

Application of AHP for the development of waste management systems that minimize infection risks in developing countries: Case studies Lesotho and South Africa

Alan C Brent, Dave EC Rogers,

Tšaletseng SM Ramabitsa-Siimane, Mark B Rohwer



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What is AHP?



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- A known multi-attribute weighting method for decision support
Saaty 1980, 1990; Madu 1994
- Has been used for solving complex decision-making problems in various disciplines
Kurttila 2000; Bititci et al. 2001; Alidi, 1996; Carmone 1997; Kamal, 2001



Benefits and limitations of the AHP approach



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- **Benefits**

- It allows a systematic approach to evaluate policy options and helps understanding of the problem.
- A mixture of quantitative and qualitative information can be incorporated.
- Account can be taken of the preferences of the various stakeholder groups with conflicting objectives.

- **Limitations**

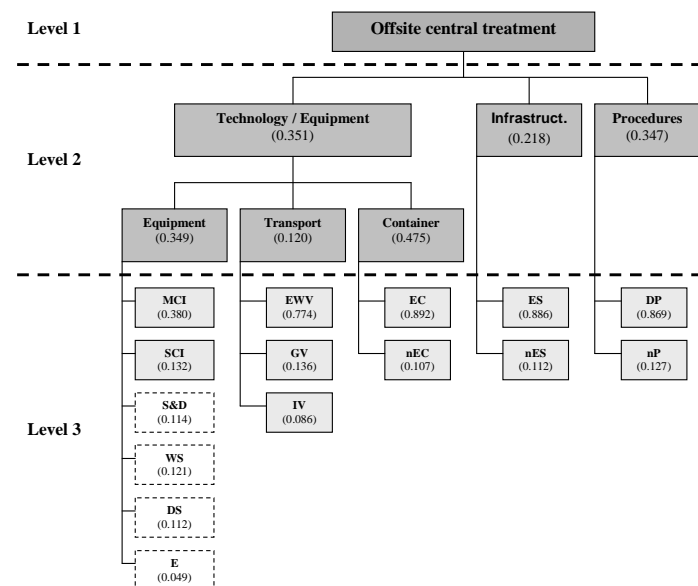
- MCDA methods do not produce the 'best' solution, but a set of preferred solutions or a general ranking of all solutions.
- There is a need for personal judgement and experience in making the decisions.
- MCDA techniques are sometimes very cumbersome and unwieldy.
- The allocation of weights to each criterion is subjective. Changing the weights could lead to a different result, i.e. rank reversal.

Complex systems and inconsistencies are specific problems with the AHP approach



Why AHP for HCWM?

- The complexities of HCWM systems result from the many possible combinations of options, or alternatives, apart from singular technologies
 - MCDA techniques are useful to compare between options/alternatives from a sustainability perspective.
 - For HCMW in rural areas specifically in terms of:
 - Technical aspects;
 - Costs; and
 - Infection risks.



Objectives of the research study



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- To propose a model
 - Which integrates the AHP with other systems approaches in order to establish primary HCWM systems that minimise infection risks in developing countries.
- To identify the key barriers to apply the AHP within such a model
 - Which must be addressed when applying the model.



Research methodology



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- South African and Lesotho HCWM systems as case studies
 - Workshops – 1 and 2.5 days respectively
- 11 participants in each workshop
 - Strategic planning, e.g. occupational health, environment, and technical government officials and public-private specialists;
 - Implementation planning, e.g. infection control, and technical government officials and public-private specialists; and
 - Implementation, e.g. health inspectors, and waste management technical specialists.

Problem statement: Hazardous waste from small rural generators



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- Highly infectious waste
 - Classified as second most dangerous i.t.o. HEP B/C on a needle.
- Under resourced
 - No facilities and/or funding to change things quickly
- Therefore: Require an appropriate system
 - Safe
 - Achievable
 - Can be monitored
 - Continuous improvement
 - Agenda 21

