

# Summary

Despite substantial investments in **digital technologies**, often driven by forward-looking national policies, manufacturing firms are still far from making digitalization effective with limited evidence of increased **cost performance** shifting away from the growth visions of “Smart Manufacturing” and “Industry 4.0”. Early information system literature suggests that to make a return on technological investment companies must changes **organizational practices** e.g., in resources, activities, capabilities, and collaborations while adopting digital technologies. However, current digital technologies come in many and more complex forms, including computing, communication, connectivity, and information processing capabilities requiring new organizational practices. The objective of this thesis is to understand what are the properties of digital technologies and how these *enable* and *require* changes to decision-making and governance practices to increase the cost performance of manufacturing firms.

Using the **automotive industry** as the setting of the research, this thesis uses mixed-method research employing both quantitative data from 102 questionnaires and qualitative data from 10 case studies collected from a representative sample of Italian automotive suppliers. Adopting a phenomenon-based research approach this thesis started with a literature review on the main properties of two main forms of digital technologies that shape the digitalization phenomena: physical-digital interface technologies and network technologies. To investigate the complementarity between practices and digital technologies some logistic regressions have been performed keeping fixed the adoption of digital technologies and cost performance (the dependent variable). Having found some “surprising facts” this thesis uses an abductive approach and use a set of management theories to explain the results.

Concerning the physical-digital interface technologies and network technologies, this thesis found respectively the properties of **virtualization** and **traceability** of physical devices in the shop floor, and **accessibility** and **synchronization** of a wide range of data throughout the organizations in a bi-directional communication framework between information systems and physical devices.

Concerning **decision-making**, the properties of these two forms of digital technologies make events, upon which decisions are made, respectively more analyzable and less equivocal making a data-driven decision-making approach diffused in the organization a compelling necessity to have an increased cost performance. It is

urgent more than ever that the managers encourage a shift from an intuition-driven (experiential, unconscious, and holistic) to a data-driven decision-making approach (analytical, conscious, and sequential) through some practices that are discussed in this thesis.

To make digitalization effective inside the factory, this thesis found that - at an increasing rate of technology complexity, customization levels, and novelty of the two different forms of digital technologies – manufacturing firms should rely on **relational governance practices** based on co-creation and continuous collaboration with technology partners like **system integrators** that would allow the reduction of transaction costs and the sharing of technological and domain knowledge.

Concerning **governance practices** with **customers**, this thesis found that the traceability and virtualization properties of physical-digital interface technologies enhance the relational governance based on quasi-integration and trust. Second, the accessibility and synchronization of network technologies require long-term contractual governance because these technologies expose a supplier to opportunistic behaviors caused by behavioral uncertainty of customers. Taken together, the different forms of digital technologies and governance practices reduce the transaction costs among the partners and therefore increase incentives for suppliers to engage in process innovation activities aimed at reducing production costs.

This thesis found some **national approaches to digitalization** by comparing Italy and the US automotive components industry reflecting institutional differences between the two countries. Using a comparable sample, this thesis found that Italian auto plants, while adopting less physical-digital interface technologies concerning the US due to smaller firms' size, show a higher diffusion of network technologies and a data-driven decision-making approach. Due to the higher empowerment of workers in continuous improvement, the Italian approach to digitalization seems more a human-centered approach with a focus on data analysis and data integration. By contrast, the US approach to digitalization is more on the use of technology to face a critical skill gap.

Overall, these results point out how complex is for automotive suppliers to introduce process innovations and to enhance cost performance in the digital transformation context. On one hand, to improve cost performance, they have to invest in different and highly specific sets of digital technologies and, on the other hand, to change decision-making approaches, to manage their interplay with the governance mechanisms with technological partners and customers.