

An Institutional Perspective in The Industry 4.0 Scenario: A Systematic Literature Review

Diego Fogaça^{1,2,3} , Mercedes Grijalvo¹ , Mario Sacomano Neto² 

¹Universidad Politécnica de Madrid (Spain)

²Federal University of São Carlos (Brazil)

³Federal University of Mato Grosso do Sul (Brazil)

fogaca.diego@gmail.com, mercedes.grijalvo@upm.es, sacomanoneto@gmail.com

Received: September 2021

Accepted: October 2021

Abstract:

Purpose: The growing adoption of Industry 4.0 offers opportunities and promotes changes in markets, business models, supply chains and operations. However, adopting new technologies and practices is beyond the simple rational decision and the search for efficiency. There are contextual social and cultural systems that influence the behavior of people and organizations. Hence, institutional theory can yield interesting insights in the study of Industry 4.0. The purpose of this article is to examine how and to what extent institutional theory has been used to explain Industry 4.0.

Design/methodology/approach: A systematic literature review of Industry 4.0 and the broader field of digitalization was performed using Scopus, Web of Science and Google Scholar. The authors analyzed the results using multivariate techniques (Descending Hierarchical Classification and Correspondence Factor Analysis) with the aid of the IRAMUTEQ software.

Findings: Results indicate there is little research that uses an institutional perspective to investigate Industry 4.0. Most of them are quantitative and are based on the concept of institutional isomorphism. Qualitative studies, e.g., case studies and the use of theories such as institutional logics and institutional work could generate a richer comprehension of Industry 4.0. Besides, consideration of meso (e.g., organizational fields) and macro (e.g., countries) level of analysis should be more extensively explored.

Research limitations/implications: There was no analysis of co-authorship or co-citation network.

Originality/value: This paper identifies research gaps and points to relevant issues frequently not considered by researchers and practitioners. It reinforces a call for an institutional perspective where the concept of Industry 4.0 can be understood as a rationalized myth. Therefore, the meaning, practices, and consequences of Industry 4.0 implementation are expected to vary across organizations and countries.

Keywords: industry 4.0, digitization, digital transformation, institutional theory, neo-institutionalism, isomorphism, institutional logics

To cite this article:

Fogaça, D., Grijalvo, M., & Sacomano Neto, M. (2022). An Institutional Perspective in The Industry 4.0 Scenario: A Systematic Literature Review. *Journal of Industrial Engineering and Management*, 15(2), 309-322. <https://doi.org/10.3926/jiem.3724>

1. Introduction

The so-called fourth industrial revolution is based on complex digital systems that, when integrated into networks and automated processes, bring together physical and virtual objects, which support an even more flexible and customized industrial mass production (Arbix, Salerno, Zancul, Amaral & Lins, 2017; Lasi, Fettke, Kemper, Feld & Hoffmann, 2014). The term “Industry 4.0” is becoming increasingly common to refer to the fourth industrial revolution. Although it still lacks a widely accepted definition (Schneider, 2018), it has been seen as a bundle of technologies (Calabrese, Levialdi-Ghiron & Tiburzi, 2021). For instance, Frank, Dalenogare and Ayala (2019) present a conceptual framework for Industry 4.0 divided into two layers: front-end technologies (Smart Manufacturing, Smart Products, Smart Supply Chain and Smart Working) and base technologies (Internet of Things, Cloud, Big Data and Analytics).

Most researchers and professionals agree that Industry 4.0 offers opportunities and promotes changes in markets, business models, supply chains, and the world of work (Schneider, 2018). The digitization of the industry and the development of “advanced manufacturing” occupy an essential position for maintaining competitiveness by increasing manufacturing processes’ efficiency and determining strategic globalization decisions (Howaldt, Kopp & Schultze, 2017; Stentoft & Rajkumar, 2020). More recently, there has been a transition from a manufacturing-oriented definition to an industrial value chain-oriented meaning associated with the digitization of value creation and delivery processes at different levels (Ghobakhloo, Fathi, Iranmanesh, Maroufkhani & Morales, 2021). In addition to manufacturing, Industry 4.0 is influencing a paradigm shift in several sectors, such as construction, healthcare, transport, and the energy sector.

From a different viewpoint, Reischauer (2018) argues that Industry 4.0 is a discourse to institutionalize innovation in manufacturing systems encompassing companies, universities and the government (Triple Helix), i.e., Industry 4.0 is more of a driving force than the result of innovations. Similarly, Meyer (2019a, 2019b) claims Industry 4.0 is an inherently vague imagined future that provides orientation to various organizations and allows sensemaking from distinct perspectives. Arbix et al. (2017) assert it is a project to ensure Germany’s leadership in high-quality industrial production and exports, maintaining its prominent position as a global supplier of technologies and manufacturing concepts. In other words, there are relevant institutional issues in the origins and dissemination of Industry 4.0. An institutional perspective can therefore bring valuable insights to Industry 4.0.

The paper aims to investigate how and to what extent the institutional theory has been used to understand Industry 4.0. For this, we perform a systematic literature review (SRL). This work is unique as it provides insight into the relationship between institutional theory and Industry 4.0. For instance, while Hinings, Gegenhuber and Greenwood (2018) have theoretically addressed the relationship between digitalization and institutional theory, the connection between the latter and Industry 4.0 remains scarcely discussed.

The following section reviews some pertinent theoretical aspects. Section 3 details the bibliographic review method used concerning data collection and analysis. Sections 4 and 5 present the results obtained and discuss them, respectively. Finally, the last section addresses implications, limitations and suggestions for future work.

2. Theoretical Background

Neoinstitutionalism or neo-institutionalism, also called new institutionalism, is a methodological approach in the study of political science, economics, organizational behavior, and sociology that explores how institutional structures, rules, norms, and cultures constrain the choices and actions of individuals (Ishiyama & Breuning, 2014). Usually, there are at least three strands in the new institutionalism: rational choice (related to economics), historical and sociological (related to organizational theory) (Farrell, 2018). Our focus in this paper is on the organizational approach. It starts from the assumption that institutions are organizing myths.

In their seminal work, Meyer and Rowan (1977) claim organizations are in a highly institutionalized context of professions, policies and programs. Many organizations ceremonially incorporate products, services, techniques, policies and programs because they are believed to produce rationality. Thus, organizations do not necessarily become more efficient from a functional point of view. Instead, organizations align their structures with the institutional context and, in doing so, gain legitimacy, resources, stability and a better chance of survival.