Procedure to obtain a solution to the problems at primary health care clinics



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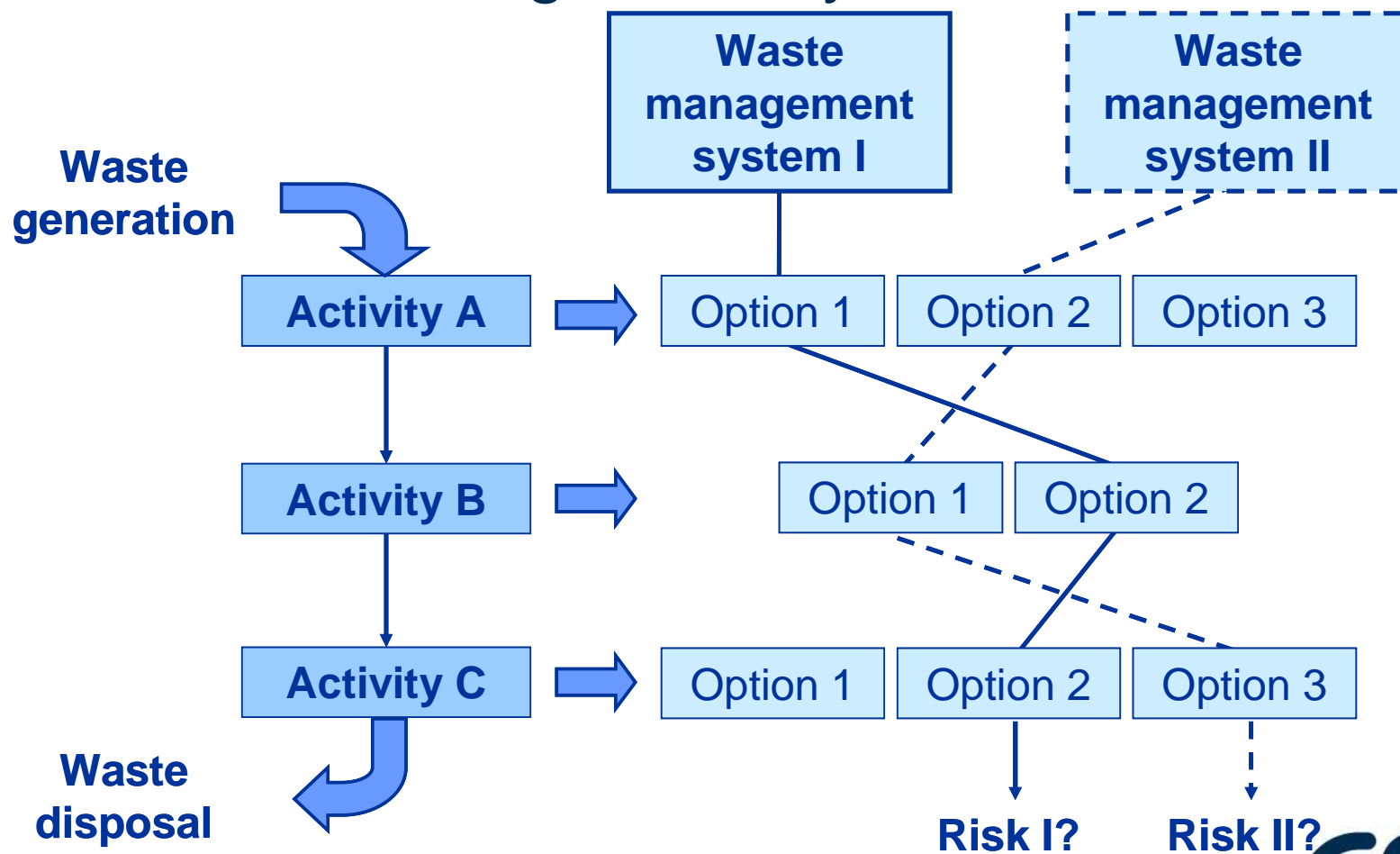
- Identify the activities that are required to manage the waste at primary health care clinics in rural area (along the waste life cycle)
 - From waste generated at the treated patient to final disposal.
- Identify options for the activitiesNo facilities and/or funding to change things quickly
