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New methodology for evaluating and classifying suppliers based on an outranking approach

**C. Maroto; D. Alós; J. Cuartero; S. Giner; M. Segura
and B. Segura**

**Department of Applied Statistics and Operational Research and Quality
Department of Economy and Social Sciences
Universitat Politècnica de València**

Purchasing department. Roquette Laisa Spain

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New methodology for evaluating and classifying suppliers based on an outranking approach



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MCDM for supplier evaluation and selection

Literature reviews: Ho, Xu and Dey, 2010 ; Chai, Liu and Ngai, 2013

➤ **Individual and integrated approaches:**

- Data Envelopment Analysis
- Mathematical programming: Linear and integer programming, Goal programming and multiobjective programming
- Analytic Hierarchy Process and Analytic Network Process
- Fuzzy set theory
- Simple multi-attribute rating technique
- Genetic algorithms

➤ **The supplier selection problem**



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Objectives

- To develop a general framework in order to evaluate products and suppliers based on a multiple criteria and group decision making process
- Application to a real company, Roquette Laisa Spain, in order to establish the best relationship with its suppliers:
 - Partners
 - Long term contracts
 - Market policies
 - Elimination

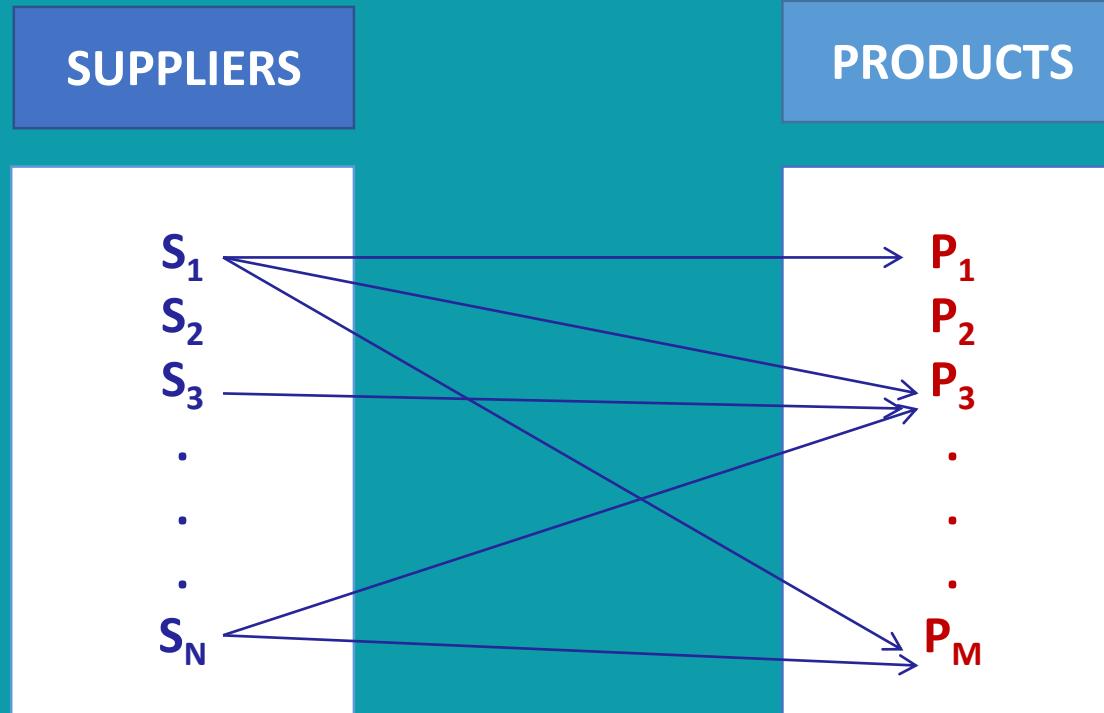
These objectives have been achieved in close collaboration with the personnel in the purchasing department of the company.

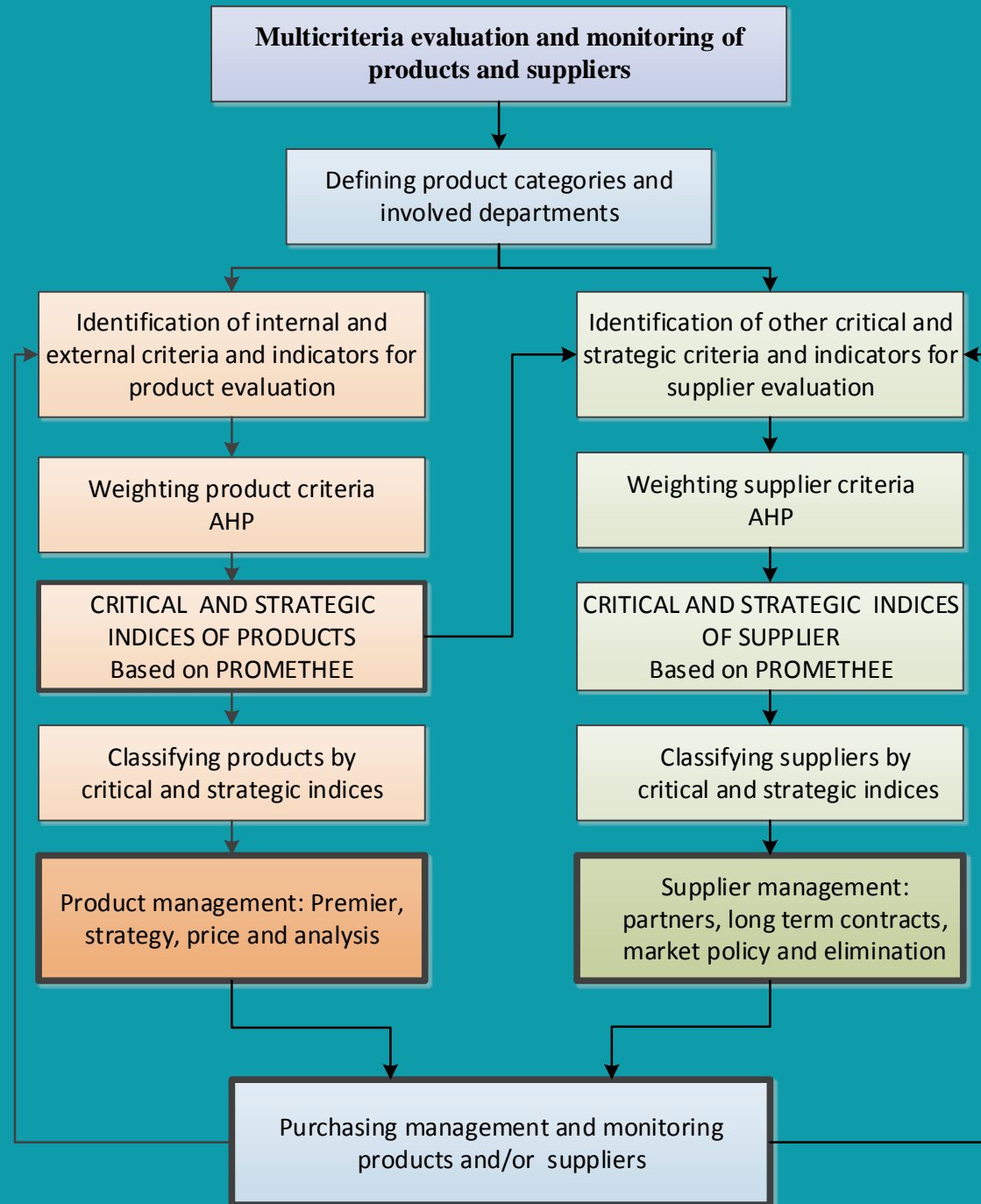


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Multiple Criteria based Methodology





