



INNOVHUB
STAZIONI SPERIMENTALI
PER L'INDUSTRIA

Innovazione e ricerca



STAZIONE SPERIMENTALE
PER LA SETA

Analisi LCA della Seta

Como

9 Maggio 2018

Silvio Farago

Innovhub SSI Stazione Sperimentale Seta

Milano

Analisi LCA

Steps of an LCA

How to assess the environmental impact?



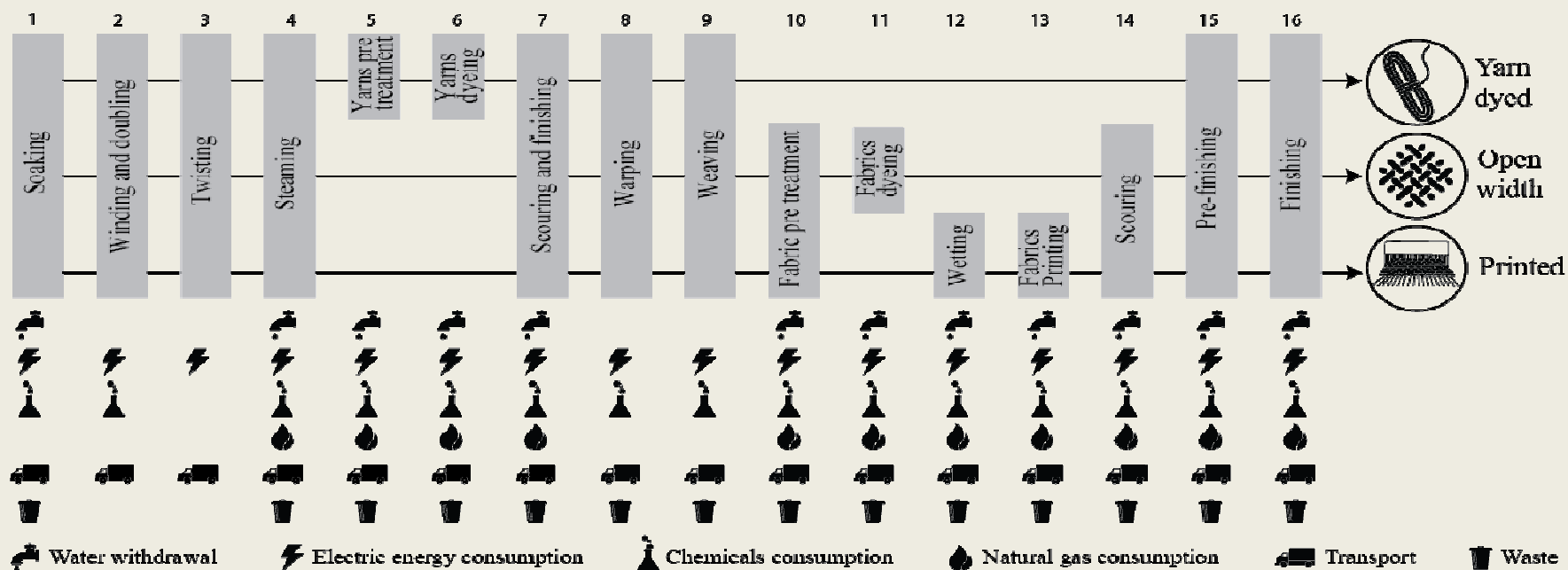
› Step 1- Campo di Applicazione

Identificare tutte le fasi del processo produttivo della filiera serica del distretto industriale di Como.

Raccolta di dati attraverso autid aziendali in 15 aziende del distretto

Identificazione di tre metodologie alternative denominate

manufacturing paths: Tessuto Tinto Filo, Tessuto tinto pezza, Tessuto stampato. Le tre metodologie di processo sono state ulteriormente suddivise in : Torcitura, Tintura in filo, Tessitura, Tintura in pezza, Stampa, Finissaggio (Macroprocesses). Ogni macroprocesso è stato scisso in 16 singoli processi (Sub-processes) come esposto di seguito



› Step 2- LCI – Iso 14040

Indicatori

Cinque indicatori sono stati calcolati per ogni processo per l'intera catena produttiva per la definizione del Life Cycle Inventory in accordo con ISO 14040

Emissioni in atmosfera e reflui acquosi sono stati considerati



Electric energy

kWh



Natural gas

m³



Water

m³



Chemicals

kg



Waste

kg

Audits Ambientali del processo di manifattura serica

Tre esempi di prodotti in seta .
L'impatto è stato calcolato
seguendo la metodologia di
scomposizione dei processi
adottata con nel **system
boundaries**.

