"Industry 4.0 Synergy: Exploring the Institutional Awareness, Adoption and Impact of Academic Partnerships on Career Growth"

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Abstract

The advent of Industry 4.0 has ushered in a transformative era for businesses, characterized by advanced digital technologies, automation, and data-driven decision-making. In this dynamic landscape, the synergy between academic institutions and industries has become increasingly crucial. This study delves into the awareness, adoption and impact of academic partnerships in the context of Industry 4.0, focusing on their role in shaping the career growth.

Through a comprehensive survey and analysis, this research investigates the extent to which individuals within academia and industry are aware of the potential benefits of collaboration. It examines the ways in which academic partnerships contribute to the acquisition of skills and knowledge necessary for career advancement in Industry 4.0. Moreover, the study explores how these collaborations facilitate the transfer of cutting-edge industry insights to the academic realm, fostering a mutually beneficial exchange of expertise.

There were 82 questions framed under 09 constructs for collecting the data from the respondents of Principals, Deans and Heads of the departments of the Institutions. The collected data was analyzed by using simple frequency test to know the literal knowledge on Industry and institution adoption on Industry 4.0 and their mutual collaboration.

Key Words: Industry 4.0 and its awareness, emerging skill adoption, academic partnership, career growth and skills.

1. Introduction

Industry 4.0, also known as the Fourth Industrial Revolution, is a transformative era marked by the fusion of digital technologies with traditional industries. It encompasses the integration of smart devices, the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and automation. Industry 4.0 is reshaping manufacturing, logistics, and services, revolutionizing how businesses operate and compete. It enables real-time data analysis, predictive maintenance, and enhanced efficiency in production processes. Human-machine collaboration and autonomous systems are central to Industry 4.0, leading to increased productivity and cost savings. This paradigm shift has profound implications for the workforce, demanding new skill sets and fostering innovation. Industry 4.0 promises to create more agile, sustainable, and competitive industries in the digital age.

The first industrialized revolution was with the introduction of the steam engine and mechanized production process. The second industrialized revolution was characterized by electric power and mass-production process. The third industrialized revolution was with the introduction of automation and digital technology. The Fourth industrial revolution is characterized with the evolution of cyber physical system, intelligent computers based on big data and artificial intelligence.

2. Industry 4.0 and Academic Institutions

In an era marked by technological revolutions and digital advancements, Industry 4.0 has emerged as a defining force reshaping the global industrial landscape. This fourth industrial revolution, characterized by the integration of smart technologies, automation, and data-driven processes, has ushered in a new era of productivity, efficiency, and innovation. As industries evolve to adapt to this transformative paradigm, the role of educational institutions in preparing the workforce for Industry 4.0 is more critical than ever.

Industry 4.0 encompasses a wide array of technologies and trends, including the Internet of Things (IoT), artificial intelligence (AI), machine learning, big data analytics, Cyber physical systems and the automation of manufacturing processes with minimum human support systems. These innovations are not just enhancing the way products are made; they are fundamentally changing the way businesses operate and compete in the global marketplace.

In this context, the synergy between educational institutions, such as universities and colleges, and industry has become essential. Collaborations between academia and the industrial sector are crucial for equipping students with the skills and knowledge required to thrive in the digital age. These partnerships also play a pivotal role in ensuring that industries remain at the forefront of innovation by bridging the gap between theoretical knowledge and practical application.

This research endeavors to explore the awareness and impact of academic partnerships within the context of Industry 4.0. Specifically, it aims to examine how these collaborations contribute to career growth and provide valuable industry insights. By delving into the awareness levels among stakeholders and assessing the tangible benefits of

academic-industry synergy, this study seeks to uncover opportunities for further enhancing these partnerships to meet the demands of a rapidly evolving industrial landscape.

