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- **Experience from the life cycle initiative**
- **Building a consensus model based on parsimony and expert workshops**
- **The new European Life Cycle Impact Assessment method**
- **Steps towards a social LCA**

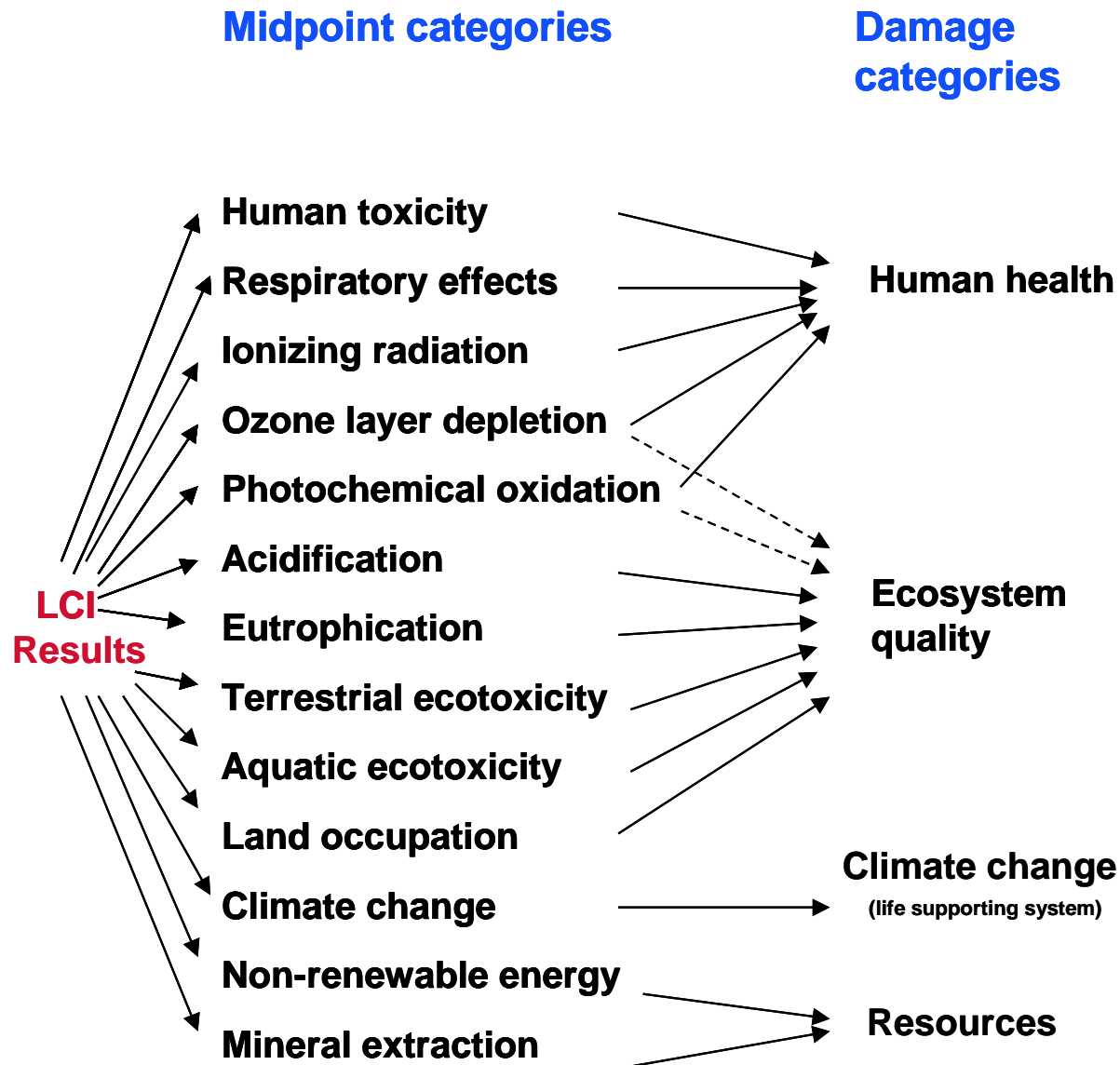


LCIA method quality has deeply evolved

- First idea was to group emissions according to air, water and soil compartments:
- The CML team at Leiden University played a very significant role in structuring the field in term of impact categories(Heijungs et al. 1992).
- Successive SETAC working groups on impact assessment follow cause-effect chains and borrow multimedia fate and exposure models (or dose-response) from various fields
SETAC-UNEP frame-work combining midpoint with damage categories (Jolliet et al. 2003).
- → take advantages of what has been learned