SYNOPSIS

100 kg tessuto tinto filo

1. Torcitura
2. Tintura rocca
3. Tessitura
- ~~4. Tintura pezza~~
- ~~5. Stampa~~
6. Finissaggio

100 kg di tessuto tinto pezza

1. Torcitura
- ~~2. Tintura rocca~~
3. Tessitura
4. Tintura pezza
- ~~5. Stampa~~
6. Finissaggio

100 kg di tessuto stampato

1. Torcitura
- ~~2. Tintura rocca~~
3. Tessitura
4. Preparazione
5. Stampa
6. Finissaggio

Audits Ambientali del processo di manifattura serica

SYNOPSIS

100 kg
Tessuto tinto filo



Electric energy 4'143,12 kWh



Natural gas 185,94 m³



Water 25'832,87 kg



Chemicals 83,79 kg

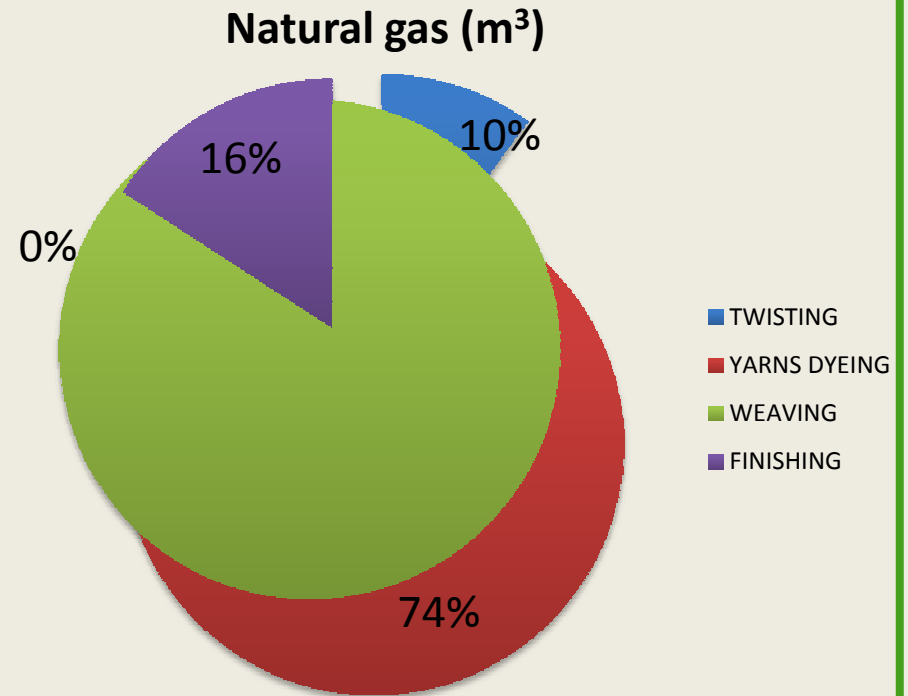


Waste 43,89 kg

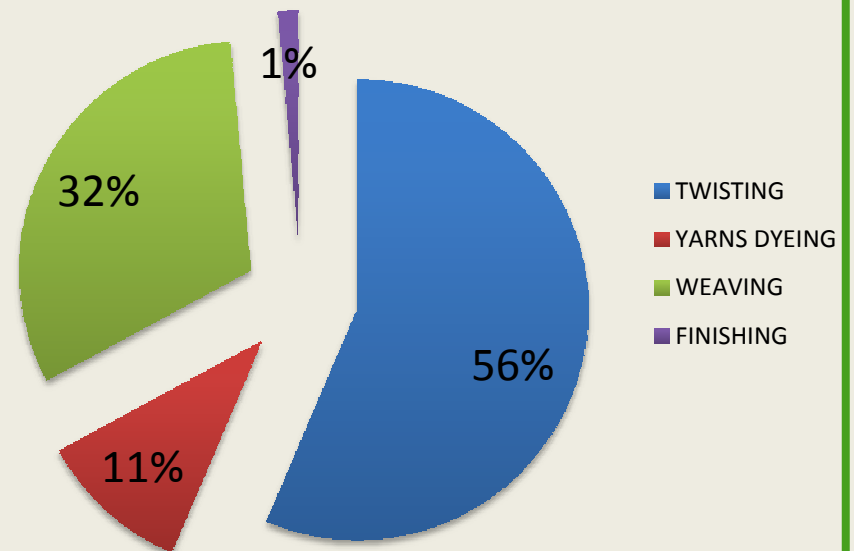
Audits Ambientali del processo di manifattura serica

SYNOPSIS

100 kg
Tessuto Tinto filo



Electric Energy (kWh)