 - Technological and equipment options.
 - Infrastructure options.
 - Procedural options.
- Assign priorities for safety for each option
- Identify waste management systems
 - Based on a combination of the different options at the activities
 - With the least risk to the public health (in general)



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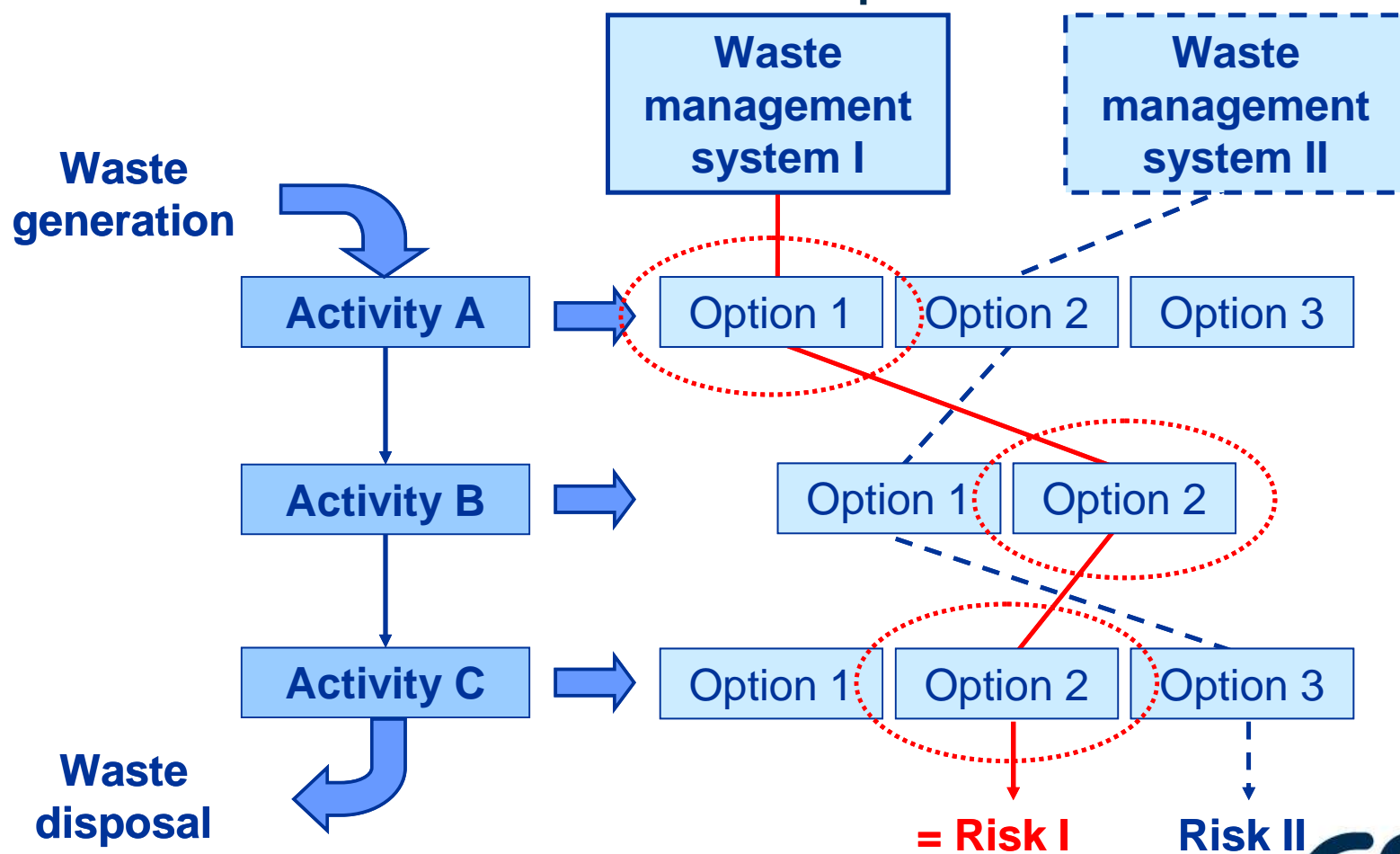