The neo-institutional theory is one of the most prominent schools of thought in organizational studies, and the research associated with it has grown in importance, quantity and scope in recent years (Alvesson & Spicer, 2019). It has been used to explain general technology development trends (Pattit, Raj & Wilemon, 2012), as well as the adoption of technologies in the public sector (Luna-Reyes & Gil-Garcia, 2011) and service industry (Soares, Mendes-Filho & Gretzel, 2020). In the field of industrial engineering, it has been employed to investigate operations (Kauppi, 2013), supply chain (Saldanha, Mello, Knemeyer & Vijayaraghavan, 2015), green supply chain (Wongthongchai & Saenchaiyathon, 2019), quality management (Braunscheidel, Hamister, Suresh & Star, 2011), and total productive maintenance (Rolfsen, 2014). An institutional perspective on the adoption and implementation of manufacturing practice seems to have higher explanatory power than competing theories (Ketokivi & Schroeder, 2004). Thus, it is promising to study Industry 4.0 from such a perspective.

DiMaggio and Powell (1983) propose three mechanisms of institutional isomorphism, that is, forces that induce organizations to become similar in form and practice: coercive, mimetic and normative. Coercive isomorphism stems from government pressure and the legal environment or actors such as monopoly service organizations or parent company rules imposed on subsidiaries. Mimetic isomorphism is associated with high-uncertainty environments regarding technologies or objectives, where leading organizations considered successful are copied by others in the field. Normative isomorphism derives from cognitive patterns and structures created by professional networks and by specialists' formal education.

The neo-institutional approach usually emphasizes the stability of organizational fields and how particular organizational forms arise, but it lacks explanations for change (Nedzhvetskaya & Fligstein, 2020). Concepts such as institutional entrepreneurship, institutional work and conflicting institutional logics have been developed to fill this gap. Institutional work addresses how individuals and organizations take purposive actions in order to create, maintain or disrupt institutions (Lawrence & Suddaby, 2006). Institutional logics are “the socially constructed historical patterns of material practices, assumptions, values, beliefs and rules by which individuals produce and reproduce their material subsistence, and provide meaning to their social reality” (Thornton & Ocasio, 2008).

3. Methods

A SRL was carried out based on the phases proposed by Randolph (2009). Firstly, the problem was formulated (“how is the institutional theory being used to understand the phenomenon of Industry 4.0?”) followed by the data collection, evaluation and discussion. A systematic review is a specific methodology that locates existing studies, selects and evaluates contributions, analyzes and synthesizes data, and reports evidence in such a way as to allow reasonably clear conclusions about what is and what is not known. A systematic review should not be considered a literature review in the traditional sense but as an independent research project that explores a clearly defined issue, usually derived from practical problems, using existing studies (Denyer & Tranfield, 2009).

Considering the research question, the SLR's objective was to find articles that simultaneously addressed the concepts of “Industry 4.0” and “Institutional Theory”. For this, it was created one search string for Industry 4.0 and another for institutional theory. Both search strings were used together. For example, the search formula applied in Scopus was as follows: (TITLE-ABS-KEY (“industr* 4.0” OR “cyber physical systems” OR “internet of things” OR “smart manufacturing” OR “smart industry” OR “made in china” OR “fourth industrial revolution” OR 4ir)) AND TITLE-ABS-KEY ((isomorphism OR “institutional logic*” OR “*institutional theory” OR neoinstitutionalism OR “neo-institutionalism” OR “institutional work” OR “institutional stud*” OR “institutional pressure” OR “social movement*” OR “inhabited institution*”))) AND (LIMIT-TO (LANGUAGE, “English”)).

As Industry 4.0 emerged in Germany and is a concept under construction, its use varies from country to country, with terms used interchangeably. For example, China launched the “Made in China 2025” project, in the USA it is common to use “Industrial Internet of Things” (IIoT) and in the Netherlands the expression “Smart Industry” is popular. The search string was created to capture these different Industry 4.0 initiatives. Following Atkinson, Koenka, Sanchez, Moshontz and Cooper (2015), we defined inclusion and exclusion criteria as shown in Table 1.

Inclusion criteria	Exclusion criteria
Scientific journals, congresses, book chapters	Grey literature
Document in English	Document in other languages
Full-text available	Only abstract or part of the text is available
Both Industry 4.0/digitalization AND institutional theory are discussed in the paper or in part of it	Industry 4.0/digitalization OR institutional theory is cited but superficially discussed
Organizational institutionalism	Historical or Rational choice institutionalism

Table 1. Inclusion and exclusion criteria for the search

For data collection, Scopus and Web of Science (WoS) databases were used in September 2021. After filtering the result by areas of knowledge and excluding duplicates, 30 documents remained, whose titles and summaries were analyzed according to their relevance to the SLR objective (see Table 1). When there was doubt about its relevance, the document was read in full. The application of these criteria resulted in the selection of 15 articles. Next, a similar search was carried out on Google Scholar (GS), analyzing the first 50 “most relevant” and the first 50 “most recent” documents. Five additional articles were selected, totaling 20 articles about both Industry 4.0 and institutional theory (see Figure 1). According to Martín-Martín, Orduna-Malea, Thelwall and Delgado-López-Cózar (2018), GS finds significantly more citations than the WoS and Scopus across all subject areas. In “Business, Economics & Management”, unique GS citations surpass 50% of all citations in the field (Martín-Martín et al., 2018).

Since few documents were located, the search was expanded to include the concept of “digital transformation” that is connected but is broader than the definition of Industry 4.0. Within the digitalization of businesses, Industry 4.0 encompasses the digitization of manufacturing (Hervas-Oliver, Estelles-Miguel, Mallol-Gasch & Boix-Palomero, 2019). The following search string was created: (“digital transformation” OR digitalization OR digitalisation OR digitization OR digitisation”) and combined with institutional theory’s string. The same logic and search engines used previously were employed. At last, 51 documents dealing with digitization and institutional theory were selected.

