Integrating LCIA and LCM:

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Evaluating environmental performances for supply chain management

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Foundations of LCE at UP

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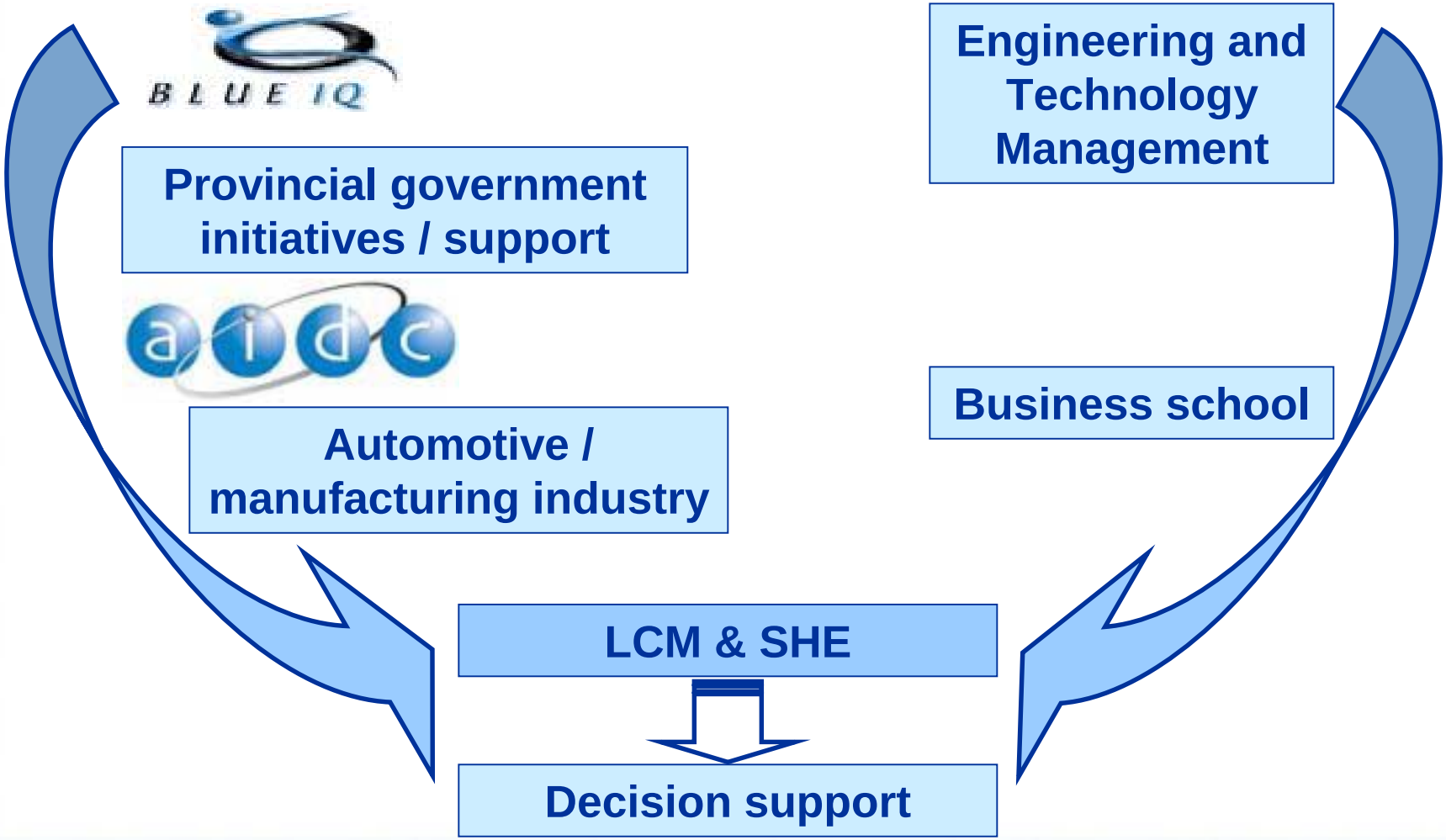

Integration of the LCE activities in the Automotive Focus Group (AFG) of UP

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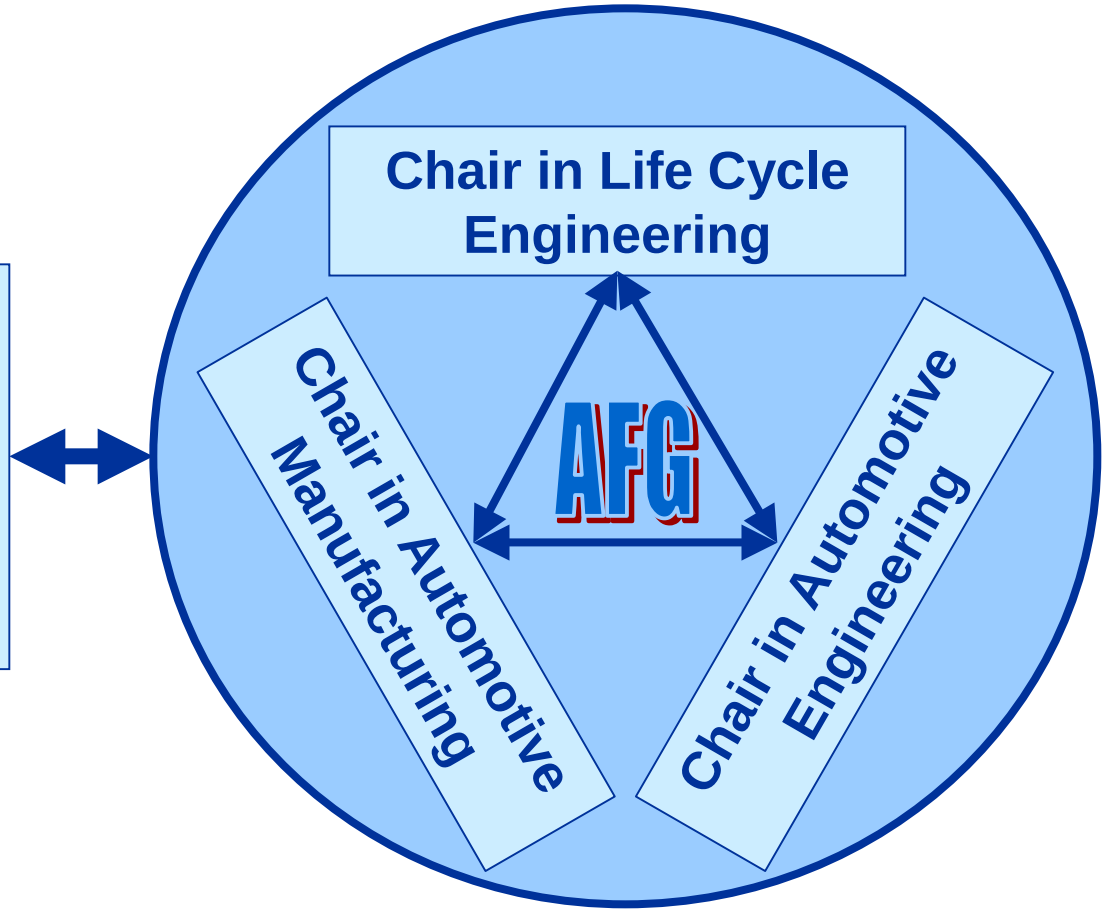
Total engineering and management support of the SA automotive industry



The automotive industry as a major exporter of South African products

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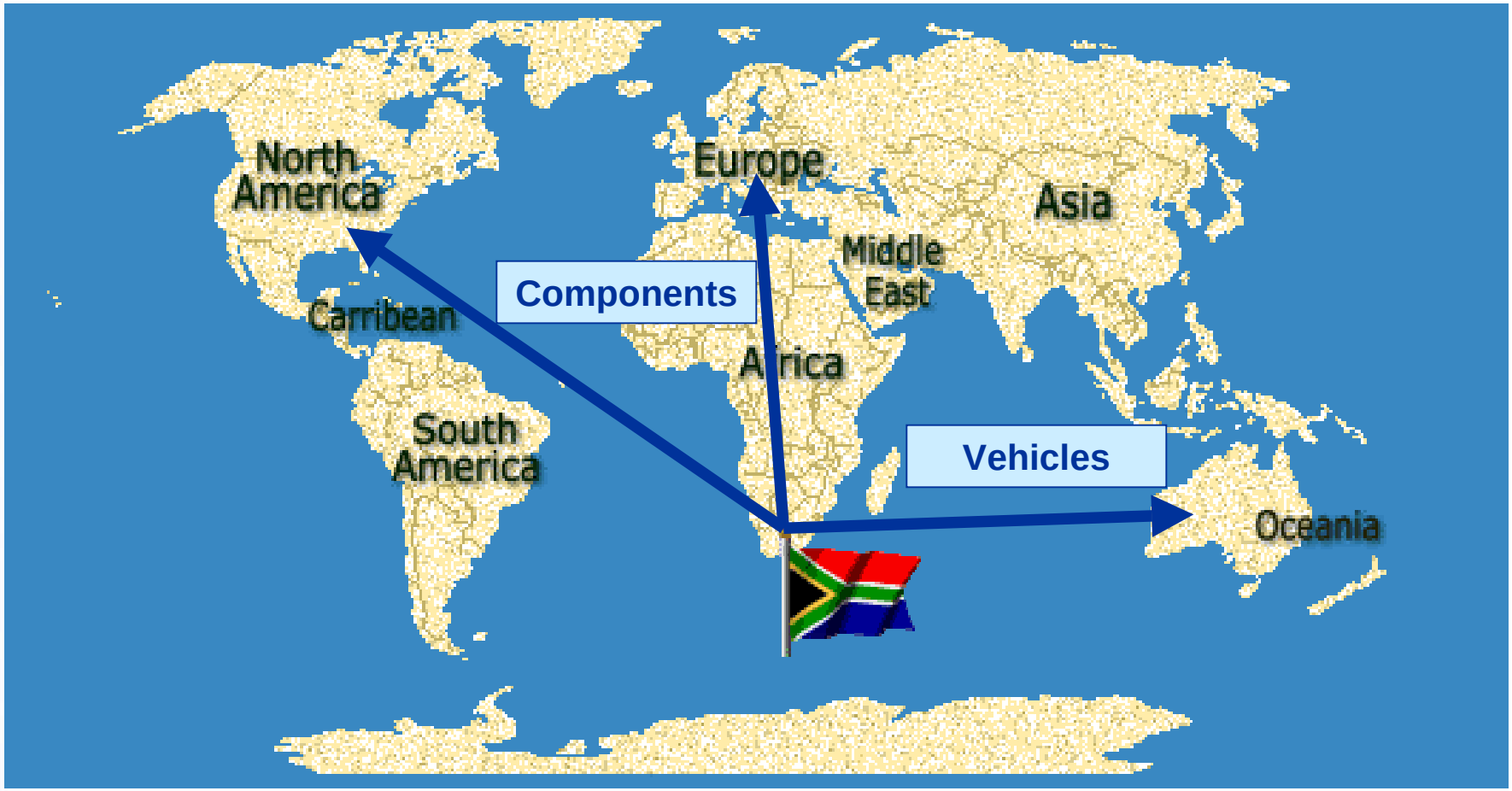

