

Analytical Hierarchy Process for Location Problems in Logistics

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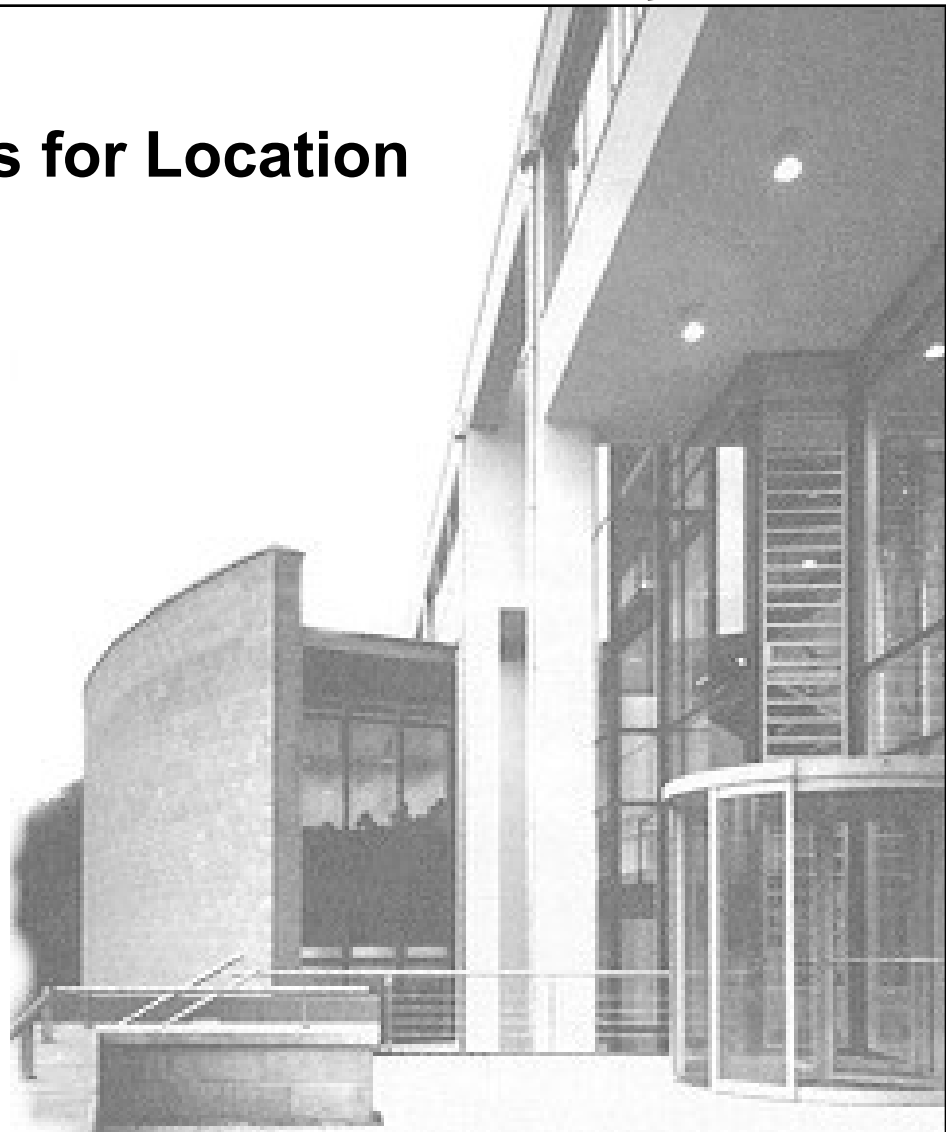
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1. Initial Position
2. Procedural Method of AHP
3. Application of AHP-Method in Practise
4. Results of AHP-Method in Practise
5. Conclusions

1. Initial Position

In the course of globalization



increasing requirements at the OEM (Original Equipment Manufacturer) inside its logistics

- rising quantity of sales in vehicles and therefore corresponding demand on spare parts
- increasing complexity by lots of new types of cars
- as an effect of this development, foundation of new logistics locations

