SUSTAINABLE LIFE CYCLE MANAGEMENT:

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A CASE STUDY IN THE PROCESS INDUSTRY TO DEVELOP A CALCULATION PROCEDURE FOR SOCIAL INDICATORS FOLLOWING CONVENTIONAL LCIA METHODS

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Aims of the presentation in terms of assessing the sustainability of operational initiatives

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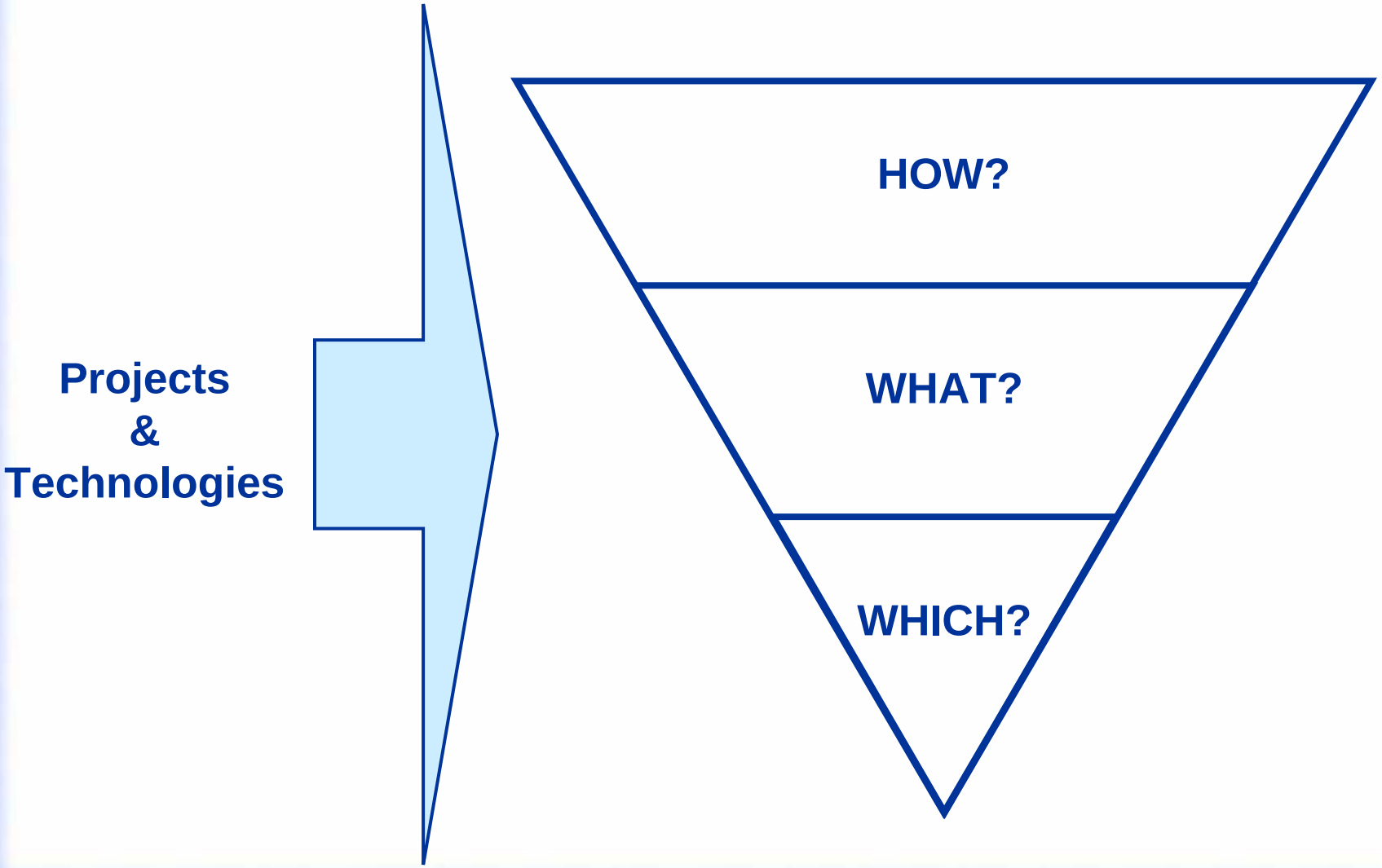