The main destinations of the component exports

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Component manufacturers

- 74 % to Europe (46 % to Germany)
- 10 % to North America

- Catalytic converters (26.6 %)
- Stitched leather seat covers (19.5 %)
- Tyres (6.6 %)
- Exhaust systems (6.2 %)
- Wheels (mostly aluminium) (5.4 %)

Future trends in the responsibility of industry

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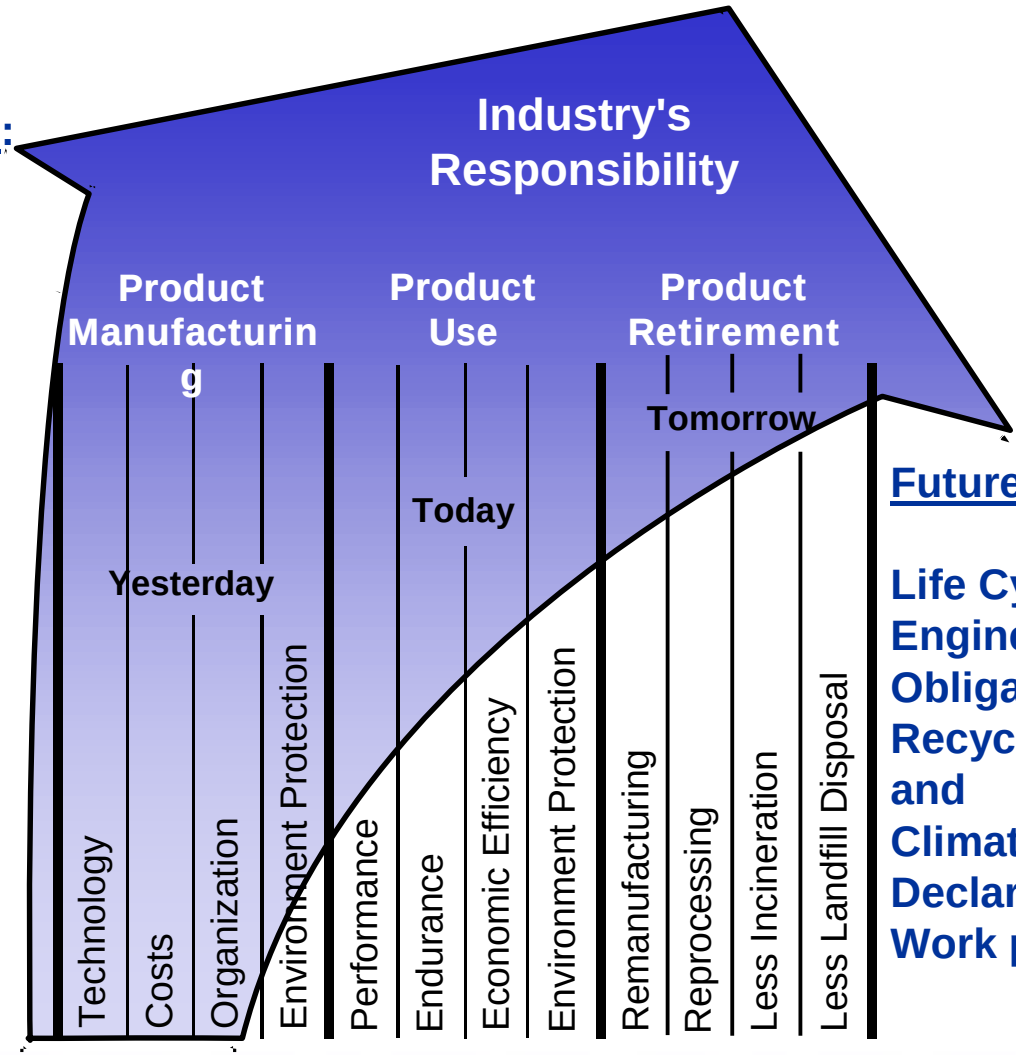
Present Challenges:

Product Take Back Regulations, Recycling, Work place



Future Challenges:

Life Cycle Engineering Obligations, Recyclability (waste) and Climate Protection Declarations Work place (new age)

Incorporating sustainable development concepts into management practices

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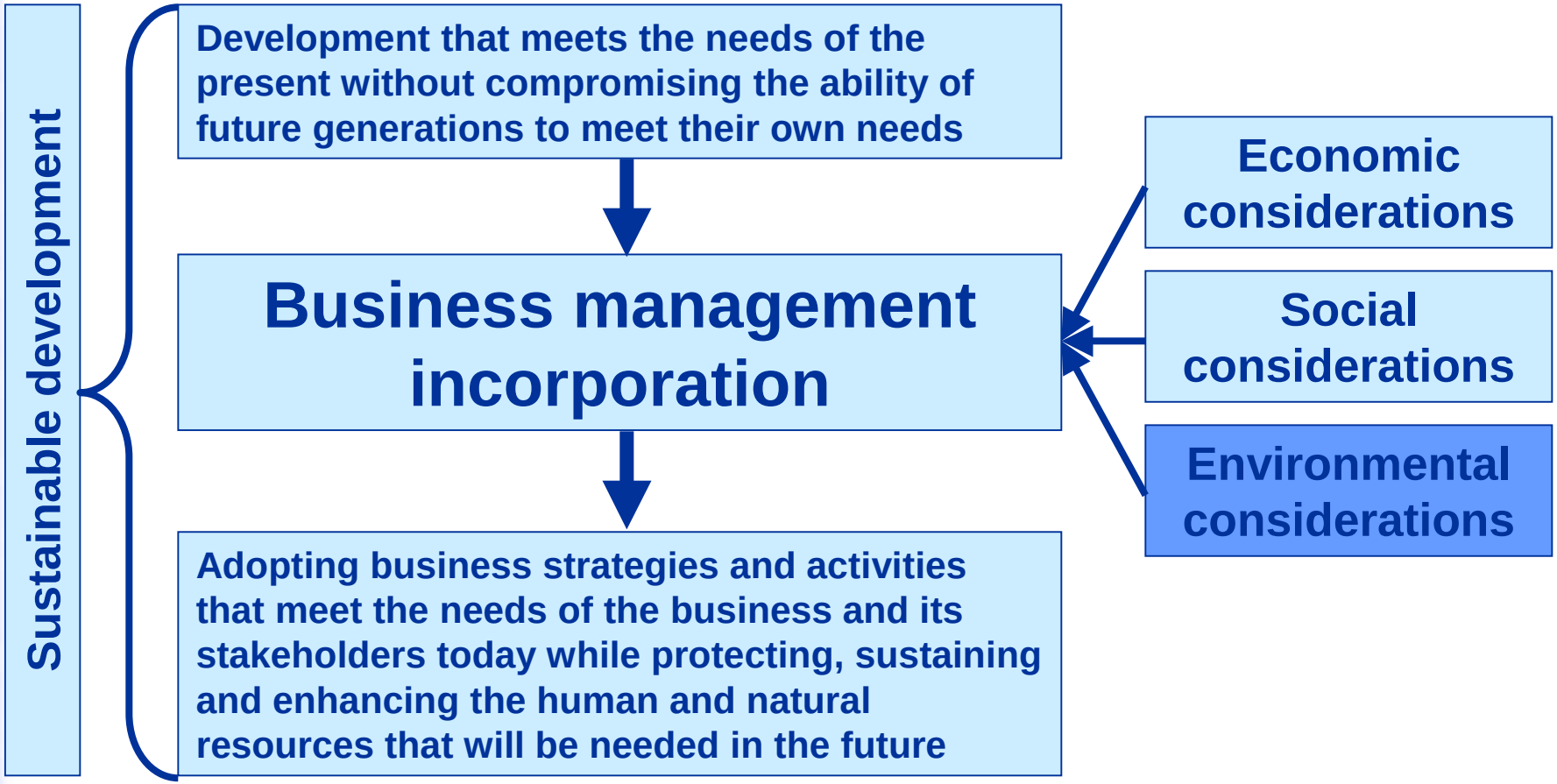

Three life cycles that are fundamental to management in the manufacturing industry