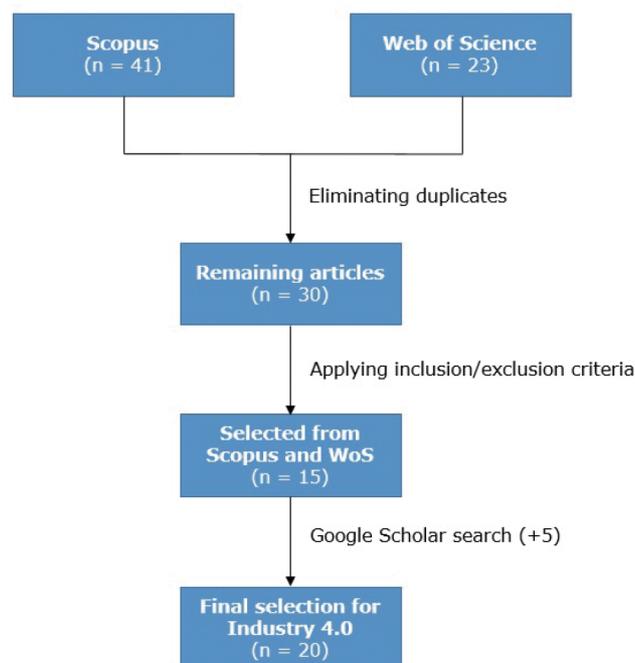


Figure 1. Search process for articles on Industry 4.0

The software IRAMUTEQ version 0.7 alpha 2 (*Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires*) was utilized to analyze the articles' abstracts as done by other authors (e.g., Dufour, Rodríguez-González and Laslier (2019) and Rizzoli (2018)). IRAMUTEQ is a free software anchored in R software and Python that allows different types of analysis and generates easily understandable graphics. Although we analyzed fewer abstracts than other studies (Dufour et al., 2019; Rizzoli, 2018), it was more than twice the minimum recommended amount of 20 to 30 texts (Camargo & Justo, n.d.). In addition, for efficient text classification, there must be retention of text fragments above 75% (Camargo & Justo, n.d.). The retention rate in our study was 78%.

First, we generated two word clouds: one for the articles related to Industry 4.0 and another related to digitalization. Word clouds can serve as a starting point for a deeper analysis. They help assess whether texts are appropriate to the information sought (Heimerl, Lohmann, Lange & Ertl, 2014). Then, we used two multivariate techniques. The Descending Hierarchical Classification (DHC), presented in the form of a dendrogram, displays stable word classes with a vocabulary similar to each other and different from other classes (Illia, Sonpar & Bauer, 2014). The Correspondence Factor Analysis (CFA), represented in a Cartesian plane, should be interpreted together with the DHC. It shows the association and opposition between words or texts. Such techniques reduce a large number of observed variables to a small number of factors. The factors represent the latent dimensions (constructs) that summarize or explain the set of observed variables (Hair, 2006).

4. Results

Figure 2 shows the word clouds created for the abstracts about Industry 4.0 (on the left) and about digitization (on the right).

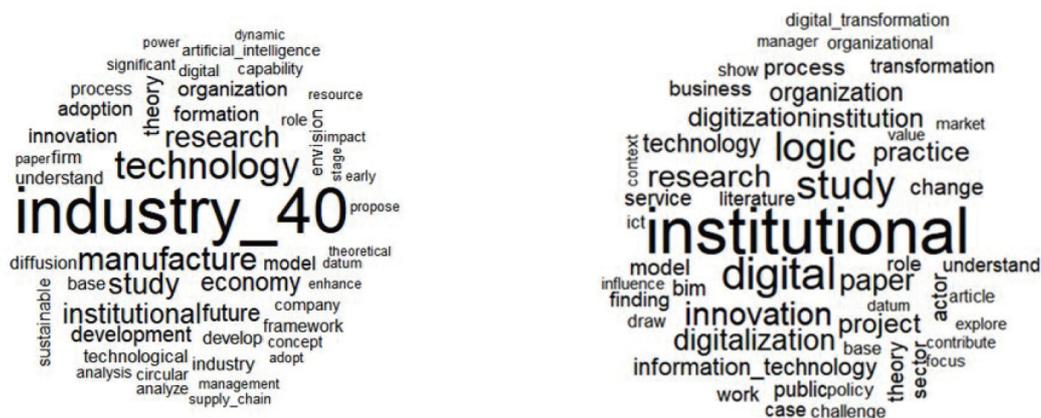


Figure 2. Word clouds for Industry 4.0 abstracts and for digitalization, respectively

The 71 abstracts (20 related to Industry 4.0 and 51 related to digitalization) were processed at IRAMUTEQ. The DHC (Figure 3) generated three classes, respectively representing 24.8%, 46.6% and 28.6% of the analyzed content. The union of Class 1 (green) and Class 2 (red), which have the greater similarity between them, were named “Digitization”. Some of the most representative words in Class 1 were “sector”, “national”, “public” and “policy” and in Class 2 were “innovation”, “logic”, “process” and “entrepreneurship”. Thus, it was inferred the themes of Class 1 were related to public sector digitalization and those of Class 2 to the process of change resulting from digitization. Class 3 (blue) was named “Industry 4.0”. In addition to the expression “Industry 4.0”, it was associated with “manufacture”, “economy” and “pressure”.

To generate Figure 4 showing the CFA, we classified each of the abstracts according to three criteria: whether it was related to Industry 4.0 or digital transformation, the research method used (survey, case study, qualitative, literature review, content analysis, or theoretical) and the underlying institutional theory (isomorphism, institutional logics, institutional work, institutional entrepreneurship, institutionalization, discursive or general). This classification required the reading of sections of some papers beyond the abstract. All articles on Industry 4.0 were fully read.

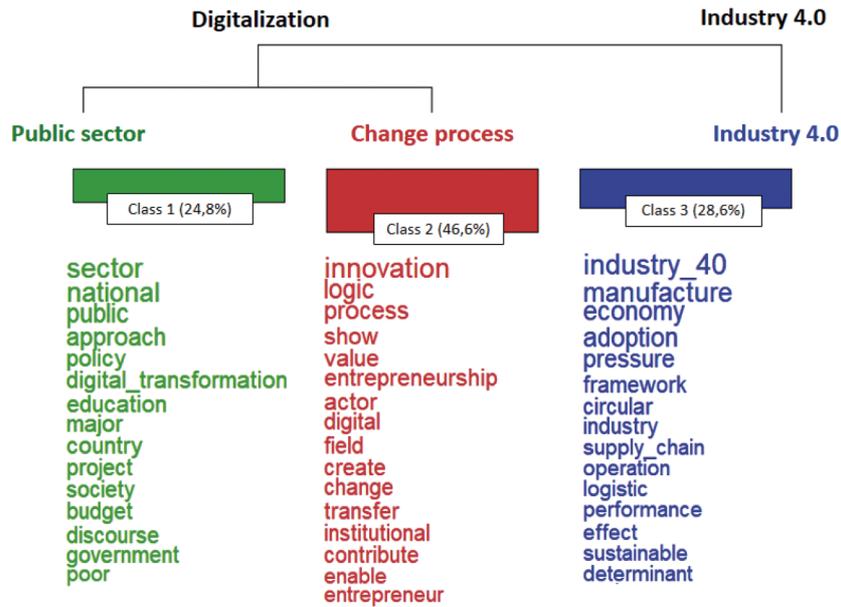


Figure 3. Descending Hierarchical Classification (DHC) of the articles' abstracts

