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Evaluation Of Business Model Innovation Towards Industry 4.0 Via Cross-Industry

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Abstract

Innovation is one of the key drivers of growth, development, and profitability, which increases competitive advantages and has recently been moving towards industry 4.0 technologically. This motivates companies to update their business models (BM) towards industry 4.0. Moreover, there is a technique with the primary characteristics for achieving this motivation called "cross-industry innovation". Cross-industry innovation is a new method of innovation that concerns the creative translation and imitation of existing solutions from other industries for responding to the needs of the current market, sectors, areas, or domains. The challenge is to find out how far managers can rely on that to innovate their BM towards Industry 4.0. The aim of this study was to investigate the application of cross-industry innovation for designing industry 4.0 BM and explore the extent to which companies can rely on it as it has not been used for this purpose previously. This study utilized a database analysis to compare cross-industry innovation practices with industry 4.0 BM's characteristics in terms of value proposition, value creation, and value capture levels. In addition, some interviews were conducted with companies that had previously implemented cross-industry innovation to validate and generalize the results. The results indicated that cross-industry innovation practices can better fulfil flexible and dynamic networks, connected information flows, high efficiency, high scalability, and high availability in terms of value creation as well as variabilization of prices and costs in terms of value capture. Therefore, it demonstrated that cross-industry innovation was a more dependable and applicable strategy for designing the BM of Industry 4.0 than current practices.

Keywords

Business Model Innovation; Industry 4.0; Cross-Industry Innovation; Value Creation; Value Capture

1. Introduction

Companies are moving towards providing customers with more detailed and tailored value offerings due to the competitive pressure of mature markets [1]–[3]. They are also constantly renewing their business models (BM) for entering and competing in new markets [4], [5]. For these purposes, established companies try to introduce value innovations and create new business models to change the competitive game in their favor [6]. From a technological point of view, business models are transferring to the fourth industrial revolution. This new revolution is not well understood by companies because it is novel and there have not been many reliable signs or results of it. Besides, this transformation is time-consuming. In this case, finding a way that could help the managers innovate their BMs while staying competitive and transferring to Industry 4.0 is necessary. [7]

While the literature on Business Model Innovation (BMI) has grown over the years, evaluations of BMI procedures and best practices, as well as BM-related discussions of Industry 4.0, are scarce. The literature examines the characteristics of Industry 4.0 BMs, assesses how firms approach BMI in the context of Industry 4.0, finds best practices, and compares them to Industry 4.0 BM characteristics (or "requirements"

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in reverse). It demonstrated how a systematic BMI process may supplement existing processes for product or service development, as well as how a specialized BMI process might improve innovation performance during Industry 4.0 and beyond. However, it is not possible to provide a success factor-based approach for investigating BMI activities and processes in a large sample of companies that could yield fundamental results and cover all the differences between companies. Furthermore, it is not possible to cover the effect of these differences because of the specific behavior of companies. Moreover, by investigating the papers in the Business Information System, some other challenges can be found, such as a lack of knowledge and a lack of employee readiness in companies for innovating in the BMs towards Industry 4.0. [8] For this purpose, this research seeks a new methodology in BMI that could be applied to different companies and industries for innovating in BMs towards Industry 4.0. This methodology should be tailored to each company while meeting the characteristics of Industry 4.0 and related goals.

Searching the sources and reviewing related papers on BMI and innovation leads to the discovery of a new innovation methodology known as "cross-industry innovation." This methodology, basically works by taking inspiration from other industries that are facing similar problems and trying to adapt and implement it in our own industry. It has been structured and developed in 2015 by Ramon Vullings and Marc Heleven [9]. This methodology has never been applied to design the BM towards industry 4.0 before, however, it shows some promise of applicability at the first sight. It integrates different sources of inspiration, such as products, services, BMs, etc., and adapts them to the company's needs, to show some early results of that innovation in another company. For investigating the usage of cross-industry innovation for designing the BM toward industry 4.0, a comparison of its practices with existing best practices of the BMI was implemented, and the practices were mirrored with industry 4.0 characteristics. For this purpose, nine interviews were conducted with companies and the founders of cross-industry innovation. These companies used cross-industry innovation to steer their BMs toward new technologies. Finally, an interview with the founders was devised to validate and generalize the findings.

These considerations lead to the following question being formulated:

- How far can we rely on cross-industry innovation for designing the BM of Industry 4.0 and replace it with traditional practices?

