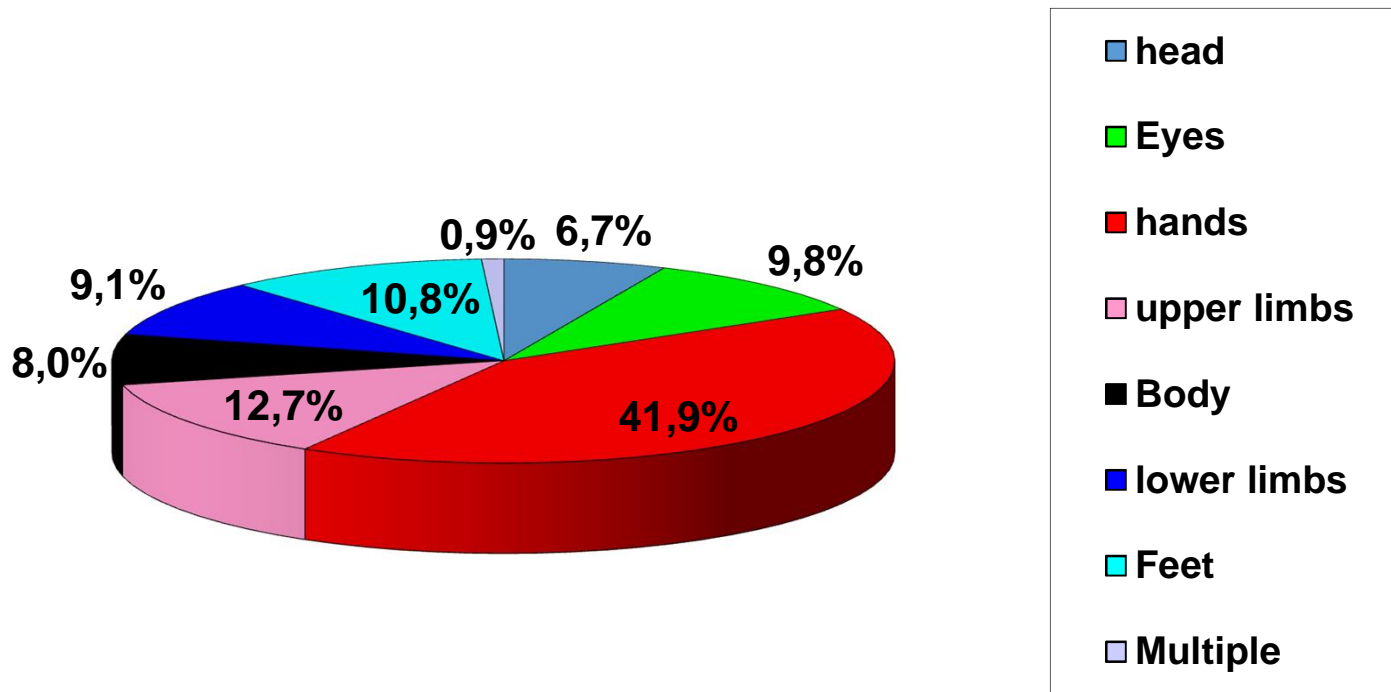
SAFETY

days lost due to injuries

$$\text{I.G.} = \frac{\text{-----}}{\text{worked hours}} \times 1.000$$



SAFETY INJURIES PLACE



Paid Injuries- Totale in the Group: 848 cases

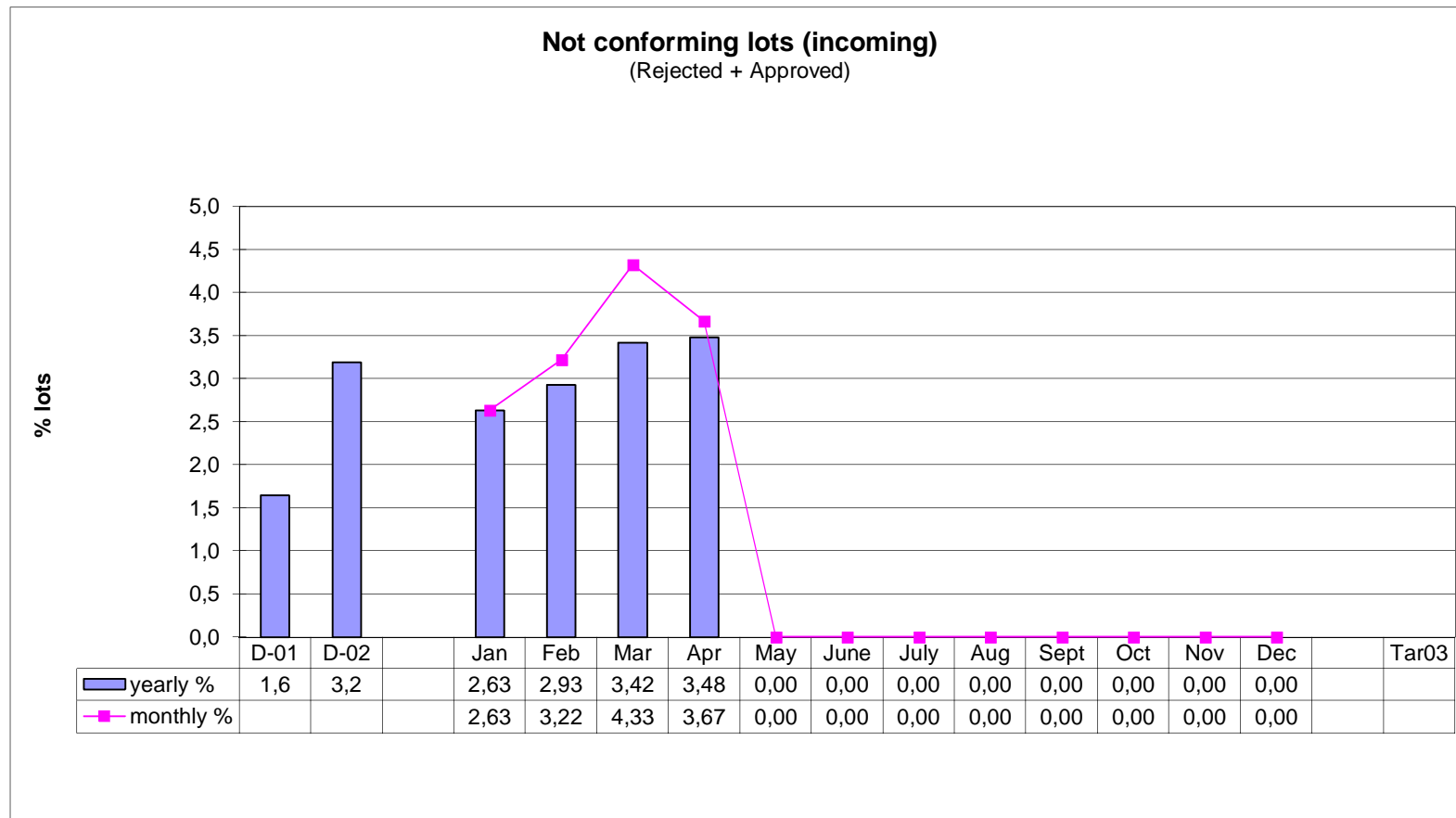
QUALITY



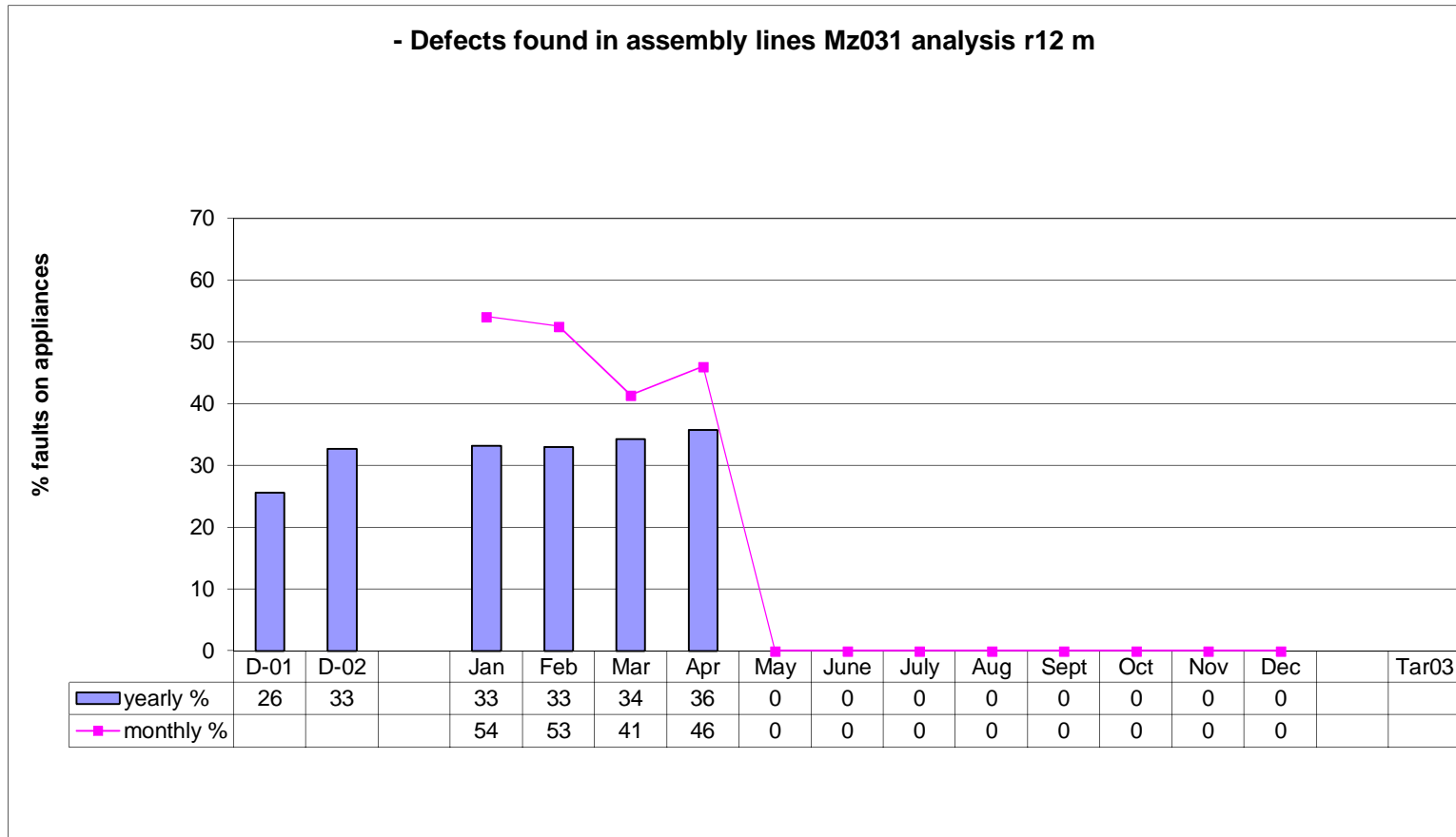
QUALITY

File in ITL									
QUALITA' : ANDAMENTO COSTI :									
QUALITA' GLOBALE									
DESCRIZIONE	POS.	CONS 95	CONS 96	CONS 97	CONS 98	CONS 99	CONS 00	CONS 01	CONS 02
- CERTIFICAZ.NE FORNITORI	11	257080	254778	250168	149199	81276	106653	98758	133313
- CONTROLLO FORNITURE	13	102832	101911	100067	149199	162553	213306	197515	266627
- CONTROLLO PROCESSO	17	102832	101911	100067	83551	81276	106653	98758	133313
- CONTROLLO STATISTICO	20	179956	178345	175117	214846	243261	319213	295582	399008
- SCARTI DI PROCESSO	15	49497	47449	48836	65467	97282	75174	85283	142039