Application to a real company



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The company:



Raw materials:



More than 700 Products:

the leader in the production, technology and application of polyols (sugar alcohols)

Applications:

Human nutrition

Pharmacy-cosmetology

Paper/board

Chemistry-bioindustry

Animal nutrition

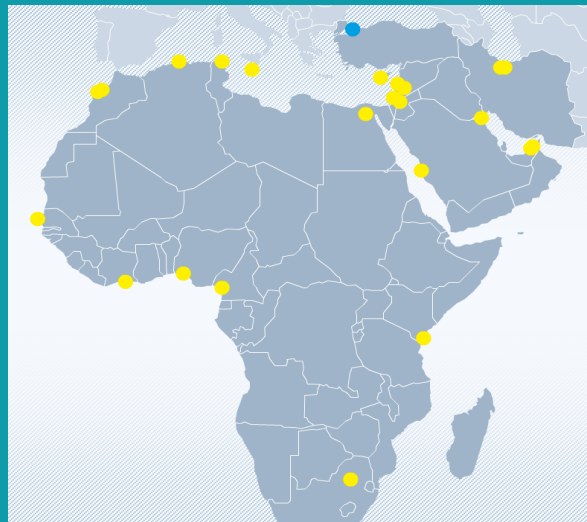
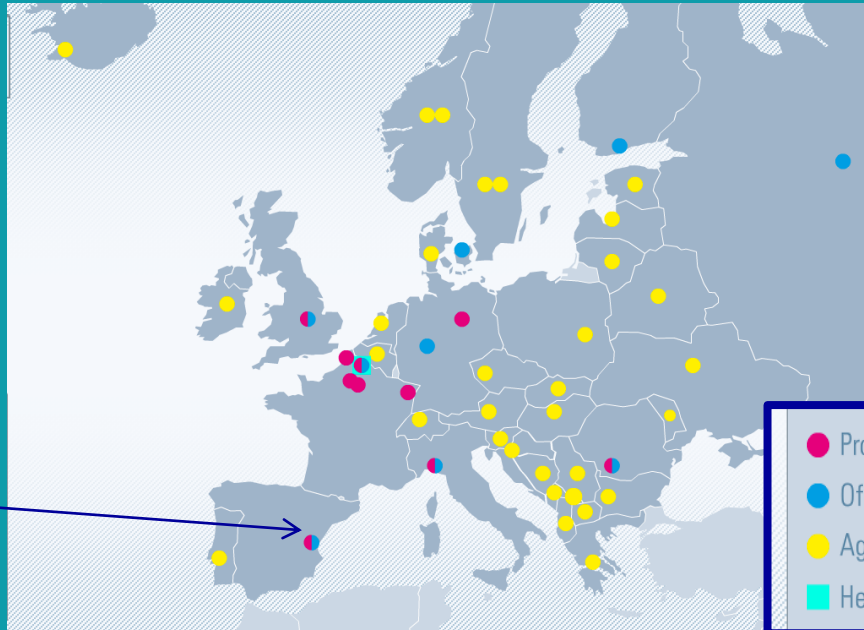


The Company: Roquette group



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(Spain)



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The problem: purchasing management

- Roquette Spain has implemented purchasing and warehouse management module of the SAP ERP software
- This system does not provide techniques to analyse and evaluate the high number of products and suppliers.
- **Previous system was only based on acquired products**
 - The products were analysed according to their risks without taking into account their suppliers.
 - Assessments have been carried out quarterly and data from last three years have been used.