Step-3 LCA – Calcolo di Impatto

Substance	Abiotic depletion potential [kg antimony-Eq]	Acidification potential [kg SO2 eq]	Endpoint total [points]	Eutrophication potential [kg PO4-Eq]	Global warming potential [kg CO2 eq]	Human toxicity [CTU]	Land use [m2a]	Metal depletion [kg Fe-Eq]	Photochemical oxidation potential [kg ethylene-Eq]	Stratospheric ozone depletion [kg CFC-11-Eq]	Ecotoxicity [CTU]	Water depletion [m3]	Ammonium ion [kg]	Nitrogen [kg]	Nitrogen oxides [kg]
ethoxylated alcohol (AE7) production, petrochemical	0,03315215	0,009197162	0,98728078	0,002570456	2,3362616	9,81833E-08	1,26E-01	0,12631504	0,000580846	7,95E-08	7,75E+00	0,0055289	5,77E-07	1,69E-08	0,000450484
paraffin production	0,02458606	0,00447598	0,015285021	7,86E-04	0,69471853	2,33691E-08	0,077191536	0,050985277	1,62E-04	4,34E-08	2,55E+00	7,02E-04	6,20E-08	8,52E-09	8,55E-05
soap production	0,006878141	0,010363938	0,38867977	0,00889695	2,617935	7,77147E-08	2,0433332	0,10970986	0,001385459	2,16E-07	1,20E+01	0,26060101	3,62E-07	2,34E-08	0,00046849
polydimethylsiloxane production	0,094364844	0,079664758	0,33500829	0,018821298	15,59411	6,80203E-07	1,5306543	0,36128177	0,003857191	4,92E-07	3,85E+01	0,040246035	5,99E-06	1,64E-07	0,002742827
ammonium chloride production	0,015878305	0,010453961	0,040487969	0,008766402	2,0152143	1,00304E-07	0,083994014	0,14119293	4,42E-04	5,99E-07	9,38E+00	0,004554313	0,017042059	1,32E-08	0,000542123
ethylene glycol dimethyl ether production	0,033439746	0,008107875	0,045587048	0,003106877	2,3216042	1,07454E-07	0,084435445	0,13521291	8,56E-04	2,56E-07	8,88E+00	0,005545127	6,64E-06	1,64E-08	0,000704303
polymethyl methacrylate production, beads	0,057070505	0,037807502	0,12540923	0,003491046	7,1282235	1,85021E-07	0,001674031	0,003325233	0,001860186	7,15E-09	3,19E+00	8,90E-04	6,43E-09	2,63E-09	2,88E-05
ethoxylated alcohol (AE>20) production, palm oil	0,030480921	0,009661907	0,080854619	0,003983145	2,9580266	1,02811E-07	0,36893971	0,11687188	9,80E-04	6,29E-08	8,16E+00	0,018966227	5,30E-07	1,42E-08	0,000476396
acetic acid production, product in 98% solution state	0,022308011	0,006342545	0,031270638	0,002821364	1,3920574	8,35886E-08	0,10891864	0,10164333	0,001426212	3,56E-07	7,48E+00	0,005392848	4,35E-06	1,02E-08	0,000373507
sodium sulfate production, from natural sources	9,53E-04	7,22E-04	0,003134298	4,41E-04	0,12397796	1,50858E-08	0,022936158	0,025328822	3,27E-05	5,83E-09	1,45E+00	6,33E-04	2,34E-08	1,88E-09	4,78E-05
soda production, solvay process	0,002370531	0,003807271	0,011056312	0,001152099	0,3517298	3,27369E-08	0,12483634	0,069944914	1,12E-04	2,10E-08	3,32E+00	0,001025304	9,63E-08	1,29E-08	0,000143819
sodium chloride production, brine solution	8,33E-04	7,89E-04	0,003251334	4,65E-04	0,1211692	1,99969E-08	0,026561067	0,048753316	3,86E-05	7,62E-09	2,20E+00	5,19E-04	3,78E-08	2,91E-09	7,18E-05
hydroxylamine production	0,14264039	0,28279803	0,31197028	0,065849032	15,308184	7,28026E-07	0,68842753	0,92873072	0,013083685	3,15E-06	6,52E+01	0,04064421	2,47E-05	1,13E-07	0,00487544
sodium dithionite production, anhydrous	0,042547491	0,10391322	0,084660323	0,010476735	3,9284455	3,06478E-07	0,25623412	0,8191873	0,004879047	1,65E-06	6,11E+01	0,026317892	6,56E-06	3,65E-08	0,00293074
hydrogen peroxide production, product in 50% solution state	0,009737592	0,004236045	0,024224528	0,001805046	1,1947362	2,42379E-07	0,068444645	0,077094341	2,15E-04	1,30E-07	9,33E+00	0,003096315	8,00E-07	5,16E-09	0,000155841
anthraquinone production	0,15267771	0,11665	0,39476767	0,032749	19,268	0,000182351	1,1484887	20,240646	0,005863	1,60E-06	1241,8567	0,059075381	1,77E-05	2,66E-07	0,007172994
polycarboxylates production, 40% active substance	0,01094459	0,003681	0,022148458	0,001404	1,1181	6,10E-08	0,046642056	0,080862758	0,000207	1,98E-07	4,7850529	0,003211678	2,83E-07	7,80E-09	0,000292415
esterquat production, from coconut oil and palm kernel oil	0,019261497	0,016092068	0,62209437	0,011589747	3,1205084	1,32537E-07	2,6384879	0,18583101	0,00157906	1,35E-07	2,11E+01	0,47363093	1,53E-06	3,23E-08	0,000872889
esterification of palm oil	0,003866872	0,006764708	0,17416319	0,007216986	2,4659807	3,01234E-08	1,4831275	0,029900472	0,001611546	5,48E-08	3,70E+00	0,078160229	9,51E-07	1,16E-08	0,000234884
ethoxylated alcohol (AE7) production, coconut oil	0,027246127	0,017256134	0,7618669	0,011345308	3,0824197	1,64784E-07	2,8169149	0,20452175	9,33E-04	1,26E-07	2,57E+01	0,60724381	7,01E-07	3,61E-08	0,000875098
fatty alcohol sulfate production, coconut oil	0,018486663	0,032035055	0,39289415	0,026561765	4,0602802	2,61086E-07	7,7412478	0,16680606	0,001422694	1,97E-07	5,73E+01	0,28370729	1,45E-06	3,10E-08	0,000789399
toner production, colour, powder	0,070878154	0,035440114	0,13740287	0,01055277	7,3192812	3,60E-07	0,15241763	0,056382097	0,001415663	1,85E-07	1,88E+01	0,018840475			
maize starch production	0,004901373	0,008110941	0,10074488	0,007836538	0,94441553	5,16728E-08	1,7620631	0,092485863	1,56E-04	7,57E-08	6,35E+00	0,066003562	1,26E-06	4,87E-08	0,0003281
ammonium bicarbonate production	0,008219165	0,003782549	0,023166847	0,001701712	1,1116278	5,66506E-08	0,073147084	0,09766632	0,000225024	1,35E-07	5,74E+00	0,003396555	1,54E-07	6,71E-09	0,000196172
urea ammonium nitrate production	0,028265397	0,023352326	0,11283495	0,00799767	5,954976	1,30394E-07	0,12646732	0,44882889	7,63E-04	5,47E-07	1,71E+01	0,003654315	2,17E-06	2,14E-08	0,000815783
non-ionic surfactant production, fatty acid derivate	0,031396169	0,029472071	1,4930338	0,023267004	4,7621535	2,72506E-07	5,4715309	0,33371586	0,001409215	2,18E-07	4,70E+01	1,2155355	2,21E-06	5,41E-08	0,001547867
soda ash, dense, to generic market for neutralising agent	0,010515316	0,006841258	0,029413814	0,003926724	1,4423665	7,95676E-08	0,072379183	0,13062472	0,000303811	1,27286E-07	7,4390663	0,003761484	1,87E-06	1,91E-08	0,000738719
cocamide diethanolamine production	0,027660619	0,029858051	1,687631	0,025732868	4,5308146	2,6701E-07	6,2273198	0,316846	0,001400195	2,08522E-07	50,012561	1,3851493	1,37E-06	5,69E-08	0,001551728
fatty acid production, from coconut oil	0,018486663	0,032035055	2,0826398	0,026561765	4,0602802	2,61086E-07	7,7412478	0,33154264	0,001422694	1,96856E-07	57,316425	1,7295319	1,01E-06	6,32E-08	0,001603945