- SMOBILIZZI MODIF.-PROG	16								
- PAREGGI DI SERIE									
- OBSOLESCENZA		305000	186000	136000	193000	250000	61670	85856	319485
- CAUSA FORNITORI		-	-						
- CONTROLLI DISTR.		-	-						
RILAVORAZIONI									
- " x RECUP.COMP.INT. C. 83...	18	2866	6859	6357	0	4742	17189	18542	4903
- " x RECUP.COMP.EST. C. 82...	18/a	4387	711	0	8397	0	3606	3419	9646
- RIPRIST.PROC ST 6 (1-2-5-7)	21	306798	100939	175320	305077	254793	130477	182244	469367
TOT.RILAVORAZIONI (18+18/A+21)		314051	108509	181677	313474	259535	151272	204204	483916
SCARTI/STK3		0,071	0,072	0,075	0,085	0,125	0,090	0,098	0,153
RIL/STK3		0,448	0,165	0,278	0,407	0,335	0,181	0,235	0,521
- TOTALE COSTI NON QUALITA'		1311248	978903	991932	1168736	1175183	1033940	1065956	1877701
STK 3 STD		70069815	#####	#####	#####	77531959	#####	86954013	92801549
TOT. COSTI QTA'/ STK3		1,87	1,49	1,52	1,52	1,52	1,23	1,23	2,02

