

Article

What Are Industry 4.0 and Industry 5.0 All About? An Integrative Institutional Model for the New Industrial Paradigms

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Abstract: Industry 4.0 (I4.0) and Industry 5.0 (I5.0) represent important changes in industrial paradigms. I4.0 is centered on efficiency and competitiveness, and I5.0 adds sustainability, human-centricity, and resilience to the framework. Despite their growing relevance, much of the existing research remains techno-centric, neglecting the sociocultural and institutional forces shaping them. This study investigates how the transition from I4.0 to I5.0 is occurring using an institutional perspective. A qualitative methodology was employed, combining theoretical synthesis and secondary data analysis to develop an integrative model. The proposed model draws on insights from Institutional Theory, Scandinavian Institutionalism, Management Fashion, and Quintuple Helix, emphasizing the role of translation and diffusion in institutionalizing these paradigms. We maintain that both of them are fundamentally discursive, shaped by institutional pressures, shared meanings, and stakeholder interactions. I4.0 already allows for a heterogeneous vision adjusted to different perspectives and stakeholders. I5.0 goes further by responding to criticism about social and environmental issues and introducing resilience, especially after the COVID-19 pandemic and the ongoing climate crisis. As a result, I5.0 aligns with a broader range of actors and interests, increasing its potential for widespread acceptance and long-term impact. This research challenges deterministic views of technology, arguing that this new industrial revolution is not eminently technology-driven but instead emphasizes the central role of discourse and institutional processes in shaping its development.

Keywords: industry 5.0; industry 4.0; institutional theory; Scandinavian institutionalism; translation ecology; management fashion; framework; triple helix; sustainability; technology



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1. Introduction

Industry 4.0 (I4.0), also known as the Fourth Industrial Revolution, emerged over a decade ago as a paradigm for transforming traditional manufacturing and industrial practices through the integration of advanced digital technologies (Lu, 2017; L. D. Xu et al., 2018). It encompasses a wide range of innovations aimed at enhancing production processes, efficiency, data management, and overall competitiveness (Piccarozzi et al., 2018). Since then, the concept has expanded beyond manufacturing (Ghobakhloo et al., 2021), with an increasing number of companies from various sectors incorporating it into their business models and value chains (Kohnová & Salajová, 2023; Ventura & Silva e Meirelles, 2025). More recently, the paradigm of Industry 5.0 (I5.0) has emerged, driven primarily by the

European Commission (2021) report, incorporating the principles of sustainability, human-centricity, and resilience (Ghobakhloo et al., 2023; Martín-Gómez et al., 2024). Research interest in this new paradigm has grown rapidly and exponentially (Ciucu-Durnoi et al., 2024; Espina-Romero et al., 2023; Madsen et al., 2023), bringing new challenges, as it is neither free of contradictions nor ambiguities (Ivanov, 2023), leaving companies just beginning to adopt I4.0 confronted with this novelty.

Understanding these fast-paced changes requires a deeper discussion of these phenomena. Therefore, the first objective of this article is *to discuss the nature of I4.0 and I5.0*, which is a necessary step toward understanding how the transition between these paradigms is occurring. Much of the existing literature, especially on I4.0, adopts a techno-centric view (Beier et al., 2020). Here, we argue that technology is profoundly socially shaped, and influenced by values, beliefs, and interests (Howcroft & Taylor, 2022). It is constituted by shared meanings, structures, and practices—beyond objective and rational considerations—bringing it closer to an institution (Zilber & Goodman, 2021). Although there is no consensus on the definition of an institution, it is broadly considered a socio-cultural construction essential for providing blueprints for organizations and organizing (Ocasio, 2023). Institutionalization is a social process where individuals accept a collective understanding of social reality that is perceived as an objective reality, i.e., becomes accepted as the inherent nature of things and/or the appropriate way of doing them (Aksom, 2022). This definition easily links to I4.0, and, as we argue, is also central to comprehending the emerging paradigm of I5.0.

Despite calls for a less techno-centric interpretation of this industrial revolution (Beier et al., 2020), especially through institutionalist lenses (D. Fogaça et al., 2022), few studies have followed this approach. Reischauer (2018) proposed interpreting I4.0 in Germany as a policy-driven discourse to institutionalize innovation systems. U. Meyer (2019) described I4.0 as an envisioned future based on the sense-making processes of different actors, also in Germany. D. R. Fogaça et al. (2024) proposed a framework for systematically understanding the discourse used by different stakeholders in this process across various countries, which can also serve as a basis for examining I5.0. The Management Fashion (MF) approach has also been utilized to understand the emergence of I4.0 (Madsen, 2019; Oesterreich et al., 2020) and I5.0 (Madsen & Slåtten, 2023), highlighting its proximity to Institutional Theory (Aksom, 2022). However, these studies lack a more integrated perspective on how different institutional concepts and mechanisms contribute to forming I4.0 and I5.0 and how they are interrelated. Thus, the second objective of this article is *to propose an integrated institutional model for understanding I4.0 and I5.0*. Together, both objectives contribute to addressing the general research question of the article:

RQ: How is the transition from Industry 4.0 to Industry 5.0 occurring?

We maintain that I4.0 and I5.0 are eminently discursive and institutional phenomena. Industry 4.0 primarily focuses on productivity and competitiveness. Through criticism, pressure, and interactions from various actors and society—along with concrete events such as the pandemic and the climate crisis—elements of sustainability, human-centricity, and resilience were incorporated into a new paradigm known as Industry 5.0. It accommodates broader environmental and social dimensions that meet the expectations of a wider range of stakeholders. The transition from I4.0 to I5.0 is not essentially a technological shift but a reconfiguration of priorities, values, and institutional understandings reflected in a new discourse.

We adopt a theoretical–conceptual approach. Unlike empirical studies that formulate and test hypotheses, this research is exploratory and theory-driven, aiming to develop a conceptual model rather than validating predefined assumptions. We conducted an extensive literature review, combining existing theoretical frameworks and secondary

sources to propose an integrative institutional model. The primary objective of this study is to analyze how the transition from I4.0 to I5.0 is occurring through an institutional perspective. Specifically, we aim to (i) discuss the nature of I4.0 and I5.0 and (ii) develop an integrative institutional model to understand these phenomena.