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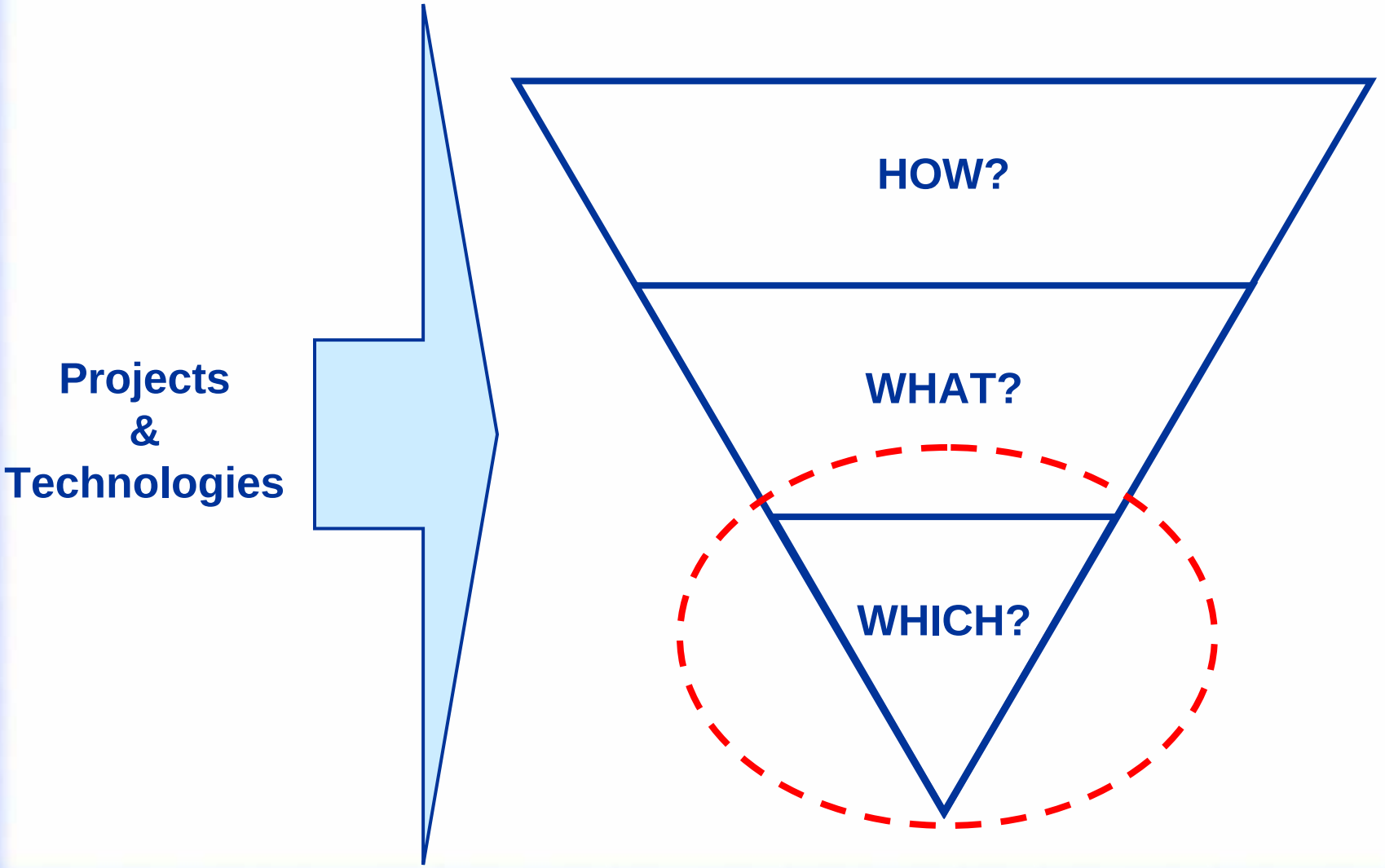

Three life cycles that are fundamental to management in the manufacturing industry