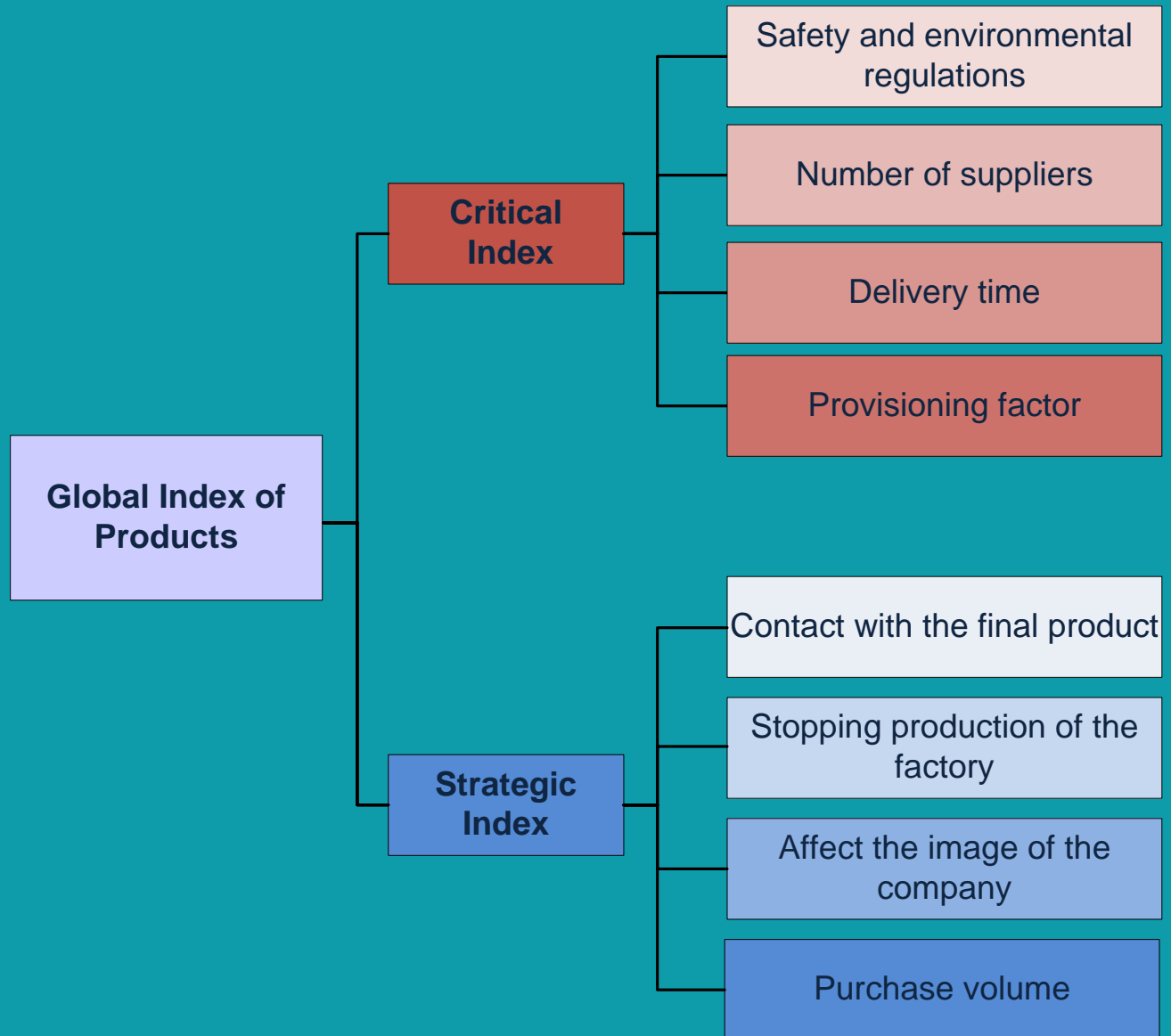
The problem: purchasing management

- The previous methodology has some **drawbacks**:
 - Criteria measured in different units were aggregated.
 - The weights of criteria were assigned after trial and error tests.
 - Very different products were able to obtain the same number for criticality.

- The company was interested in developing a new system of purchasing management:
 - ✓ Products
 - ✓ Suppliers



First-step: Critical and strategic indices of products



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Fundamental scale for pairwise comparisons in the AHP method



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Intensity of importance or contribution of one objective over the other	Definition	Explanation
1	Equal importance	The two elements contribute equally to the objective
2		Intermediate importance between 1 and 3
3	Weak importance of one over another	Experience and judgment slightly favour one element over another
4		Intermediate importance between 3 and 5
5	Essential or strong importance	Experience and judgment strongly favour one element over another
6		Intermediate importance between 5 and 7
7	Demonstrated importance	An element is strong favoured and its dominance is demonstrated in practice
8		Intermediate importance between 7 and 9
9	Absolute importance	The evidence favouring one element over another is of the highest possible order of affirmation
$1/2$ $1/3$... $1/8$ $1/9$		If the first element has a strong importance when compared to the second element, we assign a 5 on the scale. If we make the comparison of the second element in relation to the first, the value assigned on the scale is $1/5$



AHP: critical criteria weights

Pairwise comparison matrix of **critical** criteria

Critical Index	Safety and environmental regulations	Number of suppliers	Delivery time	Provisioning factor
Safety and environmental regulations	1	3	7	8
Number of suppliers	0,33	1	6	9
Delivery time	0,14	0,17	1	2
Provisioning factor	0,13	0,11	0,50	1





AHP: strategic criteria weights

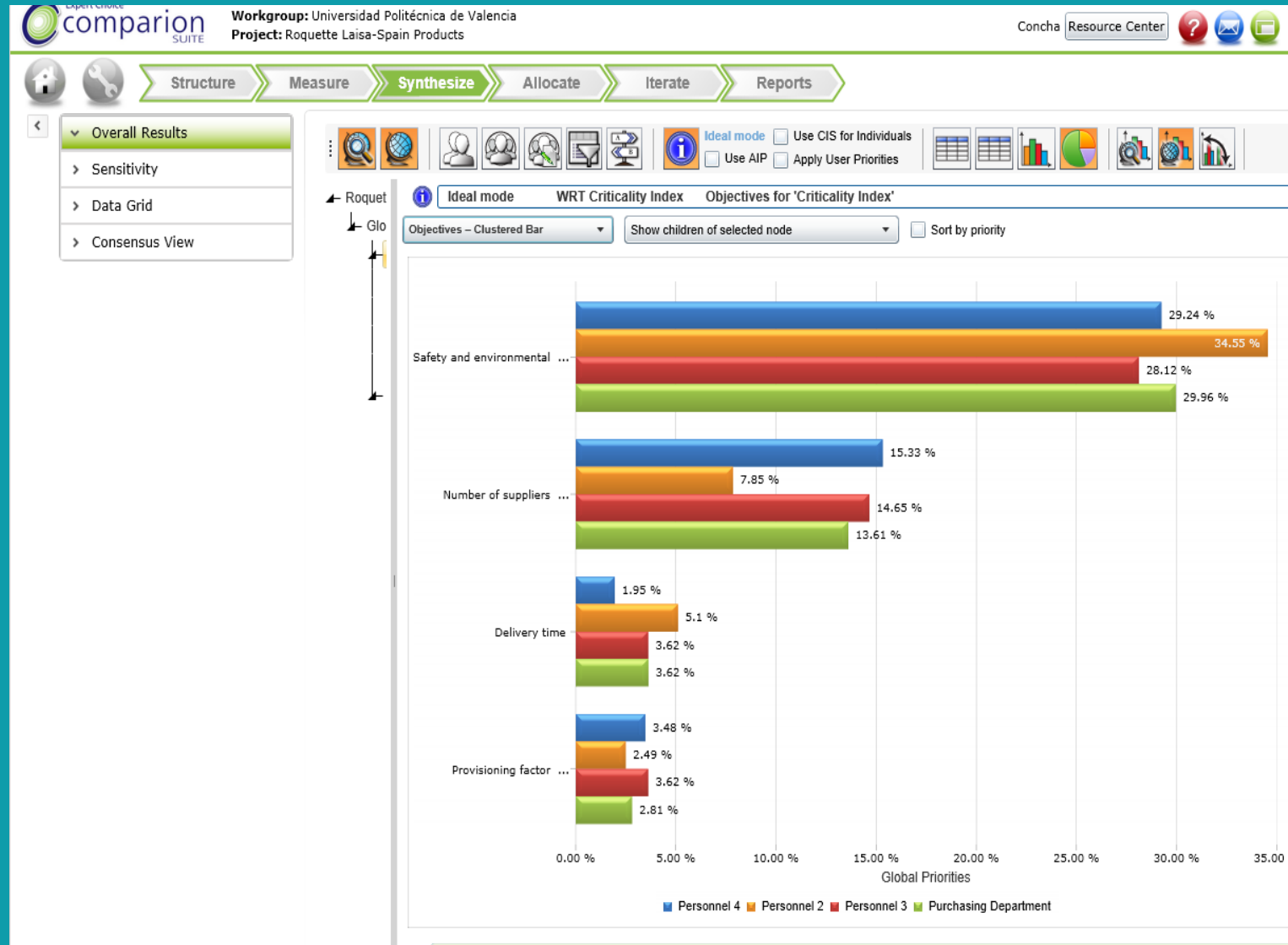
Pairwise comparison matrix of **strategic** criteria

