SUMMARY REPORT
FOR
LIFE CYCLE ASSESSMENT OF FURNITURE

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EXECUTIVE SUMMARY

1.0 Introduction

The life cycle assessment study presented below illustrates the environmental impacts of PP furniture during its life cycle and compares the same with those of its alternatives. This study has been commissioned by the Indian Centre for Plastics in the Environment (ICPE). The study has been conducted by following ISO 14040 standards guidelines for Life Cycle Assessment.

2.0 Goal of the study

The overall goal of the Life Cycle Assessment (LCA) study is to evaluate the impacts of PP furniture during its life cycle and compare it with the competing materials wood and steel.

3.0 Target Audience

The target audience are the policy makers who are involved in issuing policies related to Plastic Use and Management.

4.0 Scope of the study

The applications considered for the purpose of the study, the alternative materials considered, the functional unit and the processes/stages excluded from the scope of the study are discussed in the following sections

4.1 Applications

The applications considered for the study include:

- Chair
- Tables

4.2 Alternatives

The alternatives considered for comparison with PP furniture include:

- Steel
- Wooden

4.3 Stages of life cycle

The life cycle stages considered for this study include:

- Raw material production
- Furniture manufacture
- Furniture transportation
- Use of furniture
- Used furniture management (Reuse/ Recycle/Disposal)

The modes of disposal studied include incineration and landfill.

4.4 Functional unit of the study

The production, use and disposal of one chair for seating of one adult human.

One dining table as required for four persons.

4.5 Exclusions

The life cycle stages, processes and data not included in the study are listed below

- Infrastructural requirements
- Manufacturing of chemicals not forming a part of the final product.
- Transportation of materials by modes other than road.
- Material inputs less than 1% of the total input.
- Economic and socioeconomic parameters.

5.0 Life Cycle Impact Assessment

The Life Cycle Impact Assessment (LCIA) phase involves the evaluation of potential human health and environmental impacts due to the environmental releases and depletion of resources. LCIA involves the use of science based conversion factors for calculating the impacts each environmental release has on issues such as smog or global warming. There are various methodologies available for carrying out an LCIA The criteria for the selection of the impact assessment methodology and a brief discussion on the selected methodology is presented below in the following section.

5.1 Selection of the assessment method

Keeping in view the nature of the study, the following parameters have been decided upon for selection of the impact assessment method:

1. Completeness with respect to impact categories
2. Modeling techniques used
3. Worldwide acceptance
4. Time perspective

Keeping in line with the ISO 14040 standards guidelines, those methodologies that include higher number of impact categories have been given more emphasis. As the study is regarding comparison of products for public assertion, assessment methods using state of the art scientific models have been preferred over methods using simpler techniques. Worldwide acceptance and time perspectives have been given a comparatively lower emphasis. Also, an impact assessment method with a balanced time perspective has been preferred for the purpose of the study.

The impact assessment methods were weighted using the above criteria and the results of the same are presented below:

Table 1.1: Decision criteria for selection of LCIA method

Impact Assessment Method	Completeness	Modeling	Acceptance	Time Perspective
Eco Indicator 99 (E)	H	H	L	L
Eco Indicator 99 (H)	H	H	L	M
Eco Indicator 99 (I)	H	H	L	L
EPS	H	H	L	L
CML 2000	N	M	L	L
EDIP	M	H	M	L

(Suitability criteria: H: High, M: Medium , L: Low, N: Not suitable)

It can be observed from the **Table 1.1** that the Ecoindicator 99 methodology with a heirarchist time perspective, based on the defined criteria, stands out to be the better option.