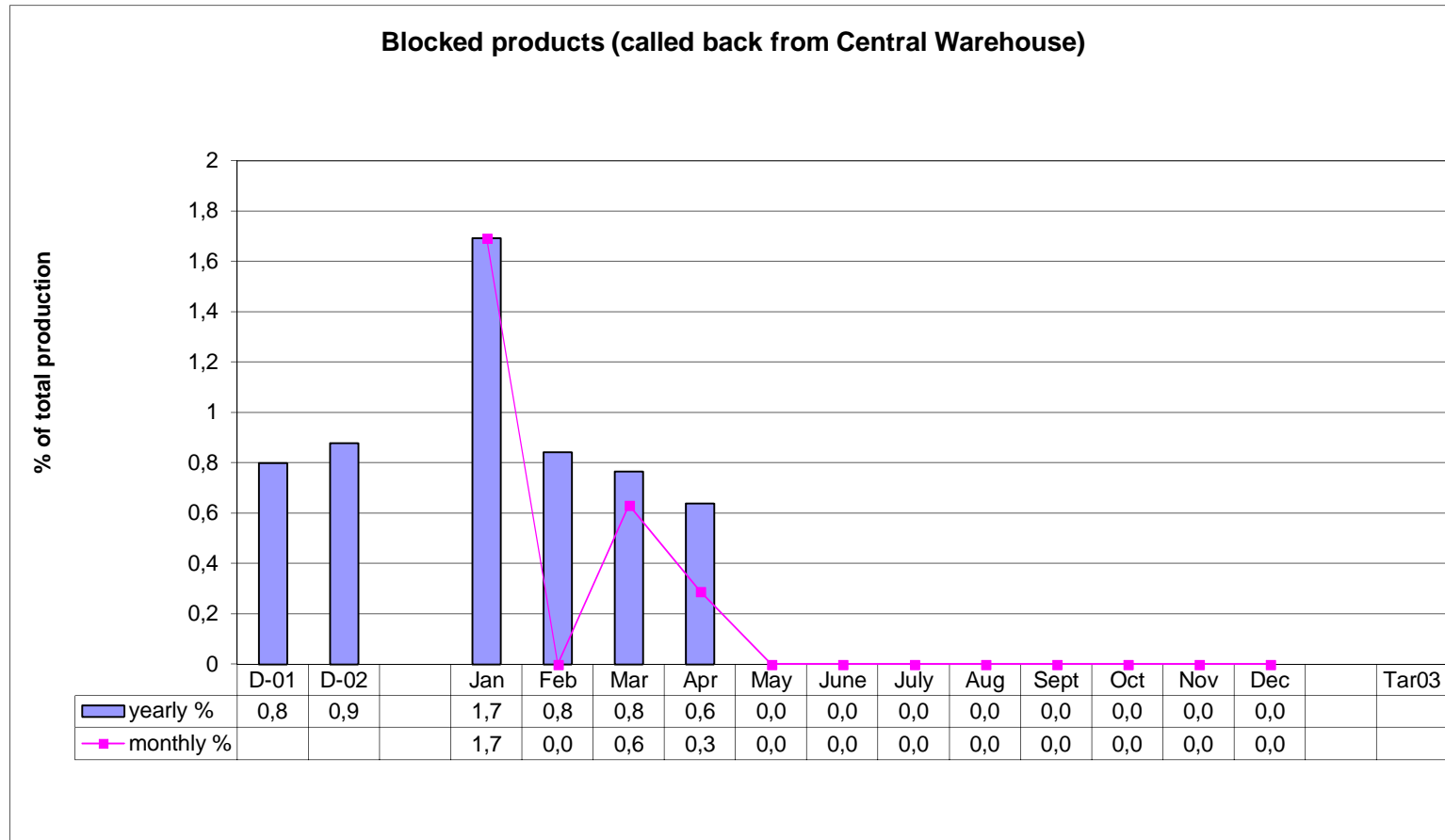
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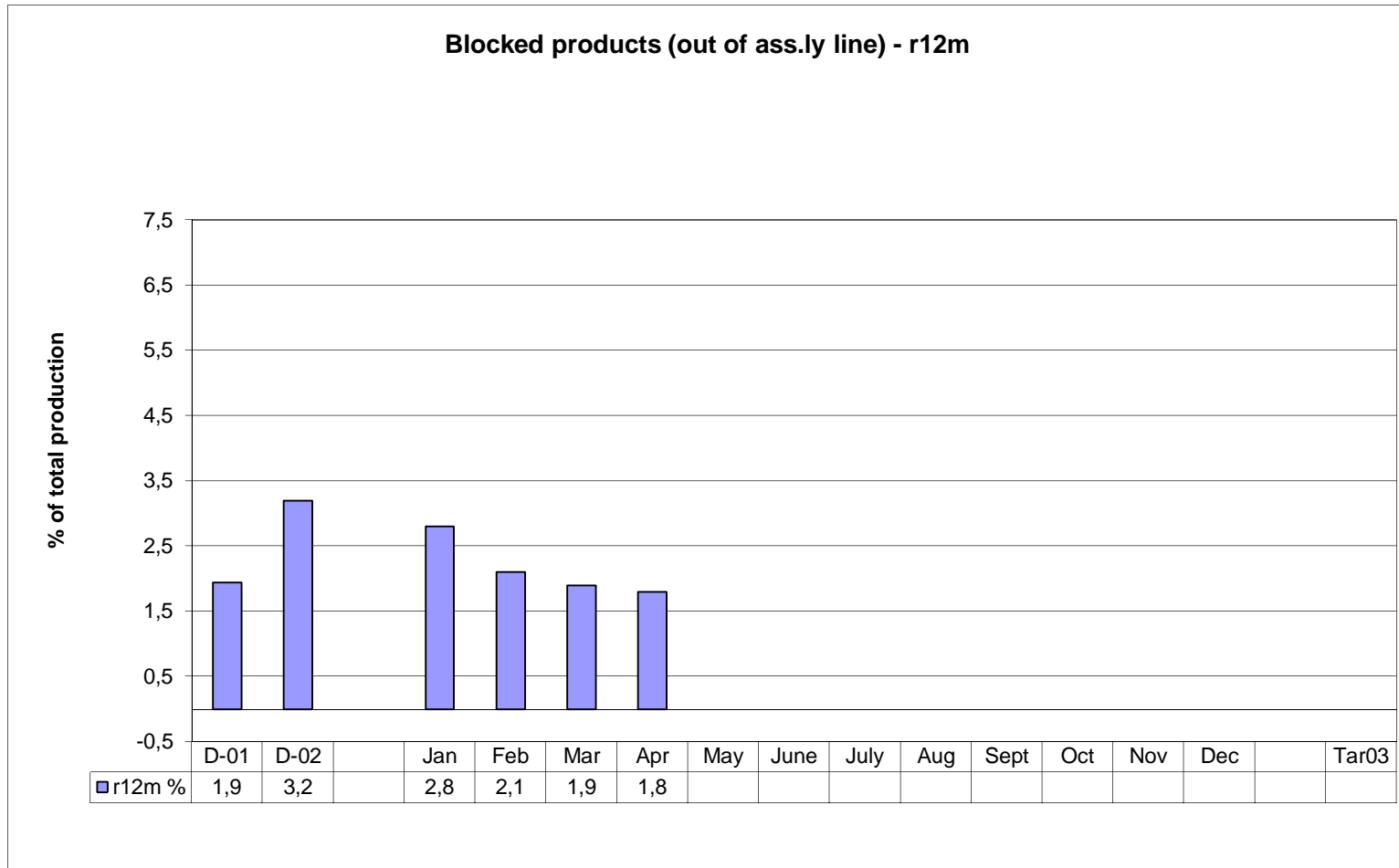
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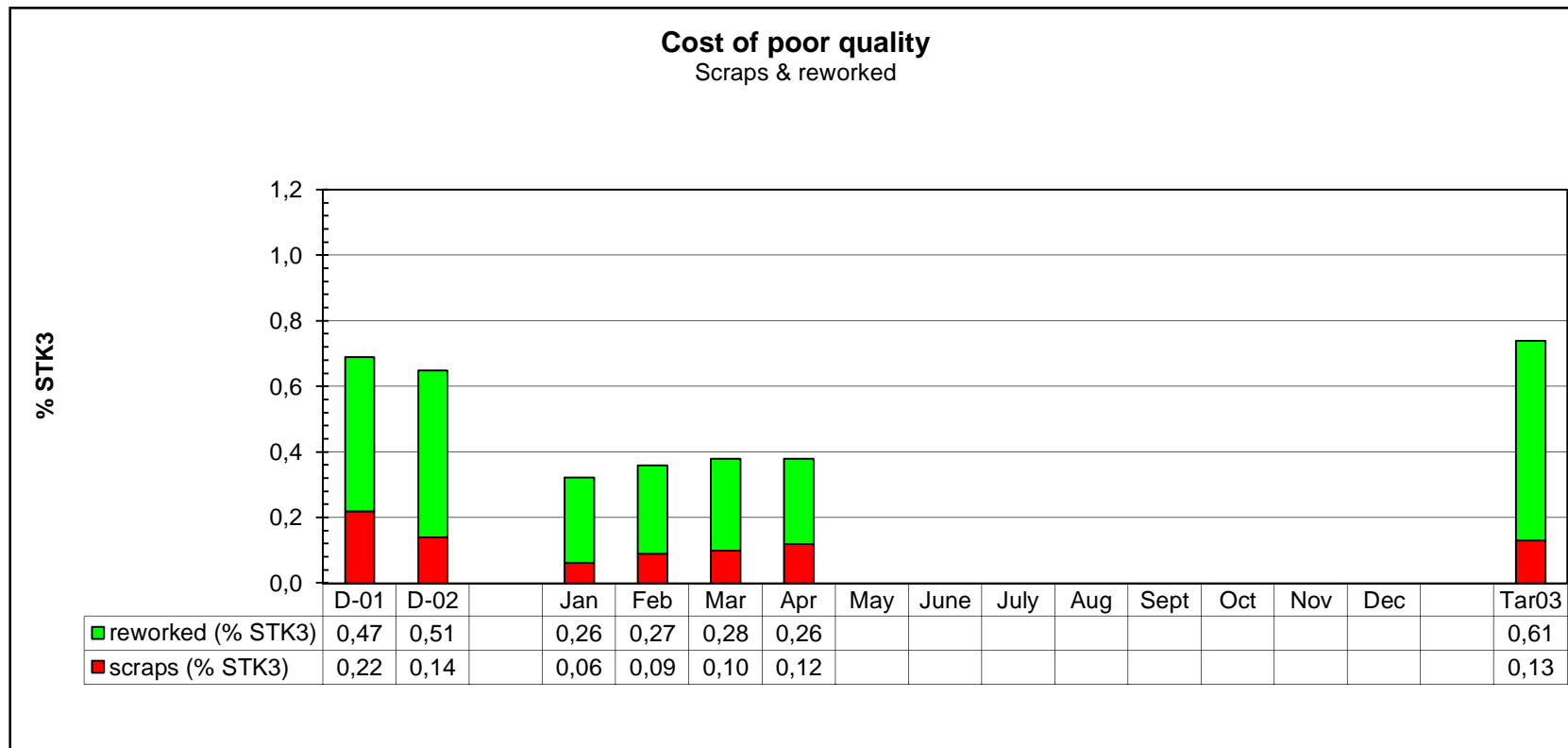
