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Strategic Implementation of Industry 4.0 in Manufacturing Enterprises located in Emerging Economies: A Resource Partnership Perspective

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Abstract

Industry 4.0 is a concept developed in Germany to resolve the 'polylemma of production' and reestablish the competitive advantage of manufacturing firms in 'high-wage' economies by delivering mass customization through integrated manufacturing systems. Digital Transformation (D.T.) projects focused on 'Industry 4.0' implementation is capital intensive and require People, Process, Technology, and Data readiness to pursue those projects. Achievement of digital readiness does not pave the way for a complete and drastic transformation. Sudden upgradation of operations and implementation of drastic changes to attain 'industry 4.0' status has a high probability of becoming another case study like the robotics strategy that Roger Smith and G.M. adopted in the 1980s. The 'speedfactory' was established in Germany and the United States based on the 'industry 4.0' concept. However, after three years, the operations got discontinued, and the 'speedfactory' was shifted to a country that would fall under the category of an emerging economy. A key question is why would the speedfactory work in an emerging economy when it failed in Germany and the U.S.? This research article seeks to provide a theory as to why based on the 'Resource Based-View' theory and follows the methodology of interpretive consolidation of quantitative and qualitative research to analyze the reasoning behind implementing 'Industry 4.0' in emerging economies. Specifically, this article proposes the 'Resource Partnership Model' for strategic implementation of 'industry 4.0' to realize sustainable competitive advantage in manufacturing firms in emerging economies. In this context, Resource Partnership Model describes the utilization of socially complex resources and the unique historical position of a manufacturing firm by forming strategic partnerships and then proceed to implement 'industry 4.0'. This model also cautions that rapid adaptation of digital technologies (without strategic partnerships) by manufacturing firms in emerging economies would result in serious resource waste and performance pitfalls.

Keywords
Industry 4.0, Implementation, Emerging Economies, Strategic Partnerships, Resource Partnership Model.

1. Introduction
"Industry 4.0" is a German government program to advance the global competitiveness of Germany's manufacturing industry, and it was first announced at the Hannover fair in 2011 (Kagermann et al., 2013; Darth and Hortch, 2014). The motivation to initiate this program was to support the shift in the focus on the production of customized products by many firms in the German manufacturing industry (Brettel et al., 2014). Even though various definitions for this program are causing confusion and lack of transparency, this program is widely accepted as the 'fourth industrial revolution' (Darth and Hortch, 2014).

The first three industrial revolutions were associated with technological evolutions such as (1) steam-powered mechanical Manufacturing, (2) electrically powered mass manufacturing, and (3) electronics and information technology-powered automation of Manufacturing (Liao et al., 2017). The fourth industrial revolution is associated with the development of the internet, which brought the idea of the interconnected world to reality by enabling the transformation of inflexible and dedicated mass production lines to become flexible machines that could actively communicate with computer systems and engage in manufacturing activities simultaneously (Buer et al., 2018). Flexibility is one of the main drivers behind 'Industry 4.0' and has been achieved by introducing internet technologies into the manufacturing industry. Most of the technical aspects of these internet technologies are already available and

being used for other isolated applications. The novelty of 'Industry 4.0' is not in new technology but in the use of a combination of available technologies in a new way (Darth and Hortch, 2014).

In the German manufacturing industry, the combination of novel production strategies (such as agile manufacturing and mass customization) and novel internet communication technologies has enabled the transformation of manufacturing firms into integrated networks. (Brettel et al., 2014). This integrated network of firms, powered by the internet to track individual products throughout the process and supply chain, is capable of leveraging real-time access to relevant product phases and production process information to enable the realization of the concept of Mass Customization (MC). Even though flexibility enabled by internet technologies is one of the main drivers of 'Industry 4.0', the core motivation behind 'Industry 4.0' is to implement the concept of polylemma of production devised by Schuh et al. in 2007 to achieve a sustainable competitive advantage for manufacturing firms in high-wage countries. MC is capable of addressing the realization of economies of scale and scope at the same time, along with planning quality and optimization. (Schuh et al. 2007). Upon successful integration of the entire production and supply value chain under 'Industry 4.0', the labor work would change to more of a coordinator and problem solver role. However, labor work will still remain irreplaceable because of MC resulting in an exponentially increasing need for coordination (Brettel et al., 2014).