Identification of activities, options and waste management systems





The total risk is a combination of the risks associated with options / activities



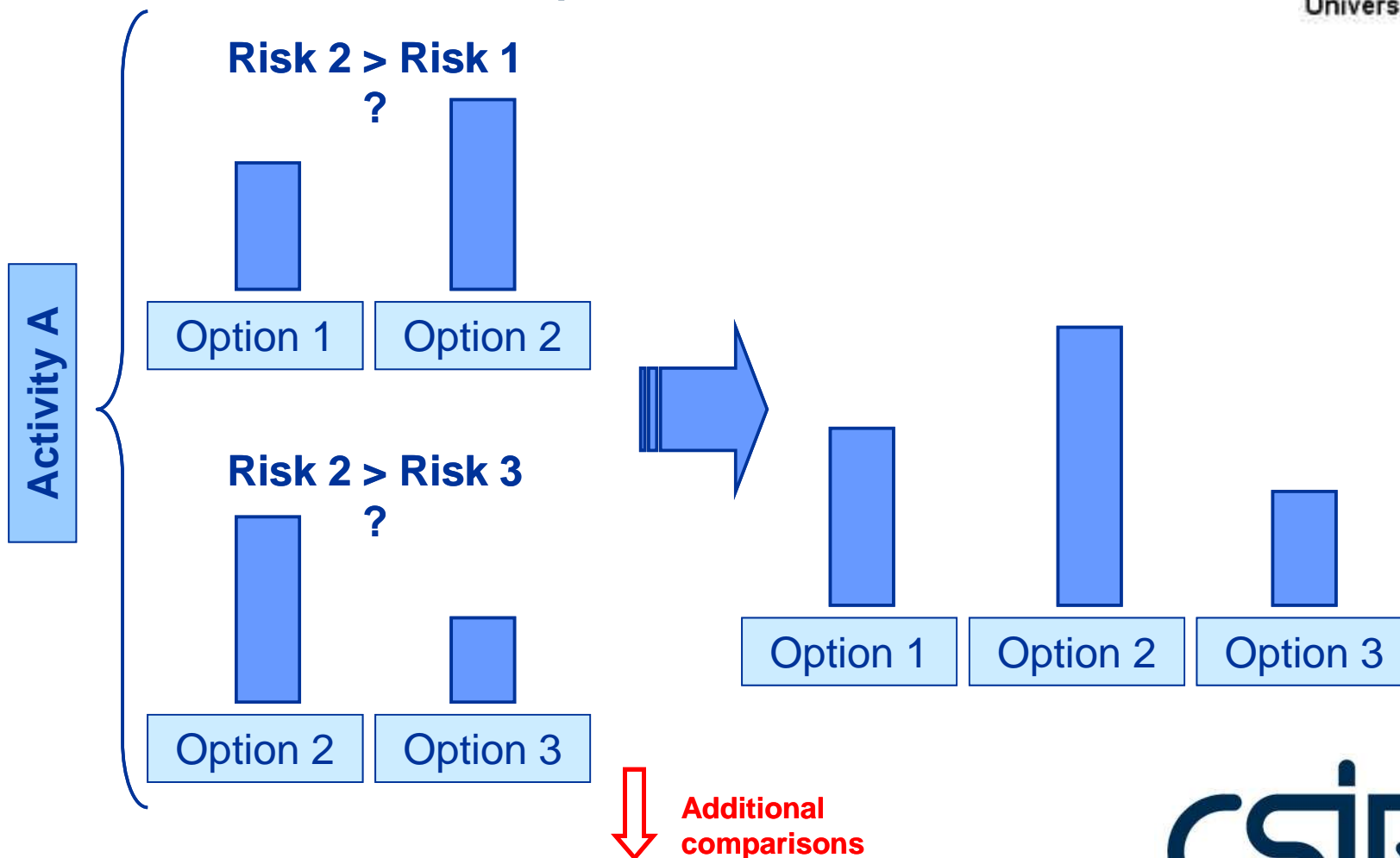
Waste disposal



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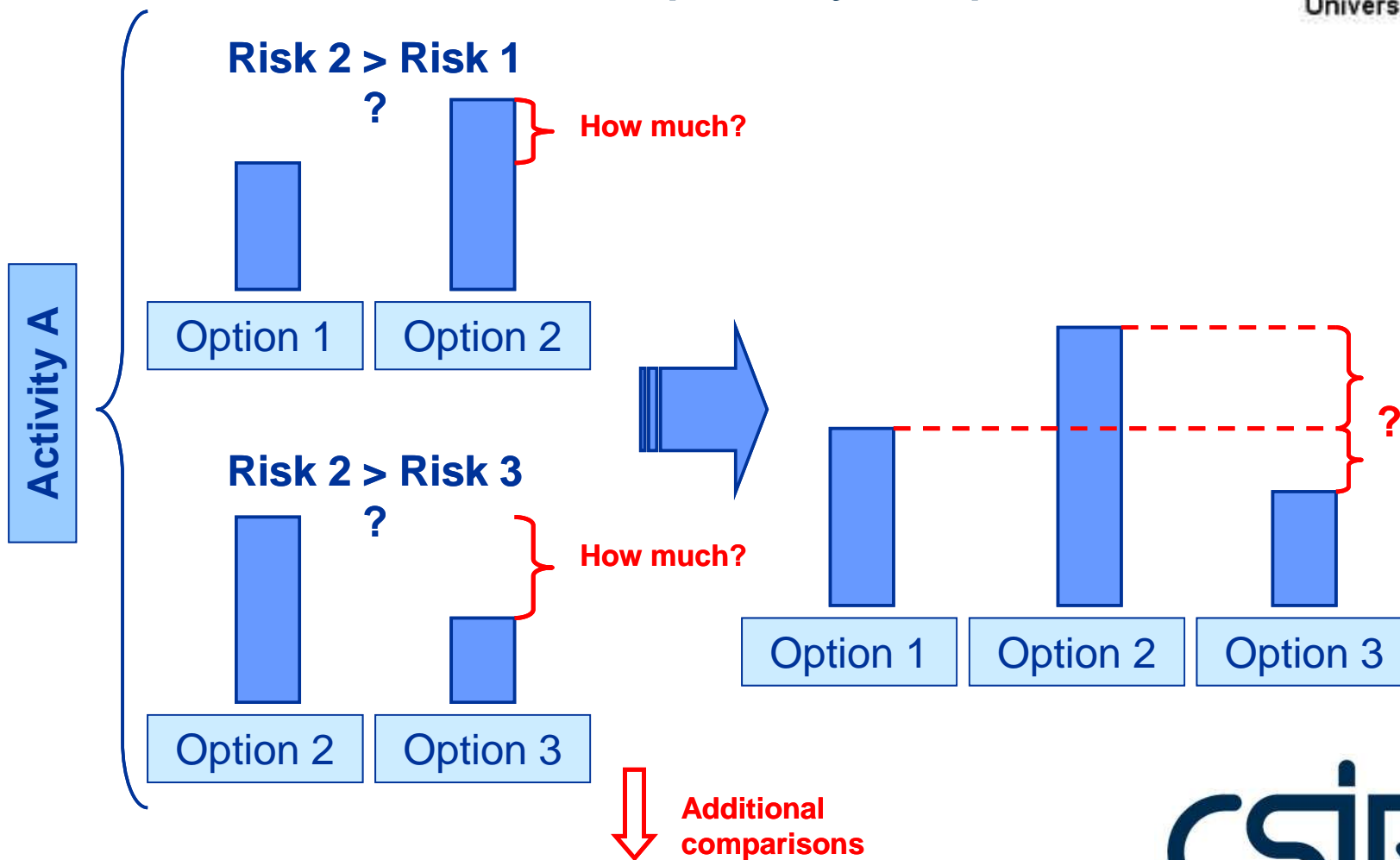