LCIA Impact 2002+



First signs of maturity as a scientific area, still improving rapidly

- In the field of toxicity, LCIA is fully part of a collaborative effort with scientists from multimedia model, risk assessment, indoor air pollution and LCIA to defined intake fraction (Bennett et al. 2002).
- Adaptations from risk assessment to the comparative LCIA framework are bringing innovative developments back for comparative risks.
- LCIA are also published in the best environmental journals such as Environmental Science and Technology.
- International Journal of LCA, the Journal of Industrial Ecology and the Journal of Cleaner Production are now in the Science Citation.

Int J LCA Index 1.7, 60 out of 160 environmental journals,



We had a dream ! Life Cycle Initiative

Context: 7 years of LCIA SETAC working groups had framed the field but reached their limits (1999)

Could go further by further stimulate structured interactions + motivate scientists & industry to unite strengths



Need broader partner(s) to really meet needs and demands. → contacted UNEP



- **→ in two weeks in Paris with Jacqueline Aloisi de Larderei**

- **→ broadened to LCI, LCM implementation**



Make toxicity screening available for comparative risk: The USEtox core team

CALTOX
McKone



EDIP
Hauschild



USES-LCA
Van de Meent
Huijbregts



IMPACT 2002
Jolliet
Margni
Rosenbaum



→ 3 comparison workshops with 5 teams, to identify most influential model components

The principles behind USEtox

Parsimonious – as simple as possible but as complex as needed – containing only the most influential model components;

Mimetic – not differing more from the original models than these differ among themselves;

Evaluated – providing a repository of knowledge through evaluation against existing models;

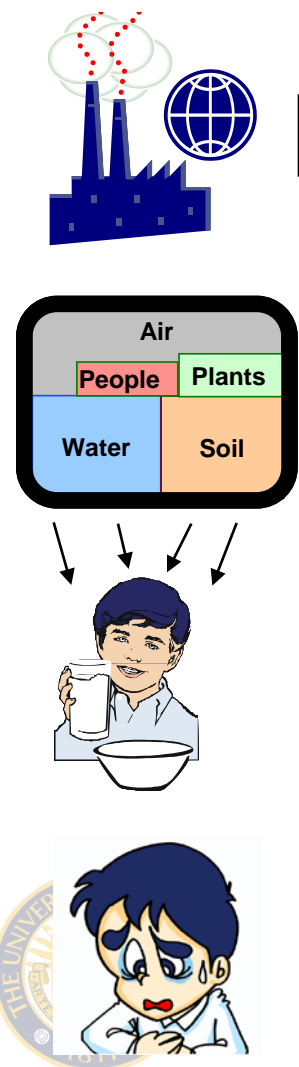
Transparent – being well documented, including the reasoning for model choices.



Framework: emission to Intake multimedia transport model

Bennett et al, ES&T 2002, 36, 207-212 A

$$iF = \frac{\text{intake of pollutant } [kg_{in}]}{\text{mass released into the environment } [kg_{emit}]}$$



Emissions to compartment m [kg_{em}/yr]

Env.Fate: $FF=k^{-1}$

Concentration & mass
in compartment n

Exposure: XP

Dose taken in [kg_{in}/yr]

Dose-response

Damage to
human health

[DALYs/yr]

*Intake
fraction iF*
[kg_{in}/kg_{em}]

$$iF = XP \cdot FF$$

**Matrix format:
Rosenbaum et al.,
Environment
international,
Vol. 33, 5, 624-634⁹**

USEtox Consensus building process

Hauschild et al., 2008. The Search for Harmony and Parsimony. Environmental Science & Technology, 42(19), 7032-7036