Recent research publication literature that focuses on 'industry 4.0' and emerging economies tend to emphasize digital transformation and rapid adaptation of technological advancements associated with 'industry 4.0' as the future of manufacturing firms. Currently, research is needed to theoretically explain the implications of implementing 'Industry 4.0' in emerging economies and to explore how 'industry 4.0' conceptualized for high-wage countries would work for emerging economies.

This research article is based on the "Resource-based view" Theory and presents two models of 'industry 4.0' implementation in emerging economies. The first model, which is widely observed in practice, is the formal strategic planning by a manufacturing firm to proceed with the implementation of 'industry 4.0' (analogous to Complex Physical Technology or Complex Information management system). The second model proposed by this research is the 'resource partnership framework' where manufacturing firms form strategic partnerships to achieve an integrated manufacturing system and then proceed with the implementation of 'industry 4.0'. The motivation for this research stems from the anecdotal example of a manufacturing firm that tried to establish an 'Industry 4.0' based 'speedfactory' in locations of high-wage countries and discontinued the operations after 2+ years and eventually, this 'speedfactory' got moved back to a country that could be classified as 'developing economies.'

1.1 Objectives

The first objective of this research article is to explain the exit of a 'speedfactory' from a 'high-wage' country using the formal strategic planning systems based on "Resource based-view" theory (Barney, 1991). The second and primary objective of this research article is to propose a "Resource Partnership Framework" based on Resource based-view theory to explain the significance of socially complex firm resources, the unique historical position of a firm, and strategic partnerships with partner firms for successfully implementing 'industry 4.0' in emerging economies.

2. Literature Review and Conceptual Model Discussions

In the past few years, the concept of Industry 4.0 emerged as one of the most studied concepts that gained popularity among academic scholars and industry practitioners. Research literature has subdivided industry 4.0 into three archetypes (Weyer et al., 2015) such as smart products, smart machines, and the augmented operator. Further, five technologies, such as the internet of things (IoT), big data analytics, cloud computing, additive Manufacturing (3D printing) and robotics, are associated with industry 4.0 in the research literature (Piccarozzi et al., 2018; Kamble et al., 2018). Other technologies like artificial intelligence, machine learning, and digital twin are emerging technologies related to industry 4.0 (Koh et al. 2019).

The Lean concept is one of the most prominent manufacturing paradigms of the 21st century (Buer et al., 2018). Industrial automation, coupled with lean and agile manufacturing practices, were delivering a competitive advantage for manufacturing firms. After the advent of the 'industry 4.0' concept in 2011, research studies investigated the influence of 'Industry 4.0' on lean Manufacturing because flexibility and productivity were the primary objectives of both concepts (Frank, 2014). 'Industry 4.0' was proclaimed as the next paradigm of the manufacturing industry. In 2016, a global brand implemented a state-of-the-art manufacturing facility based on 'industry 4.0', known as

'speedfactory .'Academic researchers and Industry practitioners closely observed the progress of production operations at this 'speedfactory .'The Oechsler speed factory located at Acworth, Georgia, was the first robotic speed factory in the U.S.A. that used completely interconnected and automated 3D printing machines to produce customized shoes (www.supplychaindrive.com). The hype and expectation from this speedfactory were huge because the success of this speedfactory would have been a proof of concept for 'Industry 4.0. However, the decision to discontinue operations and relocate the 'speedfactory' to emerging economies in Asia raises a lot of interesting research questions for academic researchers and industry practitioners.

One theoretical lens from which to view the implementation of Industry 4.0 in emerging economies is the Resource-Based View of competitive advantage (Barney, 1991) (popularly known as Resource-Based View Theory). Barney (1991) examined the link between firm resources and sustained competitive advantage. Four empirical indicators, such as value, rareness, imitability, and substitutability, were discussed, and imitability was further expanded into imperfectly imitable resources such as history-dependent, causal ambiguity, and social complexity. Formal strategic planning systems such as SWOT analysis are not rare and are highly imitable (Barney, 1991).

