

ED DESPEG

Doctoral School in Law, Political Science, Economics and Management

Proposition de Sujet de Thèse 2021

2021 PhD Subject Proposition

Title of the PhD research project: Industrial IoT Ecosystems Structure and Management: Insights from Complementors Firms' Adaptation

Thesis Supervisor: [Amel ATTOUR](#), HDR (since December 2018), Université Côte d'Azur, CNRS, GREDEG

Co-supervisor: [Lapo MOLA](#), SKEMA Business School, Université Côte d'Azur, CNRS, GREDEG

Research Institute: GREDEG (ED DESPEG)

Contact: amel.attour@univ-cotedazur.fr ; lapo.mola@skema.edu

1. Project Context

This project is concerned with the inherent particularities of the **Industrial Internet of Things (IIoT)**, which aims to connect industrial assets, including machines and control systems, by bridging operational information with information systems and business processes. This integration implies a large amount of diversified data which is intended to enhance analytical solutions and improve operational performance. Furthermore, the integration of different technologies requires a coordinated interaction of specialized organizations to deal with high technological complexity. In this sense, this study seeks to analyze the organizational and technological adaptations that heterogeneous firms must deal with when integrating IIoT and Operational Technologies (OT).

Manufacturing, transportation, utilities, and others industries supervise their production processes by implementing control systems based on Operational Technologies (OT). This manufacturing paradigm is changing with the new industrial revolution, also called **Industry 4.0**. IIoT technologies are meant to enhance the use of cyber-physical systems (CPS) capable of communicating with each other and humans by improving the quality of operational autonomous decisions making and extending the boundaries of the control system out of the physical factory environment. Moreover, Industry 4.0 implies the integration and coordination of several technologies to achieve efficiency, productivity, and safety value creation.

Several questions have been raised related to the impact that this technological evolution has on the organizational behavior and structure of the implicated actors. Moreover, there is a lack of understanding related to strategic approaches to better align these distinctive actors and create valuable solutions. Practitioners and scholars have recognized that the digital transformation of

operational systems has not been fully embraced. Industry Business to Business ecosystems entails higher levels of organizational and technological complexity that are still to be fully understood before we could see maximal exploitation of digital technologies reflected in a truly smart factory (Boyes, Hallaq, Cunningham, & Watson, 2018; Kiel, Arnold, & Voigt, 2017; Senyo, Liu, & Effah, 2019).

2. Research Objectives

This research project has the objective of defining a clear framework to understand the organizational structure, management coordination, technological functionalities, and means of evolution of IIoT ecosystems. Moreover, this study seeks to address how firms that work in an industrial context heading towards a digital transformation adapt their organizations and learning processes to be able to co-create value through IIoT solutions.

To this end, this research is aligned with the general goal of contributing to the comprehension of social features that allow and shape the digital transformation in the Industry. Accordingly, this study is theoretically rooted in the conjunction of multidisciplinary literature, such as **organization and strategic management theory**- to understand social organizations behaviors; and **informatics science, operation technology, and industrial control systems knowledge**- to clearly define the technological requirements and boundaries that frame the digital transformation in industrial firms.

3. Position in the Literature

Indeed, industry 4.0 is tightly bound to cyber-physical systems and to intelligent and connected infrastructures which are building blocks of Smart Manufacturing (Boyes et al., 2018; Metallo, Agrifoglio, Schiavone, & Mueller, 2018). Plant monitor and control processes have been made feasible due to the development of networking technology and the introduction of Industrial Automation and Control Systems (IACS). The use of the SCADA system (Supervisory Control and Data Acquisition) to provide a graphical user interface to manage process operation under control, has created the idea of a functional, yet, close and secure operational control system. In the last years, SCADA systems have evolved their facilities to connect to the internet and enable remote monitoring. However, experts on network communications point out SCADA systems lack analytics and the capacity of connectivity that could be found in IIoT solutions. Still, the difference and commonalities between both architectures, as much as the challenges and opportunities related to the substitution or integration of both technologies have not been fully explored (Boyes et al., 2018).

Furthermore, as the main focus of IIoT ecosystem is the value proposition (Khan et al., 2020), a deeper analysis of the technical and organizational aspects that frame the functionality and evolution of IIoT ecosystems is still to be developed. Whilst several prior works approached innovation ecosystems from the focal firms' point of view (Adner, 2017; Jacobides, et. al., 2018), this research seeks to contribute

to the literature by improving the understanding of the strategic role and challenges that key complementors, like solution providers, must deal with, and how their alignment affects the ecosystem performance. Adner (2017) proposes an interesting structure of ecosystems based on activities, actors, and links consciously built to create value. This study also highlights the importance of alignment among the ecosystem actors as the main strategic task of the focal firm. However, the strategic approach of complementors in this structure is still a gap to fulfill.

4. Methodology

The objective proposed by this research project calls first for a qualitative research methodology. It is expected that a multiple case analysis from diverse industrial IIoT ecosystems improves the robustness of the results. Then, a mixed approach analysis where qualitative constructs could be complemented by the operationalization of coherent measures will be developed to evaluate the performance of studied ecosystems and the impact that digital solutions have on industrial productivity.

5. Motivation

In a performance IIoT ecosystem, it is expected that actors manage themselves to align joint efforts and co-create valuable digital solutions for industrial firm clients. Still, to achieve this goal, managers must address several organizational challenges.

First, scholars and practitioners agree on identifying IIoT and IACS integration as an ecosystem formed by several interdependent firms. Though, there is not a clear understanding of how this ecosystem is structured and what is the specific function of the IIoT platform in terms of ecosystem management and value creation.

From an ecosystem lens, individual members' performance is dependent on the overall ecosystem performance. In that sense, a self-awareness of belonging to a specific ecosystem is assumed and a co-evolution of firm capabilities is needed. However, insights about how firms mutually adapt are still not well explained.

Similarly, it is expected that the co-creation of value occurs from the ecosystem actor's interactions. Still, little information is available about what kind of knowledge firms decide to share in a technological ecosystem, and when and how firms combine and transfer knowledge to the ecosystem. In that sense, prior studies have identified that manufacturing firms are reluctant about generalizable digital IIoT solutions (Pauli, Fiert, & Matzner, 2021; Udoh & Kotonya, 2018). Industry firms' processes and OT systems are outcomes of high investments in customized production process designs. Alike, industrial firms expect that IIoT ecosystems develop safe (in the sense of cybersecurity) and customized digital solutions. Contrary to the generalizable premise in non-industrial IoT platforms, with IIoT solutions, one must consider that each industrial client could imply an ecosystem learning process. Until now there is not a clear explanation about how this challenge is considered by IIoT ecosystems' value creation processes

Finally, it is well known that innovation ecosystems are governed by focal firm, which is usually the one that owns the IIoT platform and orchestrates the value creation. However, in an industry context, manufacturing firms have more bargaining power than regular customers. In some industries, earning the commitment of the factory client could set a competitive gap between rival IIoT ecosystems. One can expect that firms close to the client, such as system integrators, could have a differentiated strategic role in the ecosystem. Yet, little is known about how system integrators as key complementors in IIoT ecosystems, organize themselves to integrate one or more IIoT ecosystems.

6. References

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