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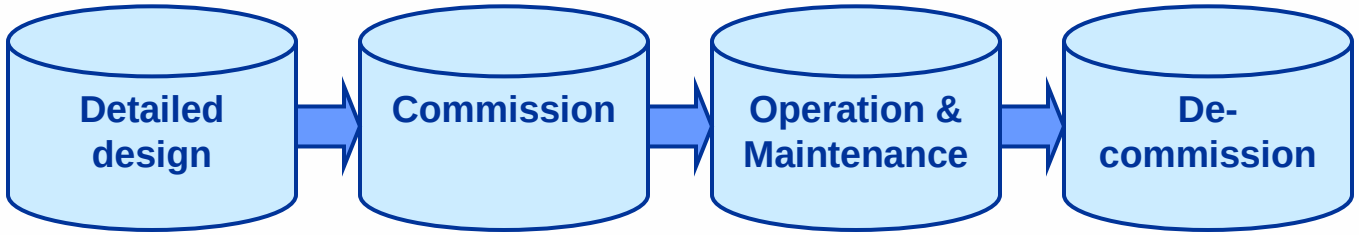
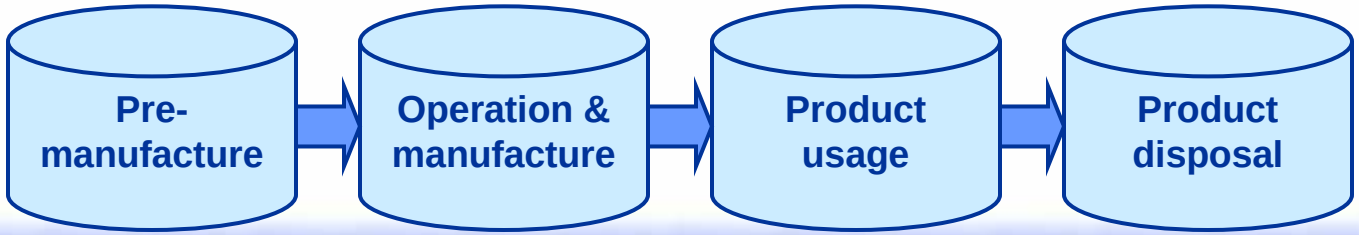
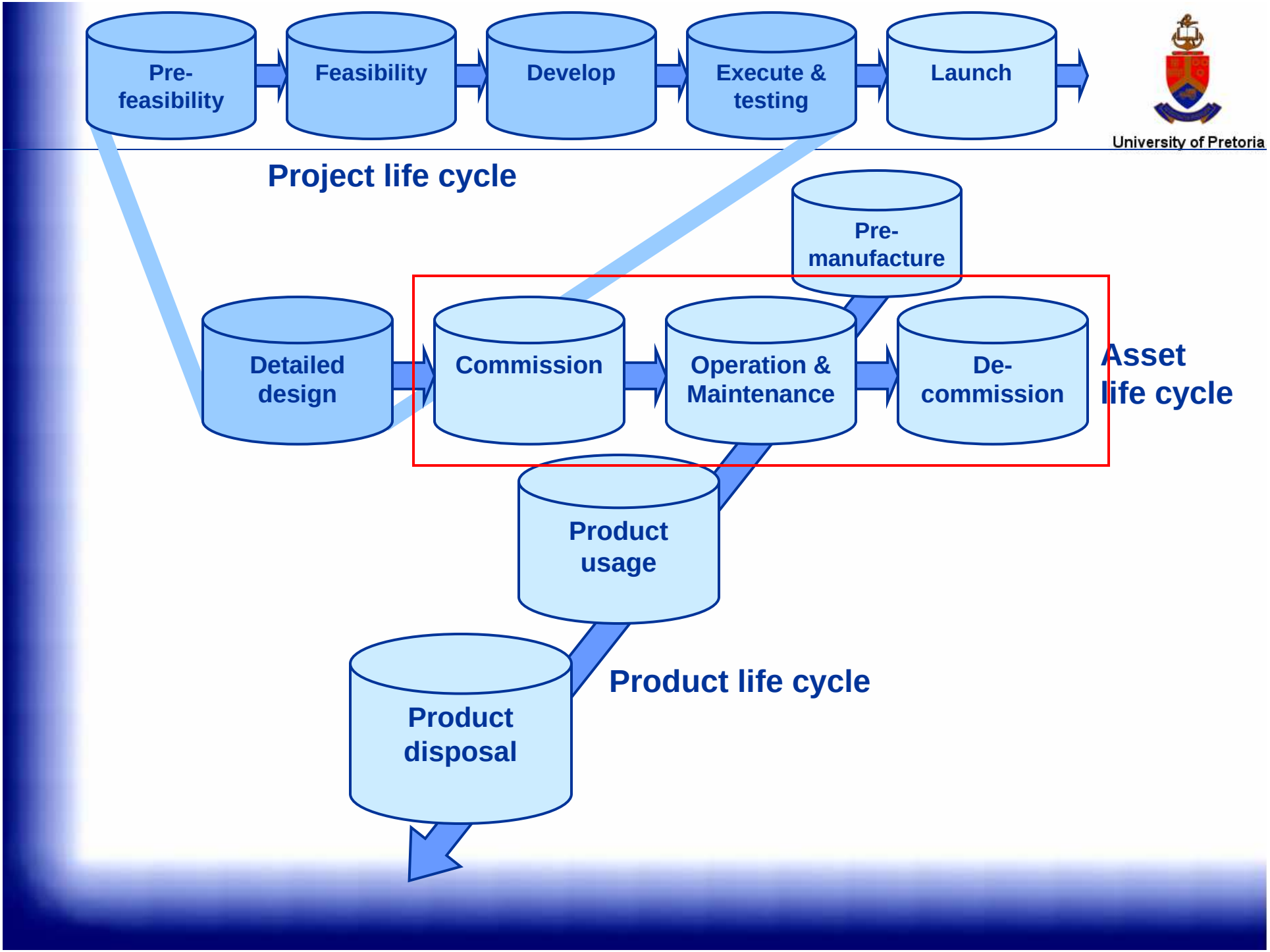
- **Project life cycles – drivers of internal change**