Drawing on the general conceptual model of Glynn and D'Aunno (2023), we incorporate the empirical insights of D. R. Fogaça et al. (2024) in characterizing the actors and their frames/discourses in I4.0, combined with the concept of translation ecology from Scandinavian Institutionalism (Nielsen et al., 2022) to explain the transition between the two paradigms. In this context, translation refers to the process by which actors adapt and reinterpret ideas, practices, and technologies as they move across different institutional settings. The notion of translation ecology emphasizes that this process is not linear but rather shaped by interactions among various actors, each with distinct interests and frames of reference. These institutional lenses provide a unique opportunity to move beyond deterministic views of technology and reveal how discourse, framing, and translation processes contribute to the institutionalization of these so-called industrial revolutions.

In the next section, we present the theoretical review underpinning our model: the conceptualization of I4.0 and I5.0, Institutional Theory and its application to these phenomena, and Scandinavian Institutionalism as a promising approach to explain them. Section 3 details the proposed model, including its main elements and the rationale behind its construction. Section 4 discusses the article's objectives: exploring the nature of I4.0 and I5.0 and our integrated institutional model's theoretical and practical contributions. Finally, Section 5 addresses the study's limitations and suggests future research directions.

2. Theoretical Background

2.1. Industry 4.0 and Industry 5.0

Industry 4.0, also known as the Fourth Industrial Revolution, originated in Germany in 2011 as part of a strategic initiative to establish itself as a leader in integrated industry (L. D. Xu et al., 2018). Despite the lack of consensus regarding its definition (Culot et al., 2020), I4.0 was initially characterized by the integration of advanced digital technologies into manufacturing processes to enhance efficiency, flexibility, and customization (Lu, 2017; Oztemel & Gursev, 2020). A definition proposed by Rupp et al. (2021, p. 12) describes it thus: "Industry 4.0 is the implementation of Cyber Physical Systems for creating Smart Factories by using the Internet of Things, Big Data, Cloud Computing, Artificial Intelligence, and Communication Technologies for Information and Communication in Real Time over the Value Chain".

More recently, the concept of I4.0 has expanded beyond the factory, encompassing the value chain and other sectors such as construction, healthcare, and agriculture (Ghobakhloo et al., 2021; Kohnová & Salajová, 2023). However, the common understanding of I4.0 remains primarily focused on technological and productivity aspects. Alternative and more interdisciplinary approaches may offer a more precise interpretation of I4.0, its impacts, and its blind spots (Beier et al., 2020; D. Fogaça et al., 2022). A frequently cited limitation of I4.0 is that environmental sustainability is not a strategic priority, playing only a limited role in its predominant definition (Beier et al., 2020; Ghobakhloo et al., 2021). Another weakness lies in the insufficient attention given to human factors, labor, and broader social dynamics (Neumann et al., 2021; Sony, 2020; Zorzenon et al., 2022). Both limitations are connected to the evolution from a prevailing technical paradigm to one emphasizing social and environmental considerations, as seen in Industry 5.0.

The term Industry 5.0 was initially coined by futurist Michael Rada but gained momentum with the release of the European Commission (2021) report (Madsen & Slåtten, 2023). Given its recent emergence, the lack of consensus regarding its definition is even

more pronounced than with I4.0. However, a common thread in much of the I5.0 literature is the integration of resilience, sustainability, and human-centric values. This integration prioritizes the collaboration between humans and advanced technologies to create adaptive, inclusive, and eco-friendly systems that benefit society as a whole (Ghobakhloo et al., 2023; Ivanov, 2023; Zizic et al., 2022). These three distinctive features of I5.0 have spurred research discussing each in depth—resilience (e.g., Hsu et al., 2024; Leng et al., 2023), sustainability (e.g., Ben Youssef & Mejri, 2023; Jamil et al., 2024), and human-centricity—either from a more technical perspective at the factory level (e.g., Nahavandi, 2019; Ordieres-Meré et al., 2023) or within a broader social context (e.g., Gamberini & Pluchino, 2024; Kolade & Owoseni, 2022). Table 1 summarizes the main differences and similarities between I4.0 and I5.0.

Table 1. Key Similarities and differences between I4.0 and I5.0.

Similarities	Differences
Shared Technological Foundations: rely on IoT, Big Data, AI, and CPS	Primary Focus: I4.0 emphasizes automation and mass production, whereas I5.0 incorporates human-centricity, sustainability, and resilience
Efficiency and Productivity: aim to enhance industrial performance and operational efficiency	Environmental Perspective: I4.0's sustainability efforts are secondary, mainly targeting process optimization, while I5.0 integrates sustainability as a core principle
Customization: promote personalization of products and services	Workforce role: I4.0 minimizes human intervention through automation, while I5.0 places humans at the center of production, emphasizing collaboration between workers and machines
Influence on Industrial Models: reshape business strategies and production systems	Impact: I4.0 is more restricted to industrial transformation, while I5.0 extends beyond factories to address societal challenges

Whether I5.0 represents a natural and incremental evolution of I4.0, a radical departure from it, or something in between remains a matter of debate (Ghobakhloo et al., 2024). This article contributes to this discussion from an institutional perspective. The following section provides a brief overview of Institutional Theory, how it has been used to investigate I4.0 and I5.0, and how it can help understand the transition from one paradigm to another.

2.2. Institutional Theory and Development of Industry 4.0/5.0

The New Institutional Theory, also known as New Institutionalism or Neoinstitutionalism, presents a non-rationalist perspective on decision-making for the adoption of organizational practices (Aksom, 2022). In their seminal work, J. W. Meyer and Rowan (1977) argue that organizations conform to *rational myths* that are socially constructed and externally validated in pursuit of legitimacy and support. The interpretation of Industry 4.0 as a *rational myth* was proposed by D. Fogaça et al. (2022). The incorporation of specific techniques, policies, and programs serves as a symbol that the organization is adhering to what is considered proper, adequate, and rational within its social and institutional context. However, these innovations do not necessarily make organizations more functionally efficient.

DiMaggio and Powell (1983) introduced three mechanisms that drive organizations to adopt practices and become structurally similar: coercive, normative, and mimetic. The first mechanism is linked to pressures such as governmental regulations, the second to professional standards, and the third to the imitation of other organizations perceived as successful in uncertain environments. This concept—*isomorphism*—has been and continues to be applied to understand the institutionalization of practices across different sectors, remaining influential across various disciplines (Greenwood & Meyer, 2008). The focus of

these studies on stability has been complemented more recently by discursive approaches that aim to investigate how institutions are created, maintained, and changed through language (Phillips et al., 2004; Schmidt, 2010). These approaches emphasize the substantive content of ideas and the interactive discourse processes within institutional contexts, providing a more dynamic understanding of institutional change.

