Additive Manufacturing for exploiting Circular Economy opportunities in the Furniture industry: A Real Options Approach

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Abstract: Small and medium-sized enterprises (SMEs) in the furniture industry face challenges due to fluctuating demand and the trend towards sustainable and customized products. However, SMEs may struggle to adopt innovative digital technologies due to high initial costs. Additionally, fluctuating demand for metal structures and components can significantly affect the supply of SMEs. Nonetheless, certain critical metals carry a high global supply risk, which can expose furniture SMEs to disruption. In this context, implementing Industry 4.0 (I4.0) technologies can increase a company's productivity and flexibility in response to sources of uncertainty, while enabling the achievement of circular economy (CE) principles. The aim of this research is to analyze investments in Additive Manufacturing (AM) for the furniture industry by using the Real Option Valuation method to model the internal flexibility mechanism of manufacturing options. The research will specifically consider the choice between externalization to third-party suppliers or internalization through the implementation of AM technologies for metal structures and component manufacture in the furniture industry. Moreover, this study examines the potential of manufacturing options to enable CE practices in order to mitigate various sources of uncertainty, including production capacity constraints, price volatility and product reliability. The results confirm that the integration of AM technologies can enhance the capabilities of furniture SMEs, leading to increased customer satisfaction, improved supply security of metal structures and components, enhanced product sustainability, and greater competitiveness in the marketplace. Finally, the study concludes by discussing the implications of each option for enabling CE practices.