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



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




Pre-feasibility
Feasibility
Develop
Execute & testing
Launch
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Project life cycle
Pre-manufacture
Detailed design
Commission
Operation & Maintenance
De-commission
Asset life cycle
Product usage
Product disposal
Product life cycle

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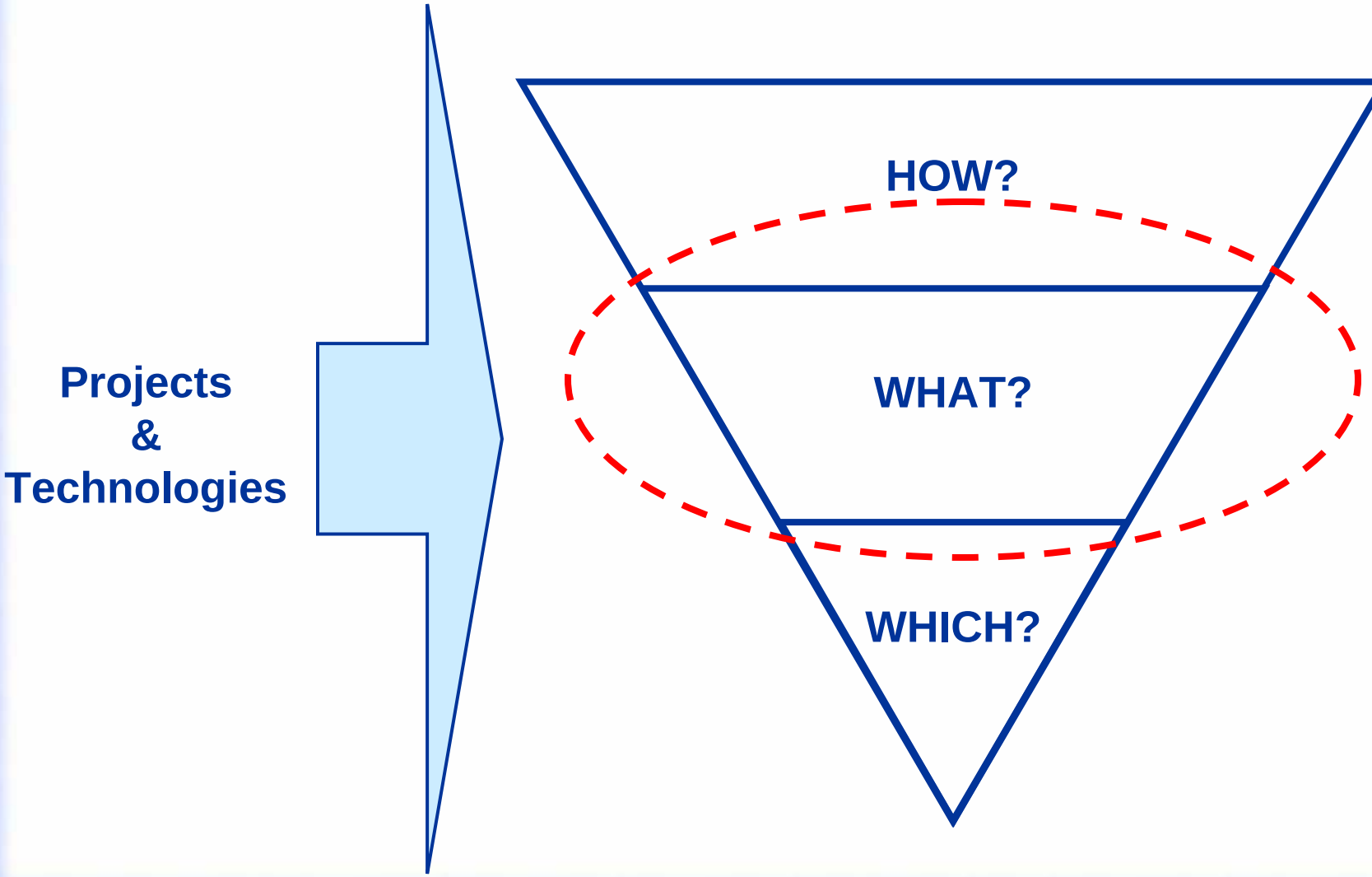

A framework of sustainable development criteria from an industry perspective

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A framework of sustainable development criteria from an industry perspective

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- **From a business perspective:**
  - **The inclusion or consideration of social aspects in sustainability practices is marginal compared to the environment and economic dimensions**
- **From an academic perspective:**
  - **The current state of the development of indicators or measurement procedures of the social performances of industry parallels that of environmental performances approximately 20 years ago**