Formal Strategic Planning Model (Figure 1) derived from the resource-based view theory to explain the strategic planning and establishment of a 'speedfactory' in a 'high-wage' economy. It is theorized in the model that formal strategic planning process that recommended the implementation of speed factory in high-wage countries overlooked the requirement for socially complex resources and unique historical position. Complex physical technologies that comprise the 'industry 4.0' concept requires firm resources to support the implementation and operations and enable sustainable advantage. In the case of 'speedfactory' implementation, the historical decline of the U.S. workforce in manufacturing industries (Figure 2), which could be a reason for the lack of socially complex firm resources to support operations of 'speedfactory' in the United States. Sections 2.1, 2.2 and 2.3 explains the strategic planning model (Figure 1) in detail and address the first objective of this research article by explaining the exit of a 'speedfactory' from a 'high-wage' country.

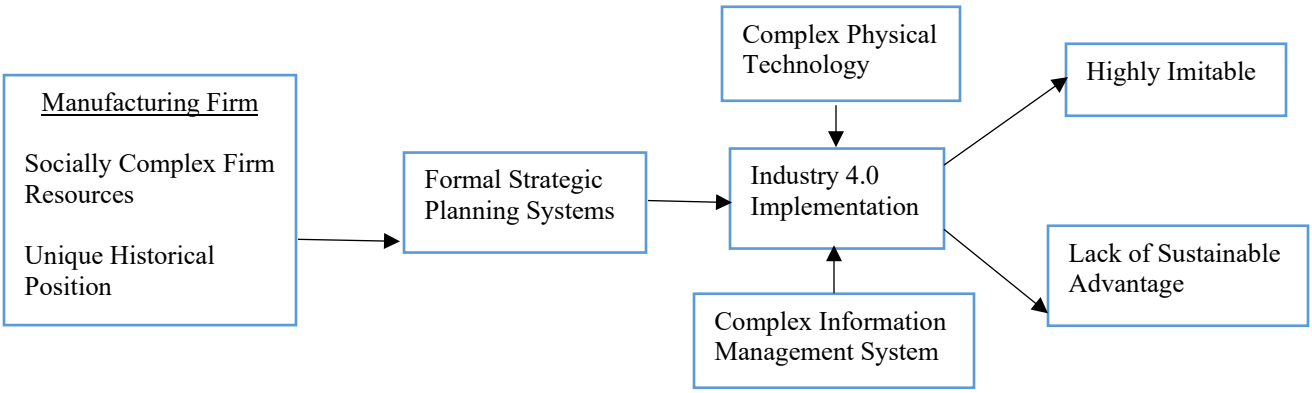

Figure 1. Formal Strategic Planning Model to Implement 'industry 4.0'

Figure 1 also illustrates the statement, "complex physical technology and complex information management systems are typically imitable resources and thereby do not serve as a contributing factor towards sustainable competitive advantage (Barney, 1991)".

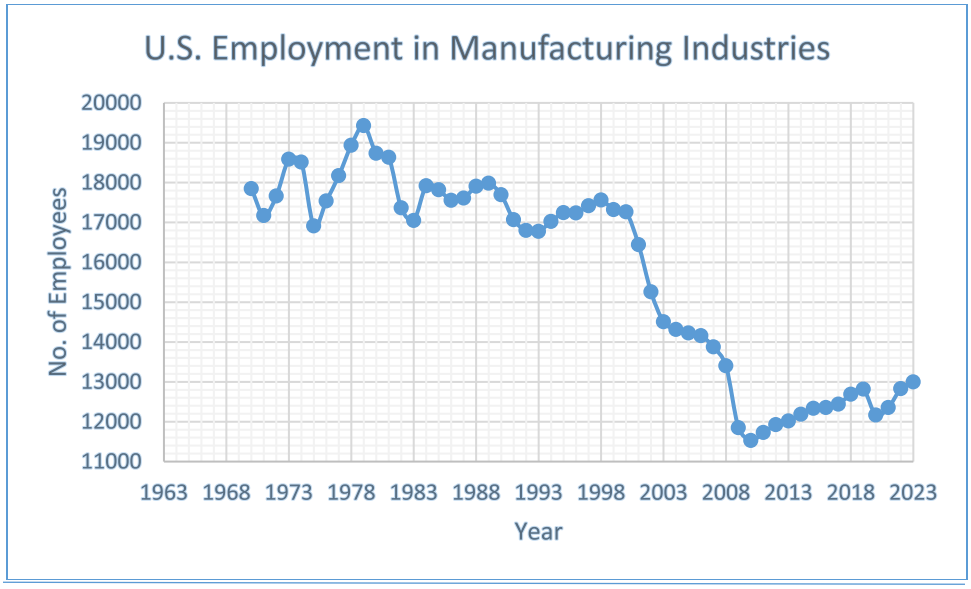

Figure 2: Historical U.S. Employment in Manufacturing Industries
Source: U.S. Bureau of Labor Statistics, http://www.bls.gov/iag/tgs/iag31-33.htm#workforce