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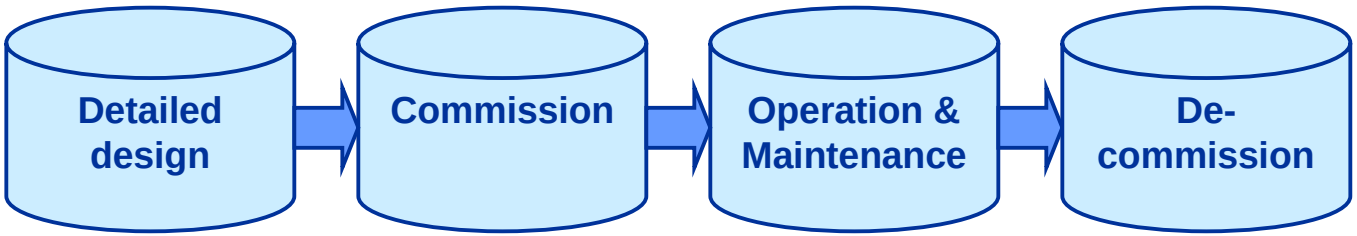
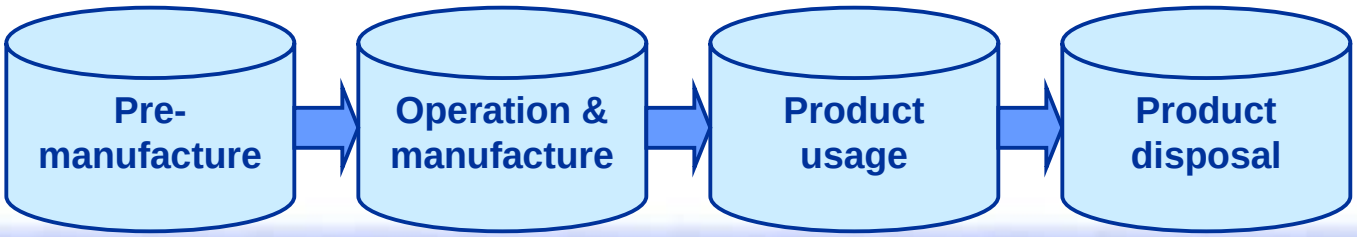
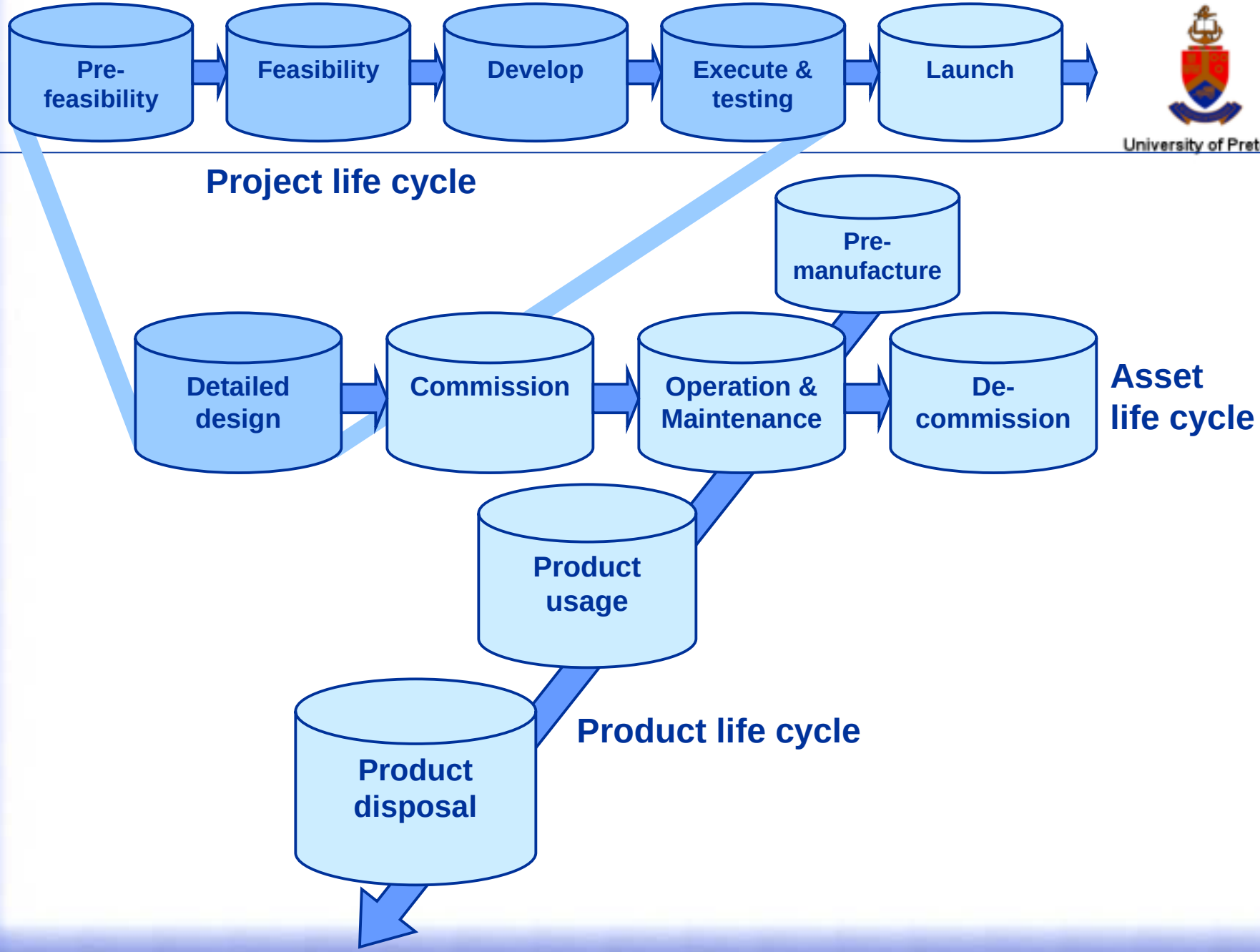
- **Project life cycles – drivers of internal change**

- **Asset life cycles – optimise internal operations**



- **Product life cycles – profit generation of operations**





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Application of the LCE approach for different management requirements

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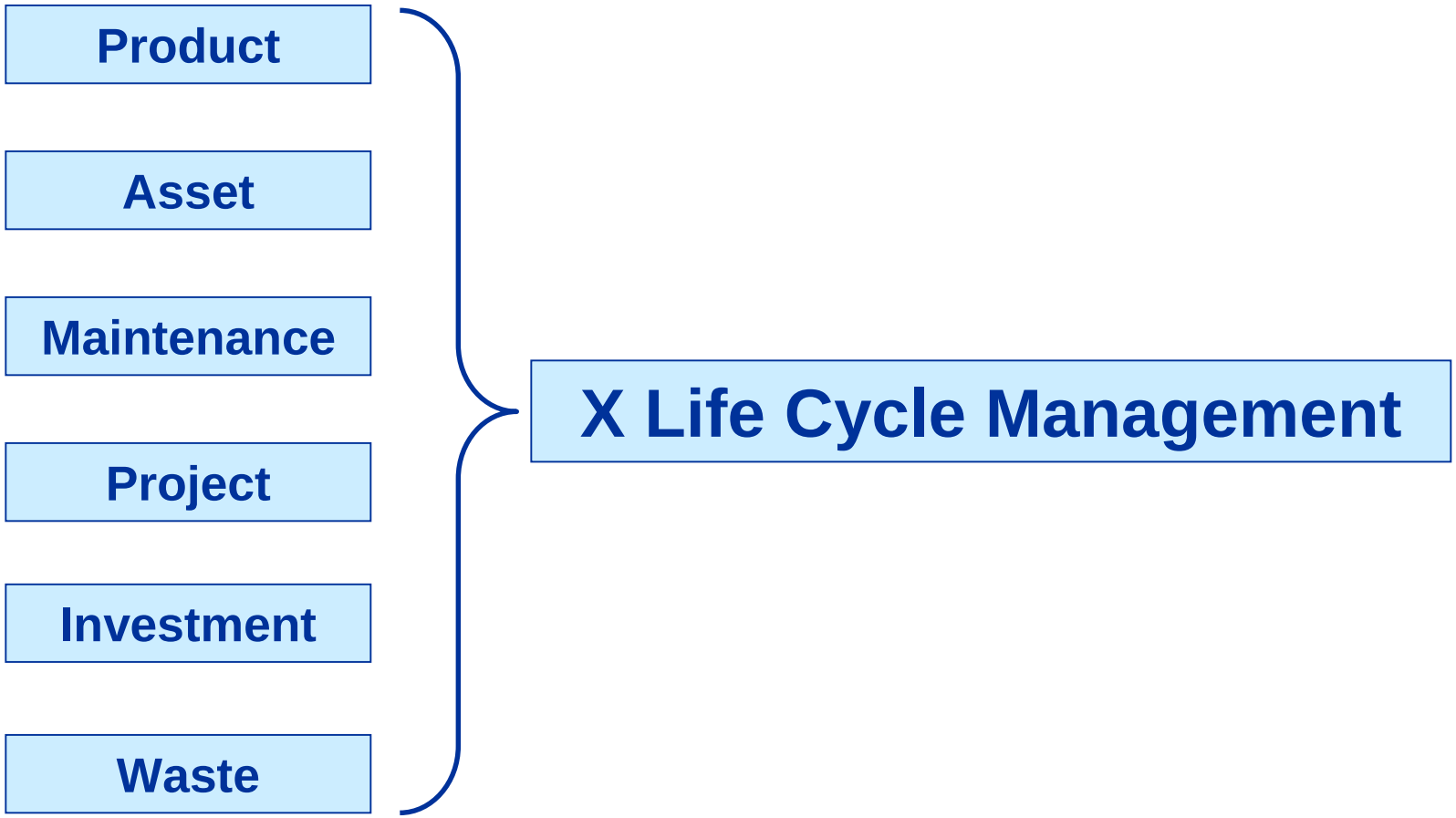

Sustainable supply management within the integrated Life Cycle Management approach

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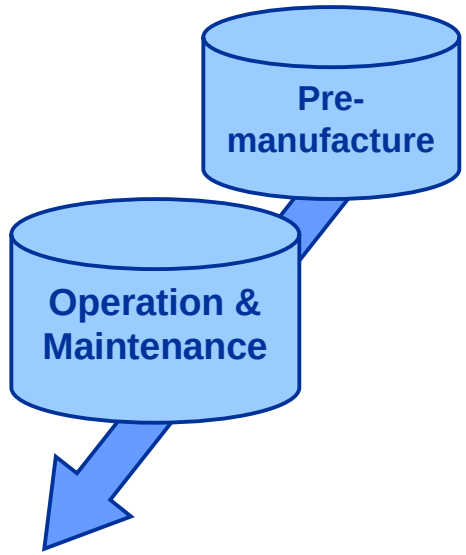
- Integrating with existing management practices
  - Environmental management
  - Quality management
  - Logistics management
  - Procurement management
  - Maintenance management
- Understanding the value/burden addition of suppliers
  - Added economic value
  - Added environmental burdens
  - Social?