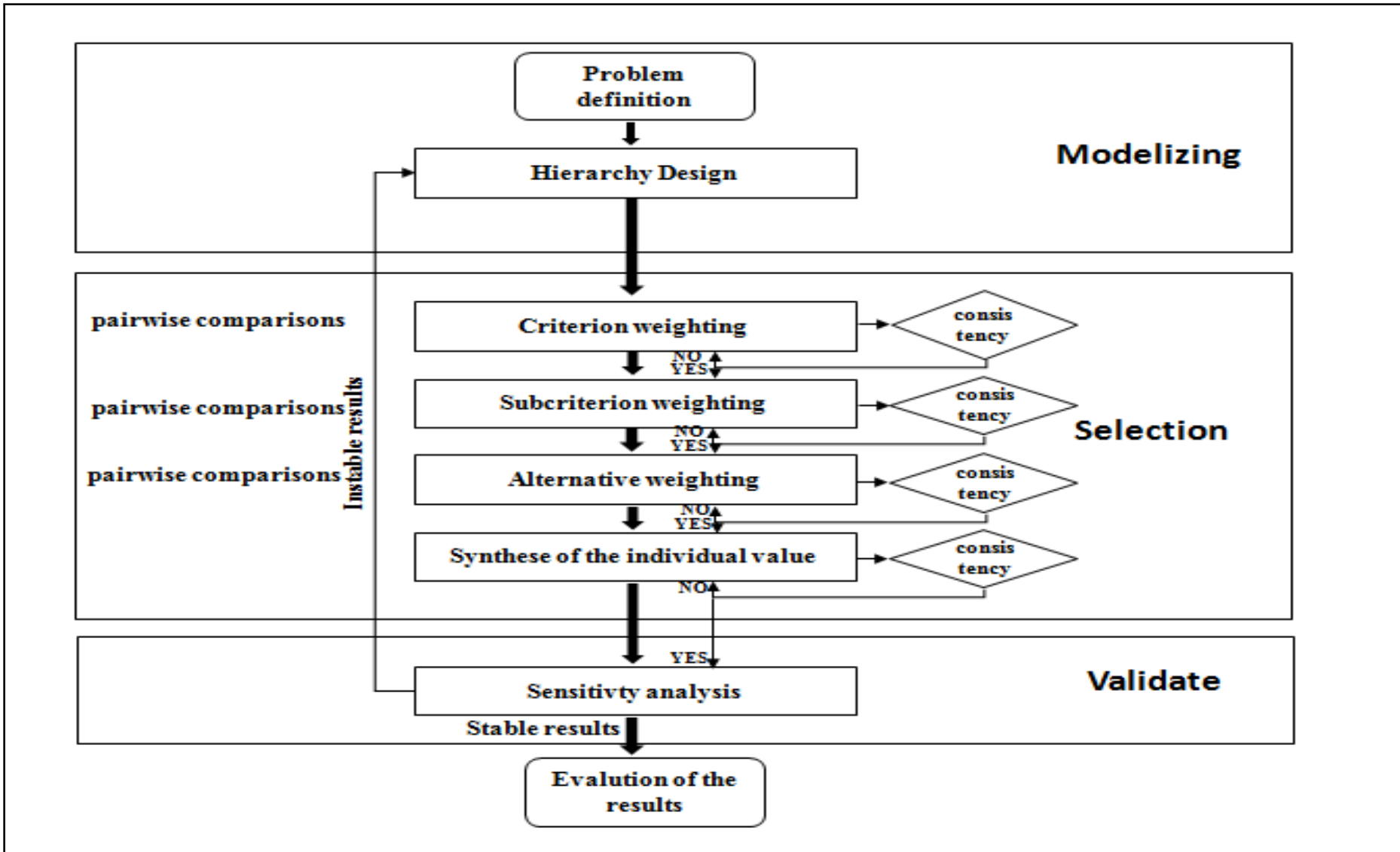
In focus of discussed OEM-company

- 1 center of distribution (red star)
- 5 logistics centres (yellow stars)

- supply of the 5 logistics centres from center of distribution
- main challenge is a complete supply in between the responsible channel of distribution



2. Procedural Method of AHP



➤ **First Level (Goal)**

definition of main-objective



identification of the optimum number of logistics centres

➤ **Second Level (General Criteria)**

definition of crucial assessment in a multi-criteria-catalogue



risks, costs, qualitative criteria

➤ **Third Level (Secondary Sub-Criteria)**



Risk (selling the location; employee discontent)

Costs (stock value; personal costs; transport costs.....)

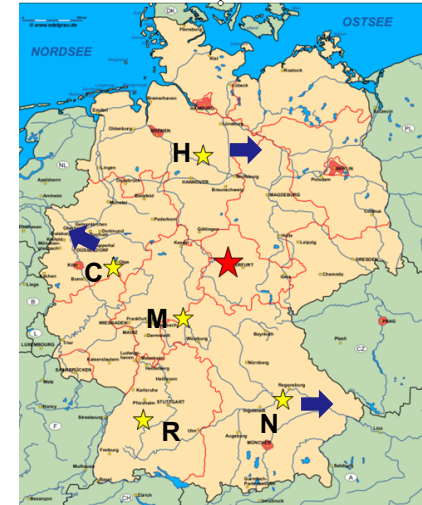
Qualitative Criteria (transport connection; nearness to business partners.....)

