Focus

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In Journal of Innovation Economics & Management Volume 40, Issue 1, 2023, pages 1 to 11
Publishers De Boeck Supérieur

ISBN 9782807399525

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"Do-It-Together" and Innovation: Transforming European Industry[1]

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This Special Issue on "Do It Together and Innovation" brings together a set of expertise, disciplines, and networks to address the environmental and socio-economic challenges facing our current industrial model. The accelerated development of advanced technologies such as the Internet of Things (IoT), 3D printing, immersive technologies, Peer-to-Peer (P2P), the interconnection between digital and physical environments, and the spread of alternative development models such as the circular economy offer the

1. *Acknowledgments*: This issue was supported by the INEDIT European Union's H2020 research program – Agreement N° 869952.

DOI: 10.3917/jie.040.0001

potential for a transition to new innovative and sustainable hybrid modes of innovation, production and consumption.

In this context, in 2018-2019 the European Commission[2] initiated a call for projects on Open Innovation for collaborative production engineering aligned with the strategy of Factories of the Future (European Commission Directorate-General for Research and Innovation, 2013), with the ambition of transferring the success of the Do-It-Yourself (DIY) phenomenon to Small and medium-sized enterprises (SMEs). Indeed, the emergence and multiplication of spaces and networks of makers, hackerspaces, micro-factories, FabLabs or other spaces equipped with digital manufacturing tools and technologies has favored new types of innovation processes and the development of a more agile, democratized, and distributed production based on commons-based peer production, particularly digital commons (Dupont, 2019; Dupont *et al.*, 2021; Fox, 2013; Kohtala, Hyysalo, 2015; Pearce, 2014).

The richness of the concepts solicited in this call for projects is reflected in the launch in 2019 of four European projects[1] addressing the following subjects: Open Innovation Digital Platform and Fablabs for Collaborative Design and Production of personalized/customized FMCG (DIY4U), open INnovation Ecosystems for Do It Together process (INEDIT), Social Manufacturing Framework for Streamlined Multi-stakeholder Open Innovation Missions in Consumer Goods Sectors (iPRODUCE), and Company-Community Collaboration for Open-Source Development of products and services (OPEN_NEXT). The diversity of the actors, industrial sectors, technologies and territories involved in these projects provides complementary perimeters of action and experimentations (Dupont *et al.*, 2022).

The feedback from these sister projects highlights the relevance of approaching this theme in the most transversal way possible by relying on the interdisciplinarity inherent to engineering, technology, and innovation management, as proposed by the articles which comprise this special issue. Nevertheless, according to the European Factories of the Future Research Association (EFFRA), these projects are only a small part of a very large public-private partnership (PPP) for research and innovation in advanced manufacturing. The EFFRA points out that with €1.15 billion, "Factories

2. https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/dt-fof-05-2019

of the Future" (FOF) is the European Union's main program to achieve the next industrial revolution: materializing Factories 4.0[3].

The FOF concept is therefore driven and supported by the industrial and manufacturing communities. It is part of the Fourth Industrial Revolution, also referred to as Industry 4.0. According to Ortt *et al.*, (2020) "*Industry 4.0 is a concept that requires integration of technological, business, and organizational aspects, several dimensions are formed in these models.*" Furthermore, implementation of Industry 4.0 differs per sector and type of company. This is even more true for SMEs, which do not always have the possibility of deploying robust and standardized processes, especially if they are not directly transferable between sectors. That means that SMEs because of their way of working have more problems with adopting and implementing Industry 4.0. In this sense, it is as if these SMEs had to abandon the DIY approach in order to enter the Industry 4.0 era by themselves.

On the other hand, society is changing and awareness of the negative impact of technological advances on our natural ecosystem seems to be increasing. Some authors have argued for a Quadruple or even Quintuple Helix of innovation (Carayannis, Rakhmatullin, 2014), aiming to integrate citizens and representatives of the biosphere into the well-established PPP innovation production process.

