

## Environmental Impact of Pallets in the Supply Chain: Including Logistics and Material Durability in a Life Cycle Assessment Approach

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**Abstract :** Pallets are devices that are used for moving and storing freight and are nearly omnipresent in supply chains. The market is dominated by timber pallets, with plastic being a common alternative. Either option underpins the use of important resources (oil, land, timber), the emission of greenhouse gases and additional waste generation in most supply chains. This study uses a dynamic approach to the life cycle assessment (LCA) of pallets. It demonstrates that what ultimately defines the environmental burden of pallets in the supply chain is how often the length of its lifespan, which depends on the durability of the material and on how pallets are utilized. This study proposes a life cycle assessment (LCA) of pallets in supply chains supported by an algorithm that estimates pallet durability in function of material resilience and of logistics. The LCA runs from cradle-to-grave, including raw material provision, manufacture, transport and end of life. The scope is representative of timber and plastic pallets in the Australian and South-East Asia markets. The materials included in this analysis are: -tropical mixed hardwood, unsustainably harvested in SE Asia; -certified softwood, sustainably harvested; -conventional plastic, a mix of virgin and scrap plastic; -recycled plastic pallets, 100% mixed plastic scrap, which are being pioneered by Re > Pal. The logistical model purports that more complex supply chains and rougher handling subject pallets to higher stress loads. More stress shortens the lifespan of pallets in function of their composition. Timber pallets can be repaired, extending their lifespan, while plastic pallets cannot. At the factory gate, softwood pallets have the lowest carbon footprint. Re > pal follows closely due to its burden-free feedstock. Tropical mixed hardwood and plastic pallets have the highest footprints. Harvesting tropical mixed hardwood in SE Asia often leads to deforestation, leading to emissions from land use change. The higher footprint of plastic pallets is due to the production of virgin plastic. Our findings show that manufacture alone does not determine the sustainability of pallets. Even though certified softwood pallets have lower carbon footprint and their lifespan can be extended by repair, the need for re-supply of materials and disposal of waste timber offsets this advantage. It also leads to most waste being generated among all pallets. In a supply chain context, Re > Pal pallets have the lowest footprint due to lower replacement and disposal needs. In addition, Re > Pal are nearly 'waste neutral', because the waste that is generated throughout their life cycle is almost totally offset by the scrap uptake for production. The absolute results of this study can be confirmed by progressing the logistics model, improving data quality, expanding the range of materials and utilization practices. Still, this LCA demonstrates that considering logistics, raw materials and material durability is central for sustainable decision-making on pallet purchasing, management and disposal.

**Keywords :** carbon footprint, life cycle assessment, recycled plastic, waste

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