The traditional concept of isomorphism has been employed to investigate the adoption of I4.0 in general (Gupta et al., 2020; Nirmal et al., 2023; Zhou & Zheng, 2023), I4.0 readiness (Ali & Johl, 2023), and digital transformation (H.-M. Kuo et al., 2022). Additionally, technologies closely related to I4.0, such as Big Data Analytics, Artificial Intelligence (Bag et al., 2021; Dubey et al., 2019), and Blockchain (Wamba & Queiroz, 2020), have also been examined through the lens of isomorphism. A discursive approach to characterizing I4.0 was proposed by Reischauer (2018) and indirectly supported by (U. Meyer, 2019), who applied the concept of *sensemaking* to analyze the heterogeneous discourse of actors involved with this phenomenon in Germany. The former argues that I4.0 is an innovation discourse that encourages the institutionalization of the Triple Helix, promoting collaboration among industry, academia, and government. D. R. Fogaça et al. (2024) advance the discursive perspective by proposing a framework to systematize the different frames mobilized by various actors in the discourse on I4.0, enabling comparisons between them and across countries.

Another approach to examining the adoption of I4.0 has been through the lens of Management Fashion (MF). This theoretical perspective was used to analyze the emergence of I4.0 (Madsen, 2019; Oesterreich et al., 2020) and I5.0 (Madsen & Slåtten, 2023). According to Firsova et al. (2023), MF can be considered a special case within the neoinstitutional theory proposed by J. W. Meyer and Rowan (1977) and DiMaggio and Powell (1983), serving as a complementary approach. Aksom (2022) suggests unifying these theories, noting that they share the same ontological basis in social constructivism. He argues that the concept of *rational myth* is practically interchangeable with *Management Fashion*. D. Fogaça et al. (2022) propose that I4.0 can be understood as a *rationalized myth* shaped by diverse institutional contexts and actors during its diffusion.

The institutionalization process involves multiple stages across various levels of analysis (Ocasio, 2023). Initially, key actors contribute to the conception of paradigms by framing their core ideas and goals, creating shared typifications of roles and practices. These paradigms are then subject to diffusion as their ideas spread across different industries and regions. However, during this process, adaptation occurs, where actors reinterpret and modify the paradigms to fit their local contexts and specific needs. Such processes illustrate how I4.0 and I5.0 can evolve as institutional phenomena. A promising approach for investigating these dynamics is Scandinavian Institutionalism, which focuses on translation and adaptation during diffusion. Despite its potential, we found no studies employing this framework to investigate I4.0 or I5.0. The following section will introduce its basic concepts.

2.3. Scandinavian Institutionalism

Scandinavian Institutionalism (SI) offers a distinctive perspective within the broader Institutional Theory framework by emphasizing the dynamic and evolving nature of change (Sahlin & Wedlin, 2008). In this context, *translation* refers to the process by which ideas, models, and practices are continuously reinterpreted, modified, and adapted as they move across different contexts. While traditional institutional theories often focus on stability and continuity, SI views change as constant, involving the continuous translation and reinterpretation of ideas (Wedlin & Sahlin, 2017). As ideas travel across contexts, they are not merely adopted but transformed, revised, and adapted. This translation approach is rooted in actor-network theory, particularly in Latour's model, and it diverges from the

more rigid frameworks of coercive, mimetic, and normative isomorphism often emphasized in North American institutionalism (Wæraas, 2021; Westney & Piekkari, 2020).

However, SI has often been related to other mainstream theories. For instance, although it does not explicitly address the concept of institutional logic, studies on public sector reforms in Scandinavia that incorporate private sector practices are linked to the concept of institutional complexity (Perkmann et al., 2022). This occurs when actors are confronted with conflicting or incompatible prescriptions regarding a course of action or goals (Greenwood et al., 2011). Additionally, due to its focus on change, Management Fashion has also been discussed in conjunction with SI (Carlsson, 2022; Wæraas & Nielsen, 2016; Wedlin & Sahlin, 2017). The same applies to institutional entrepreneurship (Czarniawska, 2009; Ritvala & Granqvist, 2009), where individuals or organizations aim to create, transform, or destabilize established institutional practices and structures (Maguire et al., 2004).

One recent promising development in SI is the concept of translation ecology (Westney & Piekkari, 2020). Introduced by Sahlin and Wedlin (2008), this concept provides a stronger theoretical foundation for SI by reconnecting it with mainstream Institutional Theory and offering a valuable approach for studies on the adoption and variation of practices (Firsova et al., 2023). It moves away from linear models of idea diffusion and instead proposes a multidirectional and dynamic process (Nielsen et al., 2022). The notion of translation ecology emphasizes that ideas are not translated in isolation but in relation to other ideas, actors, and contexts. These interactions form complex webs, where ideas, once translated, influence both the actors involved and other ideas (Nielsen et al., 2022; Wedlin & Sahlin, 2017). Section 3.3 applies the SI concept, particularly the translation ecology approach, to examine how key actors shape the transition from I4.0 to I5.0.

3. Model Development

The integrative institutional model for I4.0 and its transition to I5.0 is outlined in Figure 1. It is based on recent advances in Institutional Theory, such as the proposal of the integrative conceptual model by Glynn and D'Aunno (2023), Ocasio's (2023) stages of institutionalization, and the idea of ecologies of translation (Nielsen et al., 2022; Wedlin & Sahlin, 2017) from Scandinavian Institutionalism. Our model combines these theoretical-conceptual developments with empirical studies on digitalization, I4.0, and I5.0. For instance, the detailing of institutional elements (regulative, normative, and cultural-cognitive) carried out in Section 3.1 is based on a critical analysis of various studies on isomorphism in I4.0 (e.g., Ali & Johl, 2023; Bag et al., 2021) and on Management Fashion in I4.0 and I5.0 (Madsen, 2019; Madsen & Slåtten, 2023).

