Extended Abstract: Using System Dynamics to Evaluate Sustainable Business Models for the Aluminum Industry

By M. van Keeken, W.E.H. Dullaert, D.A.M. Inghels, P.L.J. Wissink

1. Problem statement

Energy-intensive industries face a major challenge in improving the sustainability of their supply chains (Yadav et al., 2020; EAA, 2019; Diabat et al., 2014) to meet the Paris Agreement (2016) objectives for a climate-neutral society by 2050. The aluminum sector is one such energy intensive industry. The amount of energy and carbon used within aluminum largely depends on the production processes within the supply chain (EAA, 2009). To reduce emissions within the aluminum supply chain actors will need to step away from traditional business models and adopt sustainable business models. Sustainable business models include the use of environmental and financially viable practices, e.g., material reuse, recycling and green energy sources (SSCF, 2021).

2. Method

Khakdaman et al. (2021) developed a system dynamics (SD) model to analyze the dynamics of changing technological developments, supply, demand, legislation and changing consumer demands for the aluminum rolled product supply chain. Not only does SD help to understand the structure that drives non-linear behavior (Sterman, 2000), but it also provides a means to evaluate the quantitative performance of the supply chain. In effect, we can use the SD model to determine the impact of investment decisions within the chain instigated by the implementation of selected sustainable business models. Here, we explicitly distinguish between the potential impact of investment decisions on long-term dynamics and on short-term dynamics.

3. Preliminary results

The stock and flow model developed in Khakdaman et al. (2021) takes into account long-term dynamics for evolutions of demand, supply, technology and social factors for the sustainable supply chain of aluminum, e.g., the use of ordinary least squares regressions to model demand. These long-term dynamics are used to strategically plan the transition and necessary investments for improving the level of sustainability in the chain.

Several short-term supply chain effects - such as the bullwhip effect - may also have a significant effect on disruptions and risks throughout the chain. Our current work aims to extend the SD model with short-term dynamics. We subsequently aim to evaluate and analyze promising business models for the aluminum industry to control variability in the supply chain, maximize supply chain performance and mitigate potential risks (Simchi-Levi et al., 2008).

4. Bibliography

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