It is important to identify the aims of the study, which reflect the logical processes as follows:

- Monitoring the usage of cross-industry innovation for the BMI of Industry 4.0
- Comparing cross-industry innovation with current practices for BMI of industry 4.0
- Identifying the constraints to improving the use of cross-industry innovation

The goal of the research is to introduce cross-industry innovation as an optimal and systematic way for designing the business model of industry 4.0 in companies and to cover a large number of companies in different industries for business transformation.

2. Literature review

2.1 Business Model Innovation

Foss & Saebi [10] defined BMI as "designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements". Therefore, BMI process is a change phenomenon which can lead to a business innovation process [11], [12]. BMI redefines the essence of the company value proposition, changing the nature of products and services and how they should be delivered to customers. This provides an opportunity to establish a long-term competitive advantage and differentiate from competitors. BMI investigates the various stages that businesses go through to. It also identifies the organizational capabilities and processes required to support innovation [13]–[15]. In the literature, several scholars began examining BMI led by new ventures, which, in their early phases of development, frequently experience change and innovation [15]. Besides, some others considered large corporations the focus of BMI since they needed to change and evolve their businesses [16].

2.2 Industry 4.0

The term "Industry 4.0" was first coined by the German government to promote manufacturing computerization and refers to the fourth industrial revolution (the digital revolution) [17]. Industry 4.0 thus refers to providing devices with sensors through which they are given the capability to communicate. In the last decade, the expression has included more spheres like transportation, healthcare, utilities, etc. It includes a series of smart connected objects and a network connectivity architecture that enables them to exchange information and become active participants [18]. This has the result of creating a network of things that can communicate with each other without the need for human help. The expanded capabilities of smart, connected products, as well as the data generated by them, have unleashed a new era of competitiveness, exposing businesses to new opportunities and threats [19]. Finally, combining these three extended capabilities enables autonomous product operations, self-coordination of the unit with other units and systems, autonomous product upgrades and personalization, and self-diagnosis and servicing. Leminen et al. [20] stated that the diffusion and growth of Industry 4.0 suggest possibilities for the redesign of the business model, which refers to value co-creation and redesigning value propositions in the field of Industry 4.0, as claimed by Mejtoft [21]. Industry 4.0 is shifting business models because of three main fundamental properties of digital technologies: the exact transmission of the signal, the infinite replication of the signal without degradation, and, once the investment in the network infrastructure has been made, the zero (or almost zero) marginal cost of this replication. These features are enabled by ubiquitous digital technology and improve the scalability of operations, facilitating the combination of new and old business processes [20]. In other words, it connects industries and communities to create opportunities. The numerous potentialities have been appreciated by the market, and the global Industry 4.0 market was valued at $170 billion in 2017 and is predicted to expand to $561 billion by 2025 [22].

2.3 Cross-industry Innovation

Nowadays, innovation is seen as one of the main driving forces for growth, development, and profitability. The problem is that most innovations are limited to the recombination of existing knowledge or technology that has been developed within the company, or at least within our own industry. According to various studies, most of the innovation sources are internal ones and partners within our own industry are among the most important sources of innovation. It is hard to generate major innovations as most products, services, and business models have largely been shaped by the mind-set of their respective industries and most industries are quite mature. Furthermore, the innovation between partners is considered a source of threat instead of opportunity. Drivers of innovation such as technology diffusion, shorter innovation cycles, worker mobility across industries, and global knowledge availability have simplified and expedited access to external innovation sources. Cross-industry is a new method of innovation that is about creative translation and imitation of existing solutions from other industries to meet the needs of the current market, sector, area, or domain. Such solutions can be technologies, patents, specific knowledge, capabilities, business processes, general principles, whole business models, or a combination of them [9]. Furthermore, using external knowledge in our own enterprise—cross-industry innovation—can be used as a tool for transferring our own technology to other industries for innovation. While the outside-in process leads to higher innovativeness, the inside-out process generates additional turnover with relatively little effort [9]. Businesses frequently search across industry boundaries and execute cross-industry innovation while striving for breakthrough innovations. Successful cross-industry innovation requires the integration of external partners with diverse perspectives, mind-sets, and educational backgrounds who are motivated to contribute to the development of novel ideas, concepts, techniques, and technologies [23].

3. Methodology

3.1 Research Design

Given the theory restrictions found after the literature review, we decided to investigate some specific case studies for the development of inductive theory (Figure 1). Case study building theory can be defined as an approach for research involving the development of theoretical buildings, suggestions, and/or midrange theories based on case empirical evidence with the help of one or many instances [24]. Simultaneously, case

studies can be described as strong, empirical descriptions, typically based on a range of information sources, of specific phenomena cases [25].