Although many of the expected impacts of the European call for projects are ambitious (Establish Open-Innovation networks for manufacturing that support customer-driven production; Creation of specific business models for the engineering of customized solutions, particularly for SMEs, rapid demand changes and shorter time to market; Improvement of the co-design and co-development capabilities toward a reduction of development costs of new products and services; Increase of product variety and personalization for higher customer satisfaction and loyalty)[1], we still need to support SMEs to raise their awareness of environmental issues and their ability to act.

Our factories and companies are part of a whole. Through their economic and social activities, they play a major role in the organization of territories and the impact on the natural ecosystem. If the effects induced by the large industrial groups are quickly

3. See https://www.effra.eu/factories-future, last accessed on Dec. 9th, 2022.

identifiable by the volumes they generate, the negative externalities of the SMEs (their supply chain and the industrial sector in which they are included) are sometimes more difficult to qualify.

The FOF actors have an urgent need to put into perspective the impacts generated by Cyber-Physical Systems regarding environmental and even geopolitical issues, which we can no longer ignore. The FOF must minimize or even eliminate all negative externalities for its entire value chain. Human and economic activities can be rethought through the emergence and implementation of FOF. For this, it seems wise to combine it with other concepts such as the circular economy or industrial ecology (Kasmi *et al.*, 2021).

Derived from Do-It-Yourself, Do-It-Together (DIT) is an alternative design process that enables customized open global design and manufacturing, promoting local production closer to consumers who actively contribute to their production. Value co-creation brings benefits to all stakeholders involved in DIT processes by engaging a community of customers, professionals and producers from the co-creation of product/service ideas to custom production. The DIT concept as a form of participatory design and collaborative production strategy (Dupont *et al.*, 2021) aims to create open co-creation and manufacturing ecosystems to transform Do-It-Yourself practices into a professional approach to capitalize the knowledge, creativity, and ideas of design and engineering. This approach aims to engage the integration of individuals/customers in all physical product manufacturing processes, from ideation to production for economic, societal, and environmental purposes. This radical ambition implies that DIT promotes small-scale production at local sites, even the development of an urban production model (Herrmann *et al.*, 2019, 2020; Juraschek, 2022) with decentralized and distributed characteristics (Cerdas *et al.*, 2017) as an alternative to globalized manufacturing values chains. Aiming at "design global/manufacturing local" (DGML) (Kostakis *et al.*, 2018) seems to be a prototype of an industrialization transition that is taking place as a potential driver to propose an alternative globalization manufacturing paradigm.

We propose here to shed new light on the concept of FOF with in-depth reflections on the DIT concept from technological to territorial dimensions for a more local and sustainable European Industry.

Based on theory and practice, this special issue brings together twenty international researchers and practitioners. Researchers because the authors are part of a scientific community with a specific approach to generate new knowledge and contribute to shedding light on this protean concept. Practitioners because they are actors involved in operational European projects (INEDIT[4] or OPEN_NEXT[5]), as part of an Innovation Action program. This means that these projects aim to develop concrete tools, methods, products, and services. Four articles explore the different facets of this concept, enriching existing definitions and, above all, proposing concrete avenues for implementing and operationalizing DIT, even outlining potential business models. To go further, three articles analyze more broadly the contribution of Open-Source Appropriate Technology (OSAT) and Peer-to-Peer (P2P) in the evolution of companies and how territories can promote the emergence of such innovative ecosystems that are more inclined to value and network local resources.

The paper of Marche, B., Kasmi, F., Mayer, F. and Dupont, L. aims to define and formalize the DIT approach for its operationalization based on an analysis of the literature on social manufacturing. DIT is presented as a new approach to social manufacturing that relies on the co-creation and open manufacturing of personalized products involving consumers, assisted by a community of professionals and experts in a cyber-manufacturing space. DIT is defined in this article as "*an alternative design process which allows for open global design and open-manufacturing, promoting local production closer to manufacturers/'prosumers'. It enables 'prosumers' to produce and consume goods which they have helped to design. This way, they become active co-creators who could disrupt the existing local mass production industry. Co-creation of value brings benefits to all stakeholders involved in DIT processes by engaging a community of customers, professionals, and producers from the co-creation of the product/service ideas to custom production*." Building on this definition, the authors propose a generic DIT process and an organizational framework to clarify its organization on an industrial scale. The generic DIT process mobilizes insights from the fields of co-creation and open manufacturing. The organizational framework is a combination of the social manufacturing model and the

4. https://www.inedit-project.eu
5. https://opennext.eu

open manufacturing model. The former clarifies how stakeholders collaborate to design customized products while the latter describes how the exchange of services and knowledge between stakeholders is organized. In conclusion, the authors point out that the implementation of DIT in practice requires the development of an empirical application to validate the different aspects of their conceptual framework. Specific ecosystems, logistics and economic models need to be designed and implemented to scale up to industrialization.

