

Step-by-step Social Life Cycle Assessment: A participatory approach for the identification and prioritization of impact subcategories for mobility scenarios

Ghada Bouillass, Isabelle Blanc and Paula Pérez-Lopez

Step-by-step Social Life Cycle Assessment framework: A participatory approach for the identification and prioritization of impact subcategories applied to mobility scenarios

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S1-Supporting information

Stakeholders' identification following each life cycle stage in the mobility sector

Table 1 Listing of stakeholder categories and sub-stakeholders for each life cycle stage in the automotive sector

| Life cycle stages | Stakeholders' categories | Sub-Stakeholders | Definition | Type of the relation |
|----------------------|--------------------------|---------------------------------------|---|---|
| Manufacturing | Workers | Employees | All employees (males and females) in the extraction of raw materials (minerals' extraction) and manufacturing of components (batteries, powertrains, etc.) and final products (internal combustion engine vehicles and electric vehicles) | Affected by the organization practices and decisions. |
| | | Migrant employees | The share of migrant employees / total number of employees in the sector Changes following the regulatory context | Affected by the organization practices and decisions. |
| | | Child labor | The share of child labor in the sector (males and females) Changes following the regulatory context | Affected by the organization practices and decisions. |
| | | Worker unions | Representative entities for employees in the organization and or the sector. | Concerned about the social and socio-economic risks generated by specific activities on the workers. Could influence the decision-making to protect workers' rights in the organization |
| Value Chain Actors | | Manufacturer | Designer of and developer of the final product / technology | Directly involved in the decision-making process |
| | | Suppliers / Creditors and Contractors | Industrial actors and private entities that are linked to the supply chain of the product/technology | Involved in the decision-making process / supply chain of the product/technology |
| | | Shareholders | Particular partner, who are investor in capital, the owner of a given share of the activity that gives him the prerogatives in the functioning of the company and its decisions | Directly involved in the decision-making process and could have significant influence/control |
| Society | | Government | Define regulation and transportation / manufacturing policies on the national scale | Concerned by the environmental and social and socio-economic performance of organizations. And have great influence on the decision- making process |
| | | NGOs | Local organization for environmental protection/ air quality and a local scale/ noise, biodiversity, etc. data privacy of users, etc. | Concerned by the environmental and social and socio-economic performance of organizations. And have great influence on the decision- making process |
| Local Community | | Local Authority | Local authorities that define the local politics and regulations to be respected by the organizations | Concerned by the environmental and social and socio-economic performance of available products/technologies in the market. Define local actions and plans to manage products/organizations impacts on a local scale |

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| | | | | |
|----------------------------------|---------------------------|-------------------|---|--|
| | | Local community | Local residents at a given geographical area where extraction/manufacturing activities take place | Directly and indirectly affected by the products/technologies and activities related to the manufacturing |
| Distribution And purchase | Workers | Workers | Employees in the distribution and purchase stages (male and female) | Affected by the organization practices / local / national transportation policies |
| | Users | Users | Person or group of persons that would buy the vehicle technology | Directly affected by |
| | Society | Governments | Actors' decision-makers at the national level for mobility policy and regulations and objectives (reduction of GHG emissions) | Directly involved in the decision-making: subvention policies for EV / Incentive taxes related to petroleum products |
| USE PHASE | Users | Users | Primary users of transportation technologies (Bikes, EV, Buses) and mobility services (personal, public, and shared transport) | Directly affected by the product (vehicle technology and mobility services) and practices of the: Operators of the mobility service/providers of the technology and insurance and other mobility services/ also affected by the local/national policies (ZER) |
| | Local community | Local community | Local residents at a given geographical area characterized by x types of transportation vehicles / and y mobility services / z mobility infrastructures | Affected by environmental, social and socio-economic aspects related to technologies/ mobility services (noise, local air quality, local employment, accessibility to mobility services and infrastructures for EV) |
| | Society | Governments | decision-makers at the national level for mobility policy and regulations and objectives (reduction of GHG emissions) | Directly involved in the decision-making: subvention policies for EV / Incentive taxes related to petroleum products |
| | | NGOs | Local organization for environmental protection/ air quality and a local scale/ noise, biodiversity, etc. data privacy of users, etc. | Concerned by the environmental and social and socio-economic performance of organizations. And have great influence on the decision- making process |
| | Value chain actors | Constructors | Road's infrastructures, charging infrastructures and other mobility infrastructures | Involved in the decision-making and concerned by the local and national mobility policies – subventions for charging infrastructures |
| | | Insurance | Providers of insurance services to the different users (primary and secondary: workers) | Involved in the decision-making process (private actors) could have directly affected on users |
| | | Service operators | Providers of mobility platforms (MaaS) / mobility services providers | Involved in the decision-making process. Could have direct impacts on users. Concerned by the national/local mobility policies |
| | Workers (secondary users) | Workers | Independent repairmen or those affiliated to the producers' organizations. Bus drivers, taxi drivers, and other workers in the operating stage of the vehicle (deliveries included) | Affected by the organizations practices and local and national regulatory context |