Accumulated value and burdens of manufactured products (environmental burdens example)

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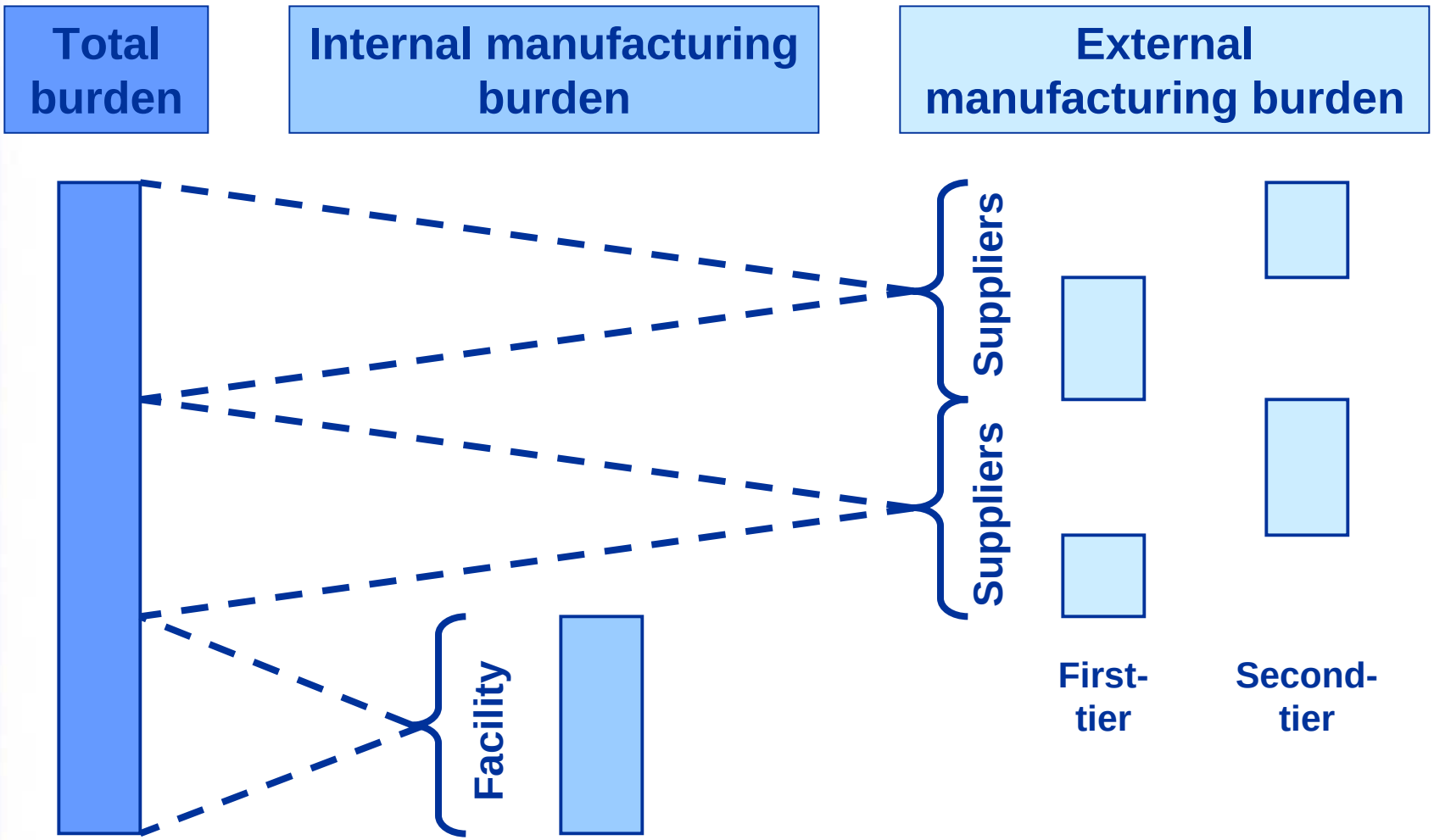

Sustainable supply chain management therefore focuses on environmental performances

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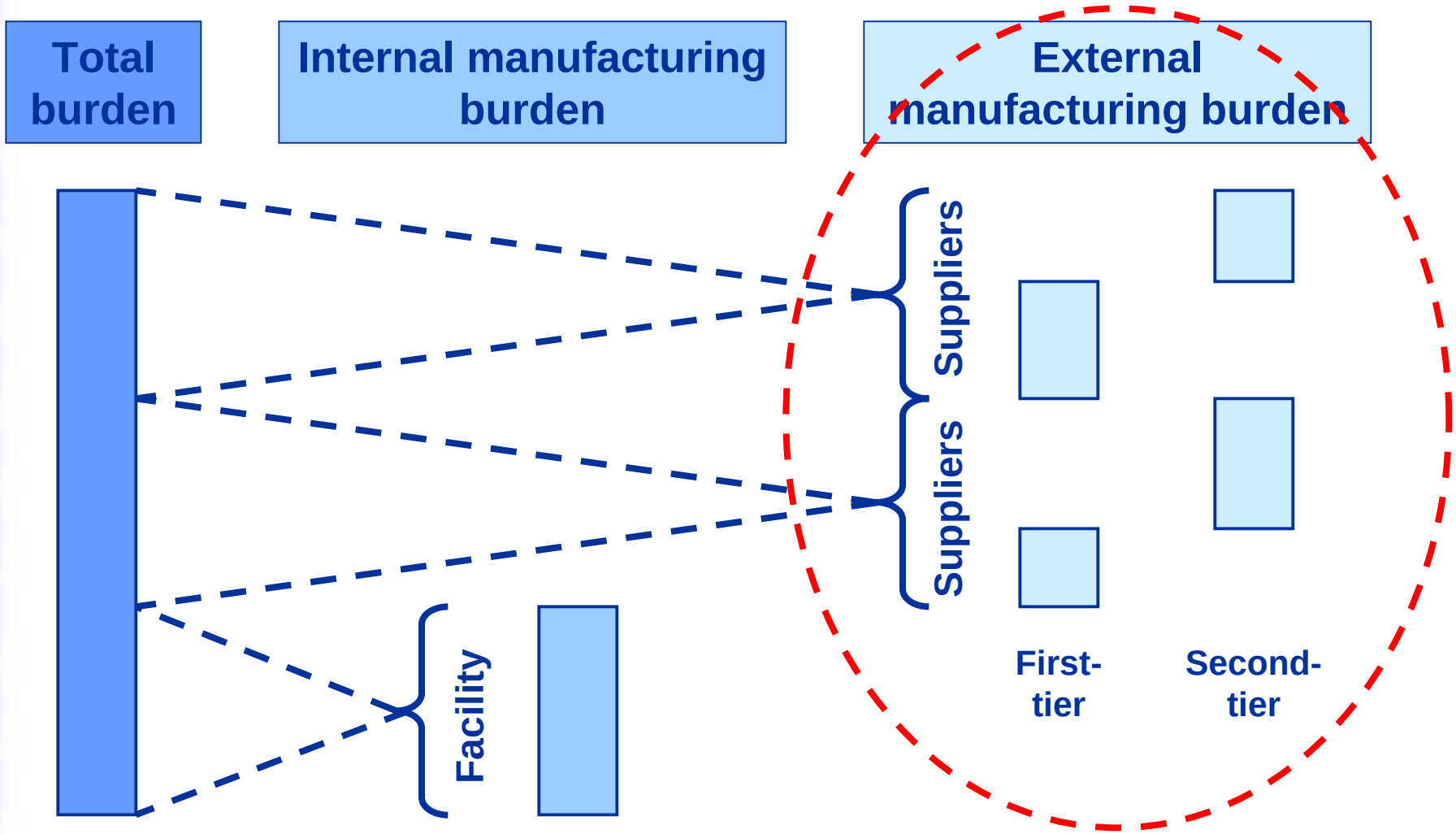

Problems with assessing environmental performances (from an OEMs perspective in SA)

- Lack of detailed environmental data in developing countries
  - Precise environmental impact causes can not be determined
- Smaller supplying countries in developing countries have only limited process information
  - Only certain process information is currently (systematically) obtained by OEMs in South Africa
    - Water usage
    - Energy usage
    - Waste produced (for land filling)
- Comparing environmental performances
  - Valuated comparisons from an OEMs perspective

