Sailing in the Open Sea: A Systematic Literature Review on Open Hardware - Unveiling Innovations, Challenges and Motivations Across Industries

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Abstract. Open hardware (OH) has emerged as a disruptive force in technology, representing a pivotal frontier in technological innovation of hardware after the pioneering phenomenon of open-source software (e.g., Bonvoisin et al. 2021; Fjeldsted et al. 2012), offering collaborative solutions to address various business and societal challenges (Ro et al. 2024). Its key characteristic lies in the democratization of hardware design, enabling global participation in the creation, modification, and dissemination of hardware solutions (Wenzel 2023). Open hardware has expanded gradually over time in different industries to include electronic circuit boards, machines, robots, medical equipment, electricity production, agricultural machinery, toys and games, optical products, musical instruments, clothing, and 3D printing is also included, as is the use of machine tools, mostly desktop ones, vehicles (mostly bicycles), and so on (Bonvoisin et al. 2016). Although the increasing interest, there is lack of studies offering insights in the main factors and the dynamics of OH adoption, especially in important industries like healthcare and agriculture where creative solutions are sorely required (see, Dos Santos et al. 2023; Pereyra et al. 2023; Doering et al. 2016; Pearce 2015). This research employs a systematic literature review (SLR) methodology provided by Gough et al. (2017) and Petticrew and Roberts (2008), to comprehensively analyze the landscape of OH in specific industries and its adoption characteristics including disruptiveness of emerging business models. 936 publications from Scopus published between 2002 and 2024 and 293 OH projects from GitHub and OSHWA repositories were collected and analyzed to explore the complex aspects of OH utilization and its implications. To give an overview of the development of OH discourse, the study first maps the bibliometric trends and thematic clusters found in the database of academic articles collected. Next, using the framework that Wisdom et al. (2014) provided, the study explores the complex nature of innovation adoption characteristics that are presented in both academic literature and real-world OH projects. Initial results of bibliometric analysis indicate that there is a growing interest in OH and its ability to thrive. In further analysis, OH is typically characterized as affordable substitute for proprietary hardware, which is particularly beneficial for developing countries and rural areas. As initial results suggest, primary barrier to adoption of OH is the adopters' lack of technical proficiency, which makes it difficult to construct from openly shared hardware designs. Moreover, the primary results of SLR also clarify a common emphasis on the pre-adoption stage of OH phenomenon, which is defined by attempts to identify the financial drivers that support and limit its economic viability and expansion. This collective approach shows a deliberate effort to set the stage for OH solutions to be widely adopted and integrated further. Furthermore, by providing an extensive overview of OH phenomena, this study seeks to encourage scholarly curiosity and create pathways for additional investigation. In the end, with its synthesis stage, the research aims to promote a mutually beneficial collaboration between academia and practice, advancing the development and democratization of OH for the benefit of society as whole.

Keywords: open hardware, innovation adoption, open-source product development, collaboration

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