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|---------------------------|-----------------------|---|---|---|
| FINAL DOSPOSAL | Value Chain Actors | Batteries Collectors | Actors involved in the secondary use/application of the battery. | Involved in the decision-making process. Concerned by the local and national |
| | | Other materials collectors | Actors involved in the recycling of the vehicles | Involved in the supply chain, concerned by the national/local regulatory context |
| | | Manufacturer | Actors involved in the recycling of vehicles and related components and raw materials. “Filière REP” | Involved in the supply chain, concerned by the national/local regulatory context |
| | User | Users of the secondary products | Users of 2 nd life of vehicles, batteries for energy storage | Affected by the technology/component and local/national regulations |
| | Local Community | Local Authority | Local regulations and actions for the final disposal of vehicle technologies and components circularity. | Involved in the decision-making process, promotion of circular economy of the materials and vehicles components at the local scale |
| | Society | NGOs | Local organization for environmental protection/ air quality and a local scale/ noise, biodiversity, etc. | Concerned by the local policies and impacts on the various stakeholders |
| Governments | | decision-makers at the national level for mobility policy and regulations and objectives (reduction of GHG emissions) | Directly involved in the decision-making: subvention policies for EV batteries (Filière REP in France) + definition of regulations of vehicles recycling | |

S2-Supporting information

Survey 1 (was addressed to users)

List of questions: 7 questions

1st part: Social and socio-economic issues related to users (passengers) in mobility

- 1- **I am mainly user of:**
 - a. Personal transportation
 - b. Public transportation
 - c. Shared transportation
 - d. Combination of personal and collective
 - e. Combination of shared and Public
 - f. Combination of shared and personal
- 2- **Public transportation: What are the social and socio-economic issues that you consider critical concerning this transportation mode?**
- 3- **Personal transportation: What are the social and socio-economic issues that you consider critical concerning this transportation mode?**
- 4- **Shared transportation: What are the social and socio-economic issues that you consider critical concerning this transportation mode?**
- 5- **In the context of an electric mobility transition, what would be the social and socio-economic issues that you are most concerned about?**
 - a. Transparency
 - b. Health
 - c. Consumer privacy
 - d. Performance of the communication System
 - e. Safety (accidents, insecurity feeling, aggression, and harassment)
 - f. End of life responsibility
 - g. Availability and interoperability of infrastructures
 - h. Accessibility and affordability
 - i. Feedback mechanism
- 6- **Do you have any comments or other suggestions for social and economic issues that have not been identified?**

2nd part: Social and socio-economic issues related to workers (question 7) and local communities (question 8) for which users are concerned.

According to you, what is the order of importance of the information provided by manufacturers on the social and socio-economic issues associated with workers in the production phase (outside Europe)?

- a. Health and safety of workers
 - b. Child labor
 - c. Forced labor
 - d. Gender equity
 - e. Working hours
 - f. Freedom of association and collective bargaining
 - g. Fair salary
 - h. Equal opportunities/discrimination
 - i. Social benefits/social security
- 7- **According to you, what is the order of importance of the information provided by the manufacturers on the social and socio-economic issues associated with the local communities in the production phase (outside Europe)?**
- a. Local employment

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- b. Delocalization and migration
 - c. Safe and healthy living conditions
 - d. Access to immaterial resources
 - e. Access to material resources
 - f. Community engagement
-

Survey 2 (was addressed to worker unions)

List of questions: 7 questions

- 1- Which category of workers do you represent?**
 - a. Auto workers' unions - manufacturing, recycling, repair
 - b. Urban Transport Unions
 - c. VTC Drivers' Unions
 - 2- How would you rate the following social and socio-economic issues for your category of workers?**
Matrix performance levels (very low, low, positive, very positive, I don't know) / Social and socio-economic issues
 - 3- In which order of priority do you attribute the social and socio-economic issues (positive or negative) associated with your category of workers?**
 - a. Health and safety of workers
 - b. Child labor
 - c. Forced labor
 - d. Gender equity
 - e. Working hours
 - f. Freedom of association and collective bargaining
 - g. Fair salary
 - h. Equal opportunities/discrimination
 - i. Social benefits/social security
 - 4- As part of the shift to electric mobility, is/will your category of worker be directly affected?**
 - a. Yes
 - b. No
 - 5- If yes in question (4):**
 - 6- In your opinion, which type of mobility (electric or conventional) presents the highest risk to your category of workers with regard to each of the following issues?**
 - a. Health and safety of workers
 - b. Child labor
 - c. Forced labor
 - d. Gender equity
 - e. Working hours
 - f. Freedom of association and collective bargaining
 - g. Fair salary
 - h. Equal opportunities/discrimination
 - i. Social benefits/social security
 - 7- Do you have any comments or other suggestions for social and economic issues that have not been identified?**
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Survey 3: Industrial, academic, and public actors –

11 questions and 5 parts corresponding to the five stakeholder categories

1- Which category of actors do you represent?

- a. Industrial actors
- b. Public actors
- c. Academic actors

1st part: social and socio-economic issues related to users in mobility

2- According to you, what are the most significant social and socio-economic issues associated with users to consider for the development of sustainable mobility? Please move the thumbnails according to the order of preference/importance you assign to each of the following issues

3- Users: how do you compare the importance of these issues depending on the type of mobility (electric or conventional)?

- a. Transparency
- b. Health
- c. Consumer privacy
- d. Performance of the communication System
- e. Safety (accidents, insecurity feeling, aggression, and harassment)
- f. End of life responsibility
- g. Availability and interoperability of infrastructures
- h. Accessibility and affordability
- i. Feedback mechanism

2nd part: social and socio-economic issues related to workers

4- According to you, what are the most significant social and socio-economic issues associated with workers in the extraction, production and transport phases? Please move the thumbnails according to the order of preference/importance you assign to each of the following issues

5- According to you, what are the most significant social and socio-economic issues associated with workers in the use phase - drivers, infrastructure workers, service managers, etc.? (France)? Please move the thumbnails according to the order of preference/importance you assign to each of the following issues

6- Workers: how do you compare the importance of these issues depending on the type of mobility (electric or conventional)?