True reflection of environmental burdens in the South African context

Assessing environmental performances from limited process parameters

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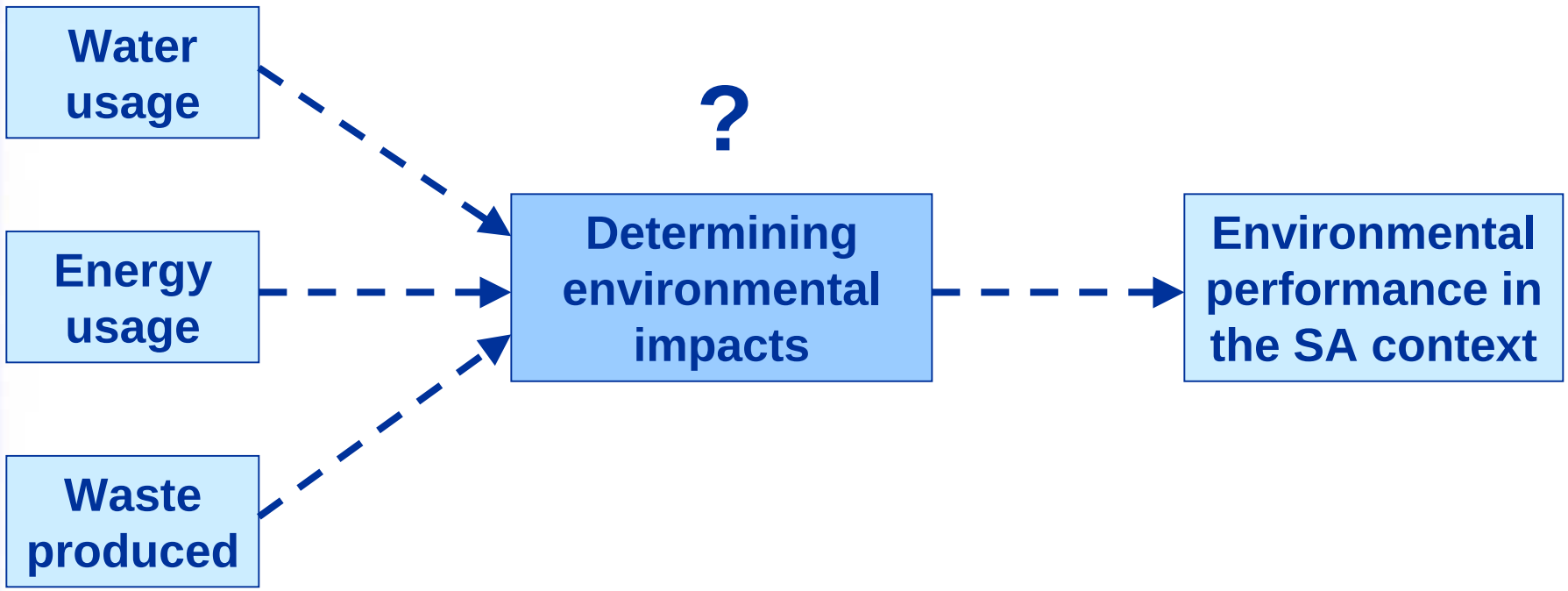

Assessing environmental performances from limited process parameters (using ISO 14040)

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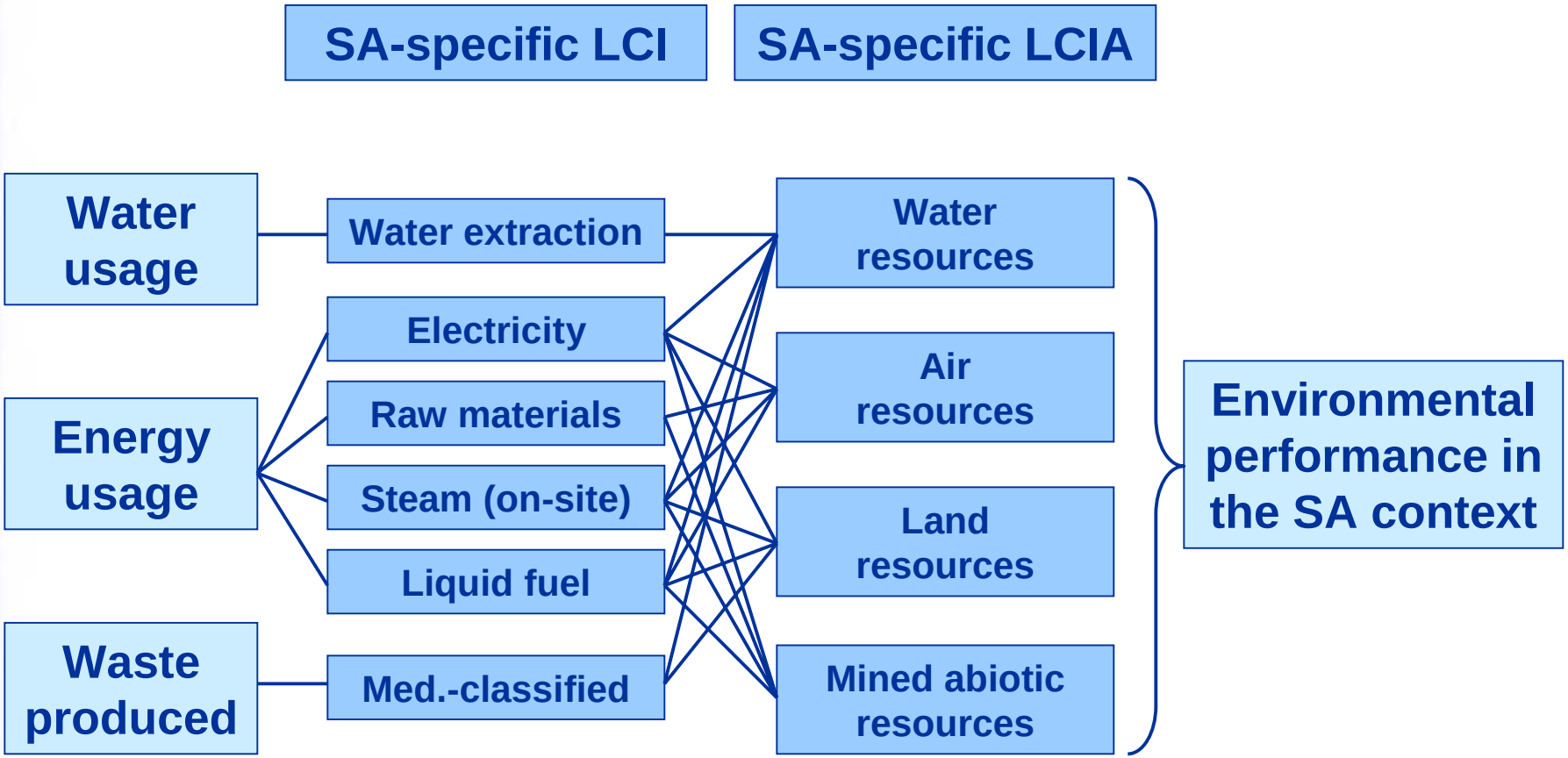

Assessing environmental performances from limited process parameters (SA-specific LCIA)

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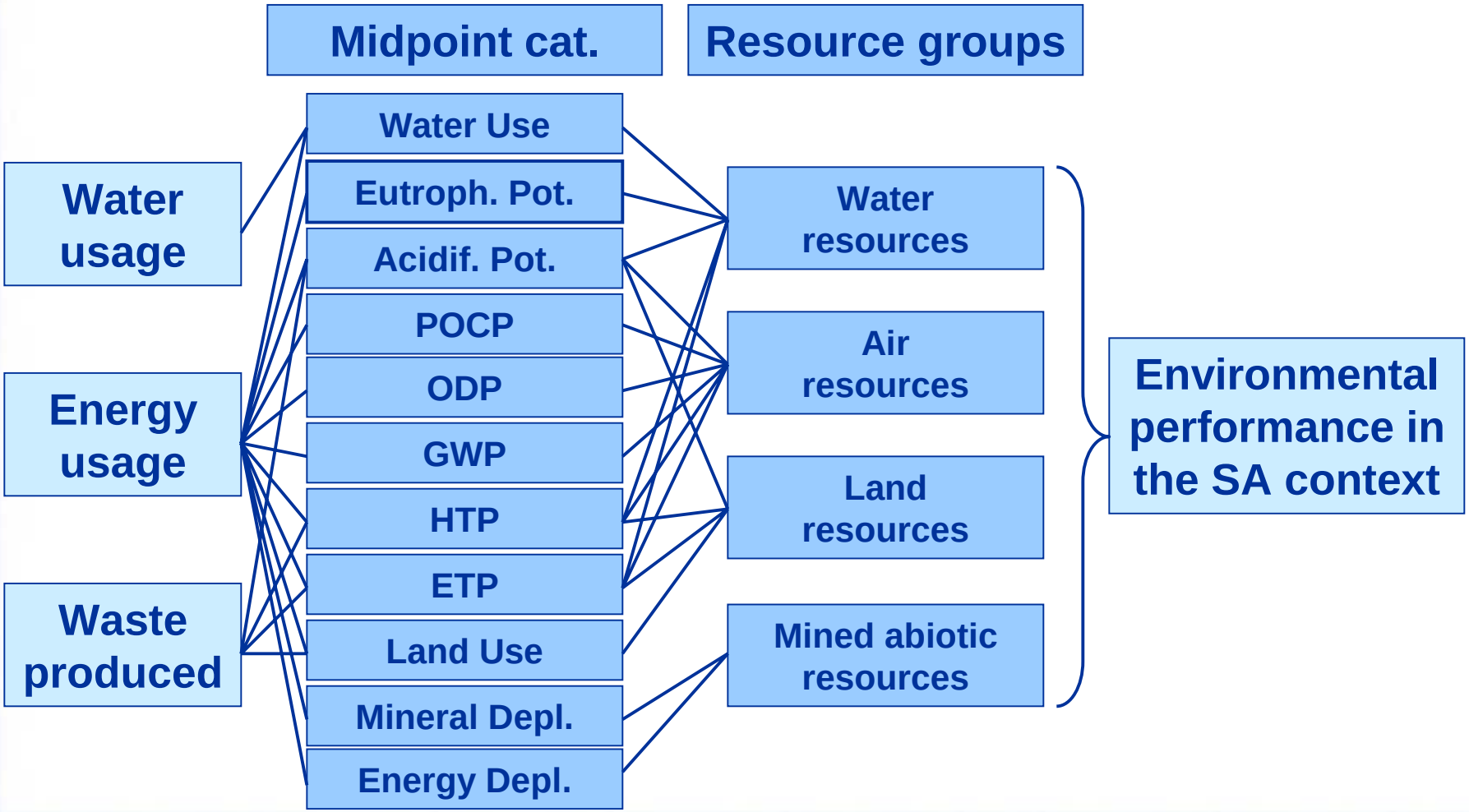