Ranking of options' risks at the activities are therefore required





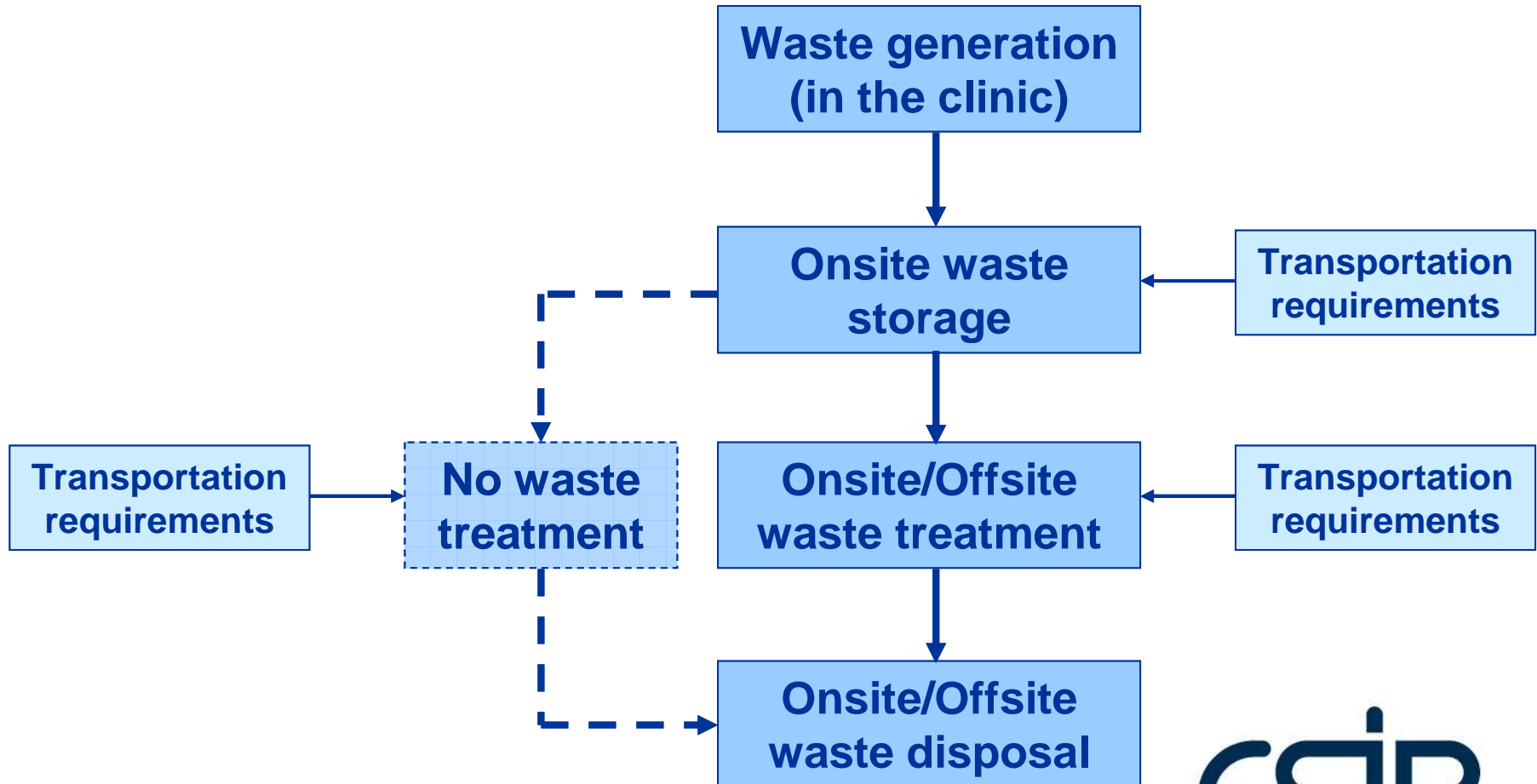
Weighting of options' risks at the activities are subsequently required



Activities identified along the life cycle of waste (at primary health care clinics)



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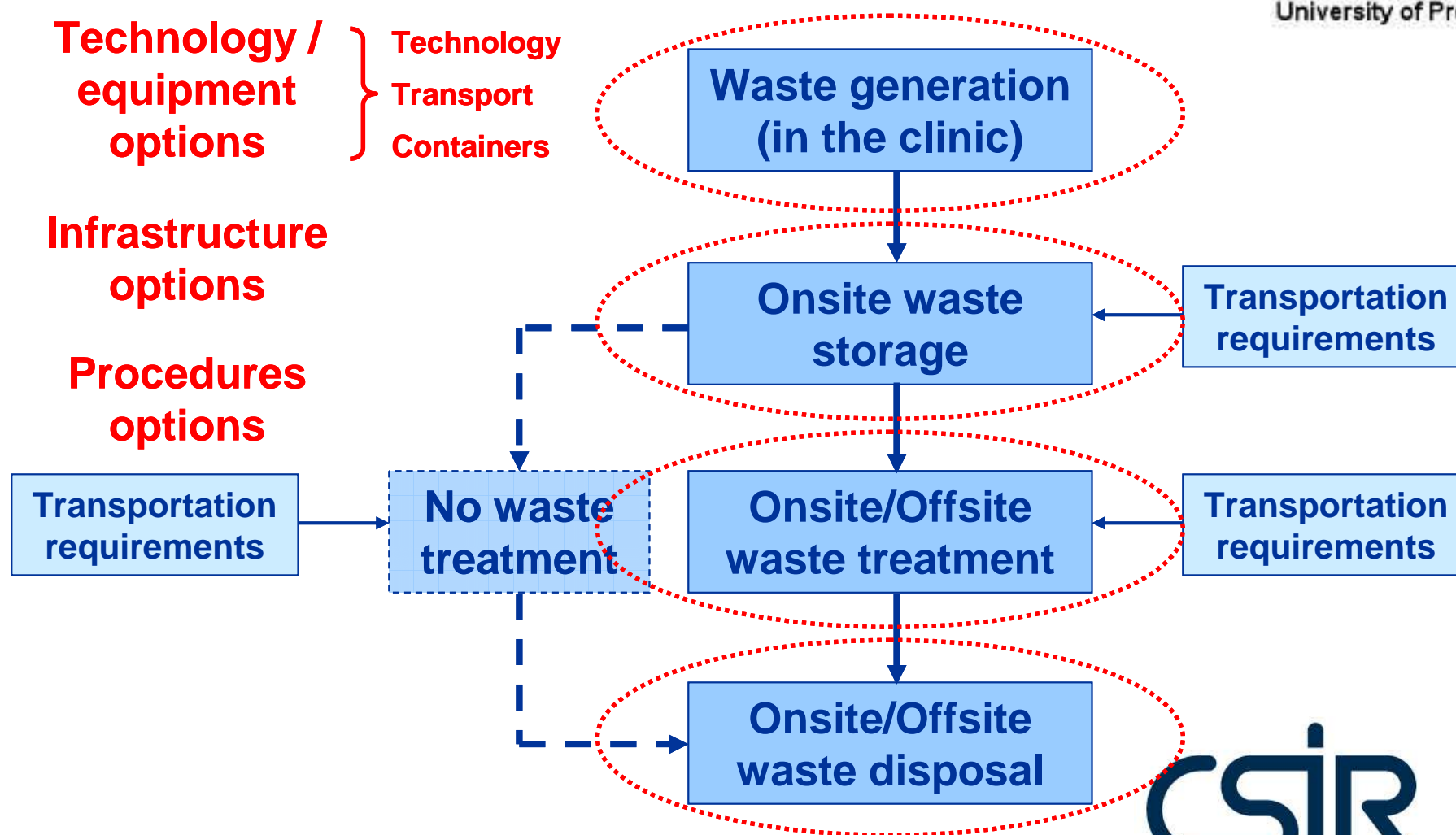
Options have been identified for these activities