- a. Health and safety of workers
- b. Child labor
- c. Forced labor
- d. Gender equity
- e. Working hours
- f. Freedom of association and collective bargaining
- g. Fair salary
- h. Equal opportunities/discrimination
- i. Social benefits/social security

3rd part: social and socio-economic issues related to local communities

7- What is the order of importance you attribute to the social and socio-economic issues associated with local communities (extraction-manufacturing phase and end of life)? Please move the thumbnails according to the order of preference/importance you assign to each of the following issues

8- What do you think are the most significant social and socio-economic issues for local communities to consider when developing urban mobility plans (France)? Please move the thumbnails according to the order of preference/importance you assign to each of the following issues

9- Local communities: how do you compare the importance of these issues depending on the type of mobility (electric or conventional)?

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- a. Local employment
- b. Delocalization and migration
- c. Safe and healthy living conditions
- d. Access to immaterial resources
- e. Access to material resources
- f. Community engagement

4th part: social and socio-economic issues related to value chain actors

10- What is the order of priority you assign to the social and socio-economic issues associated with the value chain actors? *Please move the thumbnails according to the order of preference/importance you assign to each of the following issues*

11- Value chain actors: how do you compare the importance of these issues according to the type of mobility (electric or conventional)?

- a. Promotion of social responsibility
- b. Fair competition
- c. Supplier relationships
- d. Respect of intellectual property rights

5th part: social and socio-economic issues for society

12- What are the most significant social and socio-economic issues for the development of sustainable electric mobility services? *Please move the thumbnails according to the order of preference/importance you assign to each of the following issues*

13- Society: how do you compare the importance of these issues according to the type of mobility (electric or conventional)?

- a. Corruption
- b. Contribution to socio-economic development
- c. Prevention and mitigation of armed conflicts
- d. Technology development

S3-Supporting information

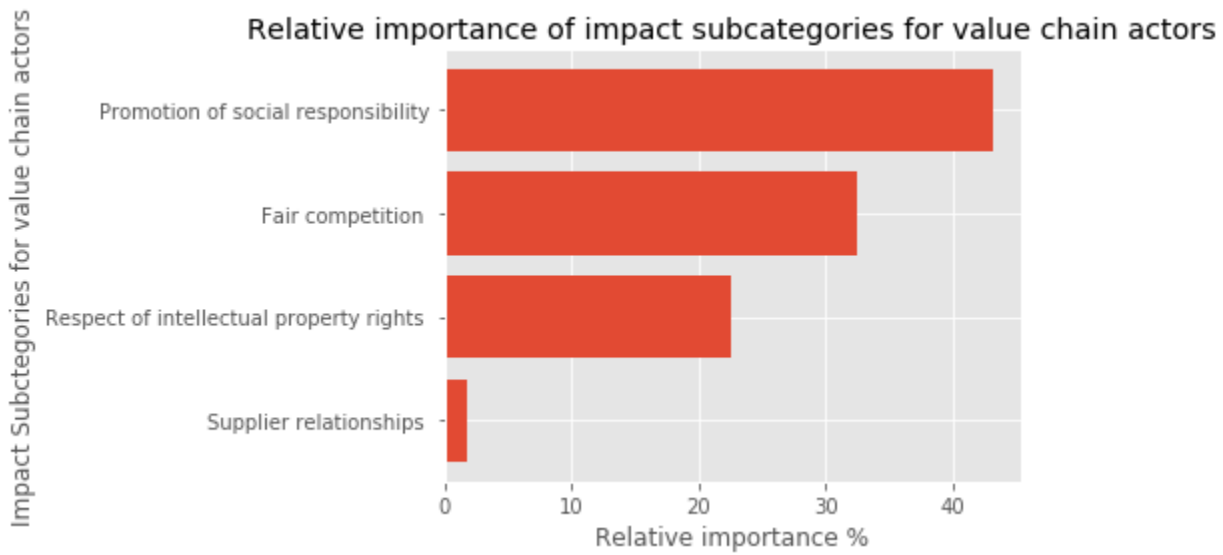
1. Life cycle stages and corresponding process activities selected from PSILCA database

| Object | Identified process Activity in PSILCA (sectors) | Countries |
|---|--|---------------|
| Battery production | Electric Accumulator & Battery | Thailand (TH) |
| | Batteries | Japan (JP) |
| | Primary battery | USA (US) |
| Vehicles and semi-trailers production, and related main components | Manufacture of motor vehicles, trailers, and semi-trailers | France (FR) |
| | Manufacture of electrical machinery | France (FR) |
| | Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel | France (FR) |
| | Recycling | France (FR) |
| Electricity Production and related activities | Electrical energy, gas, steam, and hot water | France (FR) |
| | Mining of uranium and thorium ores | France (FR) |
| Fuel production | Coke, refined petroleum products and nuclear fuel | France (FR) |
| | Crude petroleum and natural gas | France (FR) |