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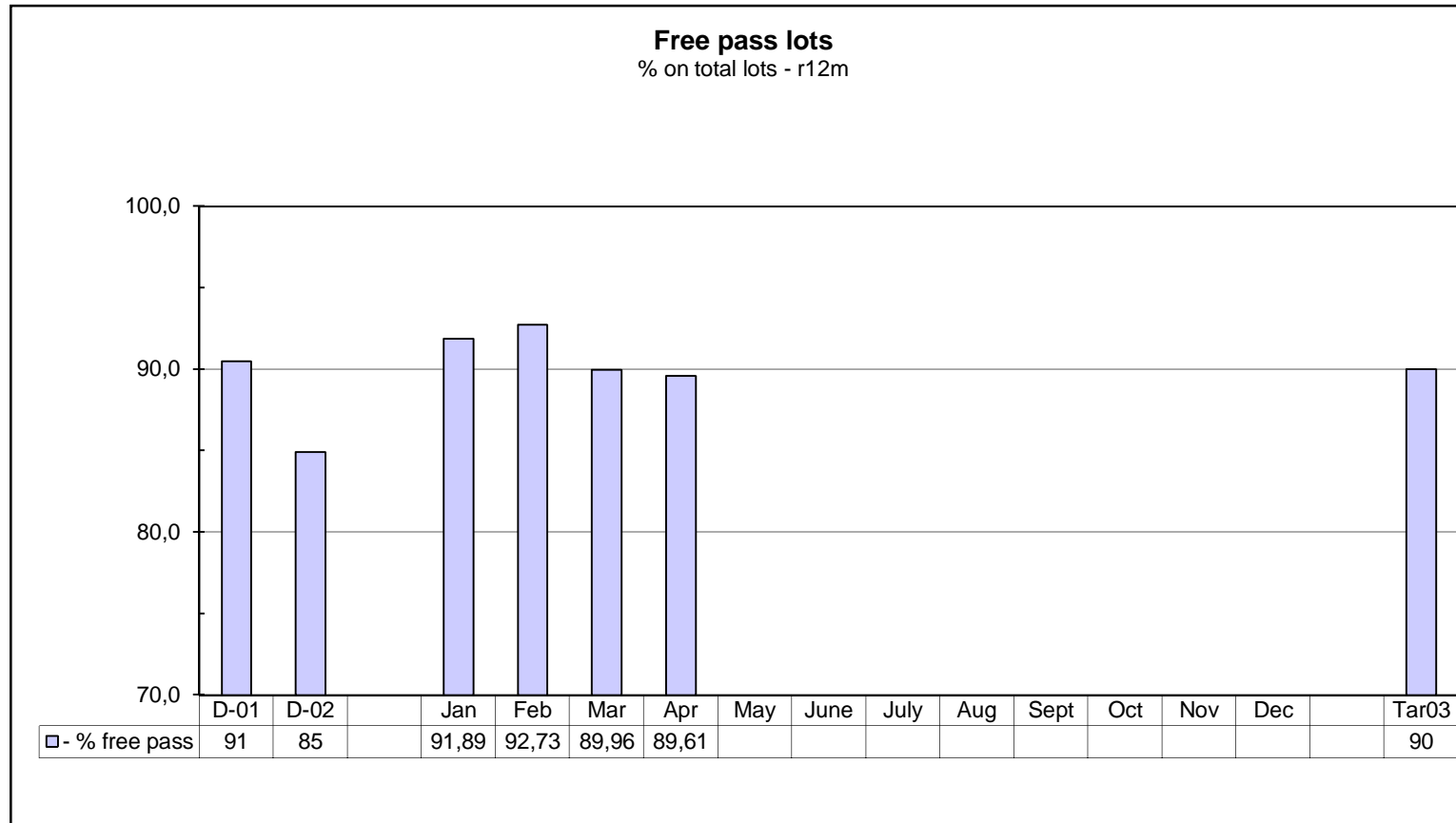
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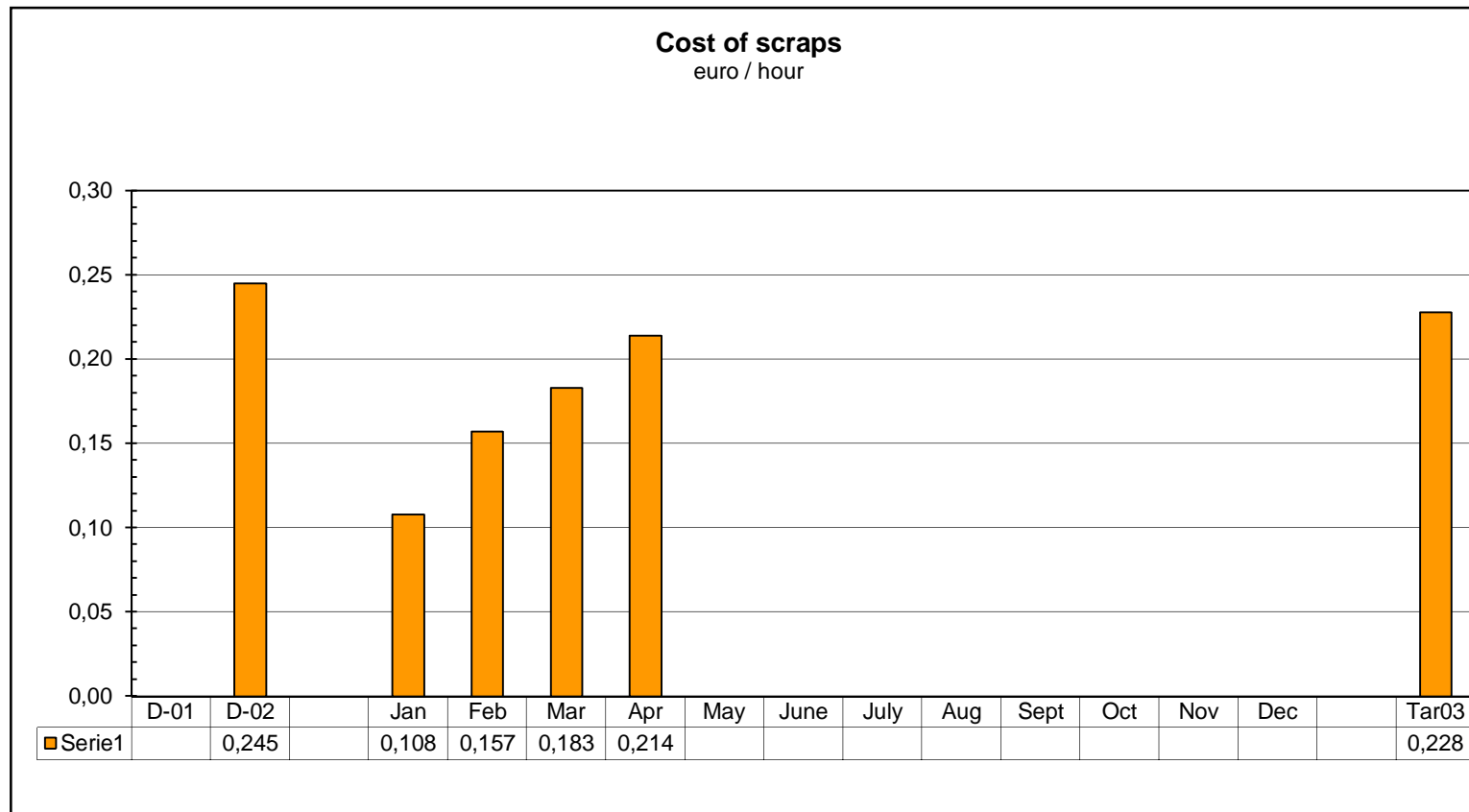
QUALITY



