Chapter 9

Blockchain Governance for Collaborative Manufacturing

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ABSTRACT

The manufacturing industry is rapidly changing due to widespread adoption of information and communication technologies. This new landscape, described as the fourth industrial revolution, will be characterized by highly complex and interdependent systems. One particular aspect of this shift is horizontal integration, or the tight coupling of firms within a value chain. Highly interconnected and interdependent manufacturing systems will encounter new challenges associated with coordination and collaboration, specifically with regards to trust. This purpose of this chapter is to explore the potential of blockchain to address these challenges. Survey data collected from manufacturing professionals suggests that the perceived nature of trust and resource value can be bounded and controlled. Concepts from game theory, systems theory, and organizational economics are used to augment this research data and inform a collaborative manufacturing blockchain model and architecture.

INTRODUCTION

Much has been written on how the manufacturing industry, through technology adoption and innovation, is facing fundamental changes. Accordingly, organizations like Platform Industry 4.0 and the National Institute of Standards and Technology (NIST) have laid out roadmaps and published works describing what the future holds for manufacturers, customers, and nations (Federal Ministry of Economic Affairs
Whether these fundamental shifts are economically influenced, socially inspired, or technologically inevitable, the effects will be far reaching. Manufacturing, at its core, is a simple process with a raw material input, transformative process, and a final product output. However, manufacturing value chains are anything but simple with cyberphysical systems, complicated processes, and cutting edge operational technologies coming together to form vast networks of value creating partnerships. The boundaries of the traditional manufacturing firm have been completely blurred as the industry leverages platforms, social networks, and the sharing economy to produce high quality and affordable end products in a lot size of one. Just as the previous industrial revolutions influenced more than industry and technology, the fourth industrial revolution will impact social and economic structures. As engineers design and build systems that will interact in a complex network of systems, new considerations must be made with respect to how these systems will interact, coordinate, and collaborate.

INDUSTRY 4.0 AND HORIZONTAL INTEGRATION

For nearly a decade, industrial nations have been allocating funds for the reinvigoration and advancement of the manufacturing sector (Kang et al., 2016). With the belief that new technologies and cheaper computing can inject new levels of global competitiveness in an aging industry, nations like the United States, China, and Germany have launched strategic initiatives, participated in private/public consortiums, and funded incubators with the hope of achieving the promise of advanced manufacturing. Not surprisingly, these initiatives are remarkably similar to one another (Kagermann, Wahlster, & Helbig, 2013; Kang et al., 2016; National Science and Technology Council, 2012). Governments recognize that achieving the vision of advanced manufacturing will require participation from industry, academia, and entrepreneurs working together to exploit the collision of information, communication, and operational technologies.

The German initiative, “Industrie 4.0,” is a good illustration of what these industrialized nations are working toward. Self-described as a “vision” where products control their own production, the authors of the first official Industry 4.0 publications describe a future enabled by the convergence of cyberphysical systems and the Internet (Pfeiffer, 2017). The Platform Industrie 4.0 working group, a government-led group of academics, industry partners, and government officials, has gone many steps forward from just describing a vision. In 2013, the working group published a final report detailing many aspects of Industry 4.0, including three features that must be implemented to fully benefit from the fourth industrial
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