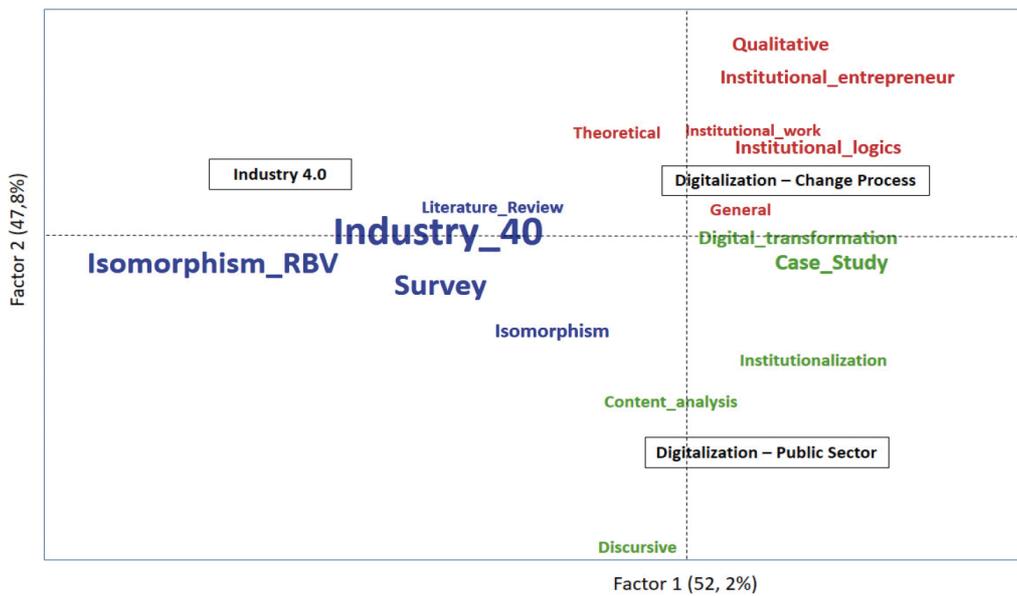


Figure 4. Correspondence Factor Analysis (CFA) of the articles' abstracts

Figure 4 is a factorial plan where Factor 1 (x-axis) explains 52.2% of the difference between the variables and Factor 2 (y-axis) explains the rest.

The horizontal axis clearly distinguishes Class 3 (Industry 4.0) from Classes 1 and 2 (Digitalization). Industry 4.0 is associated with institutional isomorphism and the survey method. In fact six (Bag, Pretorius, Gupta & Dwivedi, 2021; Gupta, Modgil, Gunasekaran & Bag, 2020; Rahman, Kamal, Aydin & Haque, 2020; Surajit & Telukdarie, 2018; Wamba & Queiroz, 2020; Xu, Zhou & Ji, 2020) out of the 20 articles in this group employ survey as the research method and coincidentally use isomorphism as the underlying institutional theory. These six articles investigate logistics or supply chain, except for one (Xu et al., 2020). In addition, four (Bag et al., 2021; Bag & Pretorius, 2020; Lopes de Sousa-Jabbour, Jabbour, Godinho-Filho & Roubaud, 2018; Surajit & Telukdarie, 2018) of the Class 3 articles deal with the theme of sustainability or circular economy (see blue words in Figure 3).

Classes 1 and 2 (green and red) stand out for their association with the theories of institutional logics (e.g., Bunduchi, Tursunbayeva & Pagliari, 2019), institutional entrepreneurship (e.g., Lappi, Aaltonen & Kujala, 2019) and institutional work (e.g., Bosch-Sijtsema & Gluch, 2019), which together account for more than half of all 51 articles on digitalization. Furthermore, qualitative and case study methods account for more than 60% of the articles in these two classes. One-third of the investigations were carried out in the public sector, 15% in the healthcare industry and 7% in the construction sector. These results corroborate those of Oesterreich, Schuir and Teuteberg (2020) except for the significant presence of the supply chain/logistics field in Industry 4.0. Although no filter for the articles' year was used, 95% of them date from the last five years and 86% are from 2019 onward.

More specifically, concerning studies on Industry 4.0, the articles published in the journals show a great diversity of themes. According to the Scopus classification, there are journals in the areas of Business, Management and Accounting, Engineering, Social Sciences, Decision Sciences and Computer Science. Only two journals appear more than once: Production Planning & Control and Technological Forecasting & Social Change. As shown in Table 2, one of the authors, Surajit Bag, appears as an author in three different works (Bag et al., 2021; Bag & Pretorius, 2020; Gupta et al., 2020). He is associated with two other researchers, Gupta and Pretorius, who appear twice in the same papers. All these articles are related to the institutional theory of isomorphism. Another author who appears more than once, Meyer (2019a, 2019b), develops his research based mainly on institutionalization and sensemaking theory.

Author	Number of papers	Citations
Surajit Bag	3	Bag et al., 2021; Bag and Pretorius, 2020; Gupta et al., 2020
Shivam Gupta	2	Bag et al., 2021; Gupta et al., 2020
Jan Pretorius	2	Bag et al., 2021; Bag and Pretorius, 2020
Uli Meyer	2	Meyer, 2019a; Meyer 2019b

Table 2. Authors related to Industry 4.0 who appeared more than once in the SLR

5. Discussion

Borrowing ideas from the digitalization field could benefit the investigation in Industry 4.0. For instance, to use qualitative or mixed methods in specific organizations and industries, or employing the concept of institutional logics for interpreting the adoption and diffusion of Industry 4.0 as done in contexts of digital transformation (e.g., Bernardi & Exworthy, 2020; Bodó, 2020; Bunduchi et al., 2019). The case study by Hervás-Oliver et al. (2019) could have used the institutional logics to explain more precisely the construction of a new identity caused by the promotion of Industry 4.0 in an industrial district. Although Aksom, Zhylynska and Gaidai (2020) contend that institutional logics have little explanatory or predictive power, they have been widely used in different areas such as management control (Damayanthi & Gooneratne, 2017), innovation (Brantnell & Baraldi, 2020) and market-shaping (Kaartemo, Nenonen & Windahl, 2020).