Define the sub-criteria of social sustainability

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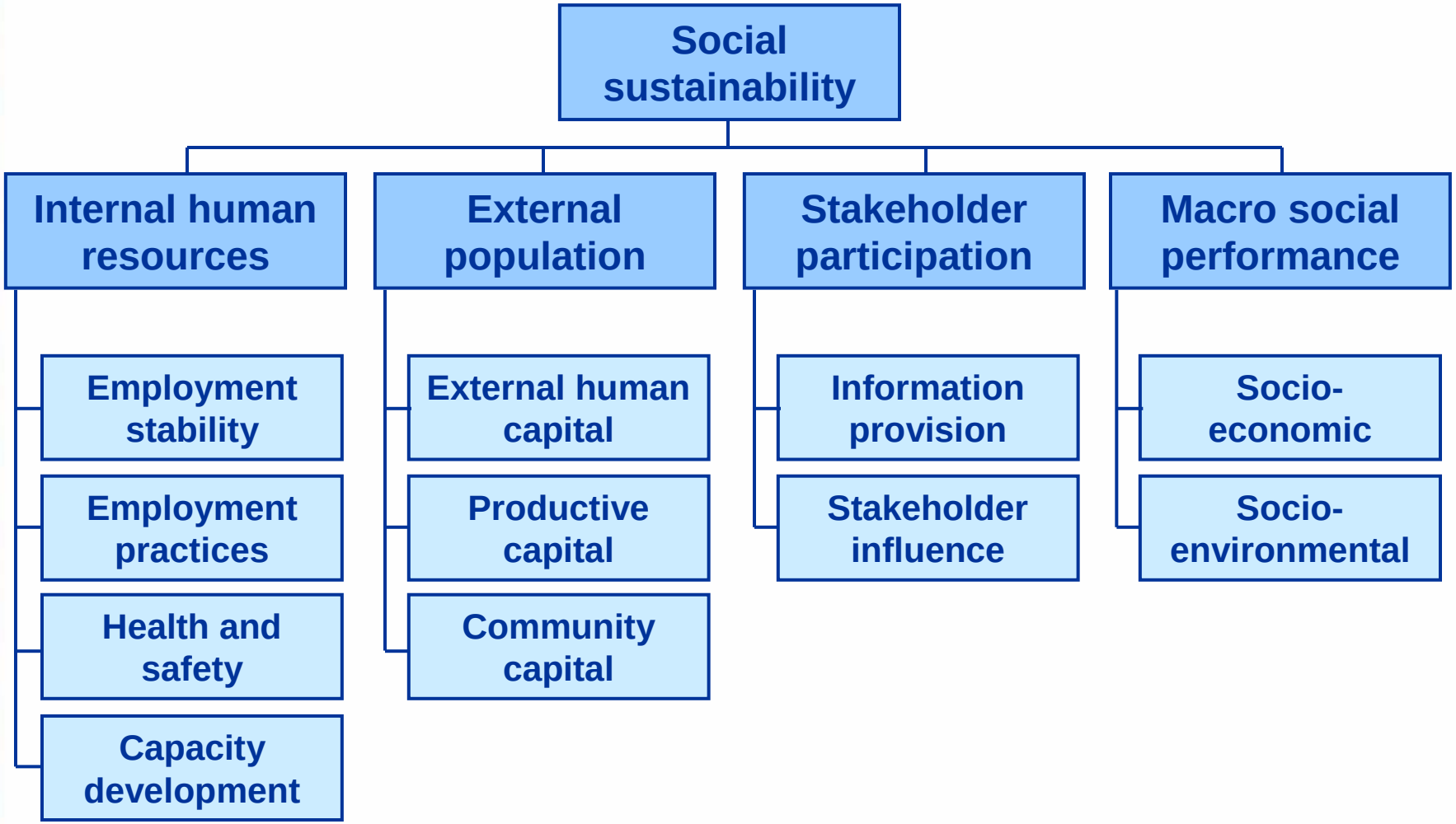