- 4 expert review workshops to frame the field and define the useful metrics
- Compare existing models (also BETR)
- → Identify main sources of difference, eliminate unintentional sources
- Construct a **parsimonious** UNEP/SETAC toxicity consensus model – **USEtox**
- Model evaluation, publication and expert review.
- Approval by International Life Cycle Panel
- Stakeholder evaluation (UNEP)



EU LCIA technical guidance document draft version - summary table

(will be available at <http://lca.jrc.ec.europa.eu/lcainfohub/index.vm>)

Impact category	Recommendation at midpoint			Recommendation from midpoint to endpoint			Consistency mid-endpoint
	Recommended model	Classification ¹	Reference	Recommended model	Classification	Reference	
Climate change	IPCC (GWP) (100 years)	I	IPCC 2007	ReCiPe	III	De Schryver and Goedkoop, 2008a	Yes
Ozone depletion	WMO (ODP) (infinite)	I	WMO 1999	ReCiPe	III	Struijs et al., 2008a	No, not fully
Human toxicity, carcinogenics	USEtox	II/III	Rosenbaum et al., 2008	DALY calculation applied to USEtox midpoint	II/III	Adapted from Huijbregts et al., 2005	Yes
Human toxicity, non- carcinogenics	USEtox	II/III	Rosenbaum et al., 2008	DALY calculation applied to USEtox midpoint	III	Adapted from Huijbregts et al., 2005	Yes
Particulate matter/Respiratory inorganics	Not settled yet: Greco et al., 2007 or RiskPoll	I/II	Greco et al., 2007/Rabl and Spadaro, 2004	Adapted DALY calculation applied to midpoint	II	Adapted from van Zelm et al., 2008, Pope et al., 2002	Yes
Ionising radiation, human health	Frischknecht et al., 2000	II	Frischknecht et al., 2000	Frischknecht et al., 2000	III	Frischknecht et al., 2000	Yes
Ionising radiation, ecosystems	Garnier-Laplace et al., 2008	III	Garnier-Laplace et al., 2008	PDF calculation applied to midpoint	III	Based on Posthuma and de Zwart, 2006 as for ecotoxicity	Yes



EU LCIA technical guidance document

Photochemical ozone formation	LOTOS-EUROS as applied in ReCiPe	II	Van Zelm et al., 2008	ReCiPe for human health, nothing for vegetation	II	Van Zelm et al., 2008	Yes
Acidification	Accumulated Exceedance	II	Seppälä et al., 2006, Posch et al., 2008	ReCiPe	III	Van Zelm et al., 2007	No
Eutrophication, terrestrial	Accumulated Exceedance	II	Seppälä et al., 2006, Posch et al., 2008	None	-	-	-
Eutrophication, aquatic	ReCiPe	II	Struijs et al., 2008	ReCiPe for freshwater, none for marine waters	III	Struijs et al., 2008b	Yes, for freshwater
Ecotoxicity	USEtox	II/III	Rosenbaum et al., 2008	PDF calculation applied to USEtox midpoint	III	Based on Posthuma and de Zwart, 2006	Yes
Land use	Milà i Canals	III	Milà i Canals et al., 2007b	ReCiPe	III	De Schryver and Goedkoop, 2008b	No
Resource depletion, water	Swiss Ecoscarcity	III	Frischknecht et al., 2008	None	-	-	-
Resource depletion, mineral, fossil (and renewable)¹	Category 1: None Category 2: EDIP97 update 2004	- II	- Hauschild and Wenzel (1998-update 2004)	Step 4: ReCiPe	III	De Schryver and Goedkoop, 2008c, Goedkoop and de Schryver, 2008	No

Life Cycle Environmental and Socio-Economic Evaluation of a Glass Bangle Factory in Firozabad (India)