The part of the model related to actors and frames (detailed in Section 3.2) is based on Reischauer's (2018) idea of I4.0 as a discourse to institutionalize innovation systems within the Triple Helix and on the heterogeneity of sensemaking and sensegiving by actors involved in I4.0, as discussed by U. Meyer (2019). Based on empirical studies, D. R. Fogaça et al. (2024) proposed a framework to better understand the relationship between actors and frames (which are related to discourse and sensegiving/sensemaking) in I4.0. In our model, we apply this framework in more detail and extend it to I5.0. In addition, we integrate the idea of the distinctive characteristics of I5.0 (resilience, sustainability, and human-centricity) with the Quintuple Helix (Carayannis et al., 2022, 2023). In the "evolution" from I4.0 to I5.0, we employ the concept of translation ecology (Nielsen et al., 2022; Wedlin & Sahlin, 2017) as a promising mechanism to explain this transition (as detailed in Section 3.3). While Figure 1 provides an overview of the entire institutional model, Figure 2 complements it by detailing how translation processes unfold among key actors.

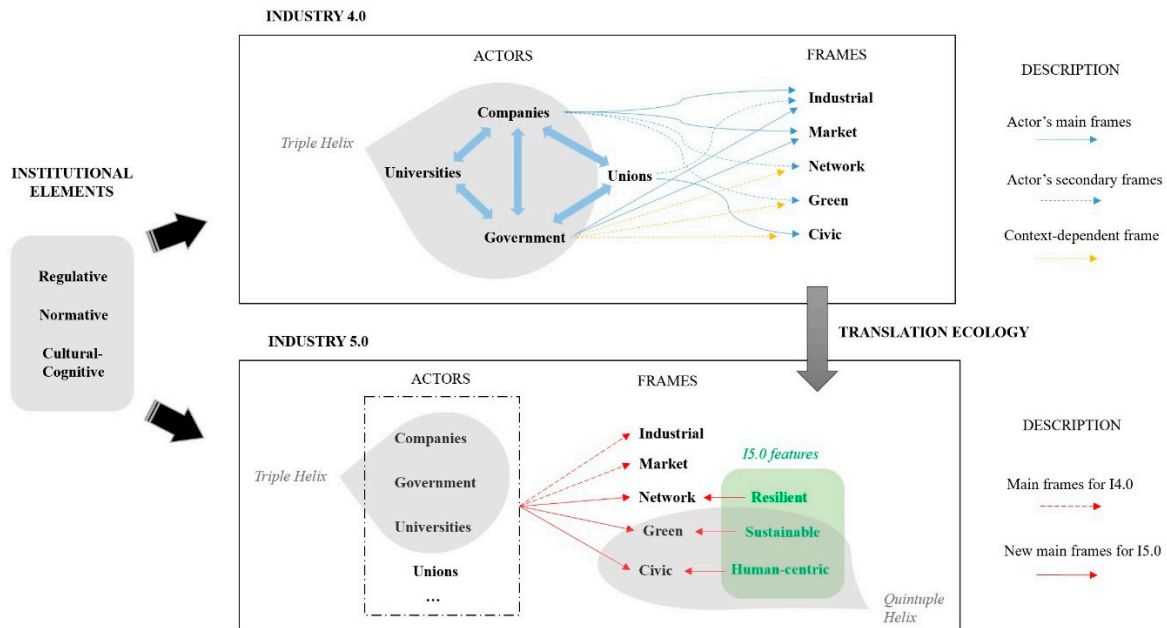


Figure 1. Overview of the institutional model for I4.0 and its transition to I5.0.

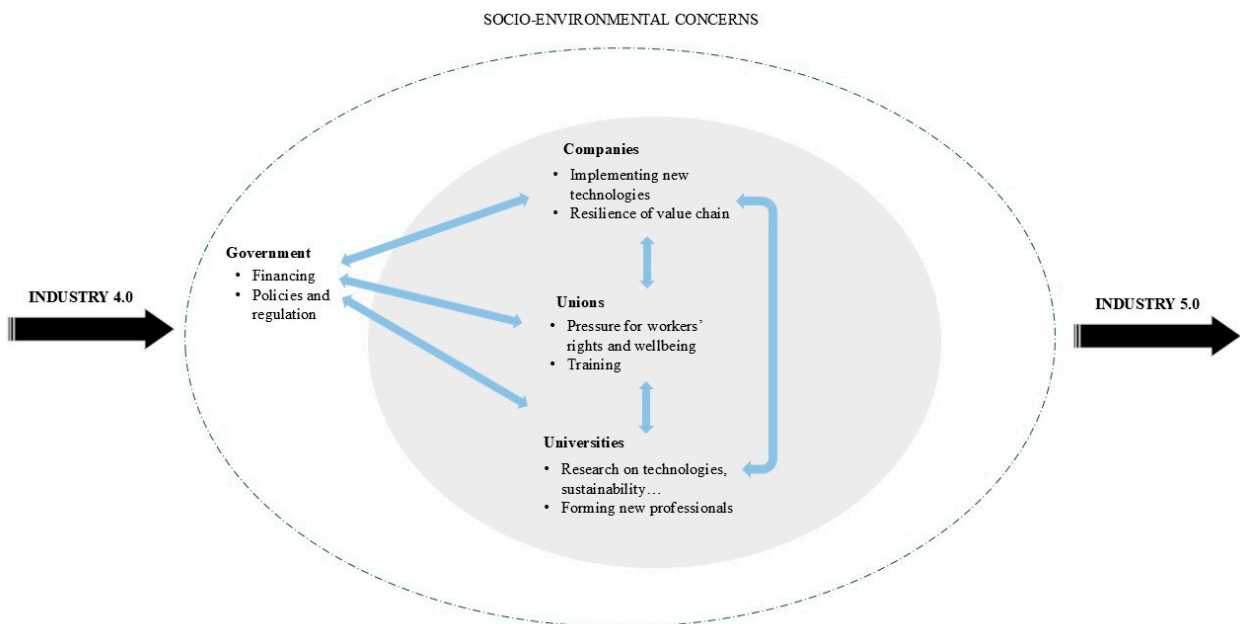


Figure 2. Actors and elements related to translation ecology from I4.0 to I5.0.

In summary, Section 3.1 details the *Institutional Elements* (left part of Figure 1), the following Section 3.2 describes the *Actors and Frames* of I4.0 and I5.0 (center of Figure 1), and Section 3.3 discusses how *Translation Ecology* can explain the transition from I4.0 to I5.0, describing Figure 2 for a more detailed view of the process.