Abiotic Resource Depletion
 Global Warming Potential
 Ozone Depletion Potential
 Acidification Potential
 Eutrophication Potential
 Photochemical Oxidants Creation Potential
 Human Toxicity Potential
 Aquatic Toxicity Potential

Chemicals
 Wastewater
 Emission in Atmosphere
 Waste
 Energy

Step-3 LCA – Calcolo di Impatto

Subprocess	Abiotic depletion potential [kg antimony-Eq]	Acidification potential [kg SO2 eq]	Endpoint total [points]	Eutrophication potential [kg PO4-Eq]	Global warming potential [kg CO2 eq]	Human toxicity [CTU]	Land use [m2a]	Metal depletion [kg Fe-Eq]	Photochemical oxidation potential [kg ethylene-Eq]	Stratospheric ozone depletion [kg CFC-11-Eq]	Ecotoxicity [CTU]	Water depletion [m3]	Ammonium ion [kg]	Nitrogen [kg]	Nitrogen oxides [kg]
Twisting	0,128905979	0,156833365	10,2821607	0,123095011	21,82297298	1,30676E-06	34,75818754	1,653653247	0,007604128	1,00923E-06	266,3086078	7,535854854	5,83513E-06	3,05016E-07	0,007792533
Yarns Dyeing	1,069957528	0,870713738	9,062710834	0,340941835	142,7850634	0,000279782	43,07431328	35,9873305	0,055153905	1,11669E-05	2472,365207	4,793592767	9,26775E-05	1,09329E-06	0,034269763
Weaving	0,014209962	0,014973805	0,696491888	0,011404415	2,131967202	1,26682E-07	3,199174606	0,126600809	0,000699474	9,66057E-08	25,05014097	0,406590691	6,21103E-07	2,25321E-08	0,00057666
Fabrics Dyeing	0,6479329	0,593426779	5,602169862	0,220582953	92,91425433	0,000277187	29,509743	33,62934547	0,037132524	8,68492E-06	2229,926365	3,146431525	0,006863108	7,58402E-07	0,021860964
Printing	0,673945404	0,571150404	10,94608847	0,355535857	110,1762406	4,53374E-06	69,3135022	4,742297454	0,033348853	6,23486E-06	521,1981538	7,334093234	3,73292E-05	1,12327E-06	0,016456517
Finishing	0,167688332	0,319020308	0,901431098	0,095157089	20,21603261	1,02542E-06	9,01935535	1,145523155	0,014910016	3,3849E-06	127,737183	0,428962931	2,66209E-05	1,52631E-07	0,005889506
Total Production	2,702640104	2,526118399	37,49105285	1,146717159	390,0465311	0,000563962	188,874276	77,28475064	0,1488489	3,05774E-05	5642,585658	23,645526	0,007026191	3,45513E-06	0,086845943