3. Application of AHP-Method in Practise (II/III)

➤ Fourth Level (k.o. criteria)

introduce k.o. criteria in order to reduce the effort of the AHP

- logistics services have to be available, at least, until 10 p.m.
- some of the existing locations cannot be closed because some extra duties in distribution spare parts outside Germany (e.g. Belgium and Netherlands from location C)
- special demands should anytime be able to delivered in 2 hours

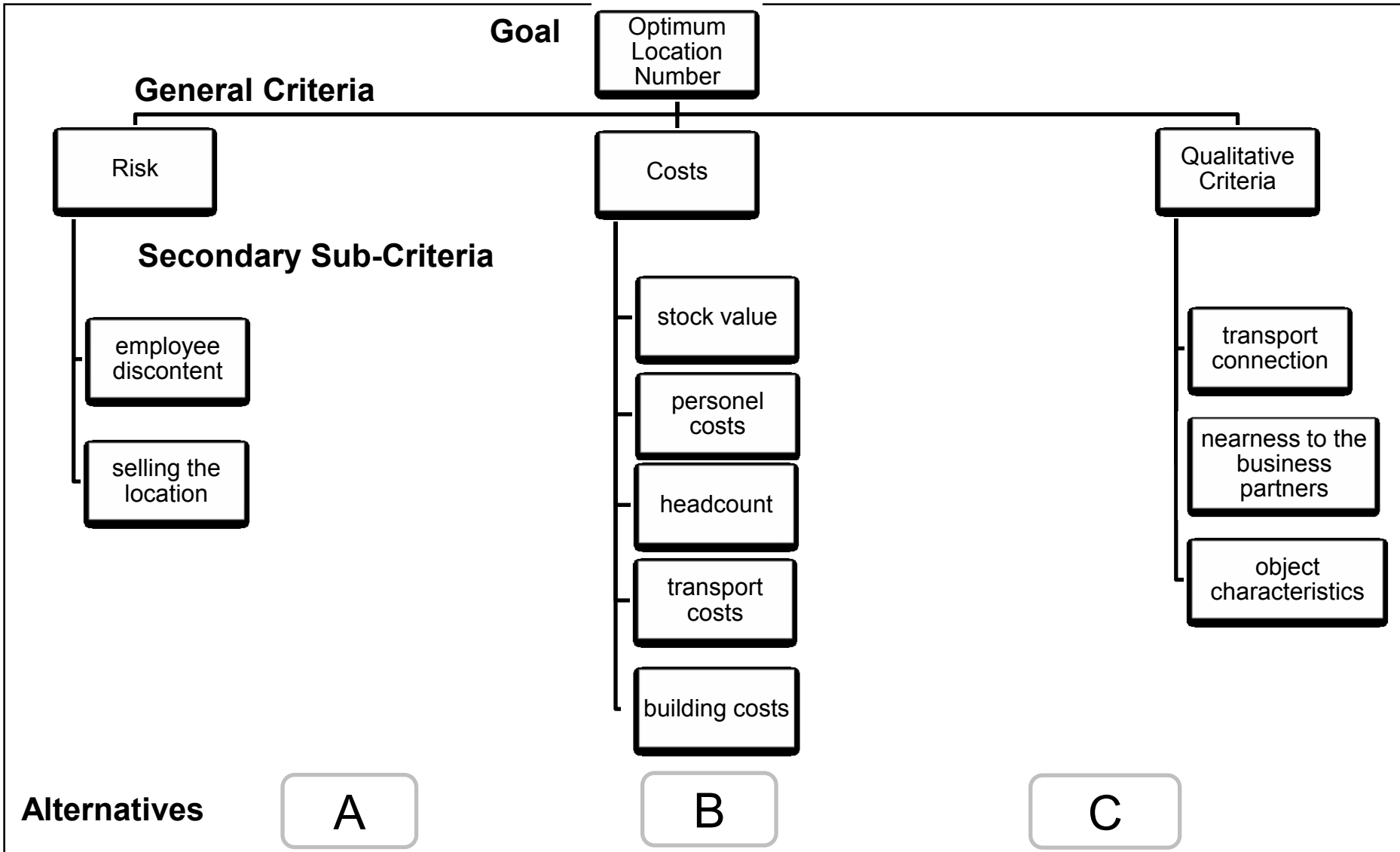


➤ Fifth Level (alternatives)

illustration of feasible alternatives (A_n) for the solution of the decision problem

- alternative A: hold existing structure
- alternative B: close location M and supply customers from remaining locations (four locations C, H, N, R)
- alternative C: close location R and supply customers from remaining locations (four locations C, H, M, N)