3.1. Institutional Elements

The institutional elements (regulative, normative, and cultural–cognitive) are based on the foundational work of DiMaggio and Powell (1983) regarding isomorphism, were further developed by Scott (2014), and have been applied to I4.0 and digital transformation research by various authors (e.g., Ali & Johl, 2023; Bag et al., 2021; Bag & Pretorius, 2020; Dubey et al., 2019; Gupta et al., 2020; H.-M. Kuo et al., 2022; Nirmal et al., 2023). The main coercive components include government, regulatory bodies, and powerful buyers and

suppliers. Normative elements such as formal education and professional associations and networks are linked to professionalization. Lastly, cultural–cognitive elements are associated with mimetic pressures, where organizations imitate those considered successful, especially in uncertain environments.

Most studies that apply these concepts are quantitative, based on survey applications (D. Fogaça et al., 2022). However, several problems have been identified. Some articles erroneously define the normative element as associated with pressures from suppliers and customers (Bag et al., 2021; Gupta et al., 2020), which should actually be linked to coercive pressures. Others provide a correct theoretical definition of normative elements but operationalize them incorrectly (Ali & Johl, 2023; Dubey et al., 2019), once again including issues related to buyers and suppliers. We also found problems in the operationalization of mimetic pressures (Bag et al., 2021) by including coercive elements, such as complying with laws and regulations. Some studies do not clearly specify the particular variables used, which hinders the reproducibility of the methods (Bag & Pretorius, 2020; Nirmal et al., 2023).

Table 2 summarizes the main regulative (coercive pressures), normative, and cultural–cognitive (mimetic pressures) elements in light of the critical analysis of articles that use them to understand Industry 4.0 and digitalization. It is possible to conduct research that evaluates institutional pressures without including all items in each category. For instance, (H.-M. Kuo et al., 2022) do not include issues related to buyers and suppliers in the regulative element, nor formal education and professional certification in the normative element. However, it is recommended that these choices be appropriately justified and substantiated on a case-by-case basis. Although we have not found studies analyzing isomorphism in Industry 5.0, these elements are common to both phenomena.

Table 2. Main institutional elements.

Regulative (Coercive) (Ali & Johl, 2023; Bag et al., 2021; Gupta et al., 2020)	Normative (H.-M. Kuo et al., 2022; Ullah et al., 2020)	Cultural–Cognitive (Mimetic) (Ali & Johl, 2023; H.-M. Kuo et al., 2022; Ullah et al., 2020)
Legislation and Regulation (at different levels)	Formal Education and Training (universities and business schools)	Best Practices and Technological Innovations (benchmarking; imitating successful competitors and industry leaders)
Standards and Technical Norms (international organizations)	Professional Certifications (for emerging technologies, practices, and sustainability)	Organizational Culture (values and beliefs within companies)
Government Policies (including tax incentives, subsidies, and financing initiatives)	Industrial Associations and Standards (best practices and networking)	Consulting Firms (best practices, technological innovations, and organizational culture)
Powerful Buyers and Suppliers (varying according to field/industry)	Professional Associations (standards by professional communities)	

There are studies on Management Fashion applied to I4.0 (Madsen, 2019; Oesterreich et al., 2020) and I5.0 (Madsen & Slåtten, 2023). Although they do not explicitly use the concept of institutional elements, they refer to regulative, normative, and cultural–cognitive issues and to central actors associated with them (which will be discussed in more detail in Section 3.2). For example, governments in relation to regulative aspects; business schools, media, and conferences regarding normative pressures; and consulting firms in relation to mimetic pressures. Such studies could benefit from adopting a perspective based on these traditional aspects of Institutional Theory. The same can be said for research investigating the barriers and challenges to the implementation of I4.0 and I5.0 practices, such as (Mukherjee et al., 2023). For I5.0, they identified barriers linked to legal and

regulatory issues (regulative pillar), ethical concerns (normative pillar), and acceptance and adaptability (cognitive–cultural pillar). Other barriers refer to specific actors: cost and funding can be associated with governments, while upskilling and reskilling may involve universities and unions.

3.2. Actors and Frames

Reischauer (2018) argues that I4.0 is a discourse aimed at promoting innovation within the Triple Helix, involving key actors such as businesses, universities, and governments. Additionally, unions are considered especially relevant for representing the workers' perspective in this process (D. R. Fogaça et al., 2023; Sony & Naik, 2020). There are other actors, such as consulting firms, technology vendors, and business media (Madsen & Slåtten, 2023), that could be included in the model (Figure 1) but are not discussed in detail here for the sake of simplicity.

The “Actors and Frames” part of our model was initially derived from Glynn and D’Aunno’s (2023) theoretical Institutionalized Identities (Typified Actors) and Institutionalized Frames (Typified Situations), combined with the variety of sensemaking empirically identified by U. Meyer (2019) in I4.0. D. R. Fogaça et al. (2024) advance this perspective through the combination of the framing approach (Cornelissen et al., 2015; Purdy et al., 2019) with selected Orders of Worth from Boltanski and Thévenot (2006)—namely, industrial, market, green, civic, and network. In an empirical study of I4.0, they further propose and organize a framework of frames, relating it to specific actors and unpacking these elements.

I4.0 emerges with a focus on increasing efficiency and productivity (industrial frame) and competitiveness and profitability (market frame), with sustainability eventually gaining prominence (green frame) (D. R. Fogaça et al., 2024). Little importance is given to issues related to labor and broader social dynamics (civic frame) in the implementation of I4.0 (Neumann et al., 2021; Oesterreich et al., 2020), with unions primarily affirming this perspective. These various frames are contested by different actors and evolve over time and depend on the regions studied. Table 3 presents a summary of the frames (which are based on Boltanski and Thevenot’s orders of worth) concerning I4.0, as proposed by (D. R. Fogaça et al., 2024), and I5.0, which we extend in this study and should be interpreted alongside Figure 1.

Table 3. Comparison of frames between Industry 4.0 and Industry 5.0.

Frames	Industry 4.0 (D. R. Fogaça et al., 2024)	Industry 5.0
Industrial	Productivity and efficiency. Central to I4.0.	It remains significant. Greater balance with other orders of worth.
Market	Competitiveness and profitability. Central to I4.0.	It remains significant. Greater balance with other orders of worth.
Green	Environment and sustainability. Initially secondary; it gains prominence over time.	Central feature. Sustainability.
Civic	Collective welfare and social justice. Secondary; mostly a concern of unions.	Central feature. Human-centered.
Network	Connectivity and real-time information. Secondary; vague definition.	Central feature. Resilience. Develops autonomy and importance at different levels.