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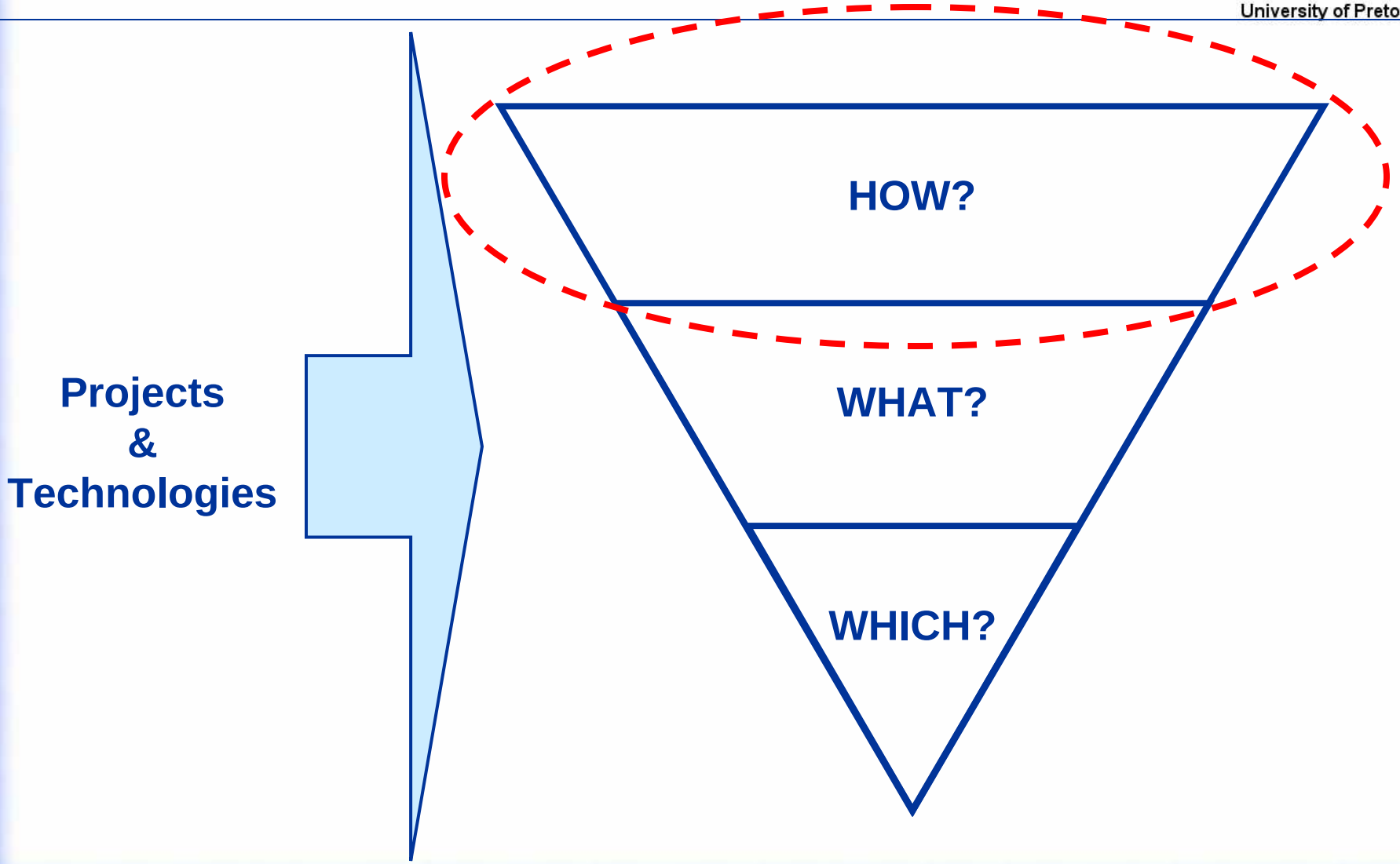

Identification of suitable indicators to assess the sustainability of projects and technologies

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- The scientific methodology to translate the operational initiative information
  - Little consensus internationally
    - Environment and social dimensions of sustainability
- The kind of information that is available at the point of assessing the sustainability performance of an operation initiative
  - For example, in the process industry, detailed data may not be available in the early stage of a new development/project
- The preferences of the specific project/technology appraisers
  - Sustainability accounting or MCDA techniques

Indicator & Evaluation Development
= Life Cycle Impact Assessment (ISO 14042)

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Mandatory Elements

Selection of impact categories, category indicators and characterization models

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Assignment of LCI results (classification)

↓

Calculation of category indicators results (characterisation)

↓

Category Indicator Results (LCIA profile)

↓

Optional Elements

Calculation of the magnitude of category indicator results relative to reference information (Normalisation)
Grouping
Weighting
Data Quality Analysis

Calculation of indicators for the four main criteria or groups of each dimension of sustainability

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Calculation of Resource Impact Indicators for the environmental dimension

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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 all environmental interventions of an evaluated system
- Q_X = Quantifiable release to or abstraction from a resource of a constituent (X) of a life cycle 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

Evaluation Method: LCIA Method (ISO 14042)

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

- SII_G = Social Impact Indicator calculated for a main social group through the summation of all impact pathways of all social interventions of an evaluated life cycle system
- Q_X = Quantifiable social intervention (X) of a life cycle system in an impact category C
- C_C = Characterisation factor for an impact category (of intervention X) within the pathway
- N_C = Normalisation factor for the impact category based on the social objectives in the region of assessment, i.e. the inverse of the target state of the impact category
- S_C = Significance (or relative importance) of the impact category in a social group based on the distance-to-target method, i.e. current social state divided by the target social state