QUALITY

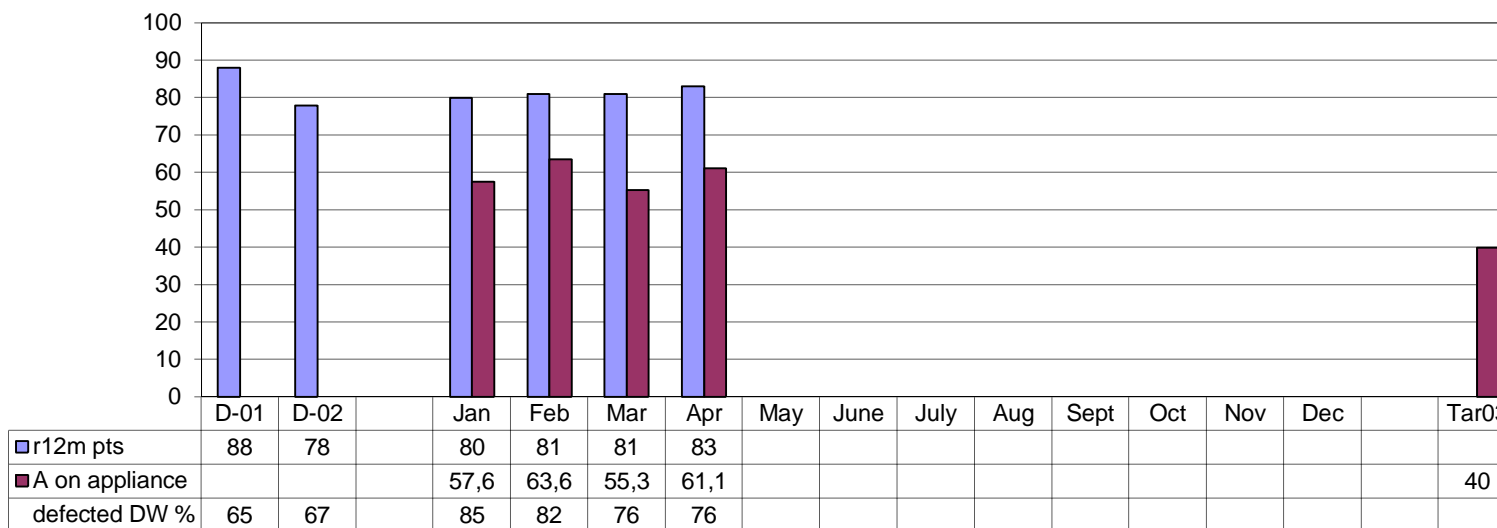


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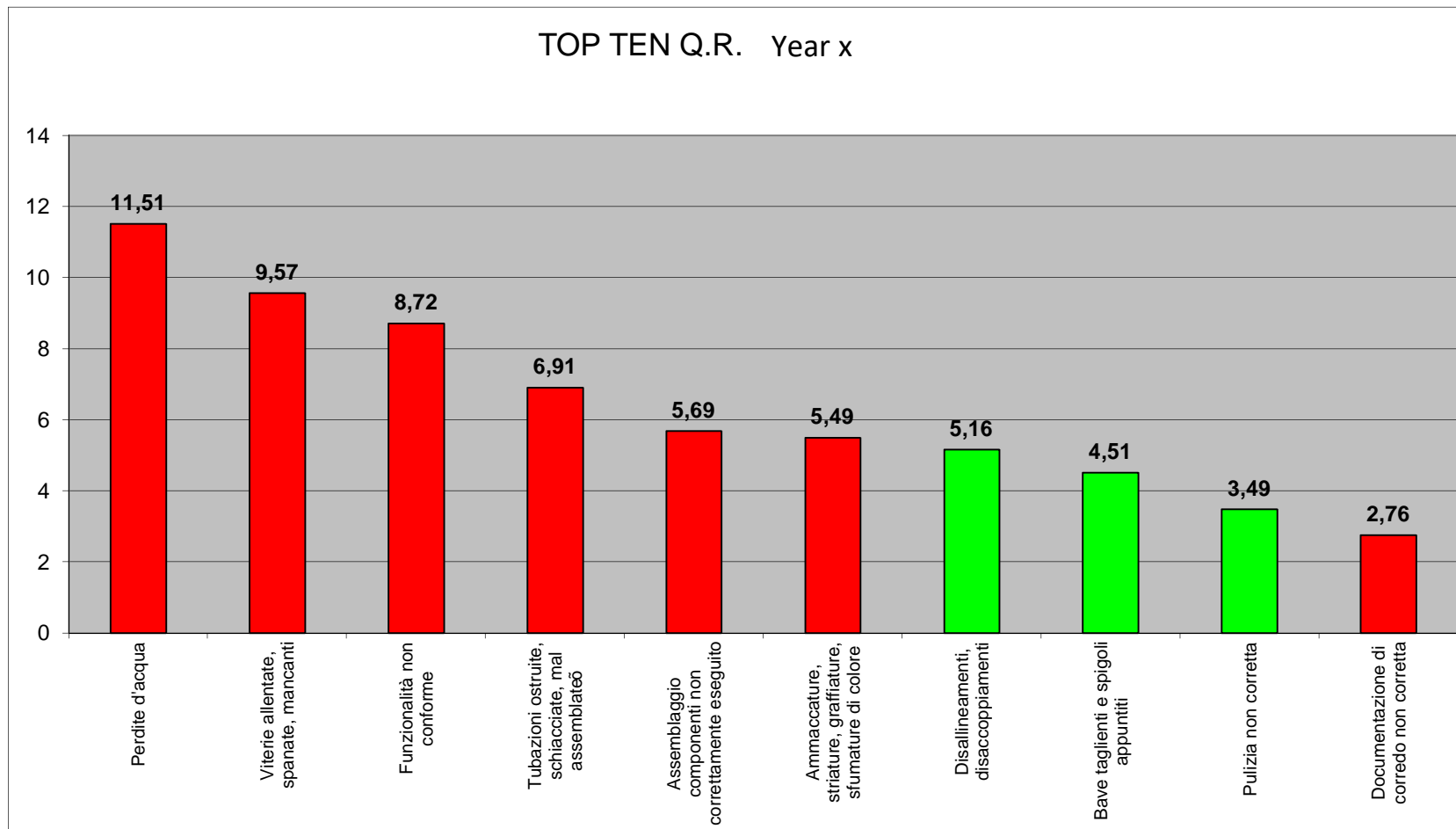