In I4.0, the main frames are the industrial and market ones, which companies and governments typically employ to justify their implementation. However, specific institutional settings in countries lead governments to adopt different policies and approaches to innovation in I4.0 (C.-C. Kuo et al., 2019). For instance, the focus on civil society and workers (civic frame) within I4.0 policies varies significantly among European Union countries (Teixeira & Tavares-Lehmann, 2022). The same applies to unions, which may align more or less with the frames of companies, depending on the level of coordination between economic actors. In a comparison among Sweden, Spain, and Brazil, the first shows a well-aligned discourse between companies and unions, while in Brazil, unions are quite critical of the potential negative impacts of I4.0. Spain occupies an intermediate position (D. R. Fogaça et al., 2023, 2024).

The primary distinction between I4.0 and I5.0 lies in its characterization as sustainable, human-centric, and resilient. In essence, three new frames—green, civic, and network—have been introduced as fundamental while maintaining the two primary frames of I4.0 (market and industrial). One of the main criticisms faced by I4.0 was its lack of focus on labor and social issues (civic frame). Although the issue of sustainability (green frame) gained traction in the I4.0 discourse, it was not considered a foundational principle. Finally, the network frame in I4.0 had a vague connotation of connectivity and real-time information. In contrast, in I5.0, this frame takes center stage and becomes autonomous in the form of resilience at different levels (Ivanov, 2023). It encompasses principles of decentralization, vertical and horizontal integration, interoperability, modularity (Ghobakhloo et al., 2023), reconfigurable plants, and an intertwined supply network (ISN) (Ivanov, 2023).

If I4.0 was a discourse aimed at fostering innovation through the Triple Helix (Reischauer, 2018), I5.0 can be interpreted as an attempt to embrace the Quintuple Helix (Carayannis et al., 2022, 2023). By incorporating these three new features—associated with civic, green, and network frames—I5.0 seeks to create a more inclusive vision of the future that allows for a more uniform interpretation and action by stakeholders. For instance, by placing human and labor issues at the core of the implementation of I5.0 in companies, the perspective of trade unions is addressed. The same applies to environmental concerns, which governments must inherently consider when formulating policies and encouraging innovation under this new paradigm. The contention over the meaning of Industry 5.0 among different actors is likely to be diminished, addressing criticisms related to socio-environmental issues of Industry 4.0, reducing resistance, and accelerating its institutionalization.

3.3. Translation Ecology: From Industry 4.0 to Industry 5.0

As discussed in 2.3, translation ecology advances Institutional Theory by creating a bridge between SI and broader institutional frameworks. It highlights the importance of interactions among diverse actors and acknowledges the multidirectional flow of translation processes, offering a clearer view of how ideas spread and transform. This approach enhances our understanding of how organizational stability and transformation coexist, illustrating how institutional practices are continuously shaped across different contexts. Furthermore, translation ecology presents itself as a promising mechanism for explaining the shift from I4.0 to I5.0, where the convergence of multiple actors and ideas contributes to the emergence of new organizational settings.

The transition from I4.0 to I5.0 involves reframing values and priorities that respond to socio-environmental concerns. Figure 2 visually represents this transition, highlighting how various actors—governments, companies, unions, and universities—interact. In this context, translation ecology captures these actors' evolving roles and frames as they reinterpret and embed new principles of resilience, sustainability, and human-centricity

into industrial practices. The government is crucial in setting up the regulative framework that influences other stakeholders, acting as primary enforcers of policies and funding initiatives that guide this transition. They establish expectations for sustainable practices through financing and regulatory measures, directly shaping how companies and other actors adapt to the new industrial paradigm.

Companies implement technological and organizational changes that are aligned with Industry 5.0's goals. Initially focused on productivity and competitiveness under I4.0, companies are now increasingly concerned with the resilience of their value chains, recognizing the importance of sustaining operations amidst complex and unpredictable challenges. By reinterpreting I4.0 principles through the I5.0 lens, companies contribute to the shift toward a more integrated and human-centered approach, acknowledging both economic and social value. Unions introduce and amplify the civic frame within this ecology, advocating for worker welfare and inclusive technological advancement. Their role extends beyond traditional labor rights to encompass training and reskilling efforts that prepare the workforce for the demands of I5.0.

Universities contribute through normative elements, not only advancing technological research but also educating future professionals. They prepare the workforce to operate within I5.0's expanded framework, fostering a skilled, socially aware, and adaptable workforce that aligns with the paradigm shift. Moreover, they are at the forefront of generating knowledge that informs and motivates I5.0 principles, influencing both policy and practice. With a focus on sustainability and social justice, universities can influence the evolution of industrial practices by embedding these values into academic and research agendas.

These actors, along with others, create the dynamics of a particular translation ecology, where socio-environmental concerns drive the adaptation and reinterpretation of industrial practices. I5.0 thus emerges not as a linear extension of I4.0 but as a multidimensional reconfiguration influenced by the interaction of multiple frames and actor-specific goals. This active interaction enables an integration of efficiency, sustainability, resilience, and inclusivity.

4. Discussion

The general research question of this article is: "How is the transition from Industry 4.0 to Industry 5.0 occurring?" To adequately address this issue, we established two objectives: first, to discuss the nature of I4.0 and I5.0, and second, to propose an integrated institutional model for them. In Section 4.1, we discuss the first objective, while the following Section 4.2 presents the theoretical and managerial contributions and implications of the previously introduced model.

4.1. Nature of I4.0 and 5.0

Some authors identify I4.0 as a technology-driven phenomenon or primarily characterize it as a bundle of technologies while acknowledging I5.0 as something different, i.e., value-driven or a complement to I4.0 beyond technology (X. Xu et al., 2021; Zizic et al., 2022). Other authors understand both I4.0 and I5.0 from the perspective of technological determinism (Aslam et al., 2020; Kasinathan et al., 2022) or similarly through the lens of the theory of disruptive innovations and business cycles (Asif et al., 2023). Based on these interpretations, I5.0 would be a logical continuation of I4.0, which would inevitably occur due to technological evolution, impacting socio-cultural values and economic structures in a new economy.