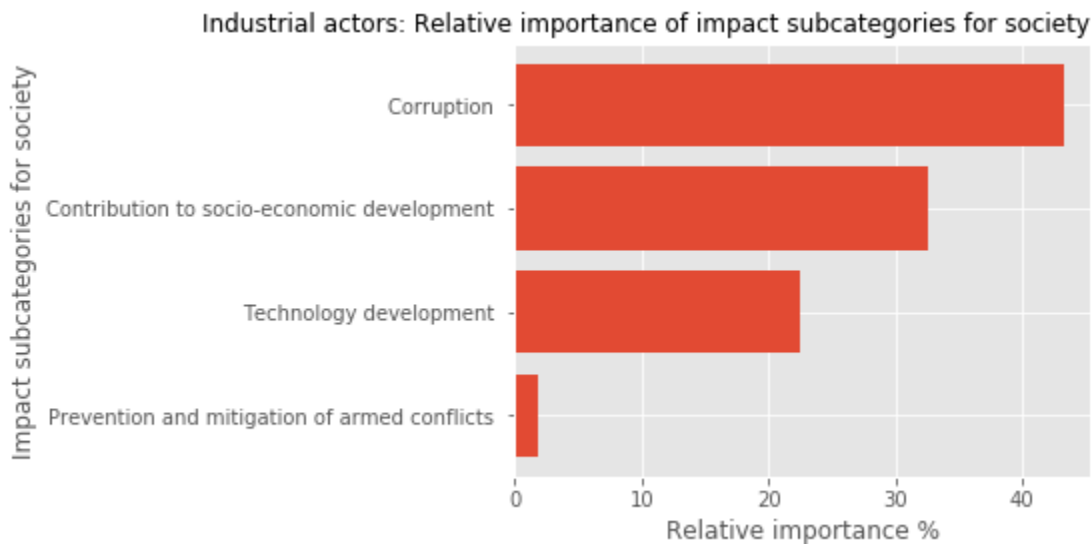
S4- Supporting information

Prioritized impacts subcategories (All the results for the developed participatory approach were developed using Python to analyze the surveys (jupyter notebook and the developed code could be provided if needed after a simple demand for the corresponding author)

Subcategories for value chain actors

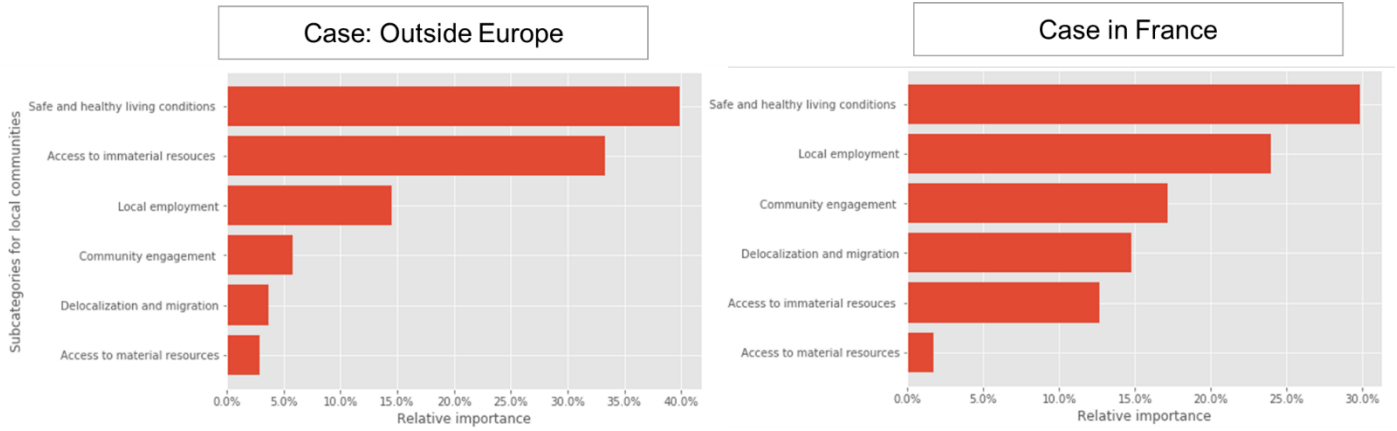


Subcategories for society



Local communities (Outside Europe and Inside France)

Prioritization of subcategories for local communities in France and outside Europe according to the consulted actors