Strategic Index	Contact with the final product	Stopping production of the factory	Affect the image of the company	Purchase volume
Contact with the final product	1	2	4	6
Stopping production of the factory	0,50	1	3	4
Affect the image of the company	0,25	0,33	1	2
Purchase volume	0,17	0,25	0,50	1

Critical index of products: weights of criteria



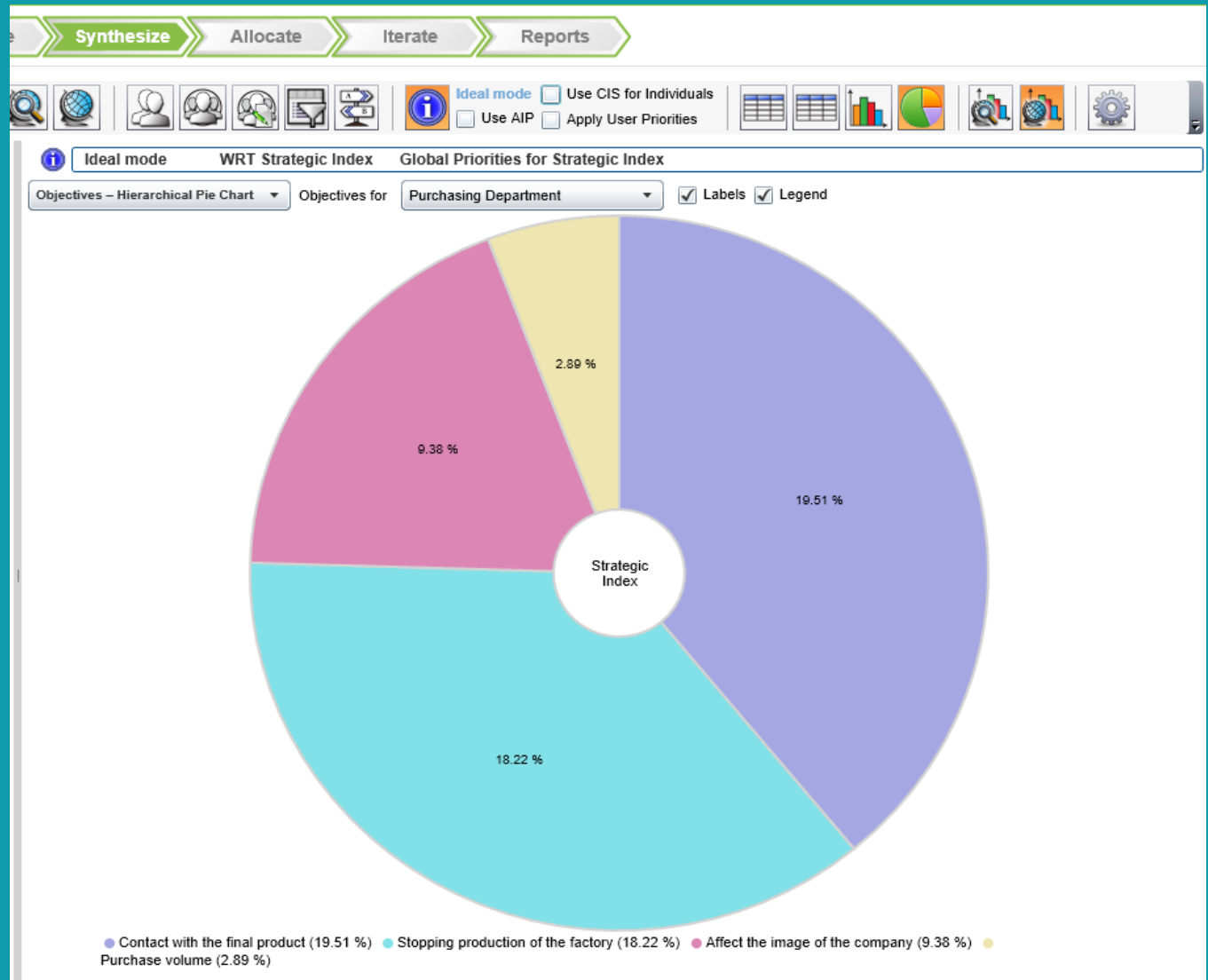
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Strategic index of products: weights of criteria



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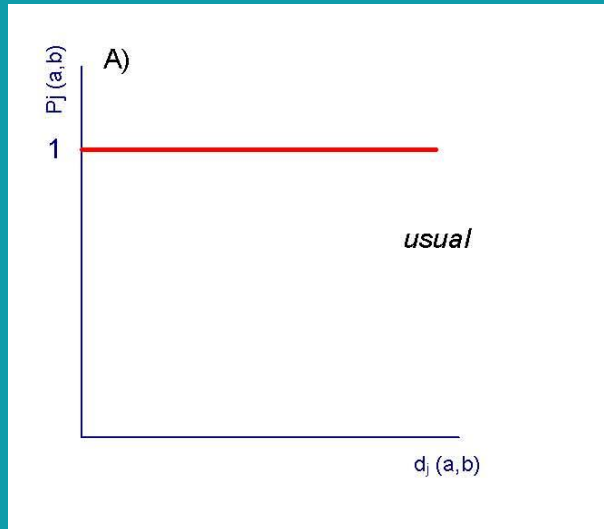
PROMETHEE II: Evaluation Table

	EVALUATION CRITERIA							
PRODUCTS	Purchase volume	Provisioning factor	Safety and environment regulations	Product affects the image	Contact with the final product	Stopping production	Delivery time	Number of suppliers
18670066	386.823,97	42	1	5	5	3	45	5
20020340	551.293,73	93	1	5	5	3	45	4
20030395	1.602.302,68	11	1	3	2	2	7	4
18670015	6.670,28	2	1	5	5	3	30	1
20042800	116.265,63	5	1	3	2	2	30	3





PROMETHEE II: Preference functions

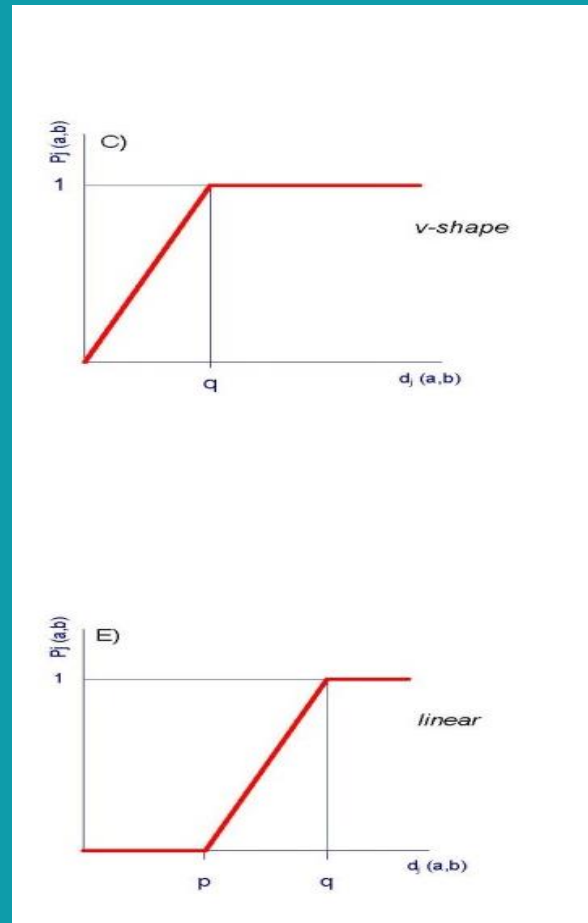


- Safety and environmental regulations
- Contact with the final product
- Stopping production of the factory
- Affect the image of the company