2.1 Socially Complex Firm Resources

Socially complex firm resources, such as a firm's work culture, leader-member exchange, interpersonal relationships among the workforce, and the firm's reputation among suppliers and customers, could play a vital role while implementing 'industry 4.0' to form an integrated manufacturing network. Research literature that analyzes and evaluates such socially complex firm resources is presented here. The Kanban systems, the pull-based production systems introduced in the 1950s by Toyota, initiated the transformation of the supply chain into a demand chain (Ganji et al., 2018). Demand Chain Management (D.C.M.) is considered an evolved version of the supply chain; the trigger for the evolution is traced back to a 'focus on customer approach. D.C.M. is based on the 'pull strategy of products rather than the 'one-size-fits-all' approach followed by the 'push' strategy of mass production (Ganji et al., 2018). A manufacturing firm practicing a demand chain operations strategy would pursue any alteration to its production or supply chain processes only if its customer service objectives demand such alterations. Lucantoni et al. (2022) reinforce the fact that lean manufacturing is one of the most efficient industrial solutions globally and is still under practice. A Manufacturing firm's 'lean thinking' culture could be a valuable firm resource to capitalize on while implementing 'industry 4.0'.

Flexibility in several parts of the manufacturing system is one of the main challenges that need to be addressed to enable 'industry 4.0'. Chehami et al. (2022) examined the critical flexibility types required in a manufacturing setup to enable the implementation of 'industry 4.0'. Storage (both upstream and downstream), machine, and material handling are the top priority areas that need to be highly flexible. The coordination between these highly flexible systems demands a skilled workforce available at a low cost. High interpersonal relationship among the workforce ensures coordination and flexibility.

Manufacturing firms establish close cooperation with suppliers and build trust (social capital), which is a prerequisite for long-term buyer-supplier relationships and a fundamental platform for 'industry 4.0' (Schmidt et al., 2022). Empirical research has identified key enablers to implementing 'industry 4.0' in individual manufacturing firms in India. One of the key enablers with strong driving power was (S. Devi K et al., 2020). Further, Ali and Aboelmaged (2021) also state the importance of 'industry 4.0' implementation to alleviate the issue of supply-demand misalignment. A Manufacturing firm's reputation among suppliers base would play a critical role while the firm is

trying to form an integrated manufacturing network. Onboarding existing customers and existing supplier base to proceed with the implementation of 'industry 4.0' would largely be influenced by socially complex firm resources.

2.2 Unique Historical Position

Another variable associated with the manufacturing firm is the manufacturing firms' unique historical position and imperfectly imitable resources influence the effort of implementing 'industry 4.0'. A review of such firm resources from the research literature is presented here. The aspiring economies (countries) that have mastered the art of achieving both productivity and quality have attracted the relocation of production facilities from 'high-wage' countries. Challenges posed by the advent of the 'industry 4.0' manufacturing system is motivating the emerging economies to maintain their competitive position in the global manufacturing arena. A pressing need for Digital Transformation (D.T.) efforts by manufacturing firms in emerging economies is recommended by Gigova et al. (2019). Emerging and underdeveloped economies have predominantly been focusing on catering to the low-cost market segments (Chatterjee et al., 2021). The scarcity of domestically produced capital equipment and lack of institutions supporting technological development efforts have caused a dependency on 'high-wage' countries to acquire advanced technologies. Chatterjee et al., 2021 propose a strategic management perspective to form partnerships with firms in emerging economies to learn the knowledge of 'industry 4.0'. Such an integrated 'industry 4.0' manufacturing system formed by the trade partnership between 'high-wage' countries and emerging economies would be influenced by the unique historical position of the partnering firms.

S.M.E.s approach the implementation of 'industry 4.0' differently by using their expertise in existing traditional methods like lean management because of cost consciousness (Nayernia et al., 2022), and Lean Manufacturing decreases non-value-added activities in order to reduce operating costs. Manufacturing firms that are experts in lean management would tread carefully down the path of implementing 'industry 4.0' (Sanders et al., 2016). Manufacturing firms in emerging economies (countries) are engaged in an 'industry 4.0' readiness assessment of critical factors such as people, processes, technology, and data capabilities (Lakmali et al., 2020). Equipped with these readiness assessments, emerging economies are focusing on efforts to increase the readiness score by investing resources and acquiring a knowledge base to enhance the critical factors driving the implementation of 'industry 4.0'.

