

A Delphi Study of Factors Affecting the Forest Biorefinery Development in the Pulp and Paper Industry: The Case of Bio-Based Products

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Abstract : Being a mature industry, pulp and paper industry (PPI) possess strength points coming from its existing infrastructure, technology know-how, and abundant availability of biomass. However, the declining trend of the wood-based products sales sends a clear signal to the industry to transform its business model in order to increase its profitability. With the emerging global attention on bio-based economy and circular economy, coupled with the low price of fossil feedstock, the PPI starts to integrate biorefinery as a value-added business model to keep the industry's competitiveness. Nonetheless, biorefinery as an innovation exposes the PPI with some barriers, of which the uncertainty of the promising product becomes one of the major hurdles. This study aims to assess factors that affect the diffusion and development of forest biorefinery in the PPI, including drivers, barriers, advantages, disadvantages, as well as the most promising bio-based products of forest biorefinery. The study examines the identified factors according to the layer of business environment, being the macro-environment, industry, and strategic group level. Besides, an overview of future state of the identified factors is elaborated as to map necessary improvements for implementing forest biorefinery. A two-phase Delphi method is used to collect the empirical data for the study, comprising of an online-based survey and interviews. Delphi method is an effective communication tools to elicit ideas from a group of experts to further reach a consensus of forecasting future trends. Collaborating a total of 50 experts in the panel, the study reveals that influential factors are found in every layers of business of the PPI. The politic dimension is apparent to have a significant influence for tackling the economy barrier while reinforcing the environmental and social benefits in the macro-environment. In the industry level, the biomass availability appears to be a strength point of the PPI while the knowledge gap on technology and market seem to be barriers. Consequently, cooperation with academia and the chemical industry has to be improved. Human resources issue is indicated as one important premise behind the preceding barrier, along with the indication of the PPI's resistance towards biorefinery implementation as an innovation. Further, cellulose-based products are acknowledged for near-term product development whereas lignin-based products are emphasized to gain importance in the long-term future.

Keywords : forest biorefinery, pulp and paper, bio-based product, Delphi method

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