3. Application of AHP-Method in Practise (III/III)



Pairwise Comparison of the General Criteria

	Qualitative Criteria	Costs	Risk
Qualitative Criteria	1	1/8	1/2
Costs	8	1	4
Risk	2	1/4	1

- Costs are regarded as very strongly more important than Qualitative Criteria, and 8 is entered in the (2;1) position and corresponding the reciprocal value 1/8 in the (1;2) position
- 4, corresponding to strong dominance or importance is assigned to Costs over Risk in the (2;3) position
- Risk are regarded as moderate more important than Qualitative Criteria, and 2 is entered in the (3;1) position and corresponding the reciprocal value 1/2 in the (1;3) position

Derivation of Priorities on the Basis of the Pairwise Comparison of the General Criteria

optimum location number	evaluation matrix P			normalized matrix $P_{\text{normalized}}$			Σ row	weight
	Q	C	R	Q	C	R		
	qualitative criteria (Q)	1	1/8	1/2	0,091	0,091		
costs (C)	8	1	4	0,727	0,727	0,727	2,182	0,727
risk (R)	2	1/4	1	0,182	0,182	0,182	0,545	0,182
Σ column	11	1,375	5,5	1	1	1	3	1

Effect/Ranking:

- 1) Costs with a weight of **0,727**
- 2) Risk with a weight of 0,182
- 3) Qualitative Criteria with a weight of 0,091

Pairwise Comparison Matrix of the Second Criteria Level Costs

costs	evaluation matrix					normalized matrix					Σ row	weight
	S	P	D	T	E	S	P	D	T	E		
stock value (S)	1	4	8	2	3	0,8264	0,4706	0,4444	0,4706	0,4959	2,7079	0,45
personnel costs (P)	1/4	1	2	1/2	1	0,2066	0,1176	0,1111	0,1176	0,0827	0,6356	0,119
headcount (D)	1/8	1/2	1	1/4	1/3	0,1033	0,0589	0,0555	0,0589	0,1240	0,4006	0,055
transport costs (T)	1/2	2	4	1	2	0,4132	0,2352	0,2222	0,2352	0,0496	1,1554	0,238
building costs (E)	1/3	1	3	1/2	1	0,2752	0,1176	0,1667	0,1176	0,2480	0,9251	0,138
Σ column	1,21	8,5	18	4,25	7,33	1	1	1	1	1	5	1

Effect/Ranking:

- 1) S with a weight of **0,45**
- 2) T with a weight of 0,238
- 3) E with a weight of 0,138
- 4) P with a weight of 0,119
- 5) D with a weight of 0,055

Global Priorities

- representing the meaning of the weight of the particular hierarchy elements in the context of the overall hierarchy

	w_1 level	w_2 level	w_{rel}
costs	0,727		
stock value		0,45	0,327
personnel costs		0,119	0,087
building costs		0,055	0,040
headcount		0,238	0,173
transport costs		0,138	0,100
qualitative criteria	0,091		
nearness to business partner		0,727	0,066
object characteristics		0,182	0,017
transport connection		0,091	0,008
risk	0,182		
selling the location		0,9	0,164
employee discontent		0,1	0,018
c1			1

Sub-Criteria Weightings for Alternatives

• e.g.:


$$w = \frac{\frac{1}{60,5}}{\frac{1}{60,5} + \frac{1}{59,5} + \frac{1}{59,3}} \approx 0,32$$

$0,0865 * 0,3293 = 0,0285$

	W _{rel}	W _i			W _{rel}		
		W _A	W _B	W _C	A	B	C
personnel costs	0,087	0,337	0,332	0,331	0,029	0,029	0,029
transport costs	0,100	0,324	0,335	0,341	0,032	0,034	0,034
building costs	0,040	0,368	0,315	0,317	0,015	0,013	0,013
stock value	0,327	0,349	0,322	0,329	0,114	0,105	0,108
headcount	0,173	0,335	0,332	0,333	0,058	0,057	0,058
nearness to business partner	0,066	0,389	0,333	0,278	0,026	0,022	0,018
object characteristics	0,017	0,333	0,389	0,278	0,006	0,007	0,005
transport connection	0,008	0,381	0,333	0,286	0,003	0,003	0,002
selling the location	0,164	0,435	0,304	0,261	0,071	0,050	0,043
employee discontent	0,018	0,435	0,304	0,261	0,008	0,005	0,005
W _{alternative}					0,362	0,324	0,314

- AHP application possible for a multi-location decision problem
- AHP weightings allow for specific decision set-up as in this OEM case study
- As a disadvantage the use of AHP still depends on personal views and weightings can be influenced by individuals

Final Outcome

 Alternative A:
Keeping the original structure

	W _{rel}		
	A	B	C
W _{alternative}	0,362	0,324	0,314



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**Thank you for your
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