5.2 Eco indicator 99

The damage categories across which the impacts can be evaluated using Eco Indicator 99 methodology are:

Human health

The damage category, 'Human health', indicates the adverse impact on human health due to the release of pollutants into the environment.. The impact categories included within this damage category are:

- Carcinogens
- Respirable organics
- Respirable inorganics
- Climate change
- Radiation
- Ozone layer

Ecosystem quality

Ecosystem quality indicates the adverse impact on ecosystem quality due to the release of pollutants into the environment. The impact categories included within Ecosystem quality are:

- Ecotoxicity
- Acidification / Eutrophication
- Land use

Resources

Resources indicate the adverse impact of consumption of material during the life cycle of the product that lead to depletion of resources. The impact categories included within Resources are:

- Minerals
- Fossil fuels

5.3 Life cycle impact assessment results

The life cycle impact assessment results for the furniture are presented in the **Tables 1.2 and Table 1.3.** . **Table 1.2** presents the scores in terms of absolute scores while **Table 1.3** presents the scores for the alternatives relative to PP. **Figure 1.1** presents the impact category score while **Figure 1.2** presents the damage category score. Lower the score, superior is the environmental performance of the product.

Keeping in line with the ISO 14040 standards guidelines, weighting sets have not been used and single scores have not been provided.

Table 1.2 : Life cycle assessment indicator scores for furniture (Points)

Damage category	PP	Steel	Wood
Human Health	5.29E-5	0.000452	0.000145
Ecosystem Quality	7.07E-6	1.37E-5	1.68E-5
Resources	0.000422	0.00043	0.000326

Table 1.3: Life cycle assessment indicator scores for furniture (%)

Damage category	PP	Steel	Wood
Human Health	1	8.54	2.74
Ecosystem Quality	1	1.94	2.38
Resources	1	1.02	0.73

Figure 1.1 : Life cycle assessment indicator scores for furniture (Impact category)