Users' perceptions on the prioritization of workers' impact subcategories

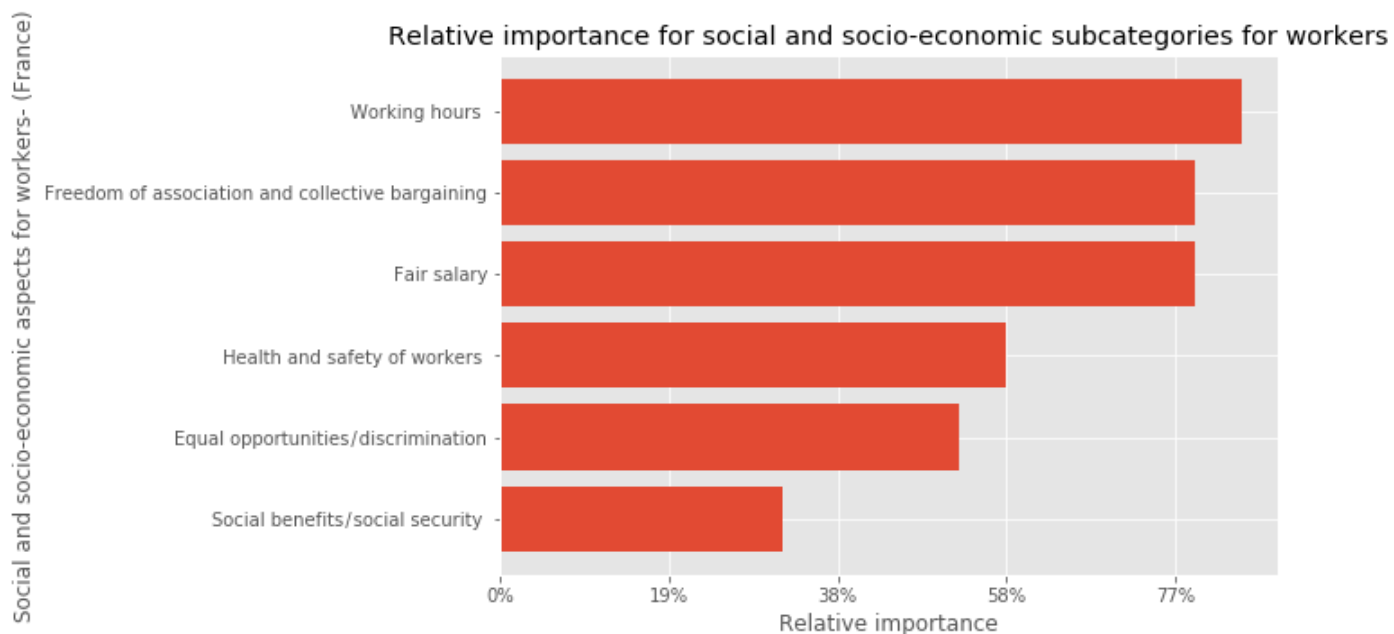
Comparison of relative importance of subcategories for workers : Outside Europe vs France



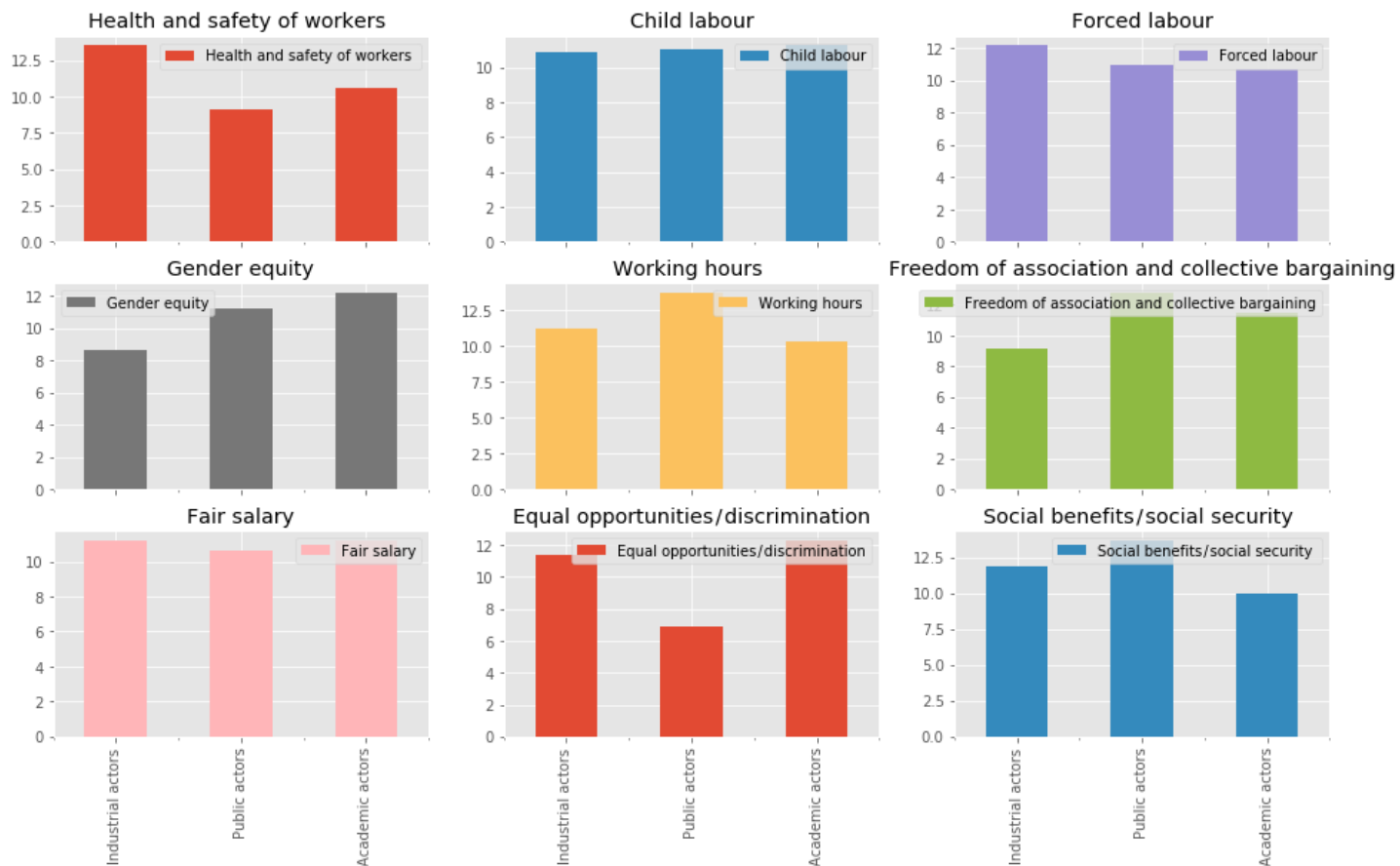
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Worker unions perspectives on the subcategories related to workers