Subprocess	Abiotic depletion potential [kg antimony-Eq]	Acidification potential [kg SO2 eq]	Endpoint total [points]	Eutrophication potential [kg PO4-Eq]	Global warming potential [kg CO2 eq]	Human toxicity [CTU]	Land use [m2a]	Metal depletion [kg Fe-Eq]	Photochemical oxidation potential [kg ethylene-Eq]	Stratospheric ozone depletion [kg CFC-11-Eq]	Ecotoxicity [CTU]	Water depletion [m3]	Ammonium ion [kg]	Nitrogen [kg]	Nitrogen oxides [kg]
Twisting	4,8%	6,2%	27,4%	10,7%	5,6%	0,2%	18,4%	2,1%	5,1%	3,3%	4,7%	31,9%	0,1%	8,8%	9,0%
Yarns Dyeing	39,6%	34,5%	24,2%	29,7%	36,6%	49,6%	22,8%	46,6%	37,1%	36,5%	43,8%	20,3%	1,3%	31,6%	39,5%
Weaving	0,5%	0,6%	1,9%	1,0%	0,5%	0,0%	1,7%	0,2%	0,5%	0,3%	0,4%	1,7%	0,0%	0,7%	0,7%
Fabrics Dyeing	24,0%	23,5%	14,9%	19,2%	23,8%	49,1%	15,6%	43,5%	24,9%	28,4%	39,5%	13,3%	97,7%	22,0%	25,2%
Printing	24,9%	22,6%	29,2%	31,0%	28,2%	0,8%	36,7%	6,1%	22,4%	20,4%	9,2%	31,0%	0,5%	32,5%	18,9%
Finishing	6,2%	12,6%	2,4%	8,3%	5,2%	0,2%	4,8%	1,5%	10,0%	11,1%	2,3%	1,8%	0,4%	4,4%	6,8%
Total Production	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

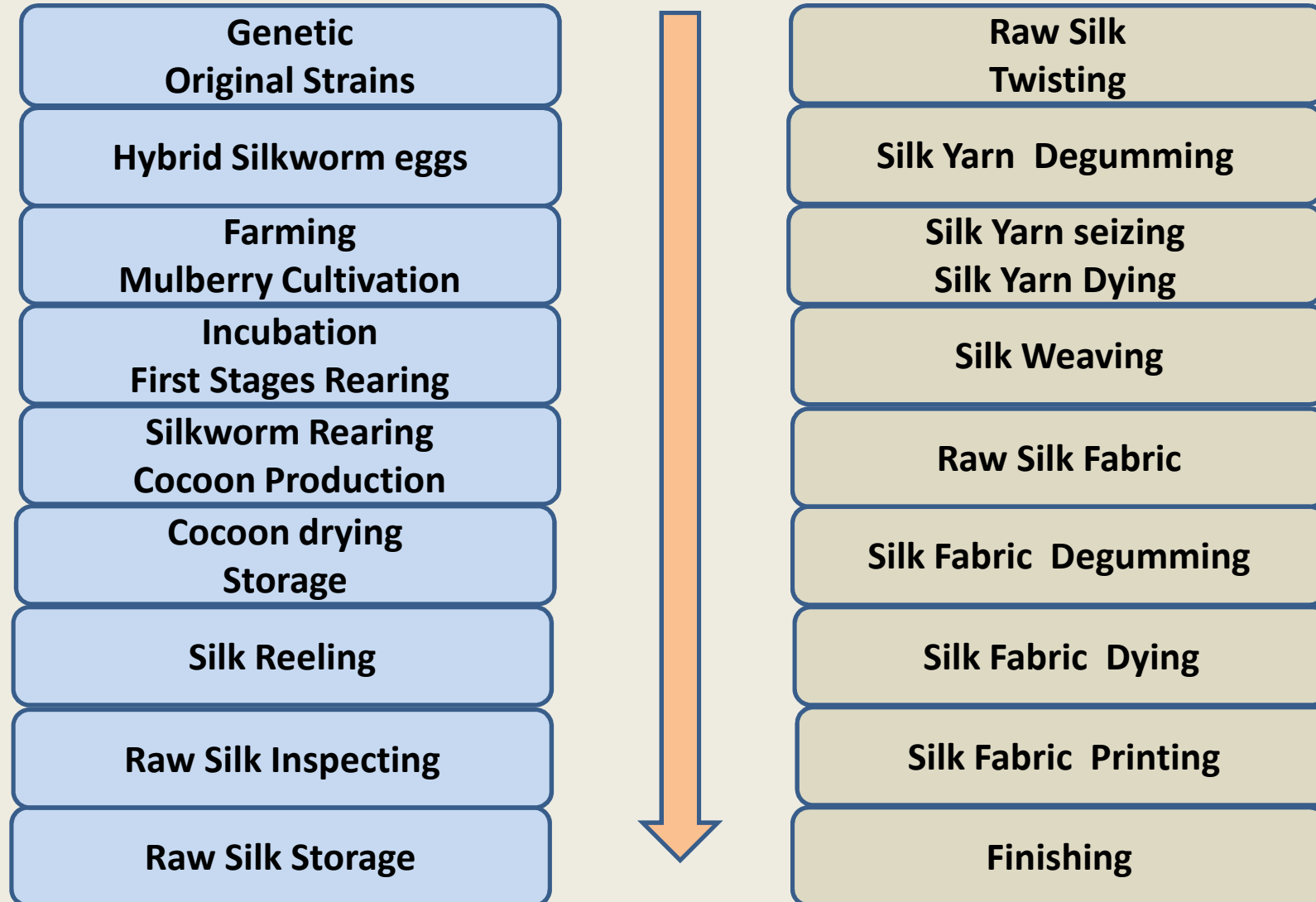
Substance	Anthraquinonic dyes	Sodium Hydrosulfite	Fatty acids ethoxylated	Marseille soap	Anthraquinonic dyes	Anthraquinonic dyes	Fatty acids ethoxylated	Anthraquinonic dyes	Marseille soap	Sodium Hydrosulfite	Anthraquinonic dyes	Fatty acids ethoxylated	Cetyl trimethyl ammonium chloride	Anthraquinonic dyes	Anthraquinonic dyes
Ind + sub	ADP [kg antimony-Eq]: Anthraquinonic dyes	AP [kg SO2 eq]: Sodium Hydrosulfite	Endpoint Total [points]: Fatty acids ethoxylated	EP [kg PO4-Eq]: Marseille soap	GWP [kg CO2 eq]: Anthraquinonic dyes	HT [CTU]: Anthraquinonic dyes	LU [m2a]: Fatty acids ethoxylated	MD [kg Fe-Eq]: Anthraquinonic dyes	POFP [kg ethylene-Eq]: Marseille soap	SOD [kg CFC-11-Eq]: Sodium Hydrosulfite	ETY [CTU]: Anthraquinonic dyes	WD [m3]: Fatty acids ethoxylated	Ammonium ion [kg]: Cetyl trimethyl ammonium chloride	Nitrogen [kg]: Anthraquinonic dyes	Nitrogen oxides [kg]: Anthraquinonic dyes
Contribute	17%	14%	34%	16%	15%	97%	25%	79%	19%	19%	66%	45%	97%	23%	25%