PROMETHEE II: Preference functions



- Number of suppliers
- Delivery time
 - $q = 80$ days
- Provisioning factor

- Purchase volume
 - $p = 50000$ euros
 - $q = 1000000$ euros

The PROMETHEE II Complete Ranking



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Criticality and strategic indices of products

Products	Critical index	Strategic index	Billing (euros)
18670015	46,37	37,57	4,656.98
20042800	52,29	60,62	96,307.10
18670066	52,44	36,10	297,134.91
20020340	51,28	35,78	465,748.47
20030395	53,42	59,32	1370,447.75

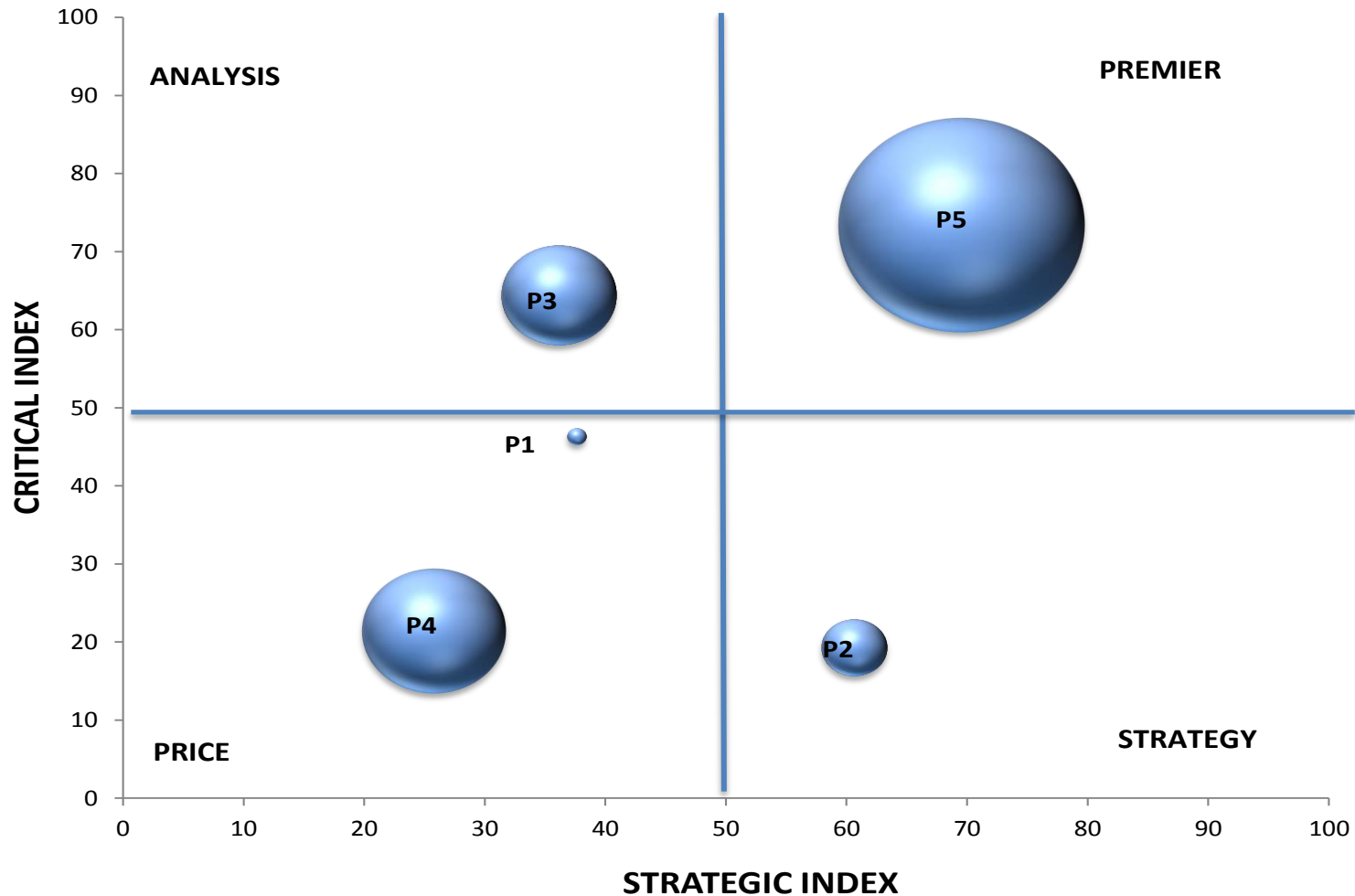


The PROMETHEE II Complete Ranking of products



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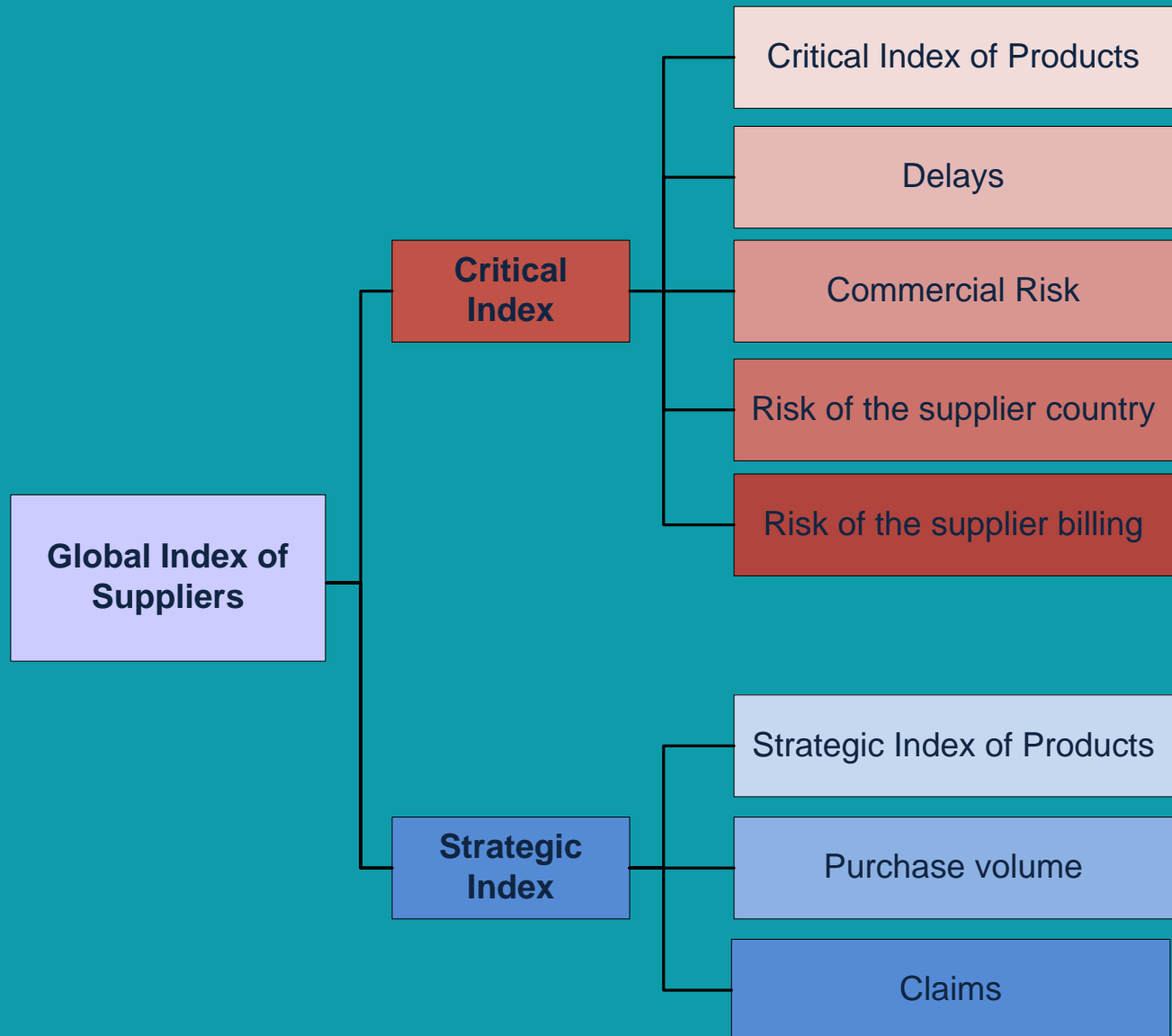
Critical and strategic indices of products



Second-step: critical and strategic indices of suppliers



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Second-step: critical and strategic indices of suppliers



