

# Industry 4.0 technology providers supply chain: the moderating role of supply chain actors

Benitez G B<sup>1</sup>, Ferreira Lima M J R<sup>2</sup>, Ayala N F<sup>1</sup>, Frank A G<sup>1</sup>

**Abstract** This work investigates the moderating role of four supply chain actors (customers, suppliers, complementors and R&D centers) for the provision of Industry 4.0 technologies. For this we employ a survey with 77 technology providers SMEs from an electro-electronic sector in southern Brazil. As remarking results, we found evidence that collaboration with companies of the same sector (complementors) can be advantageous to provide Industry 4.0 solutions.

**Keywords:** Industry 4.0; technology provision; supply chain collaboration; SMEs.

## 1 Introduction

Industry 4.0 refers to the integration of emerging technologies supported by the Internet of Things (IoT), resulting in Cyber-Physical Systems (CPS) (Dalenogare et al., 2018; Frank et al., 2019a). These technologies are responsible not only for the digitization of industrial processes, but also for the creation of value for industrial activities. In addition to the improvements that Industry 4.0 promotes in the shop floor level, these new technologies also generate new opportunities for technology development and supply chain networks (Frank et al., 2019b; Sun et al., 2019).

In general, technologies associated to Industry 4.0 provide vast possibilities for companies to develop new digital solutions (Dalenogare et al., 2018). The figure of ‘technology providers’ emerges in this context, as companies that master one or more technologies associated to Industry 4.0 and have expertise in subjects such as IT, automation, software and/or hardware. Technology providers are instrumental actors in the context of Industry 4.0 due to their knowledge capabilities and potential to provide new digital solutions (Dalenogare et al., 2018; Rübmann et al., 2015). However, since Industry 4.0 technologies are numerous and demand a wide range of knowledge and capabilities (including software, hardware, digital applications, etc.), which are hard to be found in hands of a single company, companies may require to collaborate with several supply chain actors to be able to provide complete digital solutions (Dallasega et al., 2018).

While collaboration in supply chain networks seems to be mandatory for the development of complete digital solutions in the Industry 4.0 context, it is even more important for small and medium-sized enterprises (SMEs) (Müller et al., 2018). This is because SMEs generally lack the financial resources and multidisciplinary knowledge to innovate in their products, which results in higher challenges to offer competitive digital solutions for Industry 4.0 demands (Dallasega et al., 2018). Therefore, collaboration with different actors in the supply chain network can be an alternative for such companies to develop new digital solutions and remain competitive. Collaboration in the supply chain can contribute to the development of more ‘integrated Industry 4.0 solutions’ – represented by a wide set of technologies that can be combined to address different customers’ needs – which can help to enhance companies’ competitive advantage (Dalenogare et al., 2018; Sun et al., 2019).

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<sup>1</sup>Guilherme Brittes Benitez (e-mail: [guilherme.benitez@ufrgs.br](mailto:guilherme.benitez@ufrgs.br)); Néstor Fabián Ayala ([nestor.ayala@ufrgs.br](mailto:nestor.ayala@ufrgs.br)); Alejandro Germán Frank ([agerfrank@producao.ufrgs.br](mailto:agerfrank@producao.ufrgs.br))

Organizational Engineering Group (Núcleo de Engenharia Organizacional – NEO), Department of Industrial Engineering, Universidade Federal do Rio Grande do Sul, Brazil

<sup>2</sup>Mateus José do Rêgo Ferreira Lima ([doregoferreiralima.1@buckeyemail.osu.edu](mailto:doregoferreiralima.1@buckeyemail.osu.edu))  
Fischer College of Business, The Ohio State University, Columbus, Ohio, USA

## 2 Objectives

Therefore, it is imperative for SMEs to know the supply chain actors that can contribute to the development of better Industry 4.0 solutions. In this sense, we assume that external relationships can create competitive advantage for SMEs, as proposed by the relational view theory that we follow (Dyer and Singh, 1998). This raises the following research question: *what is the contribution of different supply chain actors for the development of integrated Industry 4.0 solutions?* Our research question does not address simply ‘units’ of Industry 4.0 technologies, but the provision of ‘integrated solutions’ based on a wide set of interconnected technologies, which is one of the main challenges and opportunity in the Industry 4.0 context (Frank et al., 2019a, 2019b).

## 3 Methods

To answer our research question, this paper analyses the moderating effect of four types of supply chain actors (i.e., suppliers of technological components, technology complementors from the same sector, technology centers, and technology adopters) on the contribution of Industry 4.0 technology development to achieve three different results pursued by technology providers: technology cost reduction, increase of customer loyalty and differentiation through technology innovation. We hypothesize that the higher the levels of collaboration technology providers establish with these four supply chain actors, the better the contribution of Industry 4.0 solutions will be on these competitive outcomes. To test this hypothesis, we conducted a survey with 77 technology providers from the automation sector in Brazil.

## 4 Results

Our results demonstrate that companies should provide a wider set of complementary technologies for integrated Industry 4.0 solutions whether to reduce costs or to increase innovation and customer loyalty, and these outputs can be enhanced by the collaboration with other companies of the same sector (complementors). On the other hand, collaboration with customers and technology centers to develop Industry 4.0 solutions will elevate technology providers’ costs. Therefore, our work highlights the importance of creating supply chain networks among SMEs of the same sector to create integrative solutions for Industry 4.0.

## 5 Conclusion

As main contribution, this paper demonstrates that technology providers should pursue a relational approach by collaborating with other technology complementors in order to expand the range of solutions offered for Industry 4.0. Thus, we call to the need of establishing supply chain networks. Managers can find some takeaways from our findings. First, SMEs should try to expand their range of Industry 4.0 technologies offered and try to integrate such technologies in advanced solutions, which will help them to increase customer loyalty and technology innovation. Second, we know that this may be hard for SMEs, therefore, our study demonstrates that the best way to achieve this is by collaborating with other SMEs from the same sector that possess complementary technologies and capabilities. Third, according to our results, a highly customized solution through intensive collaboration with customers will damage cost reduction capacity of such companies. In this sense, we recommend, based on our findings, that managers may pursue complementarity and modularity of the Industry 4.0 solutions, so that they can be configured based on different needs without needing too many changes that may elevate technology costs. Lastly, our results recommend that technology providers collaborate with R&D centers, not with the aim of reducing technology cost through outsourcing (which in fact harm costs reduction due to risky and costly projects that these centers develop with companies), but as a strategy for knowledge acquisition for future technology innovation in the Industry 4.0 trend.

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