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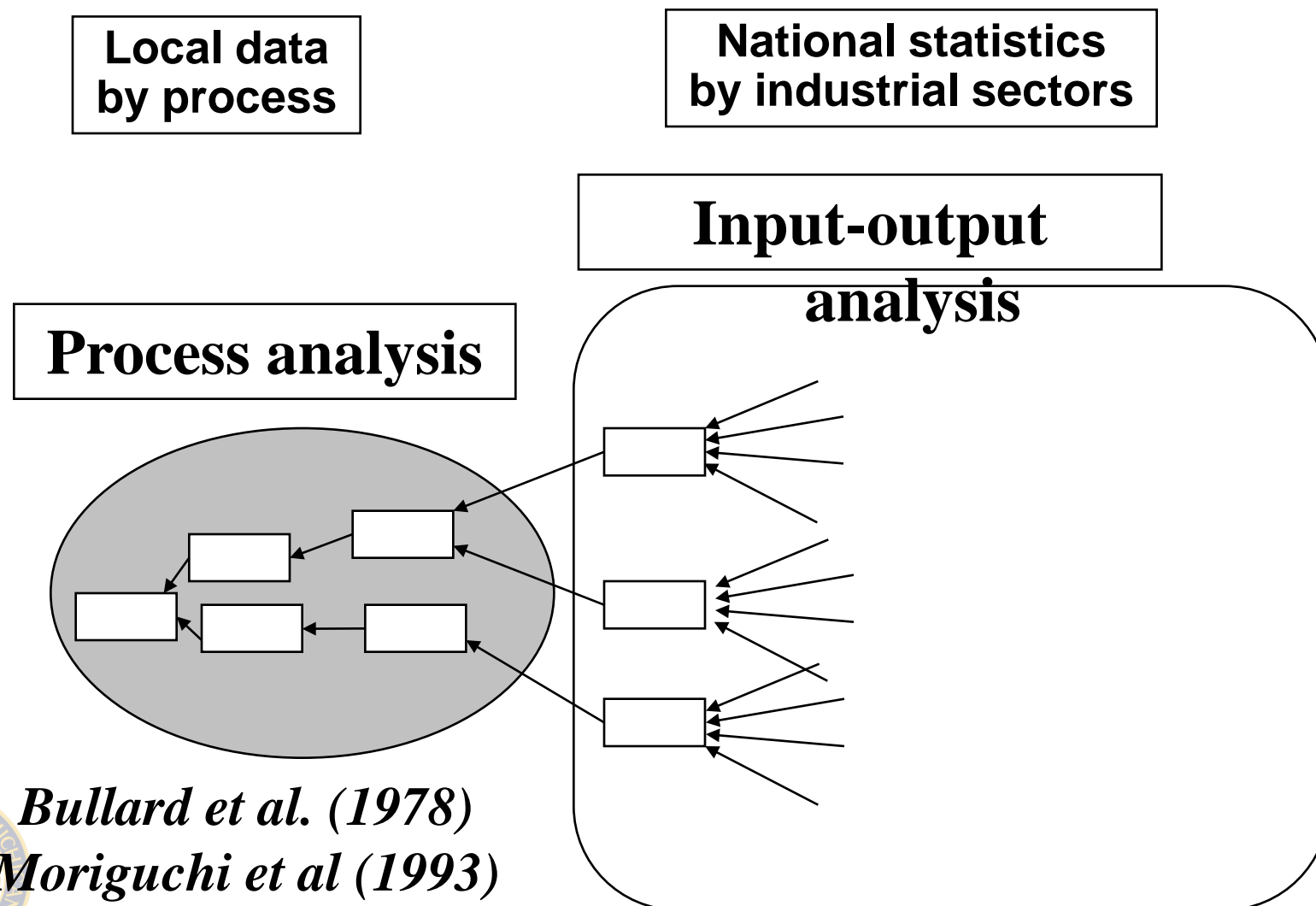
With contributions of

Pierre Jaboyedoff (Sorane SA)

Girish Sethi (TERI)

Sameer Maithel (TERI)

2. Method: Hybrid model



Bullard et al. (1978)

Moriguchi et al (1993)

Suh et al (2006)