QUALITÀ

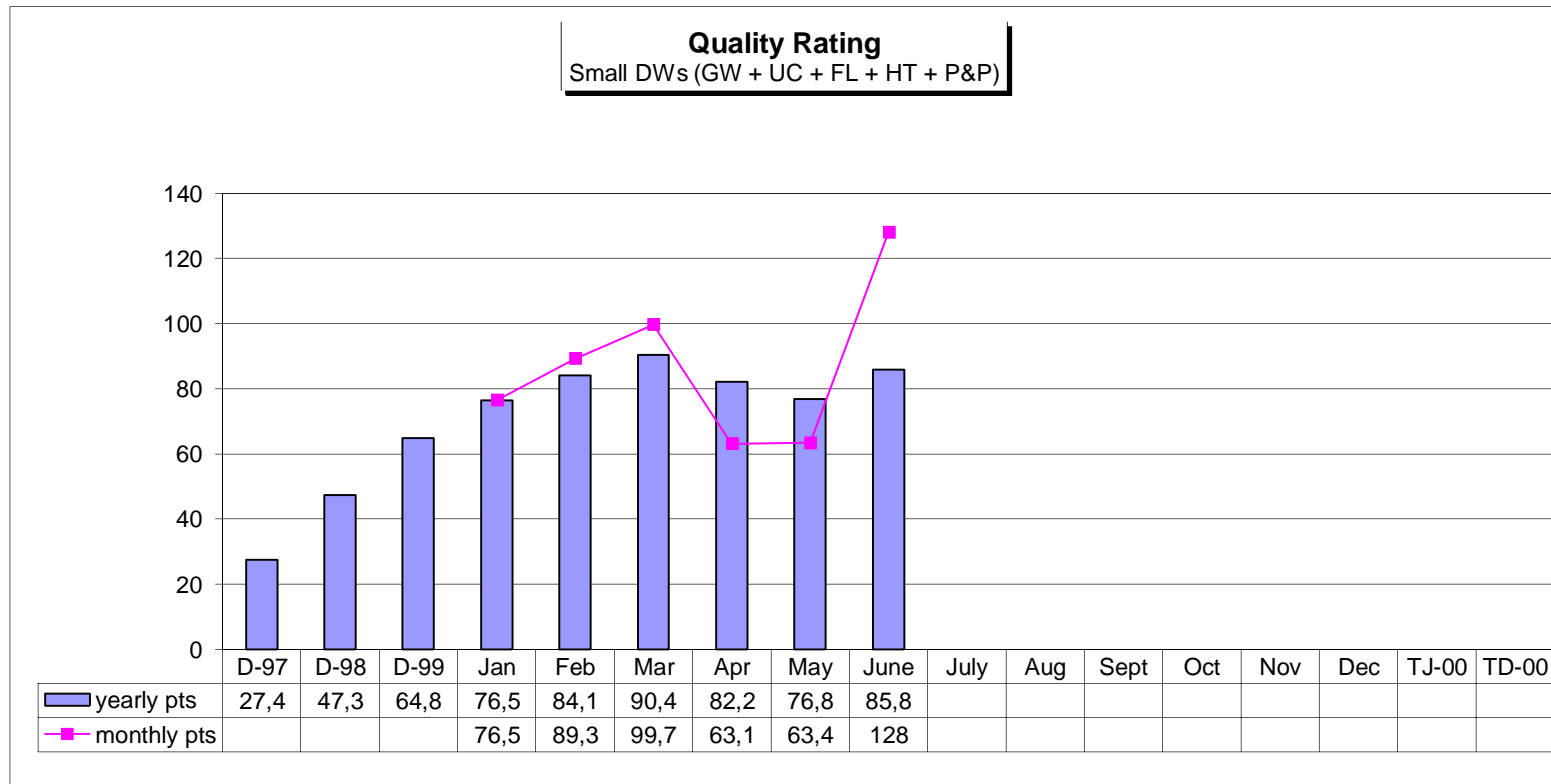
Quality Rating Rolling 12m



QUALITY



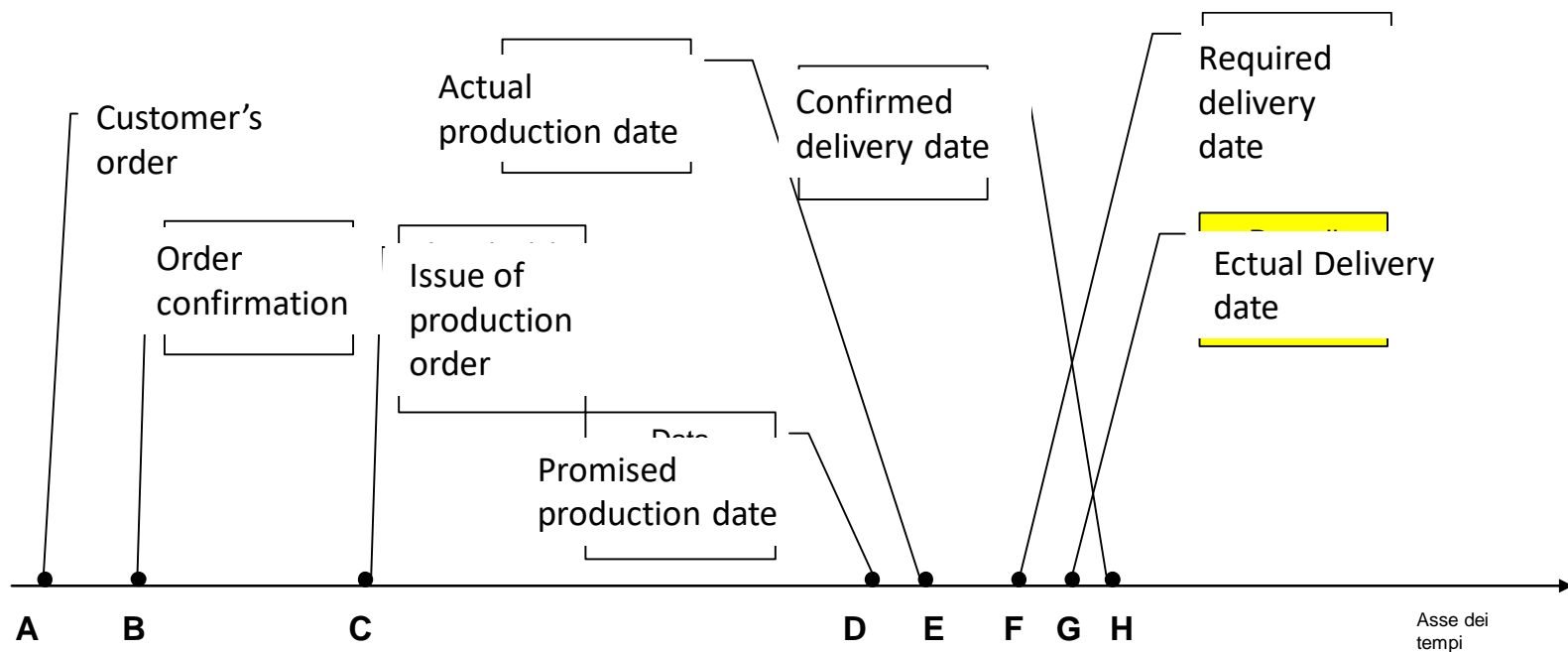
QUALITY



LOGISTICS



LOGISTICS



B - A = response time of the Commercial Office

F - A = customer expectation

D - C = performance promised by the production side

E - C = actual performance of the production part

E - D = delivery reliability of the production part

G - A = actual performance of the company logistics system (speed)

H - F = delivery reliability of the company logistics system

F - E = service of the Product Distribution Office

LOGISTICS

SID Teseo - Indicatori Logistici - Delivery Reliability (Quantity) - Us:Teseo - [T.Y.: (Delivery Reliability <1>)]

File DataMart Sheet Functions Mode Utilities Windows Help

Period: 2002 MMFG Units: Parziale Brand: ALL Product: ALL Sales Unit: ALL

Kind of service	dd.	<= 0	> 0	<-10	-10:-6	-5: 0	1:2	3:5	6:10	11:15	16:20	21:30	> 30
Quantity	total quantity												
DDS Declared Delivery	164.924	83.870	81.054	335	62	83.473	16.538	21.950	17.911	10.439	5.822	6.065	2.329