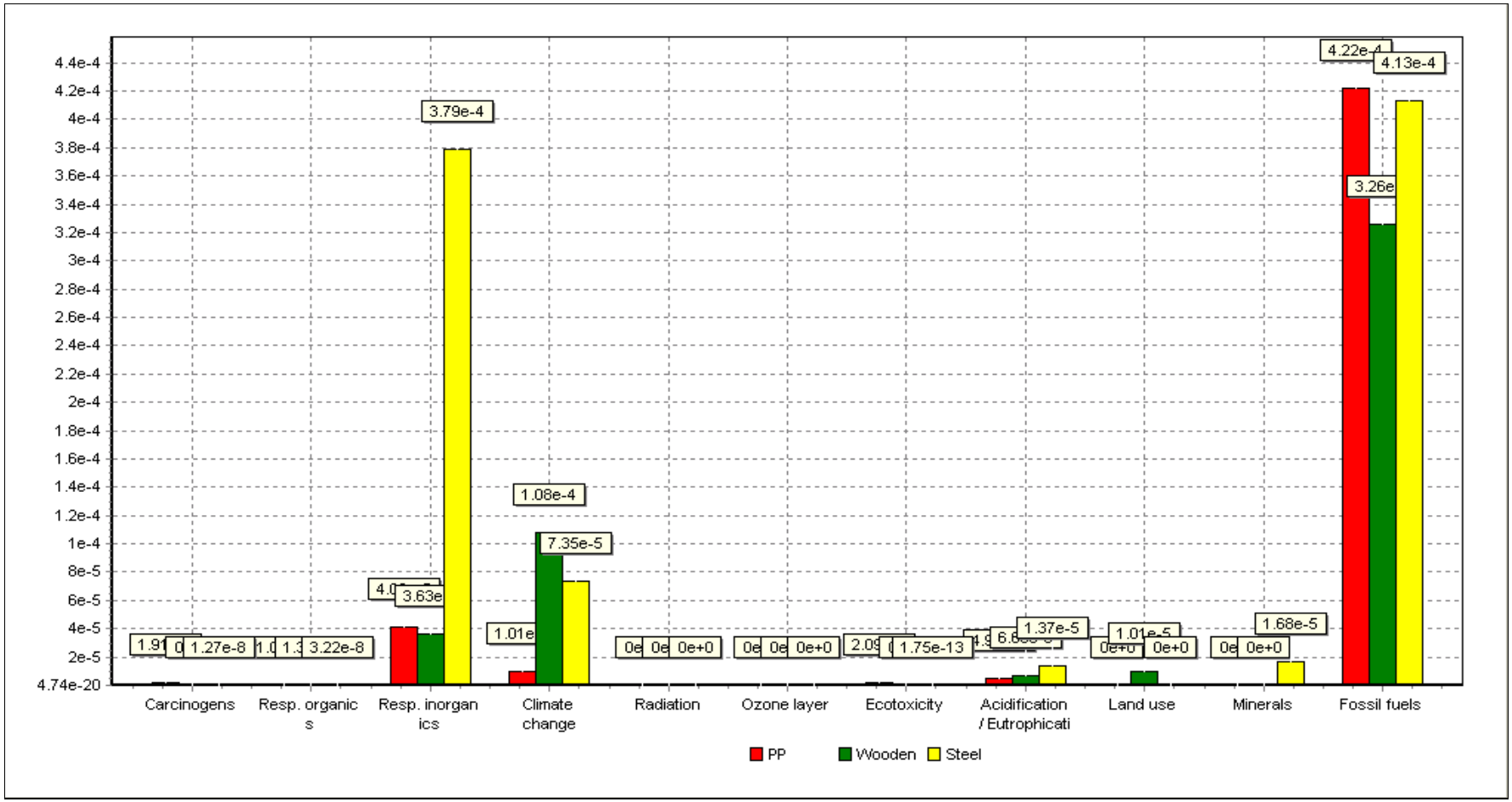
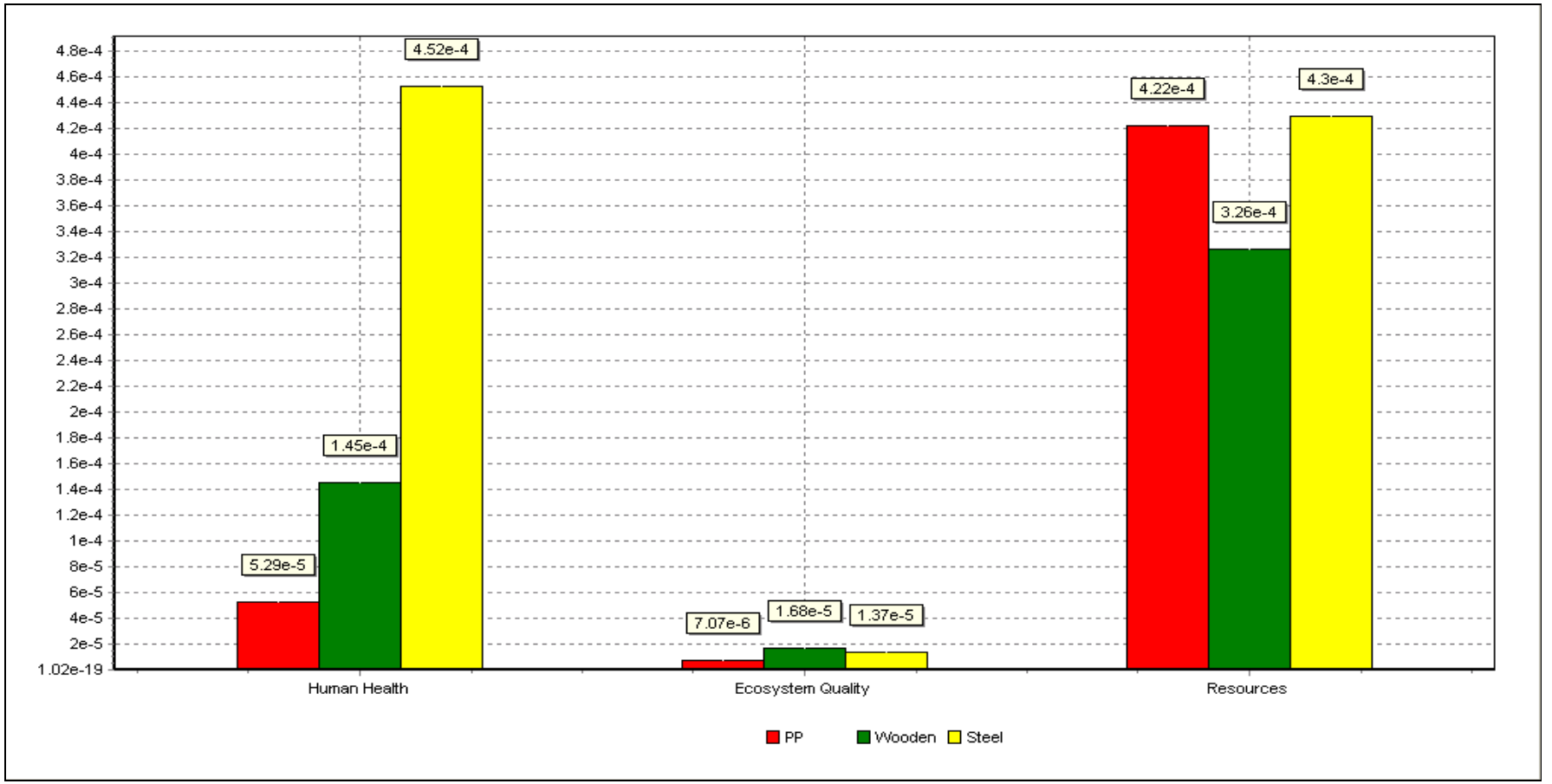