Some papers have analyzed the nature and identity of Industry 4.0 through discourse, rhetoric and content analysis without referring to institutional logics (Meyer, 2019a, 2019b; Oesterreich et al., 2020; Reischauer, 2018). We argue that institutional logics, especially its French counterpart and complement (Cloutier & Langley, 2013) “orders of worth”, could help understand Industry 4.0's successful discourse better. Both refer to “higher common principles that reflect the degree of legitimacy of certain rules and values in society and define appropriate forms of conduct” (Patriotta, Gond & Schultz, 2011: page 2). Boltanski and Thévenot (1999) initially identified six “orders of worth”, also called “economies of worth” (EW), “justification regimes” or simply “worlds”: inspired, domestic, fame, civic, market and industrial. Later two other EW were included: the connectionist or project-oriented EW (Boltanski & Chiapello, 2005) and the green one.

In Oesterreich's rhetorical analysis, they identify a “problematic discourse” where the justification for Industry 4.0 adoption is related to customer demand (market world) and sustainability issues (green world). They also distinguish

a “solution discourse” associated with greater efficiency (industrial world) and, to a lesser extent, connectivity (Oesterreich et al., 2020). Meyer (2019a, 2019b) recognizes the Industry 4.0 discourse remains vague and allows for multiple framings and sensemaking. We could identify industrial EW (e.g., optimization claims), market EW (customers willing to pay money), project-oriented EW (working independently of time and space) and civic EW (as means of Germany keeping itself industrialized and with high wages). The success of the Industry 4.0 discourse would be precisely in transiting among different modes of justification.

Proposition 1. Distinct and specific institutional logics or modes of justification will be emphasized by different types of organizations (such as companies, unions, universities and governments) when adopting Industry 4.0.

Also, institutional entrepreneurs’ role in organizations and organizational fields, as well as institutional work, can help to understand better the origins and modifications arising from Industry 4.0. Organizational field is “sets of organizations which, in the aggregate, constitute a recognized area of institutional life: key suppliers, resources and product consumers, regulatory agencies, and other organizations that produce similar services or products” (DiMaggio & Powell, 1983). Although it is a crucial level of analysis for institutional theory, it has not been empirically explored in Industry 4.0 investigations, except for Meyer (2019a).

The ideas of field formation developed by Meyer (2019a) in the case of Industry 4.0 in Germany can be complemented by the perspective of social movements. Hargrave and Van De Ven (2006) established a connection between technology innovation management literature and the social movement literature. They propose a collective action view of institutional change where change is a field-level property that arises from interactions among field members. King and Pearce (2010) highlight the mobilization of resources and identities linked to a better future for all, as well as the role of institutional entrepreneurs in carrying out various projects and activities oriented to change. The strategy identified by Schneiberg (2013: page 2) as movements that “mobilize for change within – and with – existing channels, institutions, and power structures” seems to be the most promising for understanding Industry 4.0. New organizations have been created and provided with resources, templates and technical expertise, besides promoting favorable regulative and normative environments. The work to change is incremental from within (Schneiberg, 2013), at least in Germany.

Proposition 2. Industry 4.0 is a social movement that has the German government as one of its major institutional entrepreneurs

At the macro-level of analysis, the concept of varieties of capitalism (Hall & Soskice, 2001) could give clues about the dynamics of the adoption and diffusion of Industry 4.0 in countries. Its emergence in Germany through collaboration between government, companies and universities (Reischauer, 2018) is in line with the idea of a coordinated market economy. In liberal market economies, such as the USA, a more decentralized process is expected, as Daudt and Willcox (2018) have already found. In Latin America, on the other hand, multinational companies allied with large local businesses are supposed to have a leading role (Schneider, 2009).

Proposition 3. Industry 4.0 will acquire distinct meanings as it diffuses across countries with different institutional characteristics.

Institutionalization occurs in relation to the ways meanings are contextualized within systems of meanings at the field and societal levels (Zilber, 2008). Ideas do not diffuse in a vacuum but are actively transferred and translated in a context of other ideas, actors, traditions and institutions. Ideas in the form of models and practices, such as Industry 4.0, can be adapted, modified or reshaped, but ideas can also take on new forms and meanings as they flow within and between contexts (Sahlin & Wedlin, 2008). Different countries assimilate Industry 4.0 at different levels and patterns (Erboz, 2020).

6. Conclusion

Results indicate that few studies apply institutional theory to understand Industry 4.0. In this way, the findings support that technical aspects dominate, whereas social, economic and ethical considerations have received little attention (Oesterreich et al., 2020). Most of these works adopted the survey method incorporating the idea of institutional isomorphism. Only one of them (Oti-Sarpong, Pärn, Burgess & Zaki, 2021) made use of the institutional logics perspective. This fact represents a striking difference compared to the broader field of

digitalization, where qualitative research prevails, and institutional logics is widely used to understand the adoption of technologies and practices.

A limitation of this systematic review is that it did not focus on a detailed bibliometric analysis. For example, we did not analyze the authors' network or the co-citation network in depth since few articles were simultaneously related to Industry 4.0 and institutional theory. Nevertheless, the method adopted here demonstrated the suitability of an exploratory investigation of articles' abstracts through multivariate analysis using free software.

Our study's main contribution is to identify promising new avenues of research from methodological and theoretical micro, meso and macro perspectives. Qualitative or mixed methods can bring significant insights when combined with institutional logic or institutional work (micro) concepts. A systematic comparison between different types of organizations can yield interesting results regarding the meanings, institutional logics or modes of justification in the implementation and understanding of Industry 4.0. For example, future studies can compare the discourse in companies, unions, government and industry federations to investigate whether there are divergences in the perception and interpretation of the Industry 4.0 phenomenon.

The adoption and use of the Industry 4.0 concept at universities is another interesting line of research. Universities have a prominent role in the development of Industry 4.0 through the research carried out in it and the partnerships established with companies. In addition, it trains new professionals in administration and engineering, which are especially important in the case of Industry 4.0. Professions in modern society have taken on leadership roles in creating and influencing institutions (Scott, 2008).

At a more aggregated level, social movements and an empirical definition of organizational fields can support a meso analysis of Industry 4.0. At the macro level, future research may look at different countries to determine if there are significant changes in the discourse and practices of Industry 4.0 as it diffuses. The investigation of developing countries and countries with distinct institutional characteristics is the most promising.

The adoption of Industry 4.0 has typically been viewed from a technological point of view as an expected means to increase productivity and efficiency. This paper reinforces a call for an institutional perspective where the concept of Industry 4.0 can be understood as a rationalized myth, and the reasons for its adoption are beyond objective rationality. The very meaning, practices and consequences of implementing Industry 4.0 are expected to vary across organizations and countries and deserve further study. It also serves as a warning for policy-makers and professionals to consider institutional aspects of Industry 4.0, that is, regulative, normative and cultural-cognitive issues (Scott, 1995).