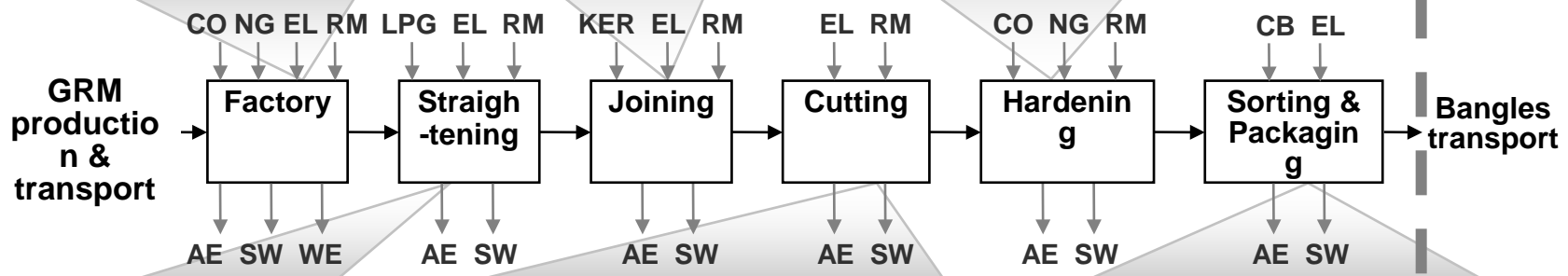


3. Case Study: glass bangles Firozabad

Functional unit: 1000 tora, 1 tora = 312 bangles

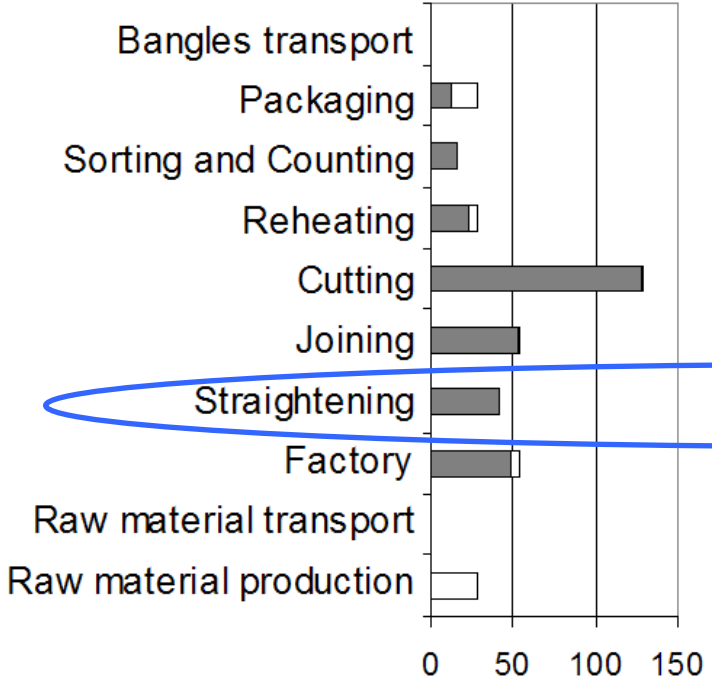


GRM	Glass Raw Material
CO	Coal
NG	Natural Gas
EL	Electricity
LPG	Liquid Petroleum Gas
KER	Kerosene
RM	Raw Material
CB	Cardboard
AE	Air Emission
SW	Solid Waste
WE	Water Effluent