The advent of 'industry 4.0' has driven manufacturing firms in 'high-wage' countries to focus on flexibility and Manufacturing efficiency. Some firms (example, Boeing or Wartsila) have started implementing "supply chain data integration" as their trajectory towards 'industry 4.0' (Culot et al., 2019). Figure 3 shows the model representation of the Resource partnership theory proposed by this research. Highly sophisticated manufacturing firms located in 'high-wage' countries are involved in process improvement projects aimed at exploiting the sensed data to assist decision-making in their material handling and material management areas (Corallo et al., 2020). Telukdarie et al. (2018) propose an information processing architecture for the global operations of multinational companies. This information processing proposal inter-site challenges via vertical, horizontal, and total business integration of business functions, optimization initiatives, and contemporary opportunities (emerging technologies).

The technology of IoT associated with 'industry 4.0' is concurrently being utilized in designing sophisticated systems in the field of healthcare, surveillance, facilities management, and many more (El-Gendy, 2020). Since the five major technologies associated with 'industry 4.0' are also being utilized in industries other than Manufacturing, the advancements and modifications to these technologies would depend on the specific applications associated with particular industries. Singh et al. (2021) report the improvements in S.C.M. capabilities in terms of quality, cost, and flexibility achieved by the implementation of IoT and A.I. technologies. (Mantravadi et al., 2018) propose that S.C.M. visibility at smart factories enhances the supply chain performance by providing 'real time' information sharing across the entire value chain. The unique historical path followed by a firm and the valuable and rare resources acquired along that path can be utilized in implementing value-creating strategies. Thus, a firm's unique historical position would influence the implementation of 'industry 4.0'.

2.3 Formal Strategic Planning for Industry 4.0 implementation

The formal strategic planning model (Figure 1) depicts socially complex firm resources and unique historical position as the primary inputs for initiating the strategic decision making to proceed with the implementation of 'industry 4.0' which could be a combination of complex physical systems and complex information management systems. Such an attempt to transform manufacturing operations would be highly imitable by competitors and would lack long-term sustainable advantage (Barney, 1991). In the case of 'speedfactory' the operations lasted only for a short period of

three years. There was no evidence of imitation by competitors and the duration of operations were not long enough to comment on sustainability. But, the suspension of the 'speedfactory' and eventually shifting the operations to emerging economies illustrates the need for additional theoretical explanation for this attempt to implement 'industry 4.0' in emerging economies.

Now, the research question "why would the 'speedfactory' work in an emerging economy when it failed in 'high-wage' countries?" comes in to play. Answering this research question is the second and primary objective of this research article. The section 3 of this article describes the methodology utilized in this research. Further, section 4 lists the research propositions based on the findings in section 3. In section 5, the 'Resource partnership model' is theorized and proposed to answer this research question to accomplish the primary objection of this research article.

3. Methodology

The methodology of 'Interpretive Consolidation of Quantitative and Qualitative Research' is applied to gain support for the "Resource Partnership Model" by review and consolidation of research findings from peer reviewed and published research. Haneef (2011) describes this methodology and its core idea of interpretive research consolidation. As a first step, a search has been done on EBSCO, with the query "industry 4.0 AND implementation" that yielded 707 results. A further refined search query to look for research articles yielded 482 results. The 93 research articles resulted from the refined query "industry 4.0 AND implementation AND Title field". These 93 articles have been thoroughly reviewed, and 43 articles with significant findings related to emerging economies and related to 'industry 4.0' implementation were referenced in this research. The method of interpretive research consolidation was significant to utilize the research findings in the available and relevant literature and leverage those results in this theory-building effort.

4.0 Research Propositions

The research findings and insights from the 43 articles that deal with 'industry 4.0' implementation in emerging economies is consolidated under three sections, as follows. In each of the three sections, research propositions are developed based on consolidated research findings. Later, these research propositions are used to propose the "Resource Partnership Model" in section 5.