3.2 Data Collection

Data was gathered through 9 structured interviews conducted in accordance with previously distributed interview instructions with companies and founders of cross-industry innovation. The primary filter to case selection was to focus and deepening on those companies which innovate designing their business models towards new technologies by cross-industry innovation. It was decided to consider all of them as primary cases and ask their CEOs or related managers to participate in an interview via different communication paths (i.e., email, LinkedIn, and the company website) in order to extract and obtain the desired data from their companies. The interview guidelines were divided into three sections that covered the interviewees' grasp of Industry 4.0, their BMI approach and cross-industry innovation methodologies. Its structure is based on Zellner's model of business process components [26]. This paradigm separates a trigger (the event that initiates the process), activities and flow (a task (process) undertaken to achieve set goals and their sequence), organization (department, unit, or individual performing the activity), and resources (methods or tools supporting the activities).

3.3 Data Analysis

Our data analysis follows qualitative research methods [27]–[29]. We employ an inductive approach, evaluating and then interpreting the facts as Spiggle suggests [30]. According to this method, data analysis encompasses categorization, abstraction, comparison, dimensionalization, integration, iteration, and refutation. We began by mirroring the Industry 4.0 BM characteristics with cross-industry practices, and we put them together in a table to understand that which practices could meet more the requirements for designing a BM for industry 4.0. The process will be followed by comparison of the best practices of BMI to cross-industry innovation practices in the joint table (Table 1). In this table, the almost same practices were placed in front of each other to obtain better comparison. The final results were iterated and changed if needed with the cross-industry innovation founders.

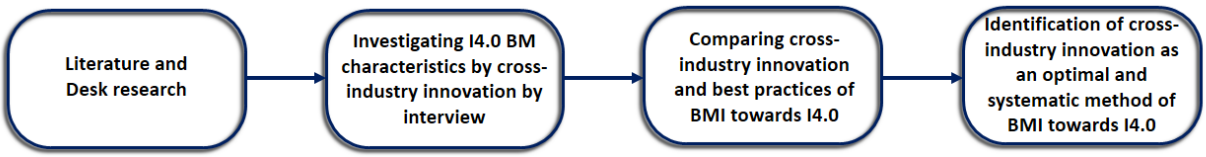

Figure 1- Research process (I4.0 is Industry 4.0)

4. Results and Discussion

In this section, we show our findings utilizing Zellner's business process components [26]. These also aided in organizing our data collection procedure. We began by describing the opportunities that initiate a BMI process, then defined its typical actions and tasks, remarked on organizational challenges, and discussed the resources (tools) used to support these activities.

4.1 Cross-industry innovation process

The main cross-industry innovation processes are cross-industry canvas, looking sideways by questioning and getting inspiration from another industry, and getting insights from desk research, interviews, and company visits.

From a value creation point of view, the innovation process can be controlled by using Cross-Industry Canvas. This connects information at different levels, which can improve efficiency and scalability.

The first company could innovate its BM by cross-industry canvas to reduce services to just the necessary ones, making efficient use of infrastructure, maximum use of assets, yield management, and no frills with

regard to other industries. Their source of innovation for these achievements was a systematic scan of markets, questioning their cost model and services with a price-elastic demand curve and high potential to increase customer integration. It results in making many successful and promising new business models.
It does not necessarily require inventing a new value for the design of VPs through cross-industry innovation. It is possible to find value in other industries by questioning. Take looking sideways with defined questions about our problem to aid in finding already implemented solutions. Finding various types and types of inspiration is critical due to the wide range of industries.
The second company, which made fleet management decisions regarding building tools, ensures that building tools in use through service contracts are in optimal condition. Their source of innovation was automotive fleet management, which focuses on long-term service contracts instead of selling cars.
The strong market research in this methodology results in focusing on customers at different levels and providing tailored services. Then, synchronization of the services is achieved by adapting the concepts of other industries to their target customers.
The third company could increase rail worker safety by cooperating with lead users to produce a dirt-resistant jacket. The new technology discovered through questioning and inspiration from another industry, as well as insights through desk research, interviews, and company visits, was the root of their creativity.
The fourth company invented the first Internet-compliant sewing machine that could directly download the sewing patterns to facilitate the machines. Their source of innovation was driven by customer requests on their website, which were gotten from desk research.
The cross-industry innovation process in these companies resulted in increasing the flexibility of the process, overcoming the experience gap, and reducing development time. Therefore, the main goals of our innovation process for BMI towards Industry 4.0 are completely achieved and perform better compared to other practices due to the nature of cross-industry innovation. Furthermore, all participants in our study believe that the cross-industry innovation process offers new value propositions and advancements in value-creating structures.