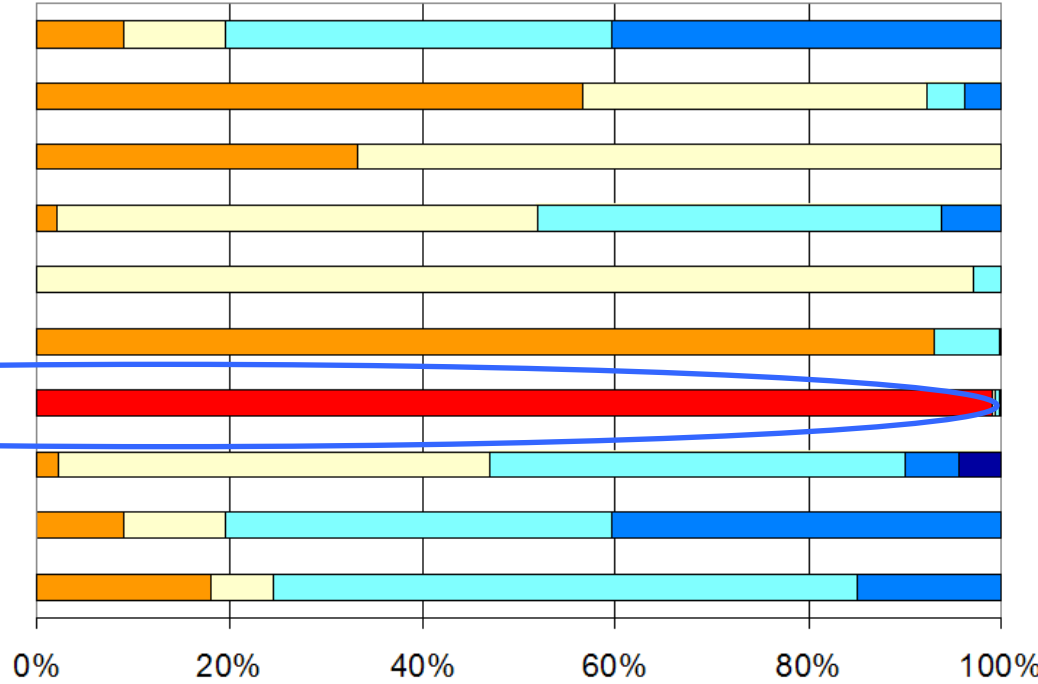


Wages along the Life Cycle

Workers (Firozabad glass industry and suppliers)



Wage & salary distribution (%age of workers by income categories)