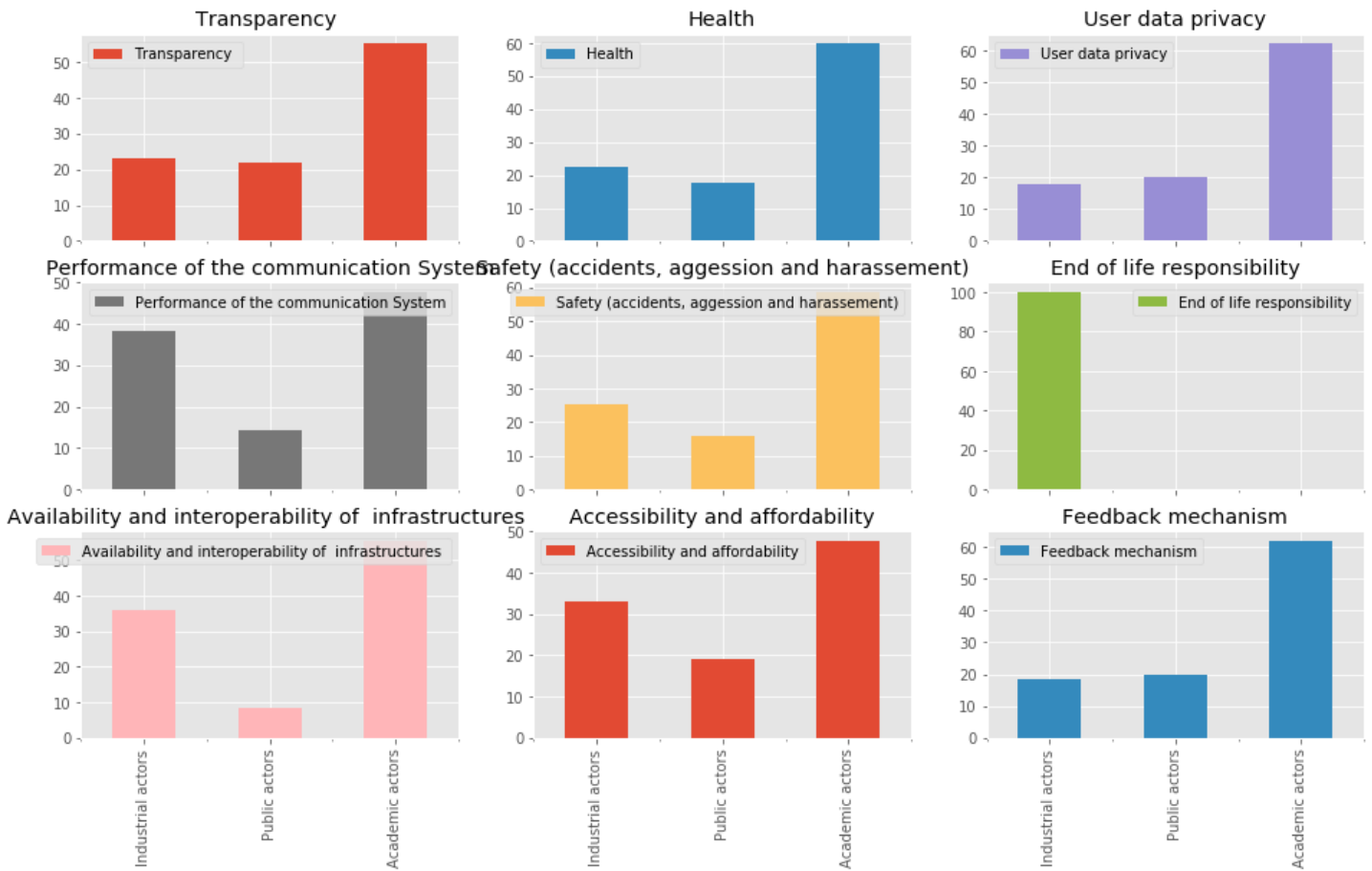
Comparison actors' perspectives: Subcategories for workers



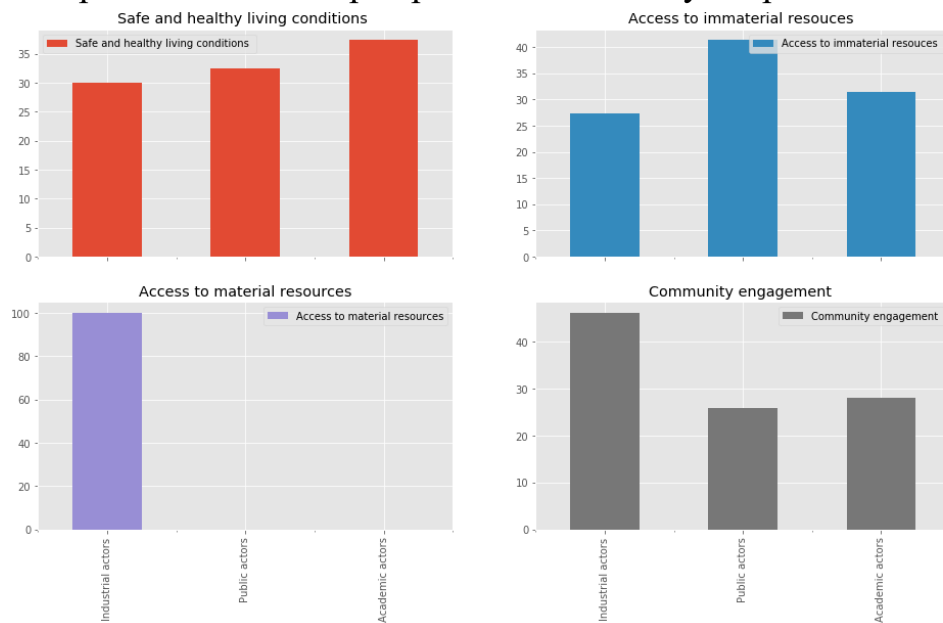
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Comparison of actors' perspectives: Subcategories for users