Contrary to this perspective, we agree with (Reischauer, 2018)'s position that I4.0 is actually a communicative action to encourage actors to innovate, and we extend it to I5.0. If in I4.0, the discourse encouraged innovation from the perspective of the Triple Helix, in I5.0,

the discourse is expanded to the Quintuple Helix (Carayannis et al., 2022). Environmental and social dimensions are included as being fundamental to this new paradigm. In addition to these, the concept of resilience is brought up mainly due to the experience with the COVID-19 pandemic (Madsen & Slåtten, 2023; Zizic et al., 2022). Technology is profoundly socially shaped and does not follow a linear or deterministic trajectory. The implementation of technologies occurs through complex processes influenced by values, policies, and the agency of diverse actors, which can lead to outcomes that deviate from the original intentions of their proponents (Howcroft & Taylor, 2022).

In this sense, an institutional interpretation of I4.0 is valuable for understanding it (D. Fogaça et al., 2022) and is supported by empirical studies. For example, Zhou and Zheng (2023) found that the relative advantages brought by I4.0 (improved performance and profitability) were not significant for adopting its technologies. On the other hand, the influence of the government (coercive pressure) and competitors (mimetic pressure) were. The main disseminator of I5.0 has been the European Commission, which instituted three main characteristics of I5.0 (resilient, sustainable, and human-centric) that have been incorporated into most research on the subject (e.g., (Asif et al., 2023; Carayannis et al., 2023; Ghobakhloo et al., 2023; Ivanov, 2023; Madsen & Slåtten, 2023; X. Xu et al., 2021; Zizic et al., 2022)).

The following excerpt shows the European Commission's view on the nature of I5.0:

*“What drives innovation? On the one hand, it is driven by blue-sky research where discoveries often find applications that innovate our existing practices. On the other, it is driven by society's evolution itself; we adapt to **emerging societal needs and realities** by searching for and implementing new solutions. Industrial policy should provide the best conditions for innovation to flourish and to give it direction so that our society benefits, that no one is left behind and that we respect the boundaries of the planet. [...] It is **our role to steer this new wave of innovation**. We need to make sure industry's evolution is **in line with our priorities**. [...] This concept paper puts forward a coherent vision for the future of European industry. We call it 'Industry 5.0'”.* (European Commission, 2021 [emphasis added])

In other words, there is no technological determinism or logical continuation of I4.0: the concept of I5.0 is currently the result of mainly a powerful actor who was influenced by concrete circumstances of reality not exclusively related to the advancement and development of technologies. I5.0, as the construction of a vision of the future, is in line with (U. Meyer, 2019) concerning I4.0, which we also extend to I5.0. It reinforces our position that the development of both I4.0 and I5.0 are more linked to discourse and sense-making activities toward innovation than technological progress, with translation processes playing a key role in how these paradigms are adapted and reinterpreted by different actors in multiple domains.

From an institutional perspective, based on the classification by Ocasio (2023), I4.0 is in a stage of objectivation. Its narrative has rapidly disseminated, continues to influence research and practice in business (Madsen & Slåtten, 2023), and is often cited as a fact rather than an idea or opinion (U. Meyer, 2019). It manifests in material artifacts and is part of the vocabulary for organizing businesses, universities, and governments (industrial policies). According to Tortorella et al. (2023, p. 7), experts view I4.0 as an irreversible trend: “companies that do not pursue their digital transformation are doomed to obsolescence”. From an institutional lens, this idea suggests that companies failing to adopt Industry 4.0 practices risk losing legitimacy and jeopardizing their very existence.

On the other hand, I5.0, according to the classification by Ocasio (2023), is in the typification stage, which is the initial phase of institutional formation. Its practices are being labeled and the roles and interactions of actors are still being determined. I5.0 is not

being constructed anew, but it is structurally and culturally embedded in institutions that already exist in society. I5.0 is not a chronological continuation of I4.0 or an alternative to it (X. Xu et al., 2021) but utilizes it to build a new paradigm (Asif et al., 2023; Zizic et al., 2022). The emphasis on the more sociocultural nature of the I4.0/I5.0 phenomenon and the importance of discourse and framing for its development lay the foundation for the integrative institutional model we propose. The next section discusses its theoretical and practical contributions and implications.

4.2. Contributions and Implications of the Institutional Model

The model offers a novel contribution by analyzing I4.0 and I5.0 and the transition between these phenomena from an institutional and discursive perspective (Phillips et al., 2004; Schmidt, 2010), diverging from the predominantly technological focus in much of the existing literature. While much of the research on this new industrial revolution views it primarily as technology-driven, emphasizing technical and economic efficiency (Rupp et al., 2021), we argue that it is, in fact, a rational myth (D. Fogaça et al., 2022), highlighting its social, cultural, and cognitive aspects. Different stakeholders emphasize specific frames and support narratives aligned with their interests (D. R. Fogaça et al., 2024). The dynamics among these actors promote the legitimization and institutionalization of these paradigms. If I4.0 already allowed for a heterogeneous vision adjusted to different perspectives and stakeholders (U. Meyer, 2019), I5.0 takes this further by incorporating sustainability, human-centricity, and resilience issues. This aligns with Carlsson's (2022) argument that concepts accommodating diverse interpretations are more likely to gain attention and support, ensuring long-term success.

From a theoretical contribution standpoint within Institutional Theory, we apply Glynn and D'Aunno's (2023) model to a concrete situation, demonstrating its applicability and utility. We also incorporate the institutionalization stages proposed by Ocasio (2023) to understand the current context of each paradigm. Additionally, the use of the translation ecology concept from Scandinavian Institutionalism (Wedlin & Sahlin, 2017) to explain the transition between paradigms exemplifies how to promote a helpful integration between these approaches, often studied in isolation. The dialogue established between our model and Management Fashion also deserves mention as an applied effort to unify this approach with more traditional Institutional Theory (Aksom, 2022). The incorporation of different institutional concepts and mechanisms can inspire other research endeavors that also foster greater dialogue between perspectives and projects linked to neoinstitutionalism. Figure 3 summarizes the main elements of our institutional model.