The impacts on the resource groups must reflect the variance in the SA eco-regions

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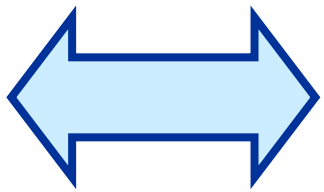

Introduced SALCA Regions for impact assessment of natural resource groups

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Environmental resources data compiled for these SALCA Regions

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- **Water quality and quantity**
  - Measurement data of key pollutants
    - Metals, organics, sulphates, etc.
  - Maximum yield and usage
- **Regional and global air impacts**
  - Ambient measurement data in major metropolitan areas
  - CO_2 and CFC-11 measurement data (all regions)
- **Land quality and quantity**
  - Measurement data of key pollutants
    - Metals, phosphates, etc.
  - National land cover database
    - Land uses, types, etc.
- **Mined abiotic resources**
  - Platinum reserves (national level)
  - Coal reserves (national level)

Ambient targets to protect resources, human health and ecosystems

Calculation of Resource Impact Indicators (per unit of process parameters

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$$RII_G = \sum_C \sum_X Q_X \cdot C_C \cdot N_C \cdot S_C$$

- RII_G = Resource Impact Indicator calculated for a main resource group through the summation of all impact pathways of LCI constituents
- Q_X = Quantity release to or abstraction from a resource of life cycle constituent X of a LCI system in an impact category C
- C_C = Characterisation factor for an impact category (of constituent X) within the pathway
- N_C = Normalisation factor for the impact category based on the ambient environmental quantity and quality objectives, i.e. the inverse of the target state of the impact category
- S_C = Significance (or relative importance) of the impact category in a resource group based on the distance-to-target method, i.e. current ambient state divided by the target ambient state

Normalisation of RII performances of companies with economic value of products (to OEMs)

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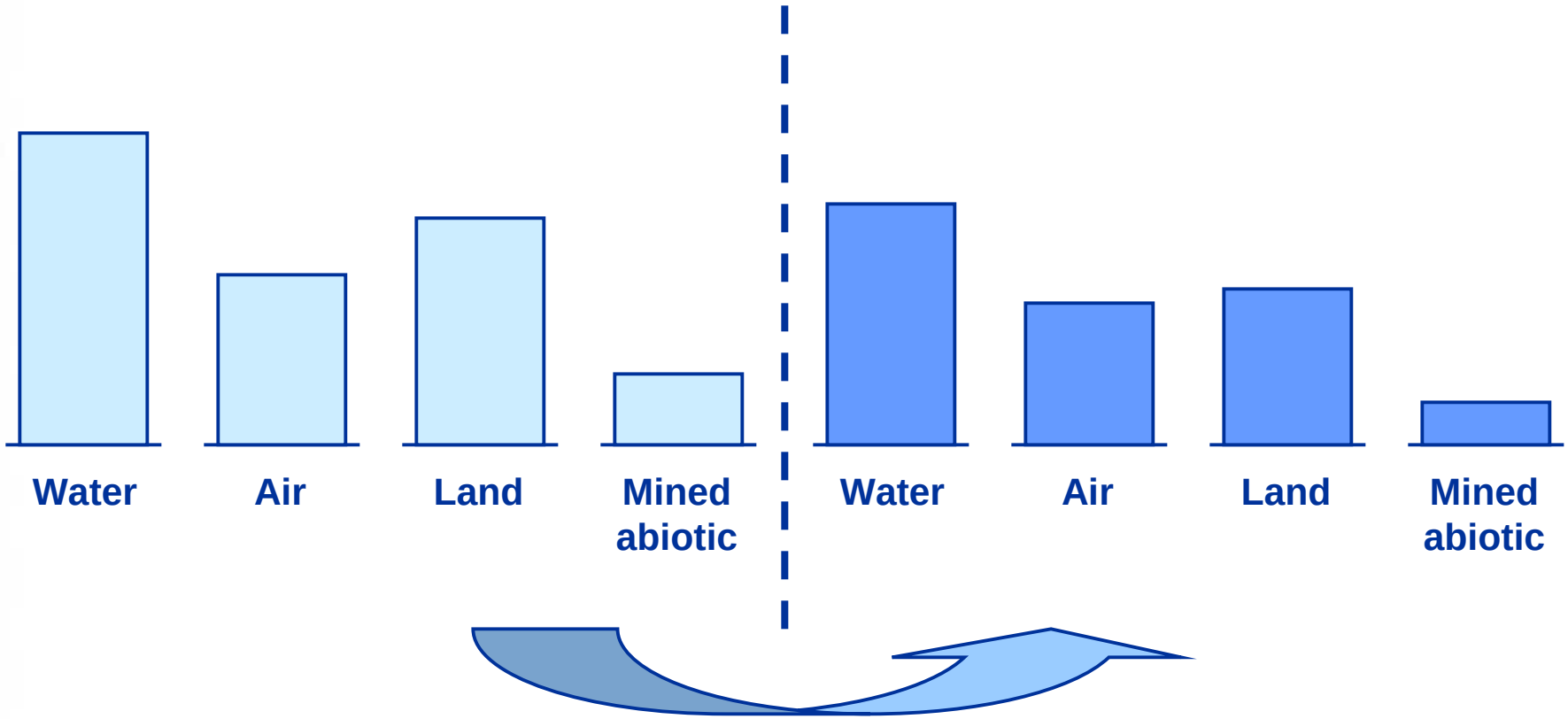

Normalisation with economic values of products (to OEMs)

Case study: Process parameters obtained from a South African OEM's first-tier suppliers

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		Fuel tank[a]	Windscreen[a]	Tyre[a]
Energy usage				
• Electricity	MJ	63.7	60.5	234.1
• Liquid fuel (diesel)	kg	0.0	0.0	0.0
• Steam	kg	0.0	0.0	20.4
• Raw materials	kg	0.0	2.0[b]	0.0
Water usage	kg	4.6	176.8	20.5
Waste produced	kg	0.1	32.0	1.0[c]
Economic value[d]	R	1000.00	1460.00	500.00

a Process parameters are shown per supplied component
b Natural gas for furnace operation
c 10% assumed losses
d 9 South African Rand is equal to approximately 1 Euro (€)

RII values calculated per supplied component

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	Fuel tank[a]	Windscreen[a]	Tyre[a]
Water resources	2.882×10^{-1}	2.779×10^{-1}	1.067×10^{0}
Air resources	6.535×10^{-3}	6.206×10^{-3}	2.406×10^{-2}
Land resources	6.148×10^{-5}	6.113×10^{-5}	2.271×10^{-4}
Mined abiotic resources	3.222×10^{-5}	4.051×10^{-5}	1.271×10^{-4}

RII values calculated per supplied component (per economic value or South African Rand)

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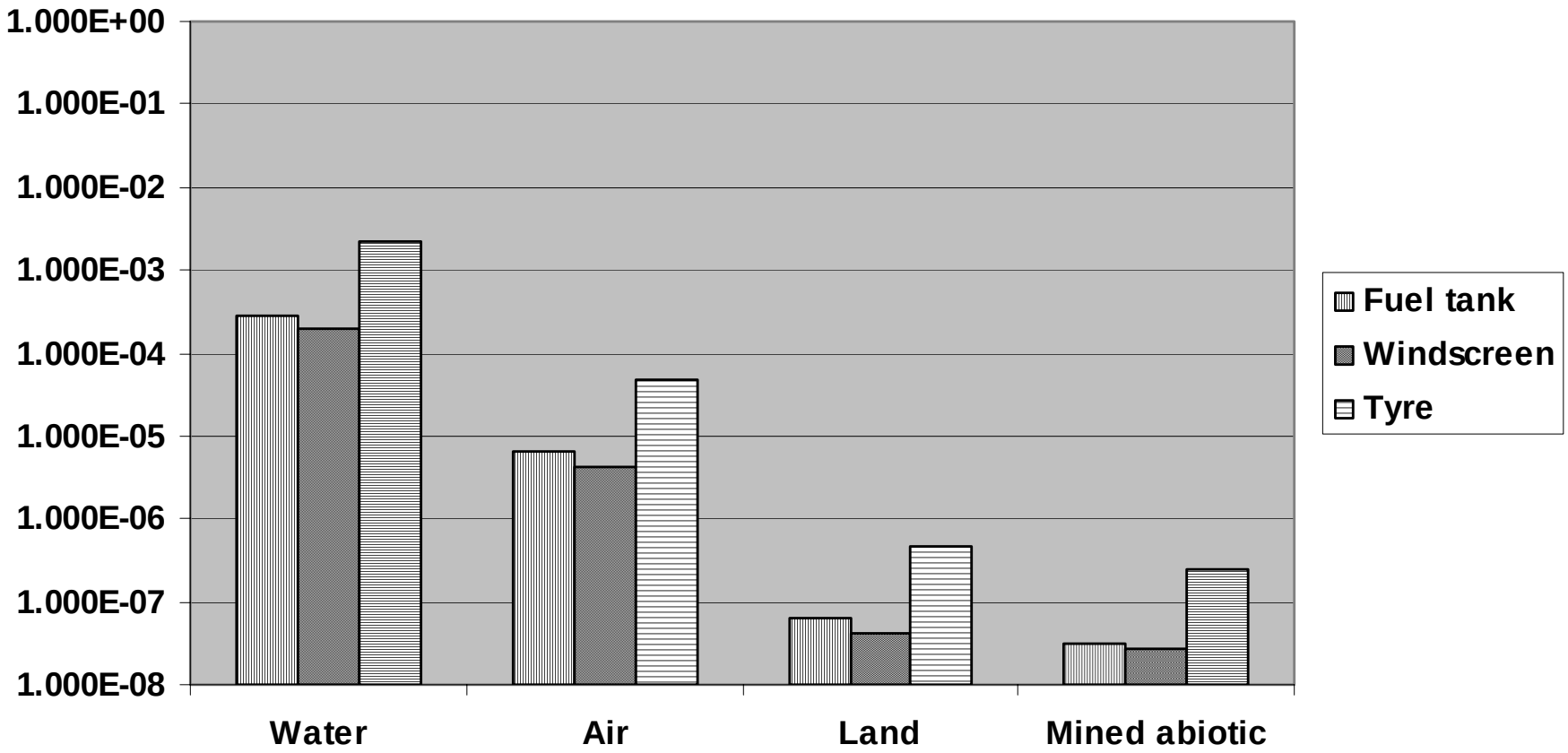