Technology / equipment options

Technology
Transport
Containers

Infrastructure options

Procedures options



Activity options are dependent on the description of primary health care waste



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- Health care waste is any material that is produced during the health care process, which will not be re-used, refurbished or recycled, and is intended for disposal. It may contain some or all of the following:
 - Medical supplies that have served their purpose and reached the end of their useful life (e.g. sharps such as syringes, scalpels, and softs such as bandages, swabs).
 - Empty vials or other containers from pharmaceutical supplies.
- It is considered not to contain:
 - Pharmaceutical waste (all pharmaceuticals are typically used up in primary rural health care centres).
 - Packaging material (this is considered normal domestic waste, to be separated from health care risk waste).
 - Anatomical waste (amputations typically not performed at primary health care centres).



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Activity options are dependent on the description of primary HCW facilities



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- Rural primary health care facilities typically serve up to 100 people per day, and provide services such as basic health care, inoculation, etc. Medical supplies that have served their purpose and reached the end of their useful life (e.g. sharps such as syringes, scalpels, and softs such as bandages, swabs).
 - They are managed by a nurse who reports to a district health care centre or hospital.
 - They do not cater for overnight patients (only day-care / outpatient care).



Workshop questions that had to be answered



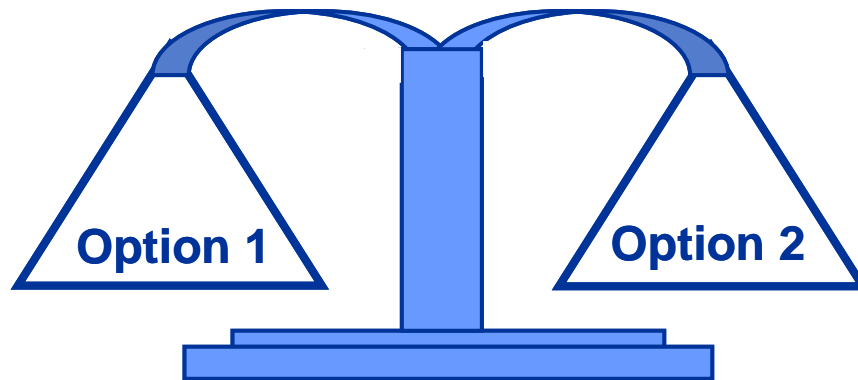
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- How do activity options compare?
 - Options at each activity of the waste life cycle.
 - From initial generation to final disposal.
 - In terms of infection risk and occupation/public safety.

 **Ranking**

- Which option is more important compared to another?
 - In terms of minimising infection risk.
 - Comparison of all options against each other.