Pallot M., Fleury S., Poussard, B. and Richir, S. provide a systematic literature review to explore the challenges and enabling technologies for implementing DIT. The authors use Product Lifecycle Analysis (PLC) to build an analysis grid for the thirty-eight most relevant articles selected for this study. They propose seven stages from which they analyze in particular the previous empirical work described in the articles: Co-creation (Social Ideation); Co-design Open Design; Open Manufacturing; Co-Marketing (Social Marketing); Social Commercialization; Green logistics and Reverse logistics; Social Reuse, Refurbishment and Repurposing. The authors focus on identifying the challenges overcome by eXtended Reality (XR) technologies and their induced benefits, as well as the cross-cutting drawbacks to the early stages of the New Product Development (NPD) PLC. EXperience Design (XD) technologies appear to be an appropriate catalyst for NPD implementation, particularly in the ideation and design stages, due to the power of virtual prototyping, allowing stakeholders to: (i) quickly reach a mutual understanding of an idea, its associated concepts and its usage scenario; (ii) anticipate the resulting User eXperience (UX); hence the possibility to deduce the degree of customer satisfaction and willingness to adopt the represented solution; (iii) acquire the necessary knowledge by learning quickly on the job without any risk; (iv) follow a safe step-by-step process to accomplish a task. The authors note a significant lack of empirical studies on the negative impacts of these technologies for DIT. They do, however, identify a significant impediment related to the lack of appropriate customer skills to appropriately contribute to design and manufacturing activities.

The paper of Leiting, T., Külschbach, A. and Stich, V. provides one of the answers to the questions raised by Marche *et al.*, 2022 by addressing sustainable business models for co-creation ecosystems.

The authors seek to develop a sustainable business model for a co-creation platform in a DIT approach with a concrete application to the furniture industry. Customers and manufacturers are brought together on a digital platform - as equal partners and supported by designers and manufacturers in a co-creation process. So far, the business models of existing platforms focus either on the customer side or the production side. There are no sustainable multi-stakeholder business models that equally involve all stakeholders in the value chain to implement DIT co-creation in practice. Therefore, the objective of the paper is to develop a business model for a DIT co-creation platform based on a four-step business model innovation framework: 1) definition of the business field, 2) determination of the business elements, 3) identification of business options, 4) creation of business models. Using this method, a platform business model was developed for the DIT co-creation process of the INEDIT project. According to the authors, this platform business model design can be applied in other application scenarios and the DIT co-creation process can be established in various industries. SMEs will benefit from this model by increasing the economic viability of producing lucrative, customized products in small batches, manufactured on demand.

With a focus on operationalizing DIT, Franz, J. and Pearce, J. propose a new business model for free and open-source hardware (FOSH), specific to companies making specialized components for manufacturers using a case study of an open-source screw manufacturer. The case study explores the economics of building a system to manufacture a specialized component for other companies and prosumers working in distributed recycling and additive manufacturing (DRAM). Component payback time is calculated under various scenarios, the sales required to provide an attractive income for a small business are quantified, and the point at which business expansion is required is determined. The authors provide five avenues for small businesses to generate revenue and leverage applications of this technology in an open-source DIT model: 1) Selling screws manufactured on the open-source screw manufacturing system; 2) Selling consumables, components, kits, or complete screw machines; 3) Selling custom open-source screws; 4) Selling services revolving around the custom screws; 5) Selling advertising via trending content on various online platforms. The authors analyze the advantages and disadvantages of this new business model and indicate that to serve the growing DRAM market, over 1,000 small businesses could follow a DIT approach of sharing FOSH designs while manufacturing and profiting locally.