Requirements to follow the Social Impact Indicator (SII) approach

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- Identify possible social interventions along the asset life cycle, including the associated product/service life cycle
  - Previously identified case studies
- Identify the classified midpoint categories with respective characterisation factors for the social interventions
  - Map the list of possible interventions against the social sub-criteria
- Establish normalisation values
  - Target background social footprint
- Establish significance factors
  - Current background social footprint

Indicator Development

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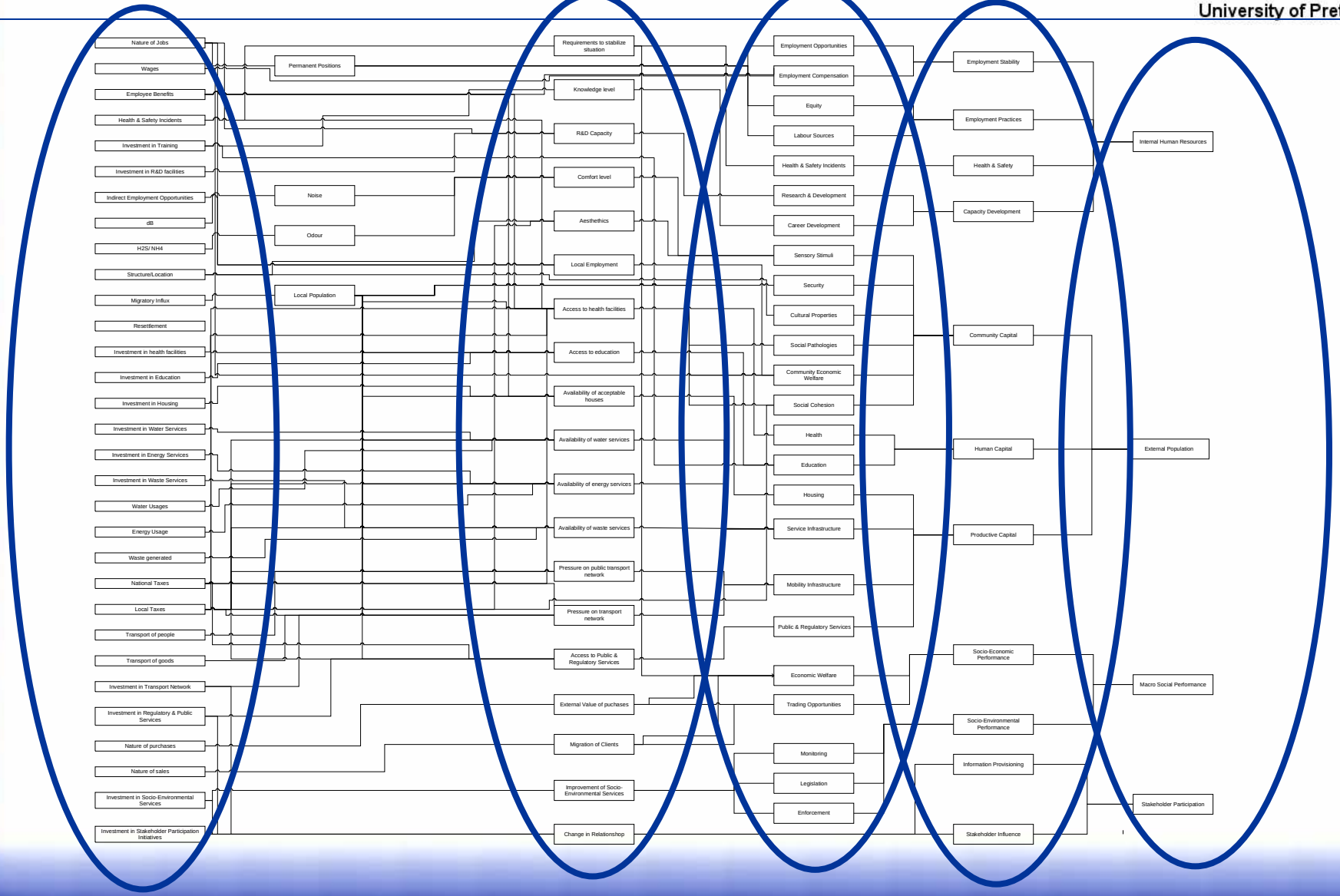

Three measurement methods are proposed to apply the defined midpoint categories

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- Established risk assessment approaches
  - Subjective evaluation of:
    - The probability of occurrence
    - The projected frequency of the occurrence
    - The potential intensity thereof
- Quantitative evaluation approaches
  - For example:
    - Full cost accounting approaches
    - Direct measurements in society
- Qualitative evaluation approaches
  - Appropriate subjective scales and associated guidelines
    - Industrial ecology discipline
    - Streamlined LCA discipline