Step-3 LCA – Calcolo di Impatto

Alcohols ethoxylated	1	ethoxylated alcohol (AE7) production, petrochemical	ethoxylated alcohol (AE7) [kg]	RER	01.01.1992 - 31.12.2020	Fatty Alcohol Ethoxylate//alcohol ethoxylate	PDF UPR LCI LCIA
Marseille soap	1	soap production	soap [kg]	RER	01.01.1992 - 31.12.2020		PDF UPR LCI LCIA
Paraffins	1	paraffin production	paraffin [kg]	RER	01.01.1995 - 31.12.2017	Wachs//wax	PDF UPR LCI LCIA
Silicones	1	polydimethylsiloxane production	polydimethylsiloxane [kg]	GLO	01.01.2015 - 31.12.2020	Silicon-based organic polymer//Silicones//PDMS	PDF UPR LCI LCIA

› Allevamento Baco da Seta



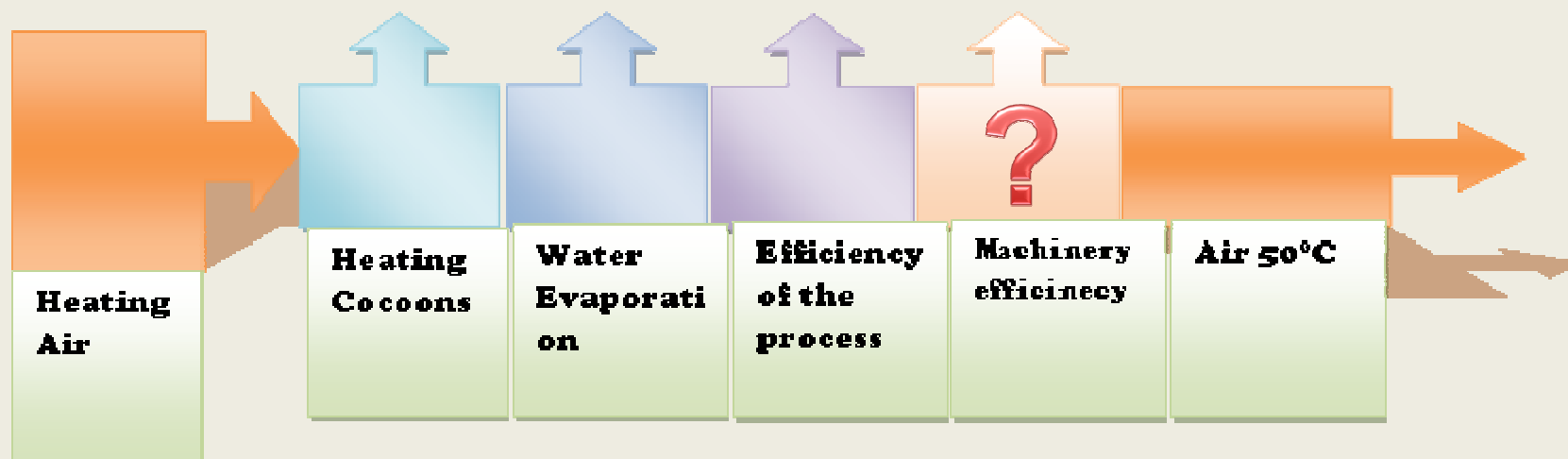
› Allevamento Baco da Seta

Rough Estimates of Sericultural Data								
ITEMS	REMARKS	1 Harvest / Years						
		Silk Basis	FC Basis	FC Basis	MF basis	MF basis	RM Basis	
Mulberry Field	M.F				ha 1,000			
Mulberry Leaves	M.L	36g of M.L/1 worm, 36g X SE = 36X555 =19,980g				t 13 (60)		
Silkworm eggs	S.E	Weight of F.C : 2.0g, 500 cocoons/1 ^{Kg} FC, 500x 1/0.9 = 555ccns/FC				eggs 400 X 10 ³		
No. Of Boxes	NC	1 Case 20,000 eggs (10.6~12.8g)				Boxes 20		
Fresh Coccons	F.C	Pupae 77~80% Shell 20~23%				Kg 700		
Raw Silk %(basis FC)	SP	0.14(14%): 7Kgs of FC/1Kg Raw silk (China)				14.2		
Raw Silk	PS	fresh basis % (dry basis%: 43~47%)				Kg 100		
Reeling	RM	Ends 230 rpm, 21 den, SP=0.14, 8hrs, 300 days/year						
Pure silk	PS	Degumming loss 18~23%				Kg 77		