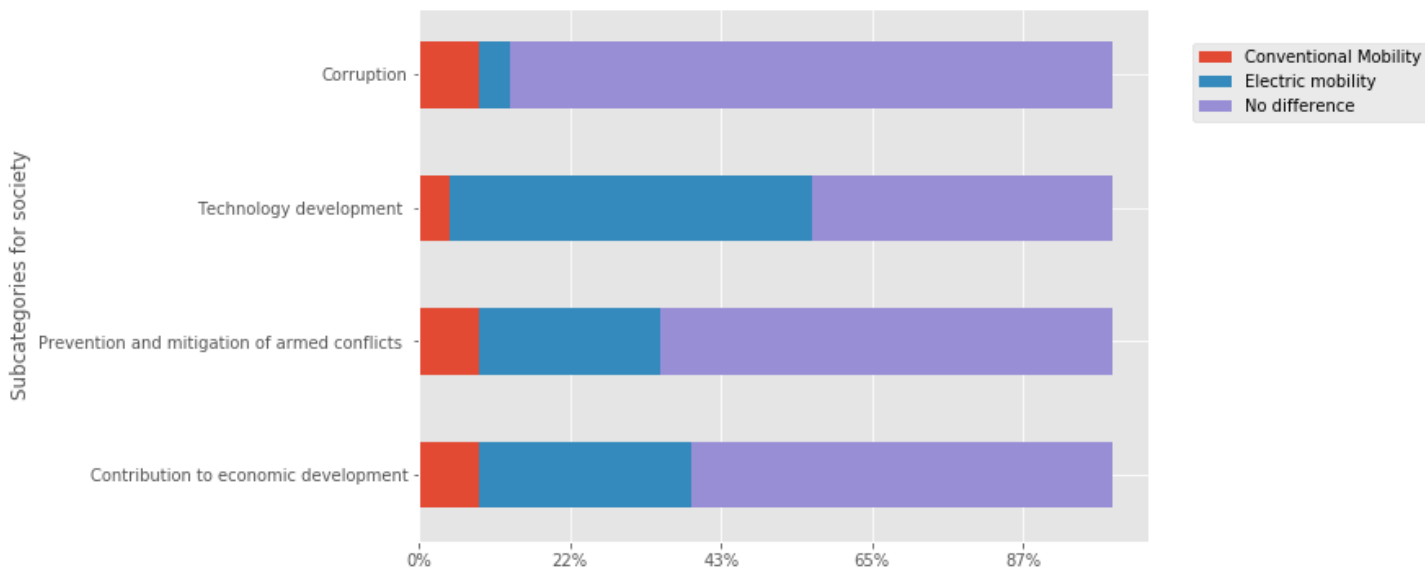
Comparison of actors' perspectives for society' impact subcategories



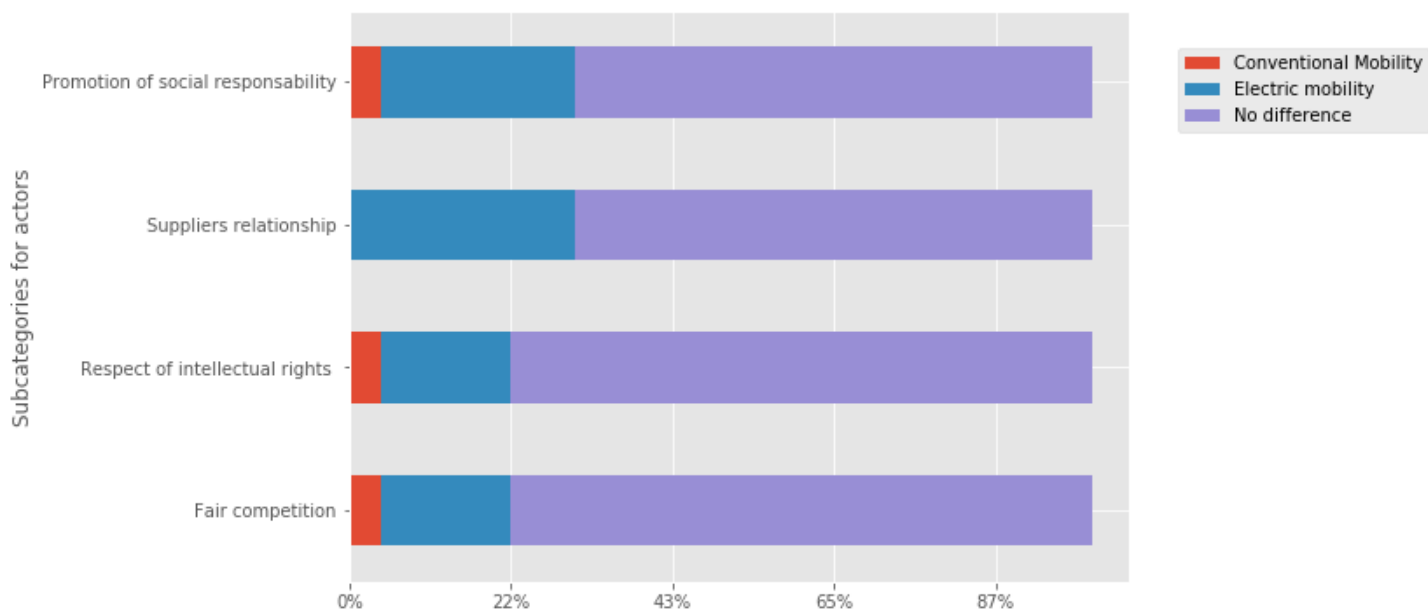
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Society's subcategories: comparison of electric mobility and conventional mobility