According to Garnier, C. and Capdevilla, I. FabLabs offer adapted responses to different emerging economic-productive trends and contribute to the transformation of traditional industry and the democratization of personal manufacturing to create a new socio-technical system of manufacturing, based on a more social approach. In their article they argue that FabLabs are social manufacturing platforms, enabling different combinations of interactions between industries and individuals, through their activities around making (producing goods from raw materials), hacking (reusing/combining produced goods) and coding (producing and reusing using digital goods). The article also defines four different modes of social fabrication depending on the technologies used (open or proprietary) and the location of the fabrication (local or industrial). It contributes to the literature on collaborative spaces by explaining prospective development scenarios in relation to new modes of production. It also complements the literature by contextualizing the physical spaces where social manufacturing takes place. In conclusion, the authors emphasize the need to compare the current implementation of the four modes of social fabrication to track the evolution of these emerging practices in future work. More empirical findings are also needed to observe and validate these practices in the field.

Hassan, M., Mies, R. and Jochem, R. highlight the significant potential of Open-Source Hardware (OSH) as a strategic source of open innovation for SMEs. They propose a Company-Community Collaboration (C3) approach as a radical innovation approach in which companies collaboratively engage within a community framework by creating joint projects with a diverse set of co-creators who follow open-source principles to create a level playing field. The authors aim to identify the key enablers that help SMEs engage in successful collaboration with OSH communities for the co-creation of physical products. For this purpose, they use a methodological approach combining a consultation of existing multidisciplinary literature and gathering expert opinions via the E-Delphi method. The results allow them to identify seven key enablers that address collaboration under various aspects such as readiness (taking into account the motivations of key people), strategic alignment (adopting a shared general vision), governance (developing a shared governance model with the OSH community), tools (having the right tools available), resources (making a strategic allocation of the available resources), value network (developing an ecosystemic collaboration), and culture (having a common collaborative culture among OSH communities). The seven enablers were defined to serve as the basis for assessing the maturity of the C3 concept.

Finally, Thomas, L. and Samuel, K. believe that it is essential to better understand the origin of Open-Source Hardware Business Models (OSHBMs) and to develop them because they could address their long-term viability in the context of transitioning to a Circular Economy. In this article, the city is used as the unit of analysis and the authors conducted a qualitative explorative case study of the city of Barcelona, where there are many commons-based cooperative platforms. Bringing together research on OSHBMs and the middleground construct, the authors underline the motivations and the socio-political action necessary to scale OSHBM from DIY projects to a DIT dynamic. The findings on the values and risks that are important to stakeholders are presented in a framework describing four synergy-catalyzing stages. The steps of the process the authors infer are: 1) build a tech for citizens project, 2) apply to governmental calls, 3) join the middleground and 4) build a consortium. Thus, this work provides a guide showing how OSH initiatives can leverage growth with external stakeholders.

These seven original contributions are complemented by three book reviews (see the Trends and comments section) proposed by Jean-François Boujut (INP Grenoble, G-Scope)[6], Benjamin Poussard (ENSAM)[7], and Mauricio Camargo (Université de Lorraine, ERPI)[8]. Through their critical readings, they reinforce the proposals and reflections of the twenty authors who cross paths here. Thus, they come back in turn to three of the major themes that feed the Do-It-Together concept: the new values generated by Open-Source Hardware, immersive technologies as a driver in the upstream phase of innovation, and finally, beyond the

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6. Pearce, J. M. (2020), Create, Share and Save Money Using Open-Source Projects, New York, McGraw-Hill Education, 176 p.
7. Sylvain Fleury, Simon Richir (2022), *Immersive Technologies to Accelerate Innovation: How Virtual and Augmented Reality Enables the Co-Creation of Concepts*, Smart Innovation, London, ISTE, 192 p.
8. Mariana Mazzucato (2021), Mission Economy: A Moonshot Guide to Changing Capitalism, Allen Lane, London, 272 p.

technological factors, it is essential to understand, integrate and make work together the political and social and behavioral dimensions. A strong collaboration based on a joint resilient public-private system seems necessary to support this emerging model.

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