› Allevamento Baco da Seta

1 Cocoon – 6-8 ml

1 cubic meter – 65-80 Kg



Energy consumption

1kg of cocoons from 20°C to 90°C

Starting Temperature of air 20°C

1 kg of fresh cocoon contain 0.60 Kg – 0.65 kg of water

Energy consumption to dry 1kg of cocoons at 90°C including losses 887 Cal

Theoretical Efficiency of the process 54,%

Efficiency of the drying machinery

Total energy consumption ? Kwh/ 100 kg of fresh cocoons

› Trattura Seta Greggia

Process	Silk Reeling					Remarks
	Electric Power Kw/8h	Water L/8H	Steam Kg/8h	Gas m3/8H	Other	
Selection	18,80					
Cooking	15,2	12		513		
Distributor	26,8	6,6				
Reeling	180,8	66,6		7900		12 sections 240 ends - 22 den - 33kg / set 8H (33x4 =132)
Rereeling + soaking	48	2,6		353		
Finishing and Inspection	12,4					
production waste (Biss)	120	14,7		1200		
Total	422	102,5		9966		9900kg/8H = 1246kg/H = 1,24 6t/H
Boiler	24	9,9				
Cleaning		12				
Life - Ligthing	31	140				15 watt /m2 (2200 m2) including services
Total	55	161,9				
Silk -Output - 132 Kg/8H						

1kg Raw Silk

2.7 KW h

0.6-1 t water

75-80Kg Steam

Step 4 – Interpretazione Comunicazione Strategic Planning (Esempio)

CO2 Liquid non Supercritical condition

Yarn Coating in situ

Foam Dispersion in Pretreatment of silk fabric

Anammox Based N rich wastewater treatment

Sericin recovery

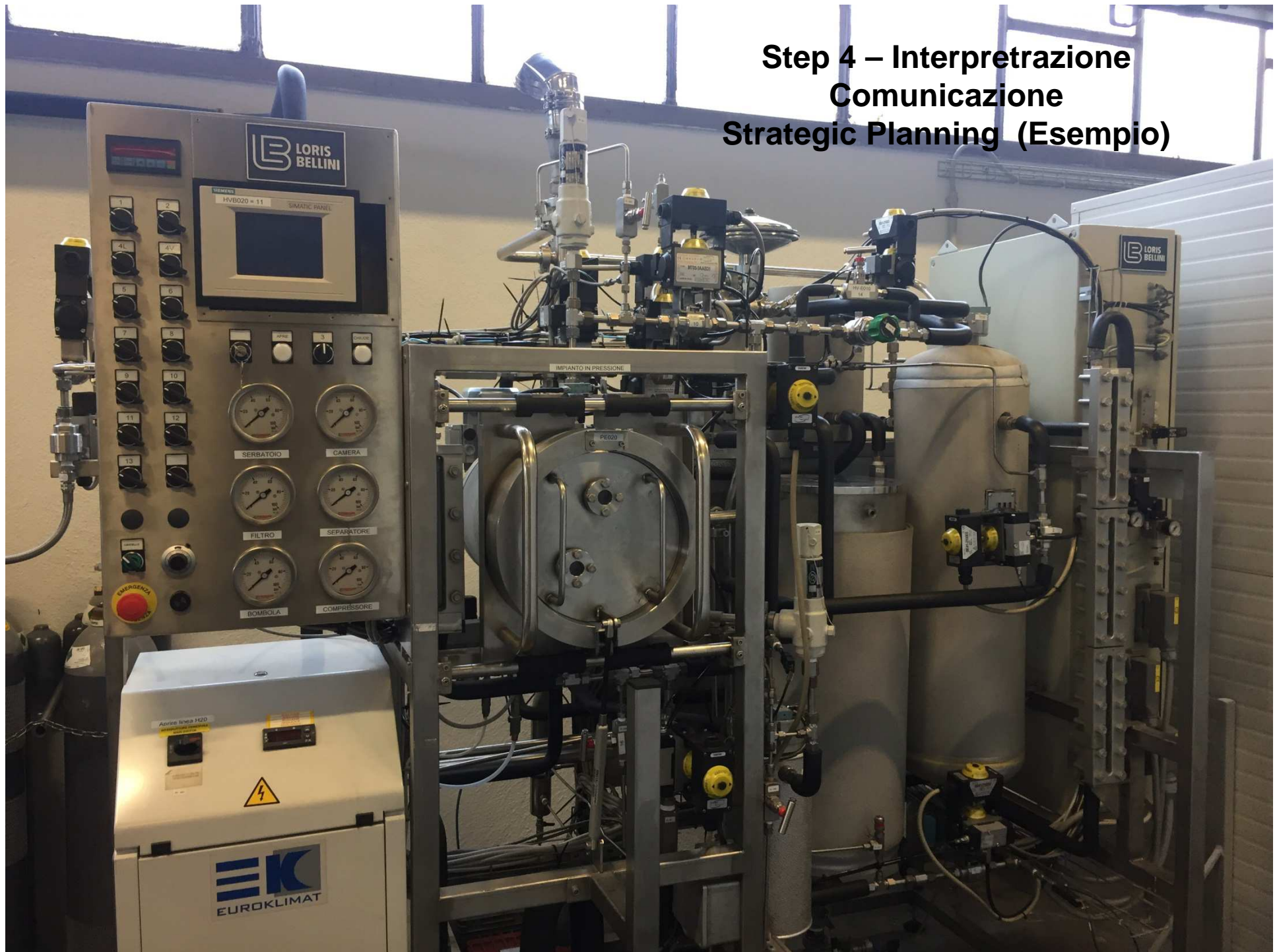
Sericin fixation (two new monomers)