4.1 Industry 4.0 Implementation is Not Rapid Adaptation of Technologies

Digital Transformation gained hype and became a 'global buzzword' a few years ago, predominantly because of the marketing efforts of technology vendors. With the fear of missing out and the urgency to gain the virtual competitive advantage promised by some of the technology vendors, many manufacturing firms rushed to start the digital transformation. Research findings show some classic examples of such efforts that ended up as total disasters. Firstly, Dikhanbayeva et al. (2021) conducted an empirical study in an emerging economy (Kazakhstan). One of their significant observations is that most firms in Kazakhstan made capital investments for technology upgradation without clear strategic objectives for such projects. Most of the firms were halting projects and scraping capital projects leading to serious resource wastage and performance pitfalls. Secondly, Hoyer et al. (2020) point out the external pressure on manufacturing firms to adapt and implement 'industry 4.0'. Manufacturing automation enabled by advanced robots has been in practice for decades. For example, the concept of a 'lights-out' factory completely occupied by automated robots that can produce continuously for weeks existed decades ago (Null and Caulfieldt, 2003). The 'digital buzz' pushed the firms into sudden external peer pressure to become digital. Thirdly, Competitive advantage over rival firms was the main objective for many firms in emerging economies to make huge investments in equipment, machinery, and personnel and implement 'industry 4.0' (Sari, 2022). Finally, another perception of manufacturing firms in emerging economies is that the huge external risk of 'digital disruption' is expected to occur due to the implementation of 'industry 4.0' by competing firms (Senova and Sebescakova, 2020). These research findings clearly indicate that most firms in emerging economies are rushing to achieve digital transformation at all costs. It is essential to point out

that 'industry 4.0' is not all about 'digital disruption'; rather, it is the formation of an integrated manufacturing system by leveraging digital transformation to achieve sustainable competitive advantage.
Based on this research, the following proposition is put forth:

Proposition 1: Industry 4.0 Implementation is Not Rapid Adaptation of Technologies

4.2: Industry 4.0 Implementation Leveraging Unique Historical Position of Partners

Manufacturing firms were competing to be part of the fourth industrial revolution. Right from S.M.E. to big corporations, every firm was motivated to proclaim that they were on par with the latest advancements in technology. The adaptation of 'industry 4.0' would bring sustainable competitive advantage only to those firms that possess unique historical positions and socially complex resources. Research literature identified the difference in the level of maturity of 'industry 4.0' technologies among various firms in Italy (Zheng et al., 2021). The need for organizational alteration was mentioned as a critical challenge for the rapid implementation of 'industry 4.0'. Gonzalez et al. (2021) assessed the degree of implementation of 'industry 4.0' in southern Spain and awarded the score of "medium" after their assessment. Their assessment also identified barriers such as the need for capital investment, training and hiring workforce, and hiring technology vendors. Silva et al. (2020) aptly point out the need for international partnerships and the involvement of multiple stakeholders in order to adapt to the latest world production model ('industry 4.0'). These research observations indicate that each manufacturing firm is unique, and even though similar technology products are readily available in the market, the degree to which a manufacturing firm can adopt any digital transformation depends on the firm's unique historical position.
Based on this research, the following proposition is put forth:

Proposition 2: Industry 4.0 Implementation is more successful when it leverages the unique historical Position of Partners.

4.3 Industry 4.0 Implementation Facilitated by Strategic Partnerships

Implementation of 'industry 4.0' technologies and projects were making significant progress in Germany. Optimistic firms were trying to get the 'first-mover' advantage and executing transformation to 'industry 4.0'. Research scholars focused on identifying and understanding the key factors that were pivotal to this manufacturing transformation. Firstly, Veile et al (2019) consolidated the lessons learned from 'industry 4.0' implementation in the German manufacturing industry. One of their key findings is that the integration of 'industry 4.0' solutions into the existing processes by expansion or modernization of existing manufacturing infrastructure was predominantly practiced. Secondly, Neumann et al (2021) present a systematic assessment of 'industry 4.0' implementation on workforce and system performance. An emphasis on the need to consider the workforce as a key stakeholder in the implementation of 'industry 4.0' is noteworthy. Finally, Cagnetti et al. (2021) conducted a systematic review of lean production and 'industry 4.0' and found that manufacturing firms have applied a combination of lean production and 'industry 4.0' as managerial strategies rather than mere technological implementations. The crucial factors identified by the research literature are preserving the existing processes, and practices (unique historical position), recognition of the workforce as an important stakeholder (socially complex resources), and implementation decisions and executions drove by managerial strategies.