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors would like to acknowledge the Spanish Agencia Estatal de Investigación, through the Grant RTI2018-094614-B-I00 (SMASHING) into the "Programa Estatal de I+D+i Orientada a los Retos de la Sociedad" funded by MCIN/AEI/ 10.13039/501100011033.

References

- Aksom, H., Zhylynska, O., & Gaidai, T. (2020). Can institutional theory be refuted, replaced or modified? *International Journal of Organizational Analysis*, 28(1), 135-159. <https://doi.org/10.1108/IJOA-02-2019-1666>
- Alvesson, M., & Spicer, A. (2019). Neo-Institutional Theory and Organization Studies: A Mid-Life Crisis? *Organization Studies*, 40(2), 199-218. <https://doi.org/10.1177/0170840618772610>
- Arbix, G., Salerno, M.S., Zancul, E., Amaral, G., & Lins, L.M. (2017). Advanced Manufacturing: What Is to Be Learnt from Germany, the U.S., and China. *Novos Estud. CEBRAP*, 36(3), 29-49. <https://doi.org/10.25091/S0101-3300201700030003>

- Atkinson, K.M., Koenka, A.C., Sanchez, C.E., Moshontz, H., & Cooper, H. (2015). Reporting standards for literature searches and report inclusion criteria: Making research syntheses more transparent and easy to replicate: Reporting Standards for Literature Searches. *Research Synthesis Methods*, 6(1), 87-95.
<https://doi.org/10.1002/jrsm.1127>
- Bag, S., & Pretorius, J.H.C. (2020). Relationships between industry 4.0, sustainable manufacturing and circular economy: Proposal of a research framework. *International Journal of Organizational Analysis*. Ahead of print.
<https://doi.org/10.1108/IJOA-04-2020-2120>
- Bag, S., Pretorius, J.H.C., Gupta, S., & Dwivedi, Y.K. (2021). Role of institutional pressures and resources in the adoption of big data analytics powered artificial intelligence, sustainable manufacturing practices and circular economy capabilities. *Technological Forecasting and Social Change*, 163. <https://doi.org/10.1016/j.techfore.2020.120420>
- Bernardi, R., & Exworthy, M. (2020). Clinical managers' identity at the crossroad of multiple institutional logics in it innovation: The case study of a health care organization in England. *Information Systems Journal*, 30(3), 566-595.
<https://doi.org/10.1111/isj.12267>
- Bodó, B. (2020). Mediated trust: A theoretical framework to address the trustworthiness of technological trust mediators. *New Media & Society*, 1-23. <https://doi.org/10.1177/1461444820939922>
- Boltanski, L., & Chiapello, E. (2005). The New Spirit of Capitalism. *International Journal of Politics, Culture, and Society*, 18(3-4), 161-188. <https://doi.org/10.1007/s10767-006-9006-9>
- Boltanski, L., & Thévenot, L. (1999). The Sociology of Critical Capacity. *European Journal of Social Theory*, 2(3), 359-377. <https://doi.org/10.1177/136843199002003010>
- Bosch-Sijtsema, P., & Gluch, P. (2019). Challenging construction project management institutions: The role and agency of BIM actors. *International Journal of Construction Management*, 1-11.
<https://doi.org/10.1080/15623599.2019.1602585>
- Brantnell, A., & Baraldi, E. (2020). Following unique logics despite institutional complexity: An inductive study of academic inventors and institutional logics. *European Management Journal*, 38(5), 684-697.
<https://doi.org/10.1016/j.emj.2020.02.005>
- Braunscheidel, M.J., Hamister, J.W., Suresh, N.C., & Star, H. (2011). An institutional theory perspective on Six Sigma adoption. *International Journal of Operations & Production Management*, 31(4), 423-451.
<https://doi.org/10.1108/01443571111119542>
- Bunduchi, R., Tursunbayeva, A., & Pagliari, C. (2019). Coping with institutional complexity: Intersecting logics and dissonant visions in a nation-wide healthcare IT implementation project. *Information Technology & People*, 33(1), 311-339. <https://doi.org/10.1108/ITP-08-2018-0373>
- Calabrese, A., Leviardi-Ghiron, N., & Tiburzi, L. (2021). 'Evolutions' and 'revolutions' in manufacturers' implementation of industry 4.0: A literature review, a multiple case study, and a conceptual framework. *Production Planning & Control*, 32(3), 213-227. <https://doi.org/10.1080/09537287.2020.1719715>
- Camargo, B.V., & Justo, A.M. (n.d.). *IRaMuTeQ Tutorial*. Available at: <http://iramuteq.org/documentation> (Accessed: November 2021).
- Cloutier, C., & Langley, A. (2013). The Logic of Institutional Logics: Insights From French Pragmatist Sociology. *Journal of Management Inquiry*, 22(4), 360-380. <https://doi.org/10.1177/1056492612469057>
- Damayanthi, S., & Gooneratne, T. (2017). Institutional logics perspective in management control research: A review of extant literature and directions for future research. *Journal of Accounting & Organizational Change*, 13(4), 520-547.
<https://doi.org/10.1108/JAOC-01-2017-0002>
- Daudt, G., & Willcox, L.D. (2018). Critical thoughts on advanced manufacturing: The experiences of Germany and USA. *Revista de Gestão*, 25(2), 178-193. <https://doi.org/10.1108/REG-12-2017-0016>