4.2 Cross-industry innovation at the organizational level

Significant disparities in the organizational anchoring of BMI processes were discovered. BMI is frequently sponsored by high management. In most organizations, the BMI project lead is either a technology manager with a background in research and innovation or a business manager, such as a member of the business unit management, product management, or business development departments. According to interviewees, governance is a success factor, however, we don’t have any special policy in cross-industry innovation at the organizational level of the company and it should be provided by other practices. The main cross-industry innovation method at the organizational level is using open sources of innovation from different industries and remixing your industry which provides a wide range of inspiration for innovation. The variability of industries and methodologies resulted in different values with different costs and prices. In this case, it is possible to observe the results of their pricing methodologies and try not to repeat their mistakes. Furthermore, the resulted pricing policy is better and more flexible than the original industry's policy.

The fourth company added sensors to the sewing machine's pressure foot, which measure and regulate speed, resulting in consistent stitches for beginners as well. Their source of innovation came from their cooperation with another company, which uses the same technology for producing optimal computer mouse devices.

The fifth company made it possible to plan sanitary installations with enormous cost savings of up to six digits. Their source of innovation was their collaboration with another company that uses the same technology for power plant planning.

The sixth company found a new method to connect glass fibers without using mechanical pressure by using adhesion technology. Their source of innovation was their collaboration with another company that works in the chemicals industry.

At this level, the cross-industry innovation strategy resulted in openness, pragmatism, and entrepreneurial thinking, which are the primary goals of BMI toward Industry 4.0. However, it was not possible to expand roles and duties at the organizational level, so other methods must fill the void.

4.3 Cross-industry innovation resources and toolkits

BMI necessitates the use of specialized resources and tools. Their development and deployment appear to be dispersed across firms today. The spectrum extends from having no specific BMI toolkit at all to having a sophisticated and IT-supported solution in place. Osterwalder's BM Canvas [31] is a popular tool for structuring BM ideas, and Gassmann's BM Patterns [32] is a tool for creative assistance. Most interviewees complain that these tools are too high-level, too restricting within the limitations they provide, and lack consistency across the process. Cross-industry innovation, on the other hand, has a large range of particular toolkits for VP and VCr, such as the transfer map, 21 methods, and so on. Experimenting with the outcomes and applying the lessons learnt is another approach of cross-industry innovation that is utilized by all firms to evaluate their innovation processes.

The first company used management toolkits for the efficient use of infrastructure, the maximum use of assets, and yield management. The toolkits aid in the production of value and the reduction of time in accordance with the company's aims. As a result, it expedites the launch of the product or service and assists it in reaching the target market.

The seventh company used a transfer map to use new technologies to become a successful automotive supplier and security process service provider. Their own military aircraft division was source of innovation based on internal experimentation and data.

Cross-industry innovation tools and resources support companies in optimizing their innovation processes and making new decisions. Moreover, they create a structure for the innovation process that guides companies during the process.

4.4 Cross-industry innovation practices for BMI towards Industry 4.0

Table 1 contrasts the properties of BMs for Industry 4.0 (rows) with cross-industry innovation practices (right columns) and BMI best practices (left columns) to summarize our findings and observations [33]. We identified essential BMI competencies that are relevant across most dimensions by highlighting significantly best practices for developing Industry 4.0 BMs (marked as "X" at the intersections in the table) and cross-industry innovation practices (marked as "✓" at the intersections in the table).

Table 1 illustrates that cross-industry innovation practices can support more characteristics on their own compared to other practices that are already applied separately in companies. As previously stated, all objectives were met, particularly the reduction of development time and product-service distinction in contrast to other techniques. However, we don’t have any special policy on cross-industry innovation at the organizational level of the company, and it should be provided by other practices. The results indicated that cross-industry innovation practices can better fulfill flexible and dynamic networks, connected information flows, high efficiency, high scalability, and high availability in terms of value creation, as well as variabilization of prices and costs in terms of value capture. At the final step, the results were iterated in an interview with cross-industry innovation founders to ensure their validation and generalization. They had seen more companies that used these methodologies for these purposes; therefore, they guaranteed the validation of these results with a larger number of companies.