Mid Points & Measurement Methods

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SIIs	Midpoint category	Measurement methods
Internal Human Resources	Permanent internal employment positions	Quantitative
	Internal Health and Safety situation	Risk
	Knowledge level / Career development	Quantitative
	Internal Research and Development capacity	Quantitative

Mid Points & Measurement Methods

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SIIs	Midpoint category	Measurement methods
External Population	Comfort level / Nuisances	Risk
	Perceived aesthetics	Qualitative/Quantitative
	Local employment	Quantitative
	Local population migration	Qualitative
	Access to health facilities	Quantitative
	Access to education	Quantitative
	Availability of acceptable housing	Quantitative
	Availability of water services	Quantitative
	Availability of energy services	Quantitative
	Availability of waste services	Quantitative
	Pressure on public transport services	Quantitative
	Pressure on the transport network / People and goods movement	Quantitative
	Access to regulatory and public services	Quantitative
	Comfort level / Nuisances	Risk

Mid Points & Measurement Methods

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SIIs	Midpoint category	Measurement methods
Macro Social Performance	External value of purchases / supply chain value	Quantitative
	Migration of clients / Changes in the product value chain	Qualitative
	Improvement of socio-environmental services	Quantitative
Stakeholder Participation	Change in relationships with stakeholders	Qualitative

Demonstration (Case Study): Chemical Plant Decommissioning (Mpumalanga)

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Intervention	Project Information Available	Social Footprint Information
Nature of Jobs	140 employment opportunities lost	Number of Employed Personnel & Unemployment Percentage
Water Usage	200 m^3 per month	Not available
Energy Usage	861 MWh per month	Electricity Usage of entire local council
Nature of Sales	R150 million annual turnover	GDP of region

Demonstration (Case Study): Chemical Plant Decommissioning (Mpumalanga)

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Area of Protection	Intervention	Normalisation Value (T_s^{-1})	Significance Value (C_s/T_s)	Midpoint Indicator Value	SII Value
Internal Human Resources	Nature of jobs	9.50×10^{-6}	0.728	-9.68×10^{-4}	**-9.68×10^{-4}**
External Population	Nature of jobs	3.49×10^{-5}	1.6667	-8.15×10^{-3}	**9.81×10^{-3}**
	Energy Usage	2.09×10^{-5}	1.0	1.80×10^{-2}	
Macro Social Performance	Nature of Sales	1.28×10^{-5}	1.0	-9.7×10^{-4}	**-9.7×10^{-4}**
Stakeholder Participation					**Not available**

Demonstration (Case Study): Chemical Plant Decommissioning (Kwa-Zulu Natal)

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Intervention	Project Information Available	Social Footprint Information
Nature of Jobs	250 employment opportunities lost	Number of Employed Personnel & Unemployment Percentage
Work-hours lost due to injuries	423.4	Target ?
Atmospheric Emissions:	0.462 kilo ton SO_2 0.104 kilo ton NO_x 0.005 kilo ton VOC	Permit: 1.375 SO_2 SO_2 and NO_x emissions for the entire Durban area
Water Usage	1 330 GL per year	Water usage of the entire local council
Energy Usage	45.13 GWh per year	Information not available
Nature of Sales	R500 million annual turnover	GDP of region

Demonstration (Case Study): Chemical Plant Decommissioning (Kwa Zulu Natal)

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Area of Protection	Intervention	Normalisation Value (T_s^{-1})	Significance Value (C_s/T_s)	Midpoint Indicator Value	SII Value
Internal Human Resources	Nature of jobs	1.11×10^{-6}	0.87	-2.3×10^{-4}	**-2.3×10^{-4}**
External Population	Nature of jobs	3.14×10^{-6}	1.85	-1.39×10^{-3}	**1.375×10^{-2}**
	Energy Usage	N/A	1.0	N/A	
	Water Usage	3.57×10^{-6}	1.0	4.74×10^{-3}	
	Sensory Stimuli	1.84×10^{-2}	1.0	1.04×10^{-2}	
Macro Social Performance	Nature of Sales	9.24×10^{-6}	1.0	-4.26×10^{-3}	**-4.26×10^{-3}**
Stakeholder Participation					**Not available**

Conclusions and further work required

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- **Conclusions:**
  - Normalisation and significance steps will be constraint by what is practicably measurable within a society where an operational initiative will occur
    - From an industry perspective
    - Availability of information will definitely differ between developing and developed countries
  - Future projection of social interventions of a project or technology may be problematic or at least differ from case to case
- **Future work:**
  - Survey within industry to determine relevant midpoint categories
  - Delphi technique case study to determine measurability of mid-points
  - Case study to test the SII calculation procedure

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Closure and questions