- Denyer, D., & Tranfield, D. (2009). Producing a systematic review. In Buchanan, D.A., & Bryman, A. (Eds.), *The Sage Handbook of Organizational Research Methods*. SAGE publications.
- DiMaggio, P.J., & Powell, W.W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, 48(2), 147-160. <https://doi.org/10.2307/2095101>
- Dufour, S., Rodríguez-González, P.M., & Laslier, M. (2019). Tracing the scientific trajectory of riparian vegetation studies: Main topics, approaches and needs in a globally changing world. *Science of The Total Environment*, 653, 1168-1185. <https://doi.org/10.1016/j.scitotenv.2018.10.383>
- Erboz, G. (2020). A qualitative study on industry 4.0 competitiveness in Turkey using Porter diamond model. *Journal of Industrial Engineering and Management*, 13(2), 266. <https://doi.org/10.3926/jiem.2915>
- Farrell, H. (2018). The Shared Challenges of Institutional Theories: Rational Choice, Historical Institutionalism, and Sociological Institutionalism. In Glückler, J.; Suddaby, R., & Lenz, R. (Orgs.), *Knowledge and Institutions* (13, 23-44). Springer International Publishing. https://doi.org/10.1007/978-3-319-75328-7_2
- Frank, A.G., Dalenogare, L.S., & Ayala, N.F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, 15-26. <https://doi.org/10.1016/j.ijpe.2019.01.004>
- Ghobakhloo, M., Fathi, M., Iranmanesh, M., Maroufkhani, P., & Morales, M.E. (2021). Industry 4.0 ten years on: A bibliometric and systematic review of concepts, sustainability value drivers, and success determinants. *Journal of Cleaner Production*, 302, 127052. <https://doi.org/10.1016/j.jclepro.2021.127052>
- Gupta, S., Modgil, S., Gunasekaran, A., & Bag, S. (2020). Dynamic capabilities and institutional theories for Industry 4.0 and digital supply chain. *Supply Chain Forum: An International Journal*, 21(3), 139-157. <https://doi.org/10.1080/16258312.2020.1757369>
- Hair, J.F. (Org.). (2006). *Multivariate data analysis* (6th ed.). Pearson Prentice Hall.
- Hall, P.A., & Soskice, D. (2001). *Varieties of Capitalism*. Oxford University Press. <https://doi.org/10.1093/0199247757.001.0001>
- Hargrave, T.J., & Van De Ven, A.H. (2006). A Collective Action Model of Institutional Innovation. *Academy of Management Review*, 31(4), 864-888. <https://doi.org/10.5465/amr.2006.22527458>
- Heimerl, F., Lohmann, S., Lange, S., & Ertl, T. (2014). Word Cloud Explorer: Text Analytics Based on Word Clouds. *47th Hawaii International Conference on System Sciences* (1833-1842). <https://doi.org/10.1109/HICSS.2014.231>
- Hervas-Oliver, J.L., Estelles-Miguel, S., Mallol-Gasch, G., & Boix-Palomero, J. (2019). A place-based policy for promoting Industry 4.0: The case of the Castellon ceramic tile district. *European Planning Studies*, 27(9), 1838-1856. <https://doi.org/10.1080/09654313.2019.1642855>
- Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization*, 28(1), 52-61. <https://doi.org/10.1016/j.infoandorg.2018.02.004>
- Howaldt, J., Kopp, R., & Schultze, J. (2017). Why Industrie 4.0 Needs Workplace Innovation—A Critical Essay About the German Debate on Advanced Manufacturing. In Oeij, P., Rus, D., & Pot, F.D. (Orgs.), *Workplace Innovation* (45-60). Springer International Publishing. https://doi.org/10.1007/978-3-319-56333-6_4
- Illia, L., Sonpar, K., & Bauer, M.W. (2014). Applying Co-occurrence Text Analysis with ALCESTE to Studies of Impression Management: Co-occurrence Text Analysis with ALCESTE. *British Journal of Management*, 25(2), 352-372. <https://doi.org/10.1111/j.1467-8551.2012.00842.x>
- Ishiyama, J.T., & Breuning, M. (2014). Neoinstitutionalism. In *Encyclopedia Britannica*. Available at: <https://www.britannica.com/topic/neoinstitutionalism>
- Kaartemo, V., Nenonen, S., & Windahl, C. (2020). Institutional work by market-shaping public actors. *Journal of Service Theory and Practice*, 30(4/5), 401-435. <https://doi.org/10.1108/JSTP-08-2019-0176>

- Kauppi, K. (2013). Extending the use of institutional theory in operations and supply chain management research: Review and research suggestions. *International Journal of Operations & Production Management*, 33(10), 1318-1345. <https://doi.org/10.1108/IJOPM-10-2011-0364>
- Ketokivi, M.A., & Schroeder, R.G. (2004). Strategic, structural contingency and institutional explanations in the adoption of innovative manufacturing practices. *Journal of Operations Management*, 22(1), 63-89. <https://doi.org/10.1016/j.jom.2003.12.002>
- King, B.G., & Pearce, N.A. (2010). The Contentiousness of Markets: Politics, Social Movements, and Institutional Change in Markets. *Annual Review of Sociology*, 36(1), 249-267. <https://doi.org/10.1146/annurev.soc.012809.102606>
- Lappi, T.M., Aaltonen, K., & Kujala, J. (2019). The birth of an ICT project alliance. *International Journal of Managing Projects in Business*, 12(2), 325-355. <https://doi.org/10.1108/IJMPB-02-2018-0036>
- Lasi, H., Fettke, P., Kemper, H.G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering*, 6(4), 239-242. <https://doi.org/10.1007/s12599-014-0334-4>
- Lawrence, T.B., & Suddaby, R. (2006). Institutions and Institutional Work. In *The SAGE Handbook of Organization Studies* (215-254). SAGE Publications. <https://doi.org/10.4135/9781848608030.n7>
- Lopes de Sousa-Jabbour, A.B., Jabbour, C.J.C., Godinho-Filho, M., & Roubaud, D. (2018). Industry 4.0 and the circular economy: A proposed research agenda and original roadmap for sustainable operations. *Annals of Operations Research*, 270(1-2), 273-286. <https://doi.org/10.1007/s10479-018-2772-8>
- Luna-Reyes, L.F., & Gil-Garcia, J.R. (2011). Using institutional theory and dynamic simulation to understand complex e-Government phenomena. *Government Information Quarterly*, 28(3), 329-345. <https://doi.org/10.1016/j.giq.2010.08.007>
- Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado-López-Cózar, E. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics*, 12(4), 1160-1177. <https://doi.org/10.1016/j.joi.2018.09.002>
- Meyer, J.W., & Rowan, B. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. *American Journal of Sociology*, 83(2), 340-363. <https://doi.org/10.1086/226550>
- Meyer, U. (2019a). The Institutionalization of an Envisioned Future. Sensemaking and Field Formation in the Case of “Industrie 4.0” in Germany. In Lösch, A., Grunwald, A., Meister, M., & Schulz-Schaeffer, I. (Eds.), *Socio-Technical Futures Shaping the Present* (111-138). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-27155-8_6
- Meyer, U. (2019b). The emergence of an envisioned future. Sensemaking in the case of “Industrie 4.0” in Germany. *Futures*, 109, 130-141. <https://doi.org/10.1016/j.futures.2019.03.001>
- Nedzhvetskaya, N., & Fligstein, N. (2020). The evolving role of organizational theory within economic sociology. *Sociology Compass*, 14(3). <https://doi.org/10.1111/soc4.12747>
- Oesterreich, T.D., Schuir, J., & Teuteberg, F. (2020). The Emperor’s New Clothes or an Enduring IT Fashion? Analyzing the Lifecycle of Industry 4.0 through the Lens of Management Fashion Theory. *Sustainability*, 12(21), 8828. <https://doi.org/10.3390/su12218828>
- Oti-Sarpong, K., Pärn, E.A., Burgess, G., & Zaki, M. (2021). Transforming the construction sector: An institutional complexity perspective. *Construction Innovation*, ahead-of-print. <https://doi.org/10.1108/CI-04-2021-0071>
- Patriotta, G., Gond, J.P., & Schultz, F. (2011). Maintaining Legitimacy: Controversies, Orders of Worth, and Public Justifications: Maintaining Legitimacy. *Journal of Management Studies*, 48(8), 1804-1836. <https://doi.org/10.1111/j.1467-6486.2010.00990.x>
- Pattit, J.M., Raj, S.P., & Wilemon, D. (2012). An institutional theory investigation of U.S. technology development trends since the mid-19th century. *Research Policy*, 41(2), 306-318. <https://doi.org/10.1016/j.respol.2011.10.008>