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AHP: critical criteria weights

An example of pairwise comparison matrix

Critical Index	Critical Index of Products	Delays	Commercial Risk	Risk of the supplier country	Risk of the supplier billing
Critical Index of Products	1	5	3	7	7
Delays	0,20	1	0,33	5	5
Commercial Risk	0,33	3,00	1	3	3
Risk of the supplier country	0,14	0,20	0,33	1	1
Risk of the supplier billing	0,14	0,20	0,33	1,00	1



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Second-step: critical and strategic indices of suppliers



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AHP: strategic criteria weights

An example of pairwise comparison matrix

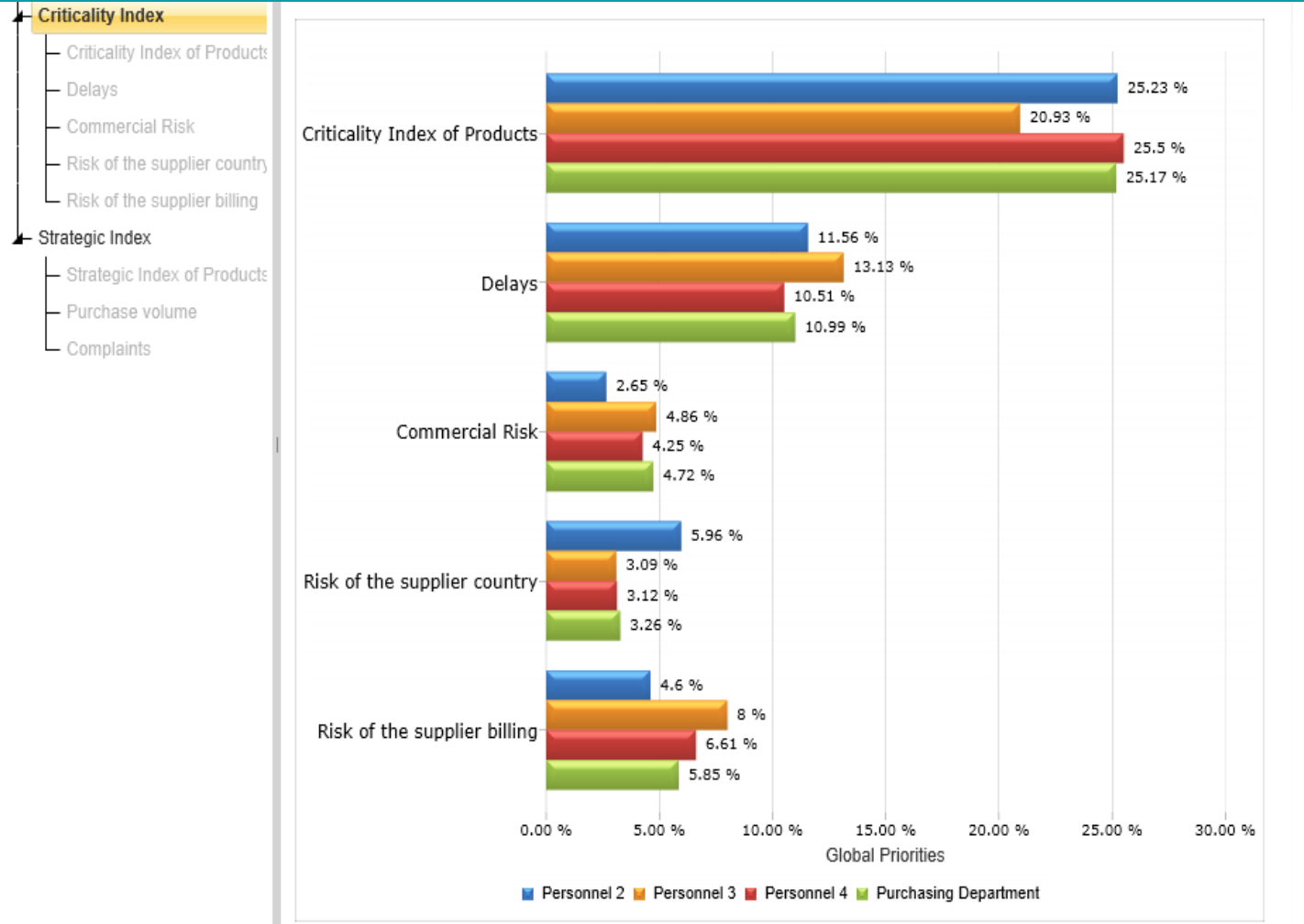
Strategic Index	Strategic Index of Products	Purchase volume	Claims
Strategic Index of Products	1	5	3
Purchase volume	0,20	1	0,33
Claims	0,33	3,00	1