The design of tangible firm resources such as equipment and robotics and the directions to intangible resources that shape the operation management processes and procedures to enable the flow of goods and information through the entire manufacturing and supply chain network should be governed by the overall business strategy (Olsen and Tomlin, 2019). The design and implementation of 'Industry 4.0' technologies should also be governed by the overall business strategy of a manufacturing firm. Frank et al. (2019) studied the implementation patterns of 'industry 4.0' in manufacturing firms. Their findings categorized the technologies such as IoT, Big data, cloud computing, etc., as 'base technologies' that are prerequisites. The next category was establishing a digital platform for information sharing with partner companies. This clearly indicates that strategic partnerships facilitate the implementation of 'industry 4.0' and enables the establishment of an integrated manufacturing network.
Based on this research, the following proposition is put forth:

Proposition 3: Industry 4.0 implementation is facilitated by strategic partnerships

5. Resource Partnership Model

The 'Resource Partnership Model' (Figure 3) is proposed and defined as:
"Resource Partnership Model is defined as the utilization of socially complex resources and unique historical position of any firm by forming strategic partnerships with other firm(s) that possess socially complex resource and unique historical positions and then proceed to implement Complex physical technology and/or Complex information management system to realize sustainable competitive advantage."

Physical tools and information systems are typically imitable (Barney, 1991). The unique combination of socially complex resources and the unique historical position of the firms under strategic partnerships makes the implementation of the physical systems and information management systems (industry 4.0) a unique and imperfectly imitable combination. Sustainable competitive advantage can be achieved by forming such imperfectly imitable strategic partnerships.

The shifting of 'speedfactory' operations to pre-existing supplier base and contract manufacturers location provide strong evidence for strategic partnership between the global brand (firm1) and their suppliers (firm2). Inline to the resource partnership model, the implementation of 'industry 4.0' via the 'speedfactory' in an emerging economy country is imperfectly imitable. Thus, it ensures sustainable competitive advantage to the global brand. More Global brands and highly sophisticated manufacturing firms who already have a firm supplier base and contract manufacturing base in emerging economy countries could follow suite and establish strategic partnerships with them to implement 'industry 4.0' and ensure exploitation of socially complex resource and unique historical position of all partnering firms and also ensure sustainable competitive advantage.