- Rahman, M., Kamal, M.M., Aydin, E., & Haque, A.U. (2020). Impact of Industry 4.0 drivers on the performance of the service sector: Comparative study of cargo logistic firms in developed and developing regions. *Production Planning & Control*, 1-16. <https://doi.org/10.1080/09537287.2020.1810758>
- Randolph, J.J. (2009). A Guide to Writing the Dissertation Literature Review. *Practical Assessment, Research & Evaluation*, 14(13), 1-13. <https://doi.org/10.7275/b0az-8t74>
- Reischauer, G. (2018). Industry 4.0 as policy-driven discourse to institutionalize innovation systems in manufacturing. *Technological Forecasting and Social Change*, 132, 26-33. <https://doi.org/10.1016/j.techfore.2018.02.012>
- Rizzoli, V. (2018). Histories of Social Psychology in Europe and North America, as Seen from Research Topics in Two Key Journals. In Tuzzi, A. (Org.), *Tracing the Life Cycle of Ideas in the Humanities and Social Sciences* (65-86). Springer International Publishing. https://doi.org/10.1007/978-3-319-97064-6_4
- Rolfesen, M. (2014). A blueprint paradox: Successful but unintended cross-national translation of total productive maintenance. *Journal of Quality in Maintenance Engineering*, 20(4), 402-414. <https://doi.org/10.1108/JQME-07-2012-0024>
- Sahlin, K., & Wedlin, L. (2008). Circulating Ideas: Imitation, Translation and Editing. In *The SAGE Handbook of Organizational Institutionalism* (218-242). SAGE Publications Ltd. <https://doi.org/10.4135/9781849200387.n9>
- Saldanha, J.P., Mello, J.E., Knemeyer, A.M., & Vijayaraghavan, T.A.S. (2015). Implementing Supply Chain Technologies in Emerging Markets: An Institutional Theory Perspective. *Journal of Supply Chain Management*, 51(1), 5-26. <https://doi.org/10.1111/jscm.12065>
- Schneiberg, M. (2013). Institutional Theory and Social Movements. In Snow, D.A., della Porta, D, Klandermans, B., & McAdam, D. (Orgs.), *The Wiley-Blackwell Encyclopedia of Social and Political Movements* (1-5). Blackwell Publishing Ltd. <https://doi.org/10.1002/9780470674871.wbespm470>
- Schneider, B.R. (2009). Hierarchical Market Economies and Varieties of Capitalism in Latin America. *Journal of Latin American Studies*, 41(3), 553-575. <https://doi.org/10.1017/S0022216X09990186>
- Schneider, P. (2018). Managerial challenges of Industry 4.0: An empirically backed research agenda for a nascent field. *Review of Managerial Science*, 12(3), 803-848.
- Scott, W.R. (1995). *Institutions and organizations*. SAGE.
- Scott, W.R. (2008). Lords of the Dance: Professionals as Institutional Agents. *Organization Studies*, 29(2), 219-238. <https://doi.org/10.1177/0170840607088151>
- Soares, A.L.V., Mendes-Filho, L., & Gretzel, U. (2020). Technology adoption in hotels: Applying institutional theory to tourism. *Tourism Review*, 76(3), 669-680. <https://doi.org/10.1108/TR-05-2019-0153>
- Stentoft, J., & Rajkumar, C. (2020). The relevance of Industry 4.0 and its relationship with moving manufacturing out, back and staying at home. *International Journal of Production Research*, 58(10), 2953-2973. <https://doi.org/10.1080/00207543.2019.1660823>
- Surajit, B., & Telukdarie, A. (2018). Business Logistics Optimization Using Industry 4.0: Current Status and Opportunities. *2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)* (1558-1562). <https://doi.org/10.1109/IEEM.2018.8607556>
- Thornton, P.H., & Ocasio, W. (2008). Institutional Logics. In *The SAGE Handbook of Organizational Institutionalism* (99-128). SAGE Publications Ltd. <https://doi.org/10.4135/9781849200387.n4>
- Wamba, S.F., & Queiroz, M.M. (2020). Industry 4.0 and the supply chain digitalisation: A blockchain diffusion perspective. *Production Planning & Control*, 1-18. <https://doi.org/10.1080/09537287.2020.1810756>
- Wongthongchai, J., & Saenchaiyathon, K. (2019). The key role of institution pressure on green supply chain practice and the firm's performance. *Journal of Industrial Engineering and Management*, 12(3), 432. <https://doi.org/10.3926/jiem.2994>

Xu, G., Zhou, Y., & Ji, H. (2020). How Can Government Promote Technology Diffusion in Manufacturing Paradigm Shift? Evidence From China. *IEEE Transactions on Engineering Management* (1-13).
<https://doi.org/10.1109/TEM.2020.2981147>

Zilber, T.B. (2008). The Work of Meanings in Institutional Processes and Thinking. In *The SAGE Handbook of Organizational Institutionalism* (150-169). SAGE Publications Ltd. <https://doi.org/10.4135/9781849200387.n6>

Journal of Industrial Engineering and Management, 2022 (www.jiem.org)



Article's contents are provided on an Attribution-Non Commercial 4.0 Creative commons International License. Readers are allowed to copy, distribute and communicate article's contents, provided the author's and Journal of Industrial Engineering and Management's names are included. It must not be used for commercial purposes. To see the complete license contents, please visit <https://creativecommons.org/licenses/by-nc/4.0/>.