Second-step: critical and strategic indices of suppliers

Results of criteria weights for criticality index of suppliers



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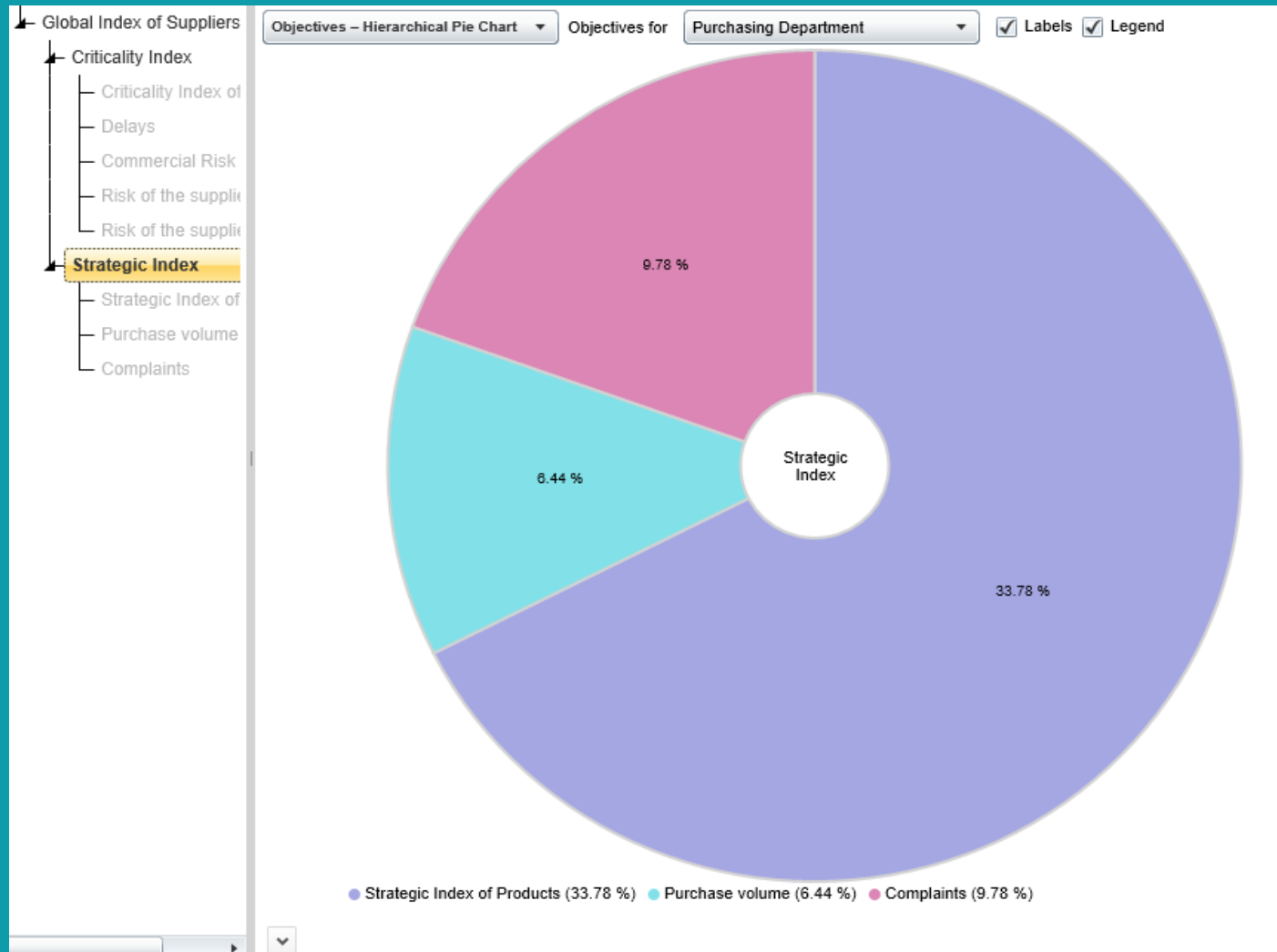


Second-step: critical and strategic indices of suppliers



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Global results of criteria weights for strategic index of suppliers



Second-step: critical and strategic indices of suppliers



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PROMETHEE II: Evaluation Table

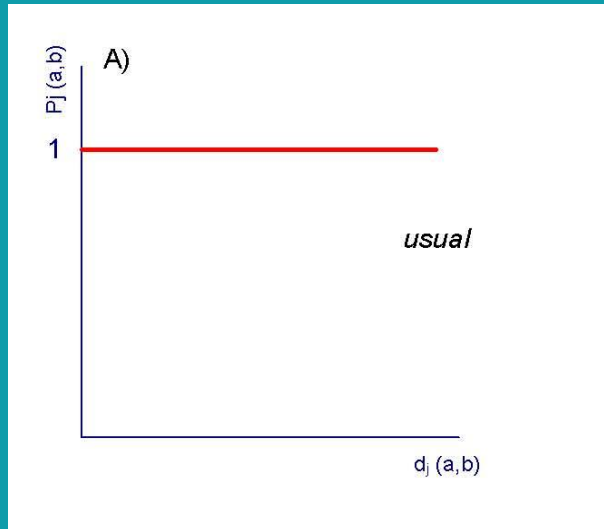
SUPPLIERS	EVALUATION CRITERIA							
	Claims	Purchase volume of supplier	Risk of the supplier billing	Risk of the supplier country	Commercial Risk	Delays	Strategic index of products	Critical index of products
302563	1	0,15	3,25	B	0	15	36,17	52,68
304061	0	4,36	15,48	B	0	0	61,40	53,93
304422	0	0,06	0,00	B	0	0	36,10	52,44
304438	1	3,79	24,50	B	0	0	59,32	53,42
304573	2	2,84	1,48	B	0	262	37,41	52,38
304601	1	1,49	1,44	B	0	85	61,11	51,76



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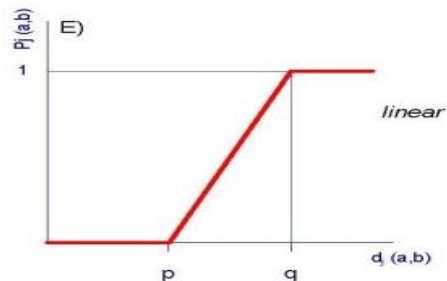
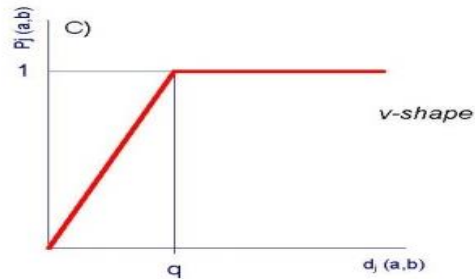
PROMETHEE II: Preference functions