Figure 1.2: Life cycle assessment indicator scores for furniture (Impact category)



6.0 Life Cycle Interpretation

Wooden furniture:

Wooden furniture during its life cycle has an impact on Respirable organics and inorganics, Climate change, Acidification/Eutrophication, Land use and Fossil fuels. However the impact on Fossil fuels, Climate change and Land use is relatively high.

As compared to PP furniture, wooden furniture have a lower impact on Resources but a higher impact on Human health and Ecosystem quality.

Wood being a renewable resource does not have a major impact on resources. The impact during the manufacturing stage is primarily due to logging, transportation and incineration. Also, as compared to PP furniture, wooden furniture has lesser life resulting in higher environmental load during its life cycle. The other important aspect which has a major bearing on the final result is the release of Carbon dioxide during the manufacturing stage (cultivation to manufacturing of furniture). Non recyclability is a disadvantage that wooden furniture have vis-à-vis PP furniture.

Steel furniture

Steel furniture during its life cycle affects eight categories. Steel furniture have a relatively high impact on Respirable inorganics, Fossil fuels and Climate change while the impact on Minerals, Carcinogens and Respirable organics is low.

As compared to PP furniture, steel furniture have a higher impact across all the three damage categories.

The steel manufacturing process is resource intensive and the energy consumption during the transportation stage is also high. Steel manufacturing process involves the use of iron ore as a raw material, which is a non renewable resource. All these factors, combined together, result in a comparatively high score for the 'Resources' damage category. The steel manufacturing process also has a high impact on climate change, respiratory organics and carcinogens. The metal emissions during the steel manufacturing process results in high impact on ecosystem quality.

PP furniture

PP furniture during its life cycle impacts Carcinogens, Respirable organics and inorganics, Climate change, Acidification/ Eutrophication and Ecotoxicity. The impact on Fossil fuel, Climate change and Respirable organics is comparatively higher than the other categories.

As compared to the impact on Human health and Ecosystem quality, Polypropylene chairs, have a higher impact on the category 'Resources'. The impact on Resources is primarily due to the use of crude oil as a raw material and its use as a source of energy during the life cycle. However, impact due to the contribution of the actual energy consumption is lower in comparison to the impact due to its use as a raw material. Recycling of PP however, results in lowering the impact on resources. The PP Chair during its life cycle also results in high impact on respirable inorganics and acidification and eutrophication. PP being lighter than steel and wooden furniture also has a lower impact during the transportation stage.

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Limitations:

The study is intended to be a comparative study for PP versus the alternatives. Hence, a completeness check has been done for the PP products. The scores are to be considered in a

relative sense and are meant to indicate higher or lower impact and are not the absolute scores for the life cycle of the products.