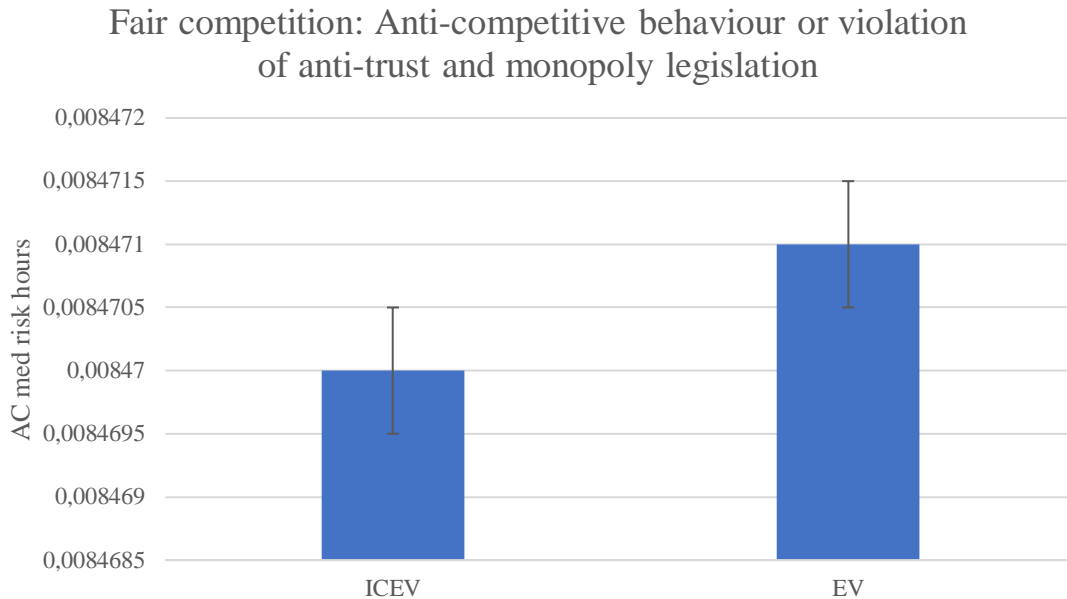
Subcategories for value chain actors: comparison of electric mobility and conventional mobility



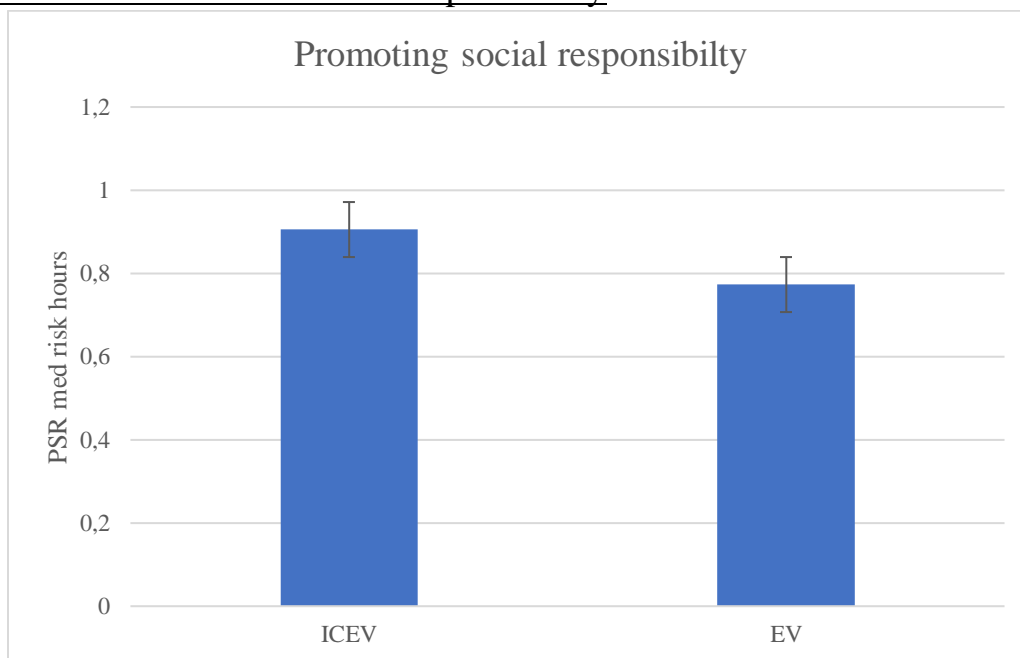
S5- Evaluation SLCIA results

Society and value chain actors related impact subcategories

Value chain actors: Fair competition impact subcategory



Value chain actors: Promotion of social responsibility



Society: contribution to economic development

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