 **Weighting**

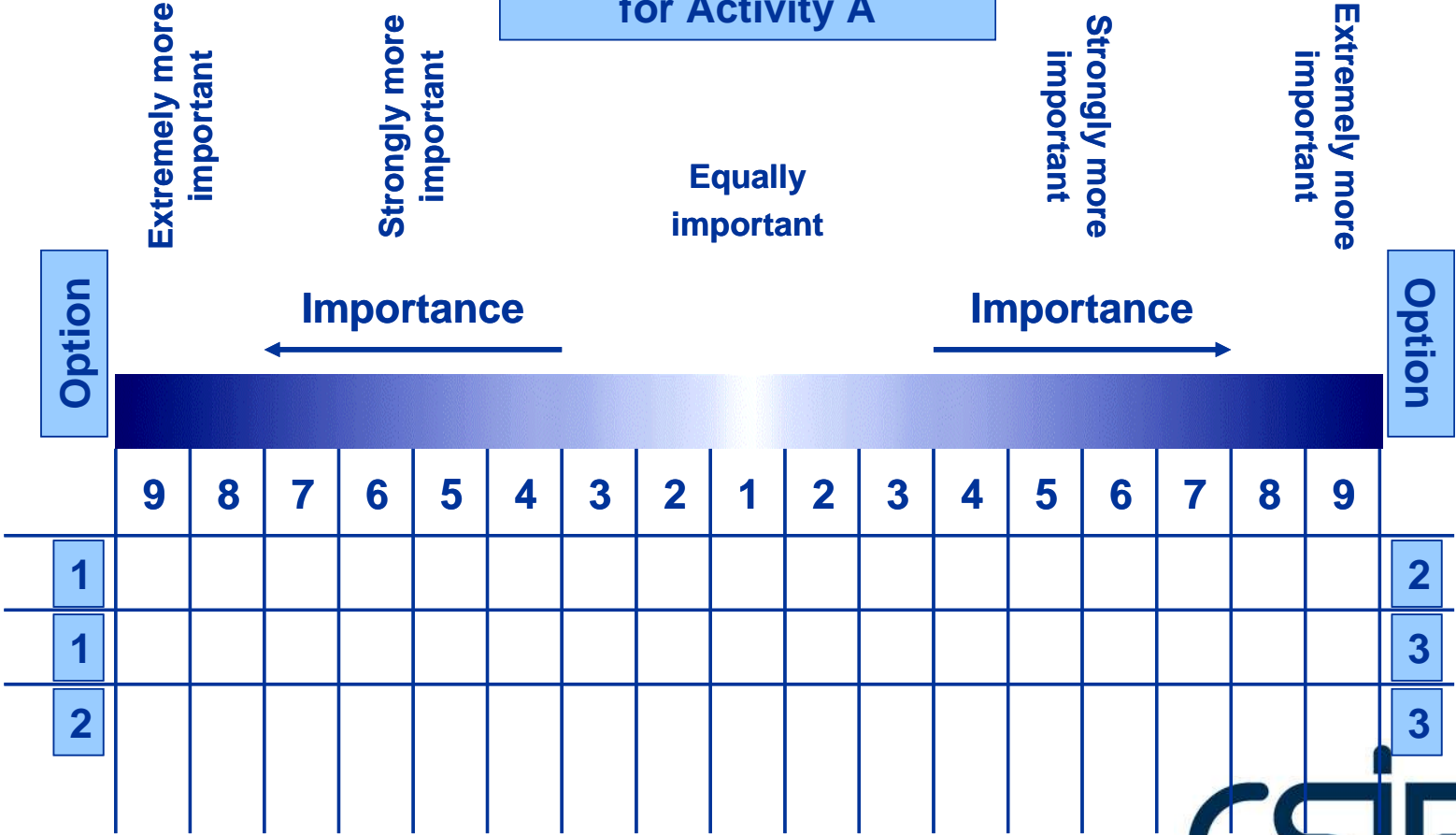


Analytical Hierarchy Procedure (AHP) to determine weighting factors



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Comparison of options for Activity A