Conclusions from the case study

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- The supplied tyre has the highest overall environmental burden per Rand value
  - In the order of a factor of 10 compared to the fuel tank and windscreen
- However, a supplied tyre has an economic value of half to a third compared with the fuel tank and windscreen
  - The ratio difference between environmental burdens associated with the complete components would therefore be smaller
- Conversely five tyres are supplied per manufactured automobile, which would increase the environmental burdens (and total cost to the supplier) by a factor of five
  - For the specific studied sedan
- But, only the manufacturing processes of the first-tier suppliers were investigated and compared
  - Environmental performances of second- and subsequent tiers are required for an overall product evaluation

Determining an overall Environmental Performance Resource Impact Indicator (EPRII)

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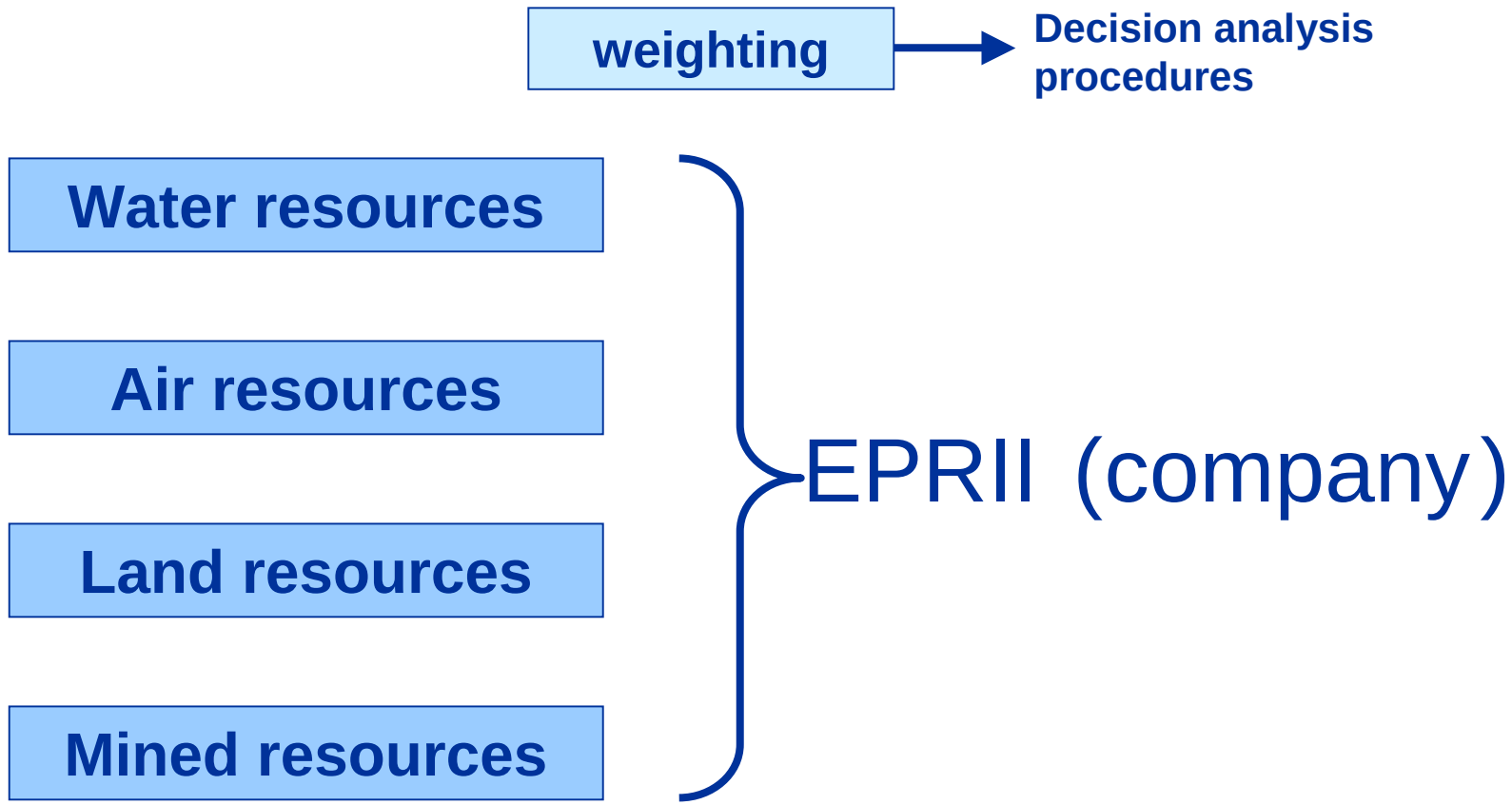

Analytical Hierarchy Procedure (AHP) to determine weighting factors for the resource groups

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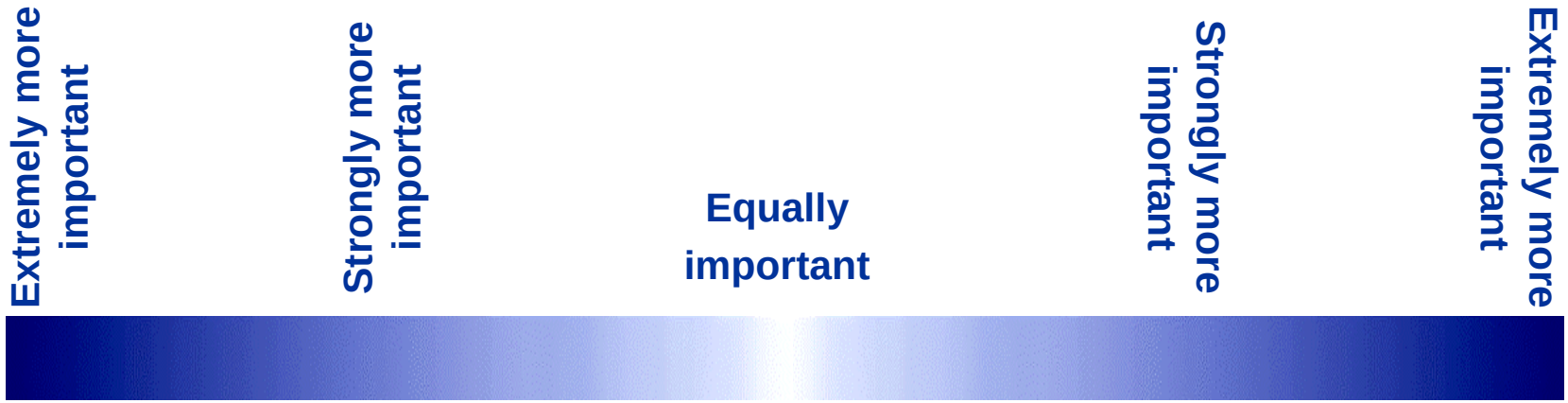

Criterion 1	Importance	Importance	Criterion 2
Air	←	→	Water
Air			Land
Air			Abiotic
Water			Land
Water			Abiotic
Land			Abiotic

AHP survey results and national government expenditure trends on the natural resource groups

