the external walls contribute 100% (3.58E4 kg CO_2eq) for GWP while internal walls contribute 57.56% (2.06E4 kg CO_2eq) for GWP. In this case study, the external walls of the building are made out of 200 mm thick cement block work and internal walls are made out of 100 mm thick cement blockwork. This result shows that the building walls (exterior and interior masonry work) is the most significant component in terms of GWP.

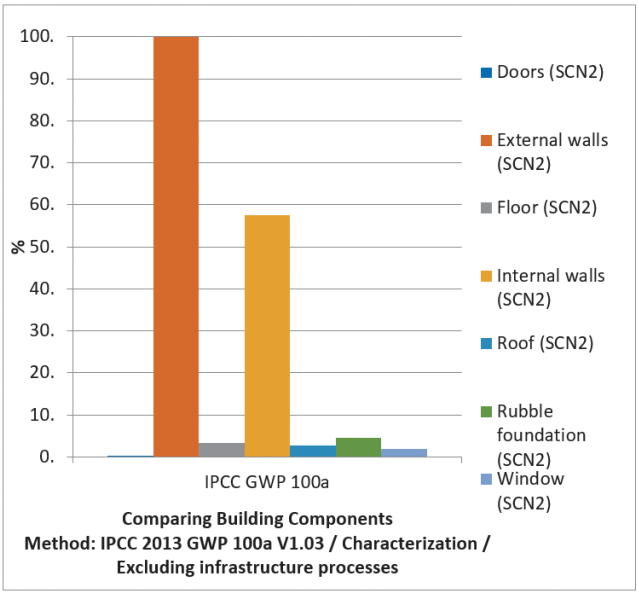

Figure 4 – Building Component wise Contribution to the Global Warming Potential (GWP)

5.2 Analysis on Results of ReCiPe Method

ReCiPe is another method for assessing the environmental impacts of the LCA. In this method, LCIA translates emissions into a limited number of environmental impact scores named characterization factors. The two main approaches for deriving characterization factors are named Midpoint level and Endpoint level. ReCipe calculates:

- 18 Midpoint indicators &
- 3 Endpoint indicators

Midpoint results are more comprehensive while endpoint results are concise. Midpoint analysis is more useful for Eco-Design purposes because it analyses seventeen single environment problems such as climate change, ozone layer depletion and human toxicity. Endpoint indicators are obtained by aggregating all seventeen midpoint indicators into three impact indicators that represent overall impacts on human health, eco-system and resource depletion.

The relative distribution of ReCiPe Midpoint environmental indicators by building components is shown in Figure 5. According to the percentage values obtained, external walls show more than 50% contribution to all eighteen indicators except 'Agricultural land occupation' with 40% and 15% contribution for 'metal depletion', respectively. Hence, building external walls are identified as the most significant building component in terms of environmental impacts. Building internal walls result shows the second-highest contribution.

In Figure 6a, the damage assessment results are given by aggregating all seventeen environmental impact categories caused by building components into three ReCiPe Endpoint indicators named 'Human health', 'Eco-system' and 'Resource'. The results of the weighting of these three damage categories are given in Figure 6b. The results indicate that External wall component as the most significant building component with the highest contribution to all three damage categories including 58.9% (1.42 kPt) contribution to 'Human health', 56% (0.7204 kPt) contribution to 'Ecosystems' and 59.8% (0.7014 kPt) contribution to 'Resources' categories. Based on the results, internal walls component show the second-largest contribution with 33.3% (0.8045 kPt), 32% (0.4119 kPt), and 32.8% (0.3845 kPt), contributions to 'Human health', 'Ecosystems' and 'Resources' categories, respectively. Hence it is evident that, during the eco-design process, more attention needs to be given to the external and internal wall component of the building.

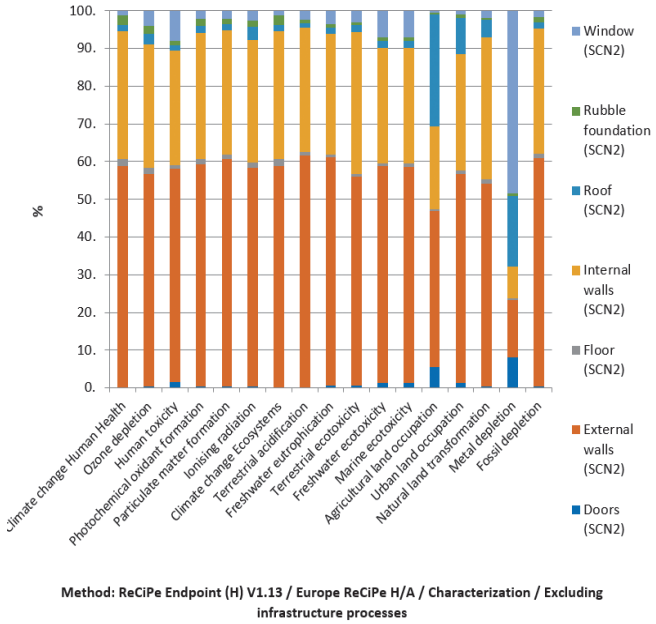

Figure 5 - Building Component wise Environmental Impact Results with Regard to ReCiPe Midpoint (H) Method