AMS Achieved Manufacturing	164.924	159.637	5.287	17.580	22.503	119.554	1.563	999	908	484	161	780	392
ADS Achieved Delivery	164.924	44.792	120.132	1.988	1.206	41.598	80.820	16.976	11.528	4.445	2.190	2.076	2.097
% of quantity													
DDS Declared Delivery	2,6	50,9	49,1	0,2	0,0	50,6	10,0	13,3	10,9	6,3	3,5	3,7	1,4
AMS Achieved Manufacturing	-3,0	96,8	3,2	10,7	13,6	72,5	0,9	0,6	0,6	0,3	0,1	0,5	0,2
ADS Achieved Delivery	1,6	27,2	72,8	1,2	0,7	25,2	49,0	10,3	7,0	2,7	1,3	1,3	1,3

LOGISTICS

$$\text{Completion \%} = \frac{\text{Number of incomplete deliveries}}{\text{Total Number of deliveries}} * 100$$

$$\text{Missing items\%} = \frac{\text{Number of missing items}}{\text{Number of shipped items}} * 100$$

LOGISTICS

$$\text{Reliability: Delta volumes\%} = \frac{\text{Number of pieces confirmed}}{\text{Number of pieces delivered}} \cdot 100$$

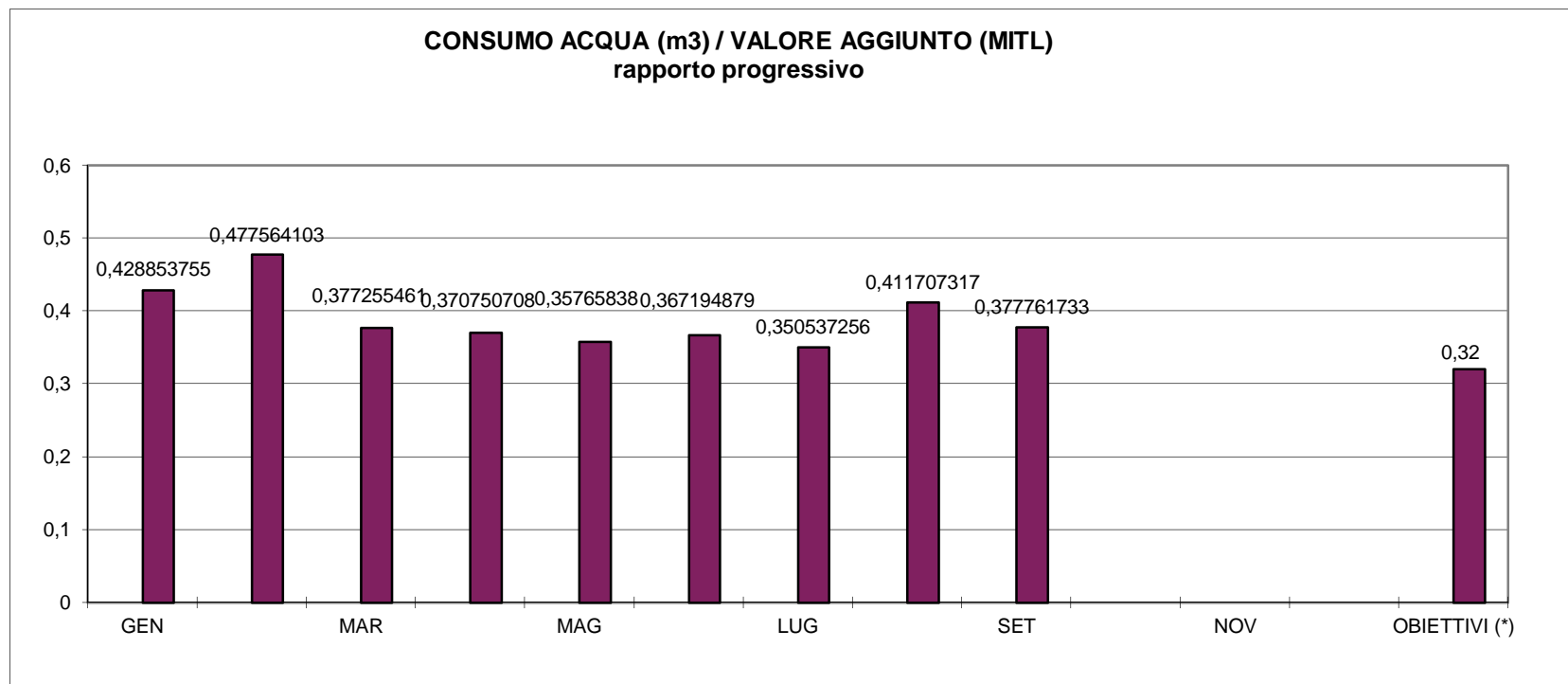
$$\text{Availability: Delta volumes\%} = \frac{\text{Number of pieces delivered}}{\text{Number of pieces required}} \cdot 100$$