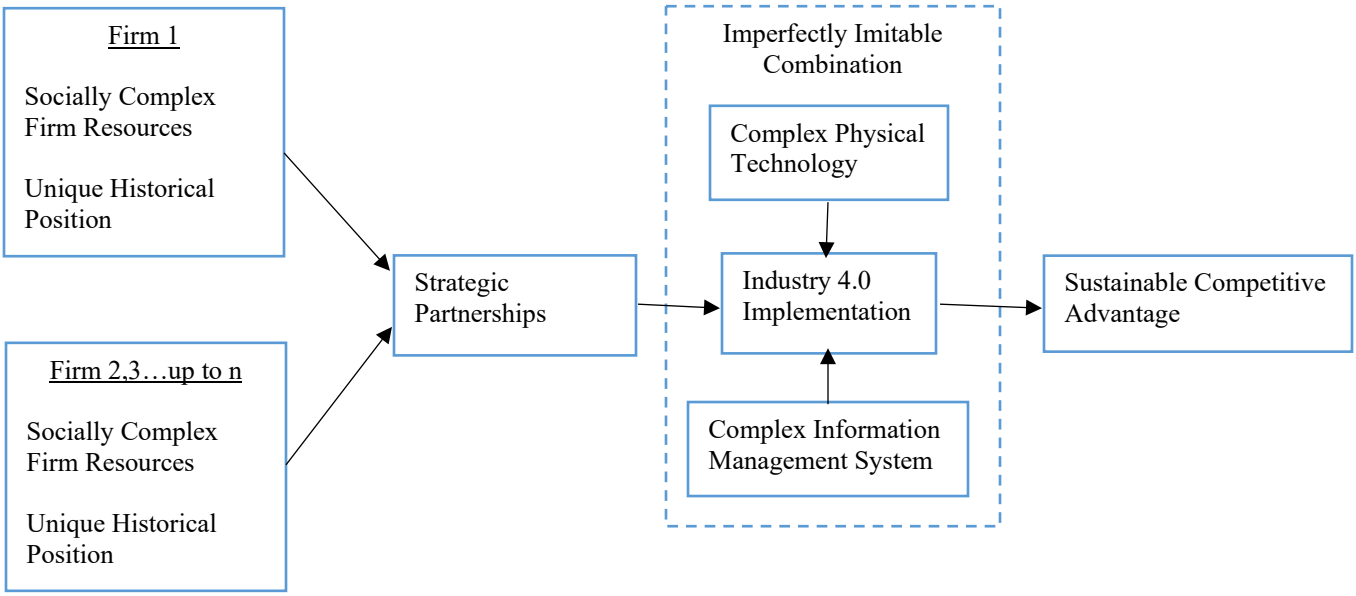

Figure 3: Resource Partnership Model

6. Results and Discussion

This research identified certain critical findings from the literature review and from the interpretive consolidation of research literature related to the implementation of 'industry 4.0' in manufacturing firms in emerging economies. Industry 4.0 was proposed as a digital transformation to form integrated manufacturing networks in 'high-wage' countries for "mass customization ."The implementation and operation of 'speedfactory' in a 'high-wage' economy were discontinued after 2+ years due to formal strategic planning without considering socially complex firm resources, unique historical position, and strategic partnerships. The way 'industry 4.0' is perceived by emerging countries as a 'rapid adaptation of technologies' under external pressure is raising concerns. Some of the research literature rightly identified the cons of perceiving 'industry 4.0' as a rapid adaptation of technologies without any "pull" from the overall

business strategy. Research findings from manufacturing firms located in emerging economies engaging in the implementation of technologies associated with 'industry 4.0' without the vision of attaining an integrated manufacturing network are mere waste of firm resources. Utilization of valuable firm resources and substantial capital investments in technology upgradation without a transparent strategic partnership with partner firms would only lead to uncertain benefits to the firm. The Resource partnership framework proposed by this research article would serve as a foundational guideline for manufacturing firms towards executing their 'industry 4.0' implementation goals.

7. Conclusion

Industry 4.0 was initially conceptualized in Germany to realize a successful transformation of the manufacturing industry that contributes 25% of the G.D.P. and employs over 7 million people (Brettel et al., 2014). The relocation of production facilities to emerging economies was perceived as a threat to established manufacturing companies in Germany. The Cluster of Excellence at RWTH University was formed to resolve the 'Polylemma of Production' by exploring the areas of individualization, virtualization, hybridization, and self-optimization (Brettel et al., 2014). This effort resulted in the formulation of the 'Industry 4.0' concept as a tailor-made solution for 'high-wage' countries to transform their manufacturing industry and reestablish their strongholds. Eventually, the concept of 'industry 4.0' attained the fame to be known as "the Fourth Industrial Revolution ."This concept tailored for 'high-wage' countries was being proposed for the adaption of manufacturing firms in emerging economies. Research literature explored the link between 'industry 4.0' and various manufacturing practices like Lean Manufacturing, TQM, etc., Rapid adaptation of technologies, and digital transformation was proposed for implementation of 'industry 4.0'. So, this article followed the methodology of interpretive consolidation of qualitative and quantitative research and presented what 'industry 4.0' is NOT. Further, this article proposed the Resource partnership framework and illustrated the need to leverage Socially complex firm resources and identify strategic partners with unique historical positions to establish a relationship to form an integrated manufacturing network and then start implementing 'industry 4.0' and technologies associated with 'industry 4.0' as a "pull" reaction to address the overall business strategy requirement. This theory development effort would streamline the proper implementation of 'industry 4.0' as it was originally conceptualized a decade ago, rather than vaguely indulging in rapid adaptation of technologies and engaging in substantial capital investments with unclear financial benefits.

8. Future Research and Limitations

The framework proposed by this article is based on the interpretive consolidation of research findings available in the research literature. However, a quantitative (empirical) verification of this theory would be the next step for future research. Currently, many manufacturing firms globally are engaged in the implementation of 'industry 4.0'. Identifying the right sample firms that engage in strategic partnership and proceed to implement 'industry 4.0' driven by their overall business strategy would be ideal candidates for quantitative verification of this theory. The Limitation of this article is the selection of applicability of this theory to manufacturing firms in emerging economies. Collection of data using interpretive consolidation methodology could also be a limitation. However, subject to verification by quantitative research in future, this limitation could be overlooked.

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