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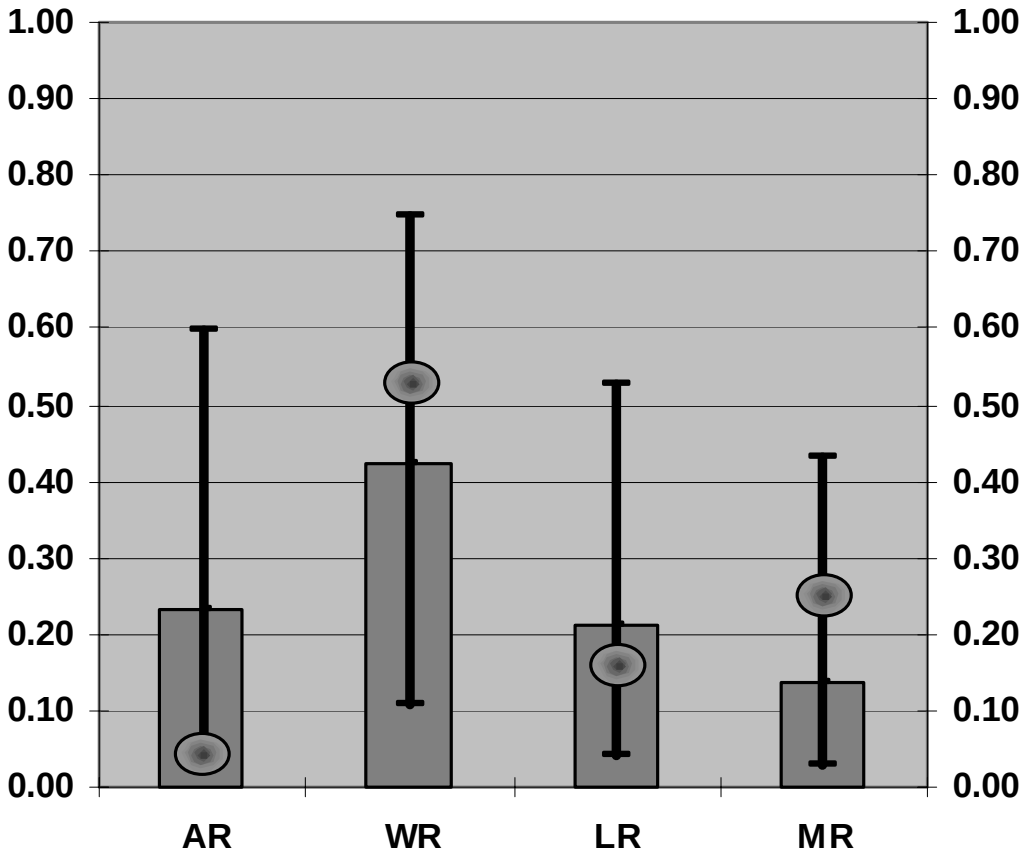

Fraction of national expenditure allocated to environmental issues

Distribution of relative weighting values obtained from individual judgements

Mean (geometric) relative weighting value obtained for the environmental criteria

Hypothetical overall EPRII for a supplier based on a comparison with another supplier (baseline)

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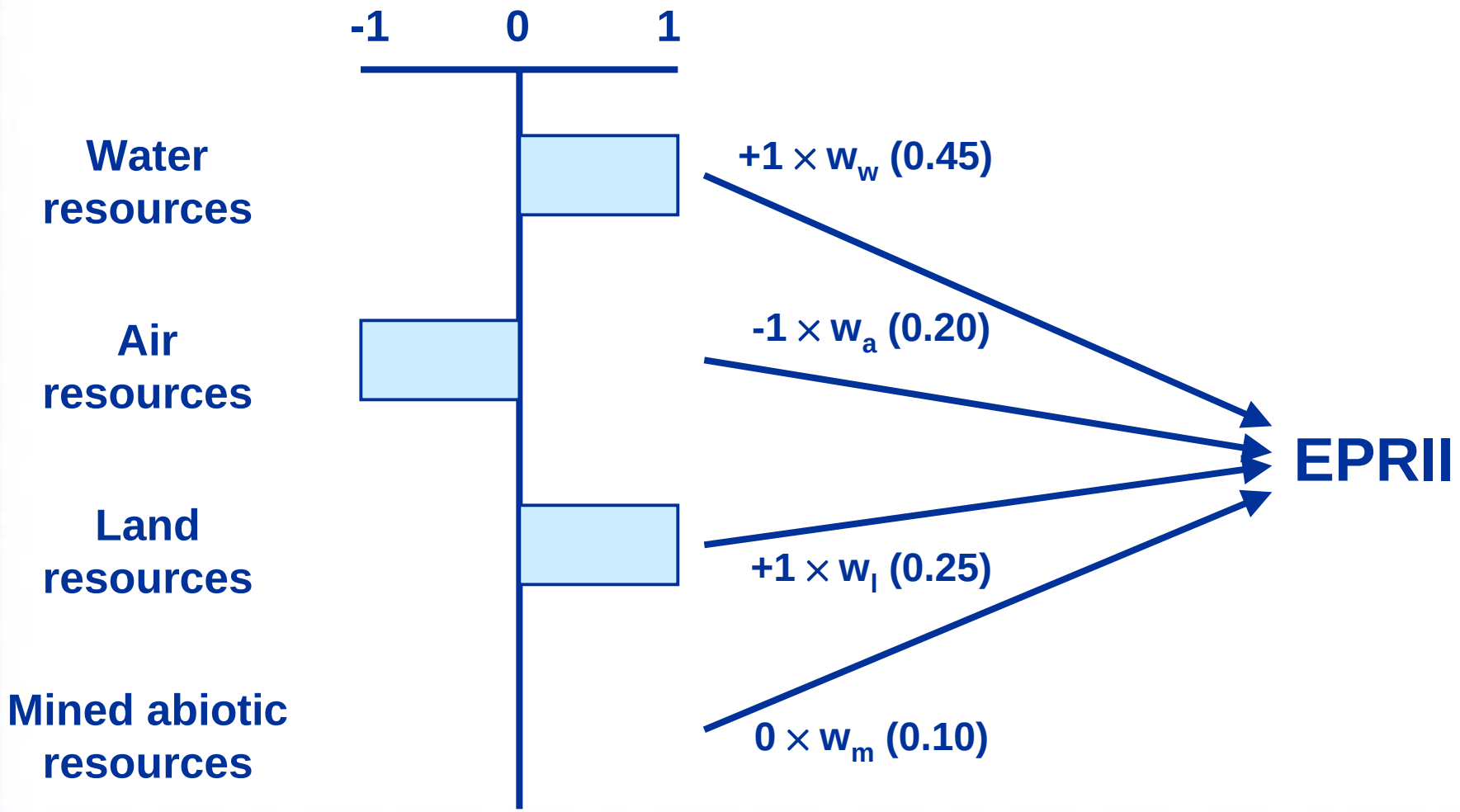

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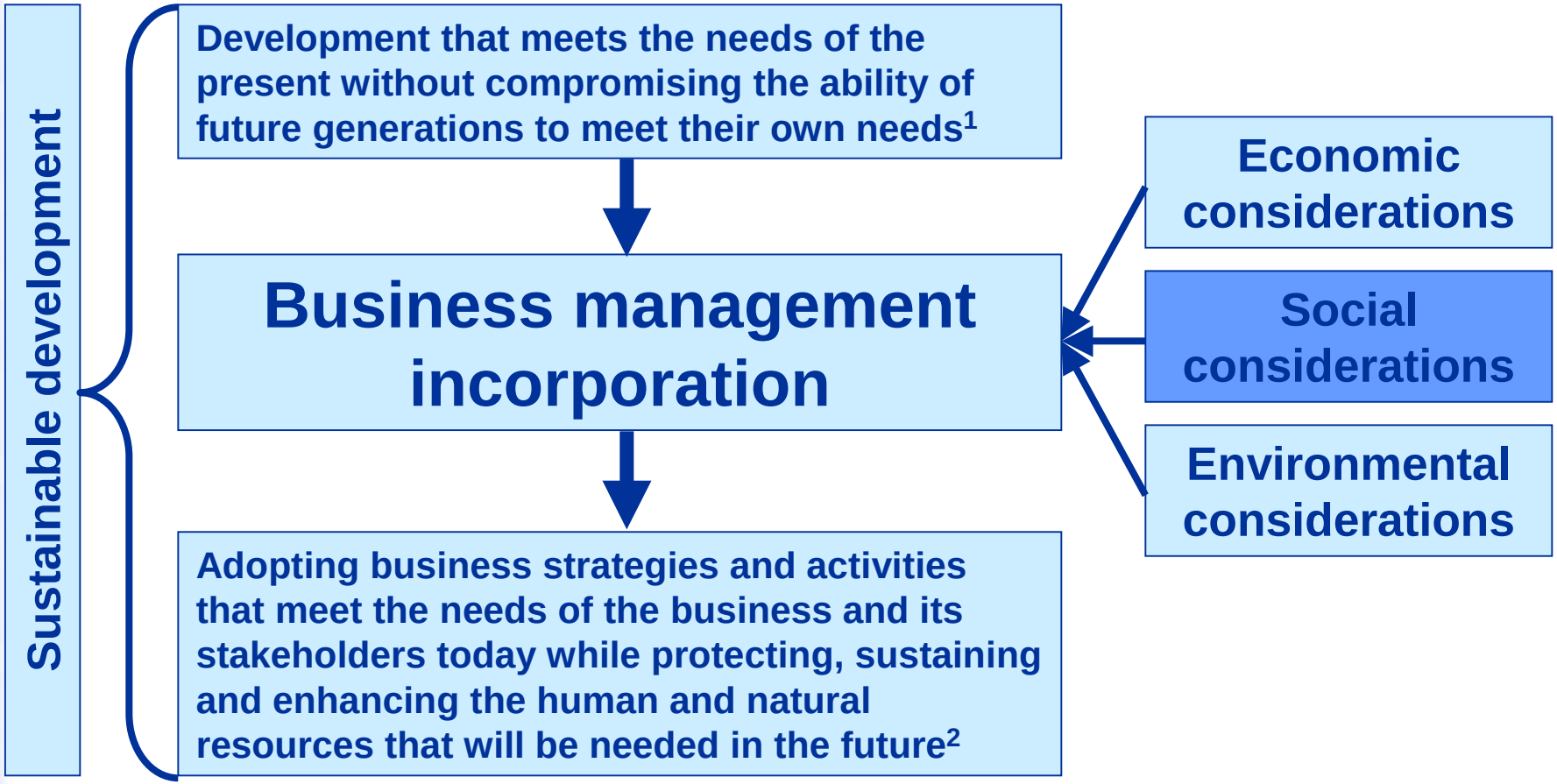

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Closure and questions