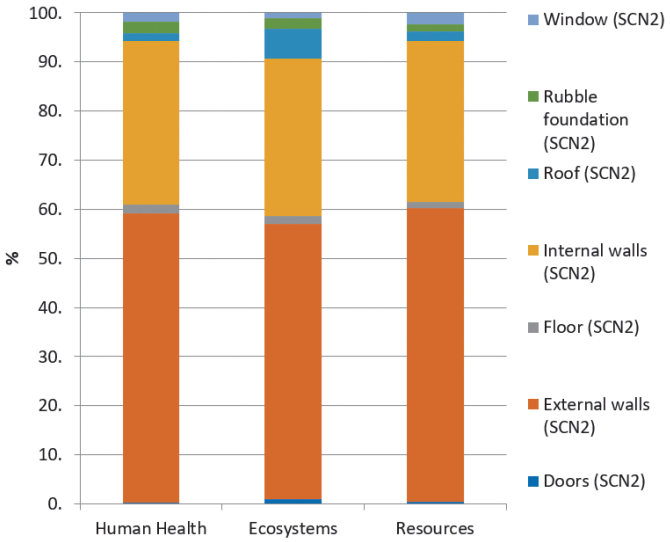

Figure 6a - Building Component wise Environmental Impact Results with Regard to ReCiPe Endpoint (H) Method

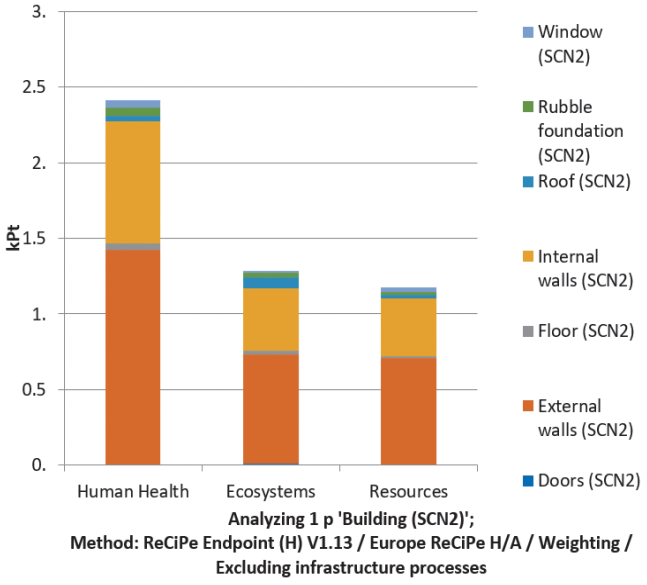

Figure 6b – Building Component wise Weighted Results with Regard to the ReCiPe Endpoint(H) Method

6. Conclusion

This paper studied the environmental impacts of typical residential building construction which is designed for a low-income family in Colombo, Sri Lanka. The analysis was done using the LCA software tool 'SimaPro 8.5.0.

According to the IPCC GWP 100 method, the external walls contribute 100% (3.58E4 kg CO_2eq) for GWP while internal walls contribute 57.56% (2.06E4 kg CO_2eq) for GWP. The analysis on results of ReCiPe Midpoint method gives, external walls displays more than 50% contribution to all eighteen indicators except 'Agricultural land occupation' with 40% and 15% contribution for 'Metal depletion' respectively. The results of the ReCiPe Endpoint method showed a 58.9% (1.42 kPt) contribution to 'Human health' and 56% (0.7204 kPt) contribution to 'Ecosystems' and 59.8% (0.7014 kPt) contribution to 'Resources' categories from the external walls component. Internal walls show the second largest contribution to 'Human health', 'Ecosystems' and 'Resources' categories respectively.

All these LCA study results highlight that the most significant building component is building walls (exterior and interior masonry work). Hence it is recommended to carry out further studies to identify alternative construction materials and alternative building construction practices for building walls that may result in lower negative impacts on the environment. The scope of this work is limited to cradle-to-gate of the residential building life cycle. It is also assumed that no electrical/mechanical equipment is involved for this construction work and only manual labour is involved.

This knowledge can be used for future large-scale human settlement projects in the local context. This knowledge can also be extended to achieve environmental sustainability in high-rise economical and residential building construction works. Hence, using this knowledge for the advancement of future works will reassure the environmental sustainability of the built environment.

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