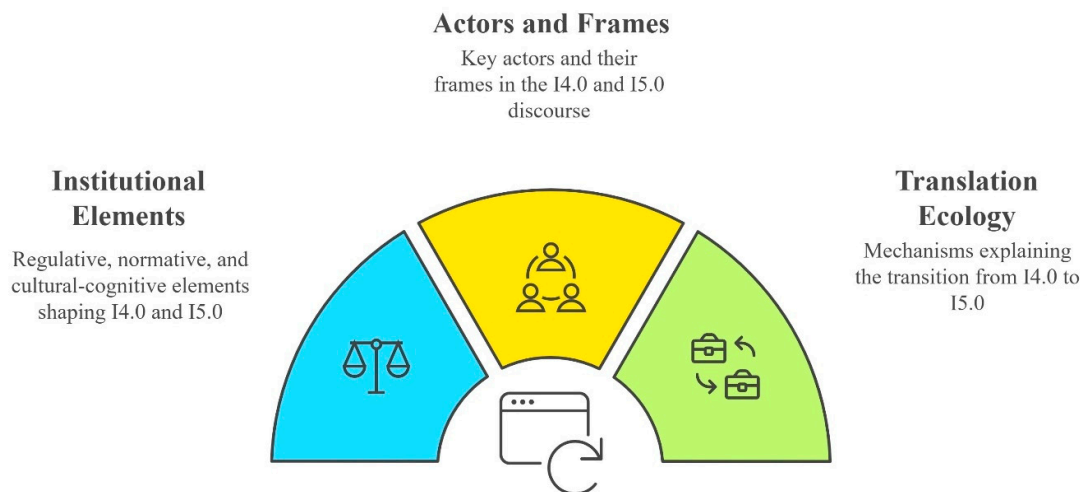


Figure 3. Key components of the integrated institutional model.

More specifically, regarding research on I4.0 and I5.0, Table 2 provides a reference summary for investigations considering institutional elements in the adoption of practices from the new industrial revolution. It is valuable not only for research focusing on isomorphic mechanisms (coercive, normative, and mimetic) collectively but also for studies investigating specific pillars. For instance, there is still limited research focusing on the normative pillar, i.e., addressing issues related to education and training (e.g., Antonazzo et al., 2023) and particularly regarding professions from an institutional perspective. Figure 1 and Table 3 together provide a framework for investigating actors (governments, companies, universities, and unions) and framings (industrial, market, civic, green, and network) in I4.0 and I5.0. Our macro-level model can be used to examine specific countries or industries or for cross-comparisons.

From a practical perspective, the model provides actionable insights for policymakers, organizations, and educators. Policymakers can design strategies that foster stakeholder collaboration, ensuring that the transition to I5.0 aligns with societal and environmental priorities. Organizations can use the model to evaluate their alignment with institutional expectations, adopting practices that integrate technological innovation with human-centric and sustainable values. Moreover, it raises awareness among companies that adopting I4.0/I5.0 is not solely a technical endeavor but also a response to institutional pressures and non-rational dynamics related to gaining legitimacy. Educational organizations can leverage the findings to develop curricula addressing the interdisciplinary skills required for I5.0. Furthermore, it encourages reflection on how the research they conduct and the professionals they train actively shape the institutionalization and definition of the paradigms of the new industrial revolution. The model thus offers a diverse and complementary framework to the mainstream discussion, contributing to a broader understanding of I4.0, I5.0, and the transition between them.

The institutional model proposed in this study is not limited to understanding the transition from I4.0 to I5.0. It can also be applied to analyze the institutionalization of management concepts and practices, such as Total Quality Management (TQM), Lean Manufacturing, and agile methodologies. These approaches have evolved and have been shaped by institutional pressures and stakeholder interactions. For example, TQM became widely adopted through coercive mechanisms such as certification requirements (e.g., ISO 9001), while Lean Manufacturing gained legitimacy through mimetic processes as organizations sought to copy Toyota's success. Initially developed for software engineering, agile methodologies have been adapted in other industries through translation processes, where actors reinterpret their principles to suit new organizational contexts. By incorporating institutional elements, framings, and translation ecology, our model can provide a framework for understanding how these management paradigms emerge, diffuse, and transform over time.

5. Conclusions

This study explored the transition from Industry 4.0 to Industry 5.0 through an integrative institutional model, addressing both the nature of these phenomena and the processes driving their development. It employed a qualitative, conceptual approach based on a critical literature review, integrating recent advances in Institutional Theory and empirical insights on I4.0 and I5.0. We challenged the dominant techno-centric perspective in the literature by framing I4.0 and I5.0 as discursive and institutional phenomena rather than purely technological shifts. Our findings suggest that I4.0, focusing on productivity and competitiveness, laid the groundwork for I5.0, which has integrated sustainability, human-centricity, and resilience as key elements. This transition has been shaped by institutional pressures, stakeholder interactions, and contextual dynamics, as highlighted by the appli-

cation of the concept of translation ecology, which explains how the transition from I4.0 to I5.0 is not linear but instead results from the iterative adaptation and reinterpretation of ideas and practices by different institutional actors across various settings.

The proposed model contributes to Institutional Theory by demonstrating the applicability of the conceptual framework that [Glynn and D'Aunno \(2023\)](#) proposed in a concrete context and by integrating insights from Scandinavian Institutionalism and Management Fashion. From a practical standpoint, the findings can provide actionable insights for policymakers, organizations, and educators. Policymakers can use the model to design strategies that foster collaboration and alignment with social and environmental priorities. Companies can benefit from understanding that I4.0 and I5.0 are not solely about technology, technical efficiency, or productivity but are institutional phenomena, where adopting these paradigms is essential to maintaining legitimacy with other stakeholders. Educational institutions can adapt their curricula to address the demands of the new I5.0 paradigm while reflecting on how their activities—research, teaching, and outreach—actively influence the construction and institutionalization of these paradigms.

While this study offers significant theoretical and practical insights, some limitations must be acknowledged. Focusing on macro-level institutional dynamics may overlook micro-level processes and the agency of individual actors. Balancing generalization with contextual specificity remains a challenge. Additionally, integrating various theoretical perspectives can lead to oversimplification or a loss of nuance, similar to what can happen with variations between industries and national contexts. The theoretical nature of the proposed model calls for empirical validation. Future research could address this gap by employing primary research methods such as interviews and surveys with stakeholders involved in implementing and developing I4.0 and I5.0. Studies could focus on specific industrial sectors, unpacking the actions of key actors involved. Comparative studies across countries could yield valuable insights by revealing the unique characteristics of the transition from I4.0 to I5.0, detailing stakeholder activities and the influence of each country's institutional conditions in this process. Particularly promising and underexplored is research on how universities have acted to shape both I4.0 and I5.0. Moreover, longitudinal studies can provide novel insights into institutional change, revealing how certain events or policies can facilitate or hinder the institutionalization of new industrial paradigms.

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