- Critical Index of Products
- Strategic Index of Products
- Commercial Risk
- Risk of the supplier country



PROMETHEE II: Preference functions



- Delays
 $q = 80$ days
- Claims

- Risk of the supplier billing
 $q = 2.3\%$
 $p = 20\%$
- Purchase volume



Critical and strategic indices of suppliers

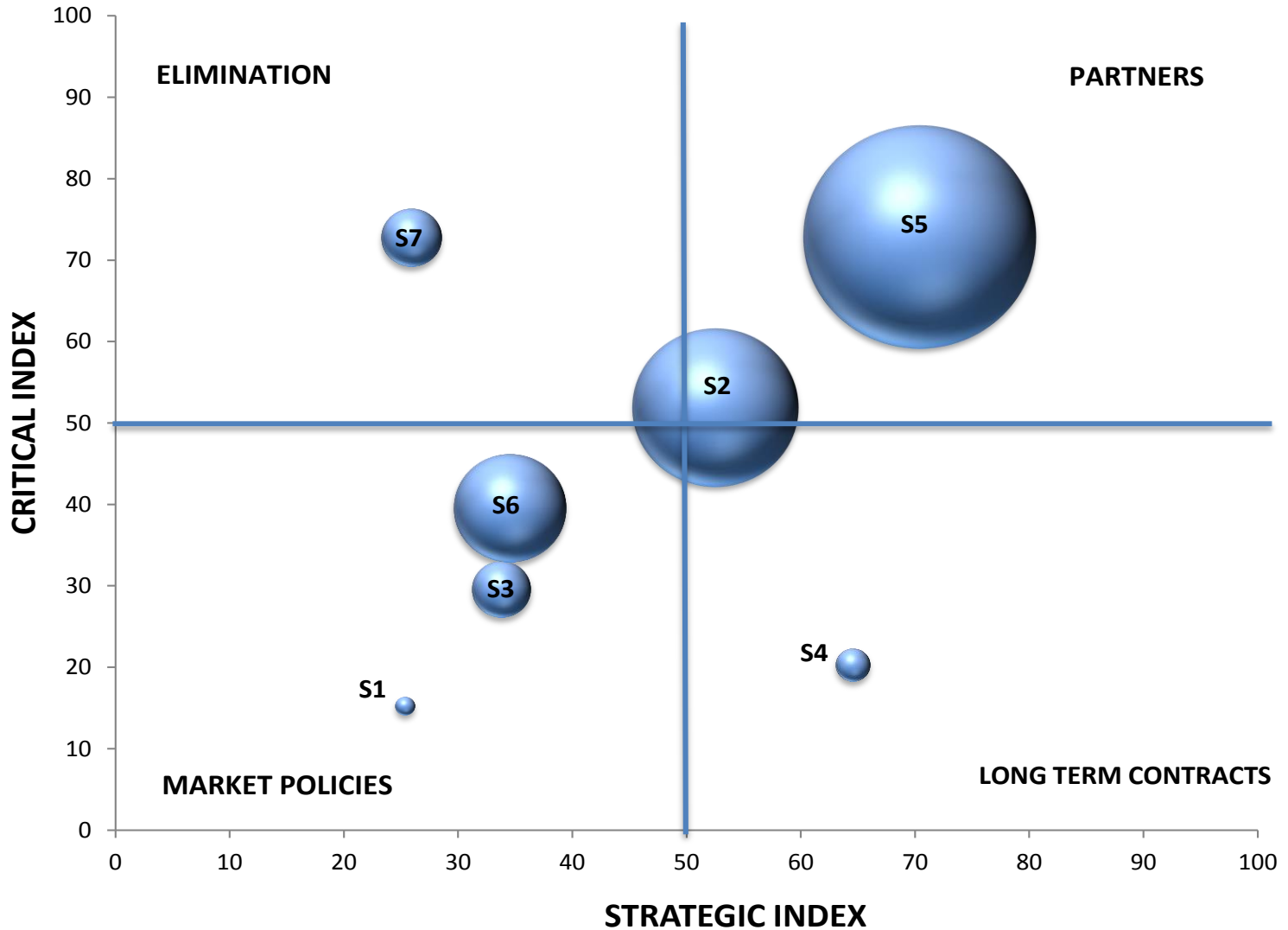
SUPPLIERS	CRITICAL INDEX	STRATEGIC INDEX	BILLING
351454	56,95	58,96	337,50
351121	41,93	39,51	153.440,00
351110	37,12	33,79	19.160,00
349878	44,93	41,72	6.422,76
346534	59,89	63,16	305.852,00
346380	39,54	34,50	71.335,70
345835	62,77	65,94	20.246,60



Second-step: critical and strategic indices of suppliers



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Conclusions

- ❖ Our framework can deal with evaluating products from one or several suppliers, qualifying suppliers for one product, classifying and selecting the best suppliers and also monitoring suppliers periodically.
- ❖ This approach does not permit obtaining the best suppliers and the optimal allocation of products to suppliers simultaneously. This is only possible by applying linear and integer programming, but these approaches can only optimize one objective.
- ❖ Mathematical programming and our approach are complementary: to develop mathematical programming models for products in the premier and strategy areas, as well as for suppliers with high strategic index.



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Conclusions

- ❖ In the case study some criteria used in the literature (safety and environmental regulations, delivery time, purchase volume, delays and claims) as well as new criteria have been considered.
- ❖ The new criteria are some strategic criteria of products (contact with the final product, stopping the production of the factory, affect the image of the company), critical index of products, strategic index of products and several risk factors (commercial, supplier country and supplier billing).
- ❖ Our proposal is a hybrid approach of AHP with an outranking multicriteria method, PROMETHEE. Group decision making by using the geometric mean to elicit the weights of criteria from a group of people.

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Conclusions

- ❖ We have designed two indices for suppliers based on the PROMETHEE method in order to evaluate how critical and strategic they are.
- ❖ The critical index are mainly related to the market while the strategic index is due to internal operations and decisions of the factory.
- ❖ This methodology has been implemented for the suppliers of chemical and packaging products in the Spanish factory that has overcome drawbacks of the previous one.



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Future work

- ❖ This methodology can be applied in other factories of Roquette group and other companies by defining their appropriate criteria.
- ❖ We are applying this methodology (ongoing work) for suppliers of **technical products** that represent a very high number (8,000) and have great diversity of applications.
- ❖ Materials for technical products: electrical, electronic, pneumatic, mechanical, hydraulic, etc. For example, in spare parts we have to consider if parts are for critical machines, safety issues, cost of materials, etc.





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