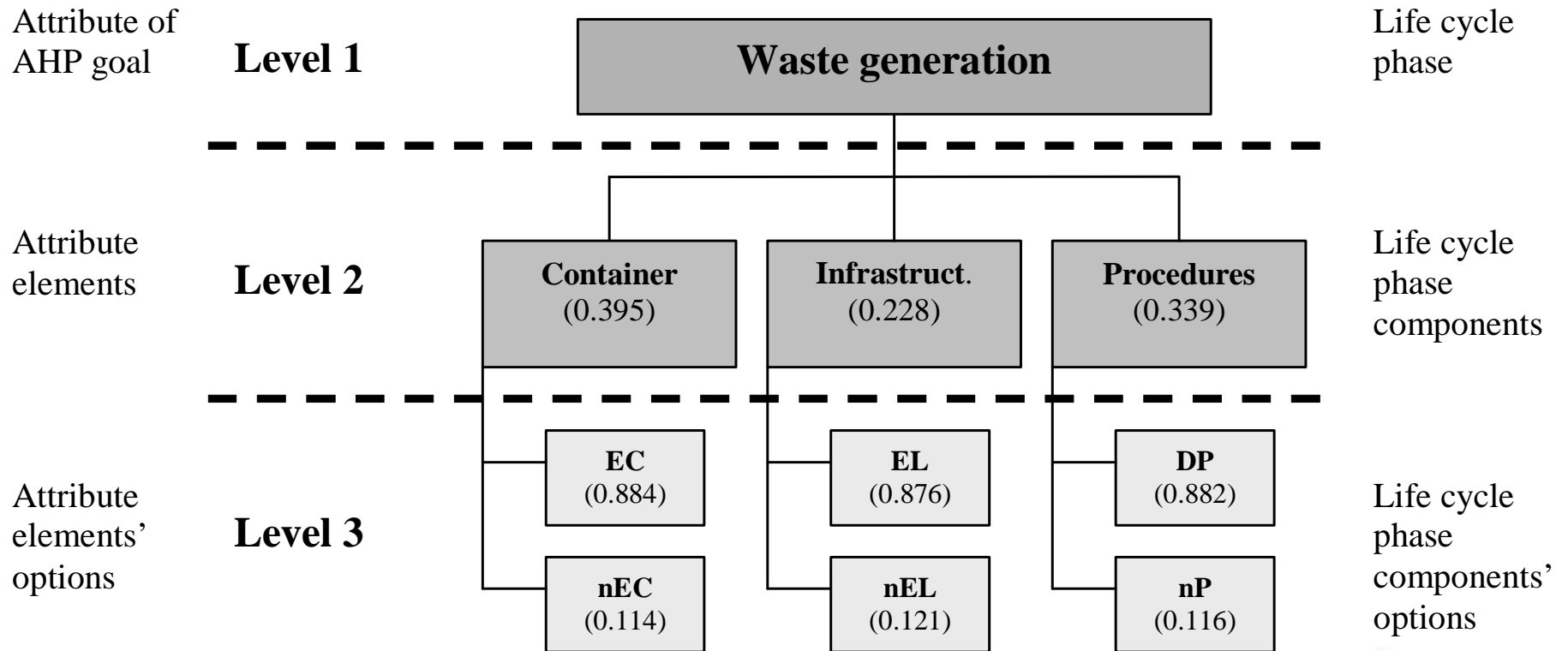


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Example of the hierarchical tree for the waste generation life cycle phase



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Alternatives are combinations of options, e.g. nEC + EL + nP



Photographs shown with discussion for mutual understanding in the group



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Example of AHP results: Waste generation life cycle phase



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Part. No.	Level 2				Level 3.1			Level 3.2			Level 3.3			Avg. CR
	Cont.	Infra.	Proc.	CR	EC	nEC	CR	EL	nEL	CR	DP	nP	CR	
1	0.333	0.333	0.333	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.000
2	0.460	0.221	0.319	0.117	0.900	0.100	0.000	0.889	0.111	0.000	0.889	0.111	0.000	0.029
3	0.413	0.260	0.327	0.046	0.833	0.167	0.000	0.857	0.143	0.000	0.875	0.125	0.000	0.012
4	0.400	0.400	0.200	0.000	0.875	0.125	0.000	0.875	0.125	0.000	0.833	0.167	0.000	0.000
5	0.333	0.333	0.333	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.000
6	0.333	0.333	0.333	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.000
7	0.333	0.333	0.333	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.000
8	0.333	0.333	0.333	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.900	0.100	0.000	0.000
9	0.571	0.143	0.286	0.000	0.857	0.143	0.000	0.857	0.143	0.000	0.857	0.143	0.000	0.000
10	0.455	0.091	0.455	0.056	0.875	0.125	0.000	0.833	0.167	0.000	0.875	0.125	0.000	0.014
11	0.452	0.072	0.476	0.002	0.889	0.111	0.000	0.833	0.167	0.000	0.875	0.125	0.000	0.001
Mean	0.395	0.228	0.331	-	0.884	0.114	-	0.876	0.121	-	0.882	0.116	-	-
Avg.	0.401	0.259	0.339	0.020	0.884	0.116	0.000	0.877	0.123	0.000	0.882	0.118	0.000	0.005
Std. Dev.	0.078	0.112	0.074	0.038	0.022	0.022	0.000	0.027	0.027	0.000	0.022	0.022	0.000	0.010



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Calculation of risk indicators for each alternative for a life cycle phase



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Options	Overall weights
EC	0.349
NEC	0.045
EL	0.200
NEL	0.028
DP	0.292
NP	0.038

Alternatives	Risk factors
EC+EL+DP	1.0
nEC+EL+DP	1.6
EC+nEL+DP	1.3
nEC+nEL+DP	2.3
EC+EL+nP	1.4
nEC+EL+nP	3.0
EC+nEL+nP	2.0
nEC+nEL+nP	7.6

Issues identified with applying AHP



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- The available time for a workshop
 - At least two days with two workshop facilitators and one assistant are required.
- Group size
 - A workshop should comprise of no more than 15 participants that represent the different stakeholder groups of the HCWM systems.
- Diversity of educational level and background of participants
 - Facilitators of workshops must take cognisance of the fact that the stakeholders of HCWM systems in developing countries represent different levels in public and private sectors, with varying educational backgrounds. Therefore separate discussions in subgroups may be necessary to reach consensus and thereby improve consistencies.

Issues identified with applying AHP



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- **AHP scale and set of comparisons**
 - Much time is required to explain the AHP scale, the set of pair-wise comparisons, and the importance of consistency in order to achieve buy-in to the process.
- **Individual judgements**
 - The problem of judgements, and possible outliers, has been noted (Laininen and Hämäläinen, 2002), which can be addressed with mathematical manipulation of the AHP matrices such as regression. At the very least it is important to report the intervals of priority weights (Mustajoki et al., 2005).

Questions

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See also: Brent, Rogers, Ramabitsa-Siimane, Rohwer.
European Journal of Operational Research.
In press and available on request

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