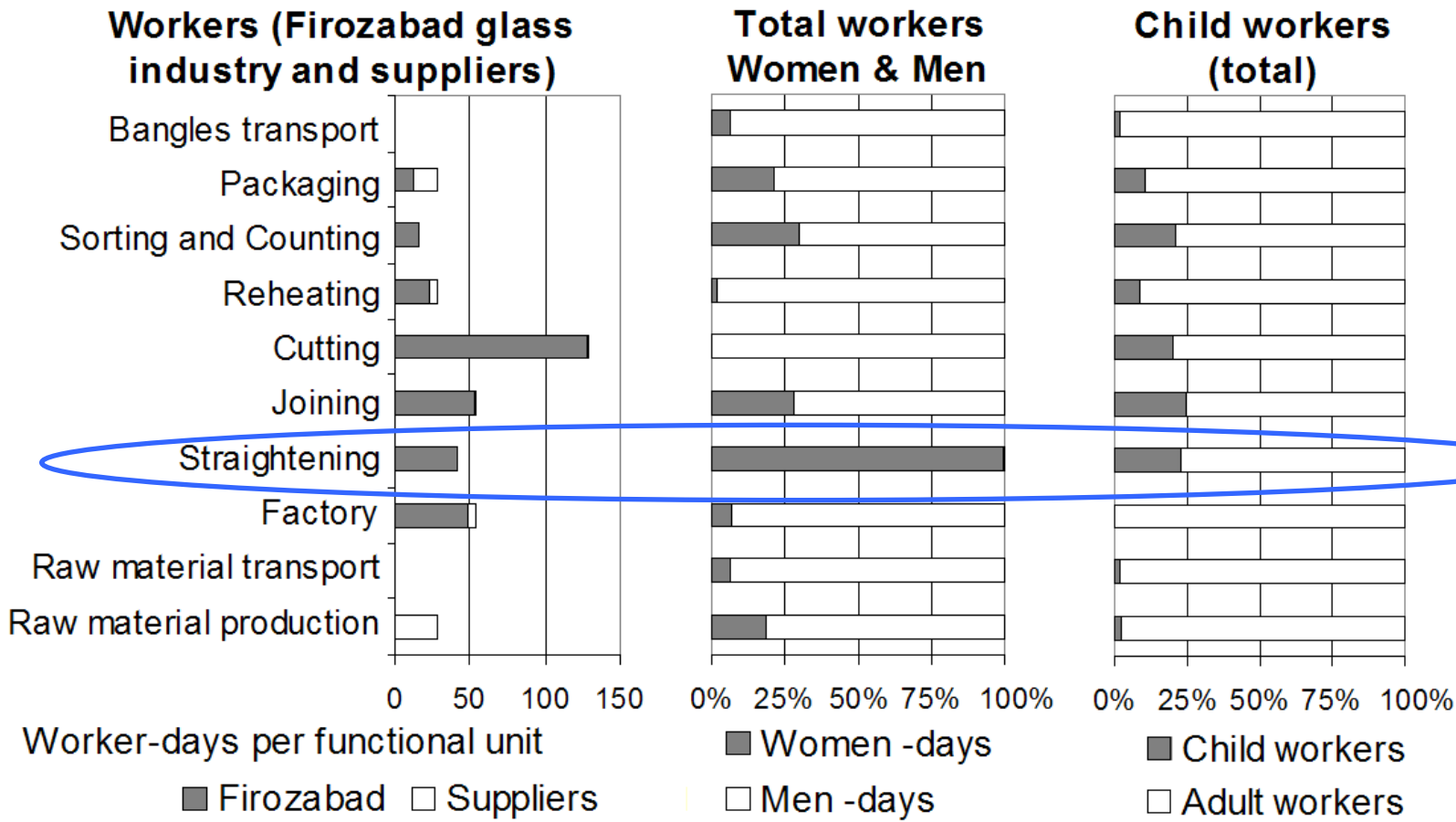
Worker-days per functional unit

■ Firozabad □ Suppliers

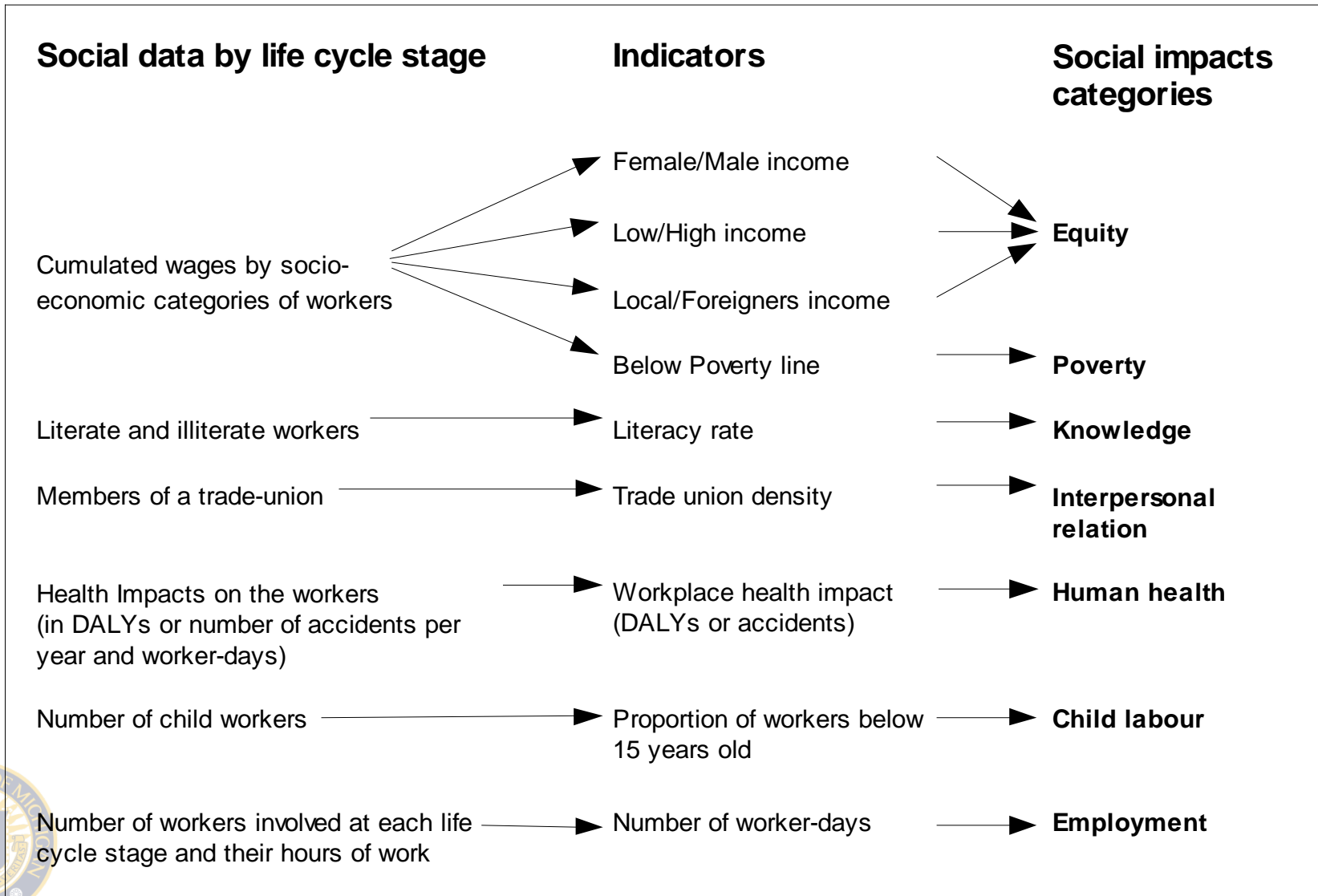
■ Rs I ≤ 25 per day
 ■ Rs 25 < I ≤ 75
 ■ Rs 75 < I ≤ 125
■ Rs 125 < I ≤ 200
 ■ Rs 200 < I ≤ 500
 ■ Rs I > 500