Green Crosslinkers

Low temperature Dyeing Process (no heavy metal dyestuff)

Acqua 0 – Dyeing process reducing water consumption

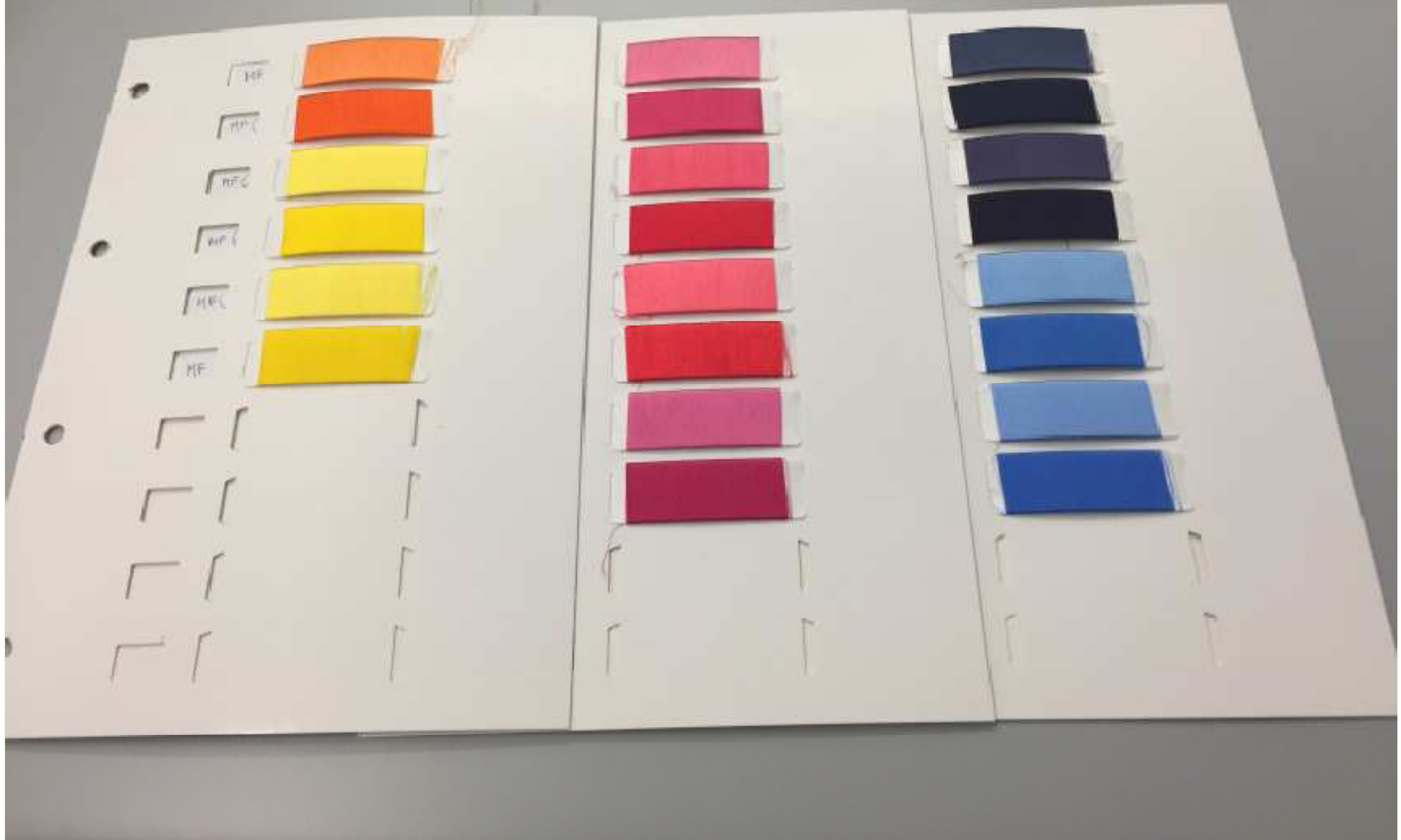
Step 4 – Interpretazione Comunicazione Strategic Planning (Esempio)





**Step 4 – Interpretazione
Comunicazione
Strategic Planning (Esempio)**

Step 4 – Interpretazione Comunicazione Strategic Planning (Esempio)



Step 4 – Interpretazione Comunicazione Strategic Planning (Esempio)





INNOVHUB
STAZIONI SPERIMENTALI
PER L'INDUSTRIA

Innovazione e ricerca



STAZIONE SPERIMENTALE
PER LA SETA

Grazie per l'attenzione

Silvio Farago