It is understood, both theoretically and empirically, that cross-industry innovation methods can match the features of industry 4.0 at many levels of its BM, including value proposition, value creation, and value capture. Furthermore, cross-industry innovation techniques outperformed current BMI best practices in terms of meeting the aims of Industry 4.0 BM. They can be considered at several levels of the organization,

Table 1: Existing and cross-industry practices

	Industry 4.0 BM Characteristics														
BMI Best Practices	High product/service differentiation/ customization	End-customer focus, B2B2C	Comprehensive Service business	Synchronized product/service combinations/ VAS	Value chain integration, consolidated control	Flexible and dynamic VCr networks	Connected information flows	Close (End-) customer relations, B2B2C	Short time-to-market	High efficiency	High scalability	High availability, preventive maintenance	Value appropriation from data/digital structures	Variabilization of prices and costs	Cross-industry Practices
Agile, iterative, proactive and open BMI process	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓	✓	✓	✓ X	✓ X	BMI by Cross-industry Canvas
Inter-departmental and cross-entity collaboration Intra-industry knowledge transfer	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	Looking sideways by questioning and inspiration from another industry for finding the answer in them
Feedback loops with customers	✓ X	✓ X	✓ X	✓ X	✓	✓	✓ X	✓ X	✓ X	✓			✓ X		Getting insights from desk research, interviews and company visits
Open organization with dedicated BMI or I4.0 team with interdisciplinary staffing and partner	X	X	X	X	X	X	X	X	X	X	X	X	X		Not a specific organizational strategy at high levels of innovation
Entrepreneurial culture with freedom and responsibility	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓	✓ X	X	✓	✓	✓	✓ X	✓ X	Open source of innovation from different industries and remix your industry
Dedicated BMI toolkit (BM structuring + VP modelling framework)	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓	✓	✓	✓ X	✓	Special toolkits for VP and VCr like transfer map, 21 ways and etc.
Ecosystem analysis methodology tools and networking skills	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X	✓ X		✓	✓ X	✓	✓ X	✓	Experimenting the results and Adapting the lessons learned

✓= Identified cross-industry practices that are supportive or critical for this issue / X = Identified existing practices that are supportive or critical for this issue

such as process, organization, and resources and tools for attaining goals. However, it lacks a high-level organizational strategy for innovation and should be supplemented by other techniques.

The first drawback of the findings is that the information was gathered through a small number of interviews and one specific actor role. In the future, it would be beneficial to work on large-scale databases with a broader collection of informants. This allows for a more in-depth examination of the phenomenon. Another disadvantage is the lack of quantitative data, which necessitates assigning weights to features in order to make appropriate practice comparisons.

5. Conclusion

We can extract knowledge and make original additions to the existing literature even if it is based on particular case studies. These studies helped obtain a detailed picture of cross-industry innovation practices so that they could be used more efficiently. Furthermore, structuring and organizing these studies helps managers control their processes while using cross-industry practices. Moreover, these findings allow us to learn how cross-industry collaboration can help companies at various stages of their innovation process.

The current study has some consequences in practice. Our findings show that managers and entrepreneurs of established companies and start-ups can innovate their business models by pursuing an Industry 4.0 strategy through cross-industry innovation. By innovating their BM and orienting to Industry 4.0, they can disrupt the market and compete with the blue ocean approach.

Management practices can be accounted for as an example that was not mentioned in cross-industry innovation. They should dedicate a group for BMI and Industry 4.0 with interdisciplinary skills. Also, the managers should do sponsorship and create an open environment for the organization to do partnership and collaboration. Finally, it should be noted that a successful implementation of cross-industry innovation can be performed by selecting and integrating additional innovation strategies and working on them concurrently.

According to the findings, cross-industry innovation techniques can better fulfill flexible and dynamic networks, connected information flows, high efficiency, scalability, and availability in terms of value creation, as well as pricing and cost variability in terms of value capture. As a result, it revealed that cross-industry innovation was a more reliable and applicable technique than present practices for developing the BM of Industry 4.0.

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Biography

Mohammadhossein Chitsazzadeh earned a Master of Science in Management Engineering from the Polytechnic University of Milan, Italy, and the RWTH Aachen University, Germany. He was a project manager at FIR e. V. at RWTH Aachen. Currently, he is employed as a project manager and PhD candidate in the Advanced Systems Engineering group at the Heinz Nixdorf Institute.

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Roman Senderek studied Economics and is responsible for the newly founded Smart Work department at FIR at RWTH Aachen, which deals with issues related to the design of customized teaching and learning solutions as well as human-oriented design that promotes learning in the digitized world of work.

Volker Stich has been the head of the Institute for Industrial Management (FIR) at RWTH Aachen University since 1997. Prof. Dr.-Ing. Volker Stich has worked for 10 years for the St. Gobain-Automotive Group and led the management of European plant logistics.