Sustainable Hydrogen Supply Chain Design based on a Multi-Objective Optimization approach. The case of seaports in Chile

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Abstract. The linear economy and the traditional use of energy sources have caused several environmental problems worldwide, such as the increase in the earth's temperature, droughts, and the melting of glaciers. These, in turn, negatively impact the quality of life, for example, by reducing the availability of food and water for the population. Consequently, international agreements such as the Paris Agreement have been implemented to limit climate change, establishing goals for producing energy based on unconventional renewable energy sources. In this context, the production and use of green hydrogen has emerged as an environmentally friendly energy solution. This, because clean energy sources can be used for its production. The related literature focused on designing a supply chain using multi-objective optimization, primarily focusing on economic and environmental aspects, leaving out social and political factors from the analysis. Specifically, the objective function of the articles is recurrently to minimize the total daily costs of the supply chain subject to demand constraints, capacity constraints, and constraints related to the production aspects of the plant. Moreover, the articles focused on hydrogen supply chains frequently consider three main phases: production, storage, and distribution of hydrogen. Considering this background, this work proposes a multi-objective optimization model for designing the hydrogen supply chain that incorporates five sustainability dimensions, both in its objective functions and constraints. The implementation of a hydrogen production plant and subsequent hydrogen distribution among different ports of Chile is presented as a case study to demonstrate the usefulness of this proposal. Mainly because this country presents a high potential for renewable energies and policies associated with green hydrogen, as outlined in the National Green Hydrogen Strategy developed by the Chilean Ministry of Energy. The results show the conditions allowing optimal and sustainable hydrogen production and distribution implementation throughout its supply chain.

Keywords: *Supply chain design, multi-objective optimization, hydrogen.*

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