LOGISTICS

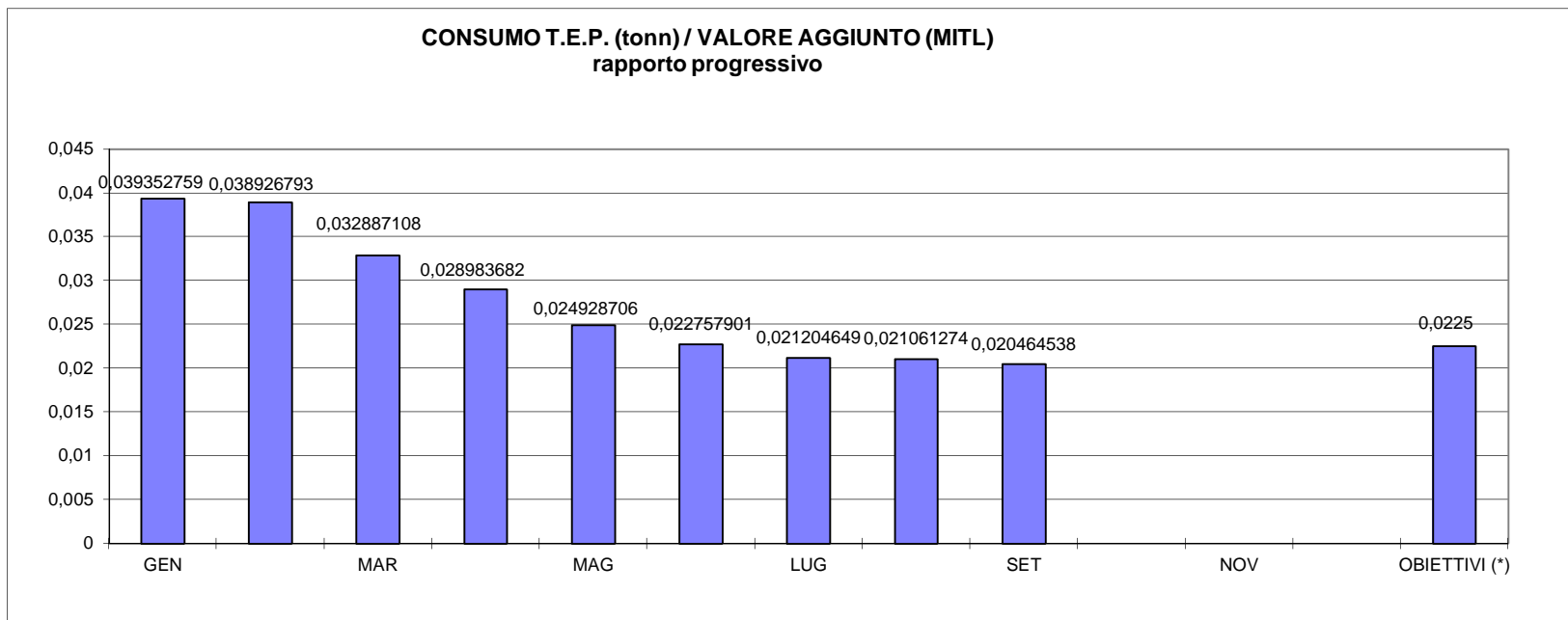
$$\text{Product volumes variances \%} = \frac{\text{Number of produced pieces}}{\text{Number of planned pieces}} * 100$$

$$\text{Product mix variances \%} = \frac{\text{Number of different codes produced}}{\text{Number of produced pieces}} * 100$$

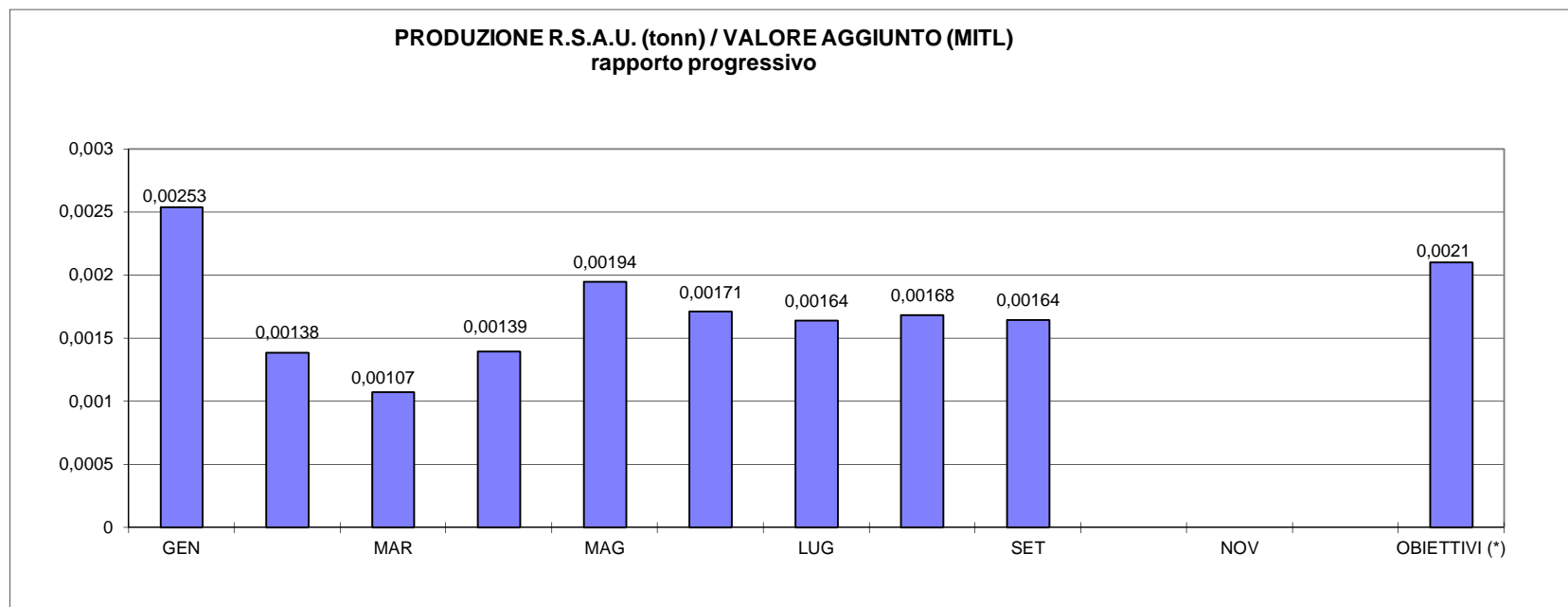
ENVIRONMENT



ENVIRONMENT



ENVIRONMENT



PROFITABILITY

$$\text{Turnover pro-capite} = \frac{\text{Turnover in the period}}{\text{average workforce in the period}} \quad (\text{€}/\text{employees})$$

$$\text{Added value pro-capite} = \frac{\text{Addes value in the period}}{\text{average workforce in the period}} \quad (\text{€}/ \text{ employees})$$