Worker distribution along Life Cycle

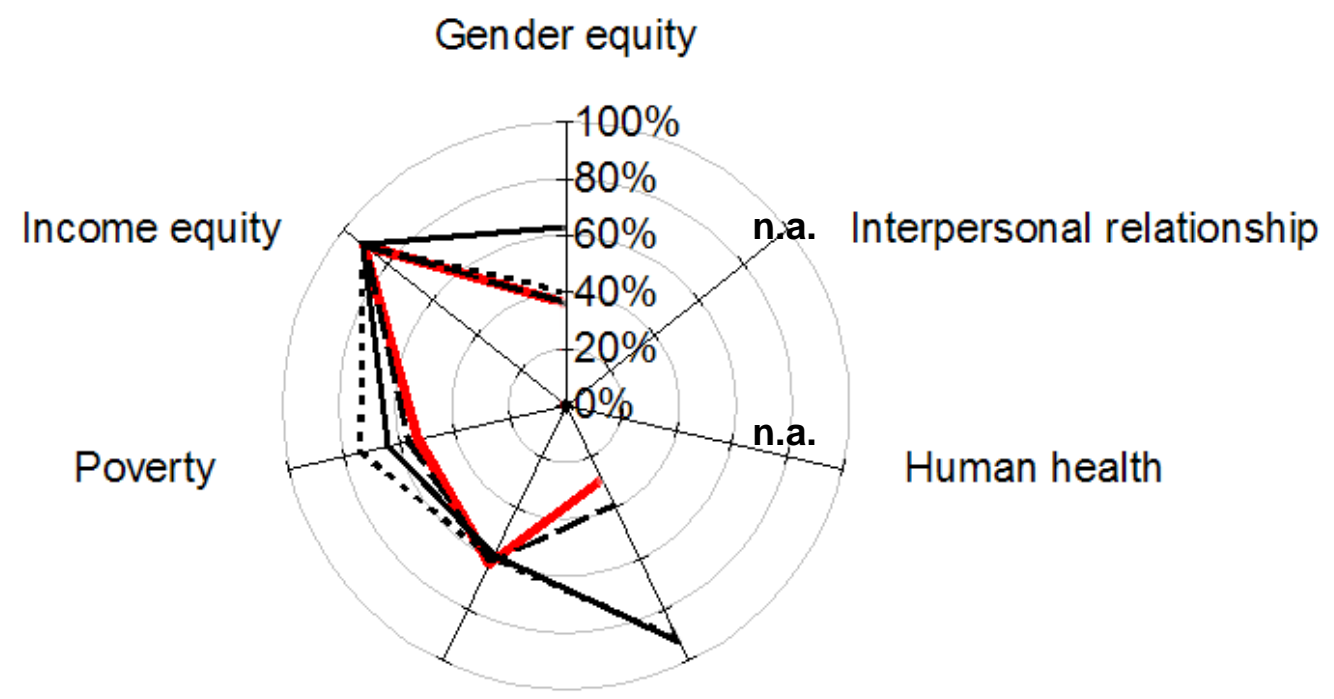


Social LCA: Methodology



Social performance: glass bangle absolute score

Indicator scores



— Firozabad
 - - - Suppliers
 — Glass bangle
 — India