3. Literature Review

Manjet Kaur Mehar Singh, (2021), conducted the study about the role of education sector globally and selectively in some Asian countries such as Malaysia, Thailand, Myanmar, Singapore, etc. in improving in terms of being an Education 4.0 standard and equipping the global workforce citizens of the future to work in parallel with intelligent systems and robots. According to him, education and institutions were about creating sustainable innovations for future learning. This tagline emphasizes the role of education policymakers and educators to ensure successful learning for digital natives and neo digital natives as the education landscape and currently challenged by the great disruptors. Investing the Knowledge capital and harvesting the technological innovations, has empowered the industry. Despite, he has identified that Industry 4.0 has created a vacuum in the education landscape and the education prepares to handle and embrace Industry 4.0.

Based on the research done by **Adekunle Oke Et AL, (2020),** the study was conducted in South African geography, and identified that the business operations are undergoing drastic changes due to the disruptive effects of technology innovations; however, there is insufficient knowledge regarding the acceptability and consequences of the fourth industrial revolution, in the education sector. His study explores the readiness of the education sector for fourth industrial revolution. His findings showed that the education sector, is unprepared for the technology revolution, although there are indications for opportunities to harness the potential of the much-anticipated technology boom. Moreover, his study demonstrated clearly that there is a mutual symbiotic relationship between the education sector and technology innovations. His findings showed that the technology can leverage and can facilitate student's learning experience and transforms the workplace, although there is a need to assess the learning environment, to understand the facilitators and barriers to the fourth industrial revolution diffusion. His findings also indicated the opportunity for the education sector to harness the innovations associated with the technology through research and teaching to enhance learner's experience. His findings clearly indicated that there is a scope for significant improvement in education curricula, as well as investments.

The survey conducted by **Silvia.H.Bonilla, (2018)** was contradicting to the above 2 concepts. According to Silvia, the new evolution of the production and industrial process called Industry 4.0, and its related technologies such as the Internet of Things, big data analytics, and cyber–physical systems, among others, still have an unknown potential impact on sustainability and the environment. Silvia conducted the literature-based analysis to discuss the sustainability impact and challenges of Industry 4.0 from four different scenarios: deployment, operation and technologies, integration and compliance with the sustainable development goals, and long-run scenarios.

According **to World Economic Forum, (2016),** disruptive changes to business models will have a profound impact on the employment landscape. Many of the major drivers of transformation can affect the global industries and are expected to have a significant impact on jobs, ranging from significant job creation to job displacement, and from

heightened labour productivity to widening skills gaps. In many industries and countries, the most in-demand occupations or specialties did not exist 10 or even five years ago, and the pace of change is set to accelerate.

By one popular estimate, 65% of children entering primary school today will ultimately end up working in completely new job types that don't yet exist.1 In such a rapidly evolving employment landscape, the ability to anticipate and prepare for future skills requirements, job content and the aggregate effect on employment is increasingly critical for businesses, governments and individuals in order to fully seize the opportunities presented by these trends—and to mitigate undesirable outcomes. Past waves of technological advancement and demographic change have led to increased prosperity, productivity and job creation. According to WEF, these transitions were free of risk or difficulty. Anticipating and preparing for the current transition is therefore critical. As a core component of the World Economic Forum's Global Challenge Initiative on education, employment, skills and human capital, the Future of jobs project aims to bring specificity to the upcoming disruptions to the employment and skills landscape in industries and regions and to stimulate deeper thinking about how business and governments can manage this

change.

The industry analysis presented in this Report will form the basis of dialogue with industry leaders to address industry-specific talent challenges, while the country and regional analysis presented in this Report will be integrated into national and regional public-private collaborations to promote employment and skills.

4. Research Methodology

The data collection effort was aimed to assess the awareness, adoption and impact of Industry 4.0 technologies across the institutions under Engineering and allied streams, Arts and allied streams, Science and allied streams and finally medical and allied streams

The survey was conducted with a carefully selected sample size to gather insights into the current state of Industry 4.0 adoption in these sectors with the structured questionnaire. The questionnaire consists of two parts namely industry and institution biography and research-oriented questions. **The sample size for the present research was 36 across the various institutional categories. The institutional category comprises of Engineering and allied streams, Arts and allied streams, Science and allied streams and finally medical and allied streams.** A structured questionnaire was adopted as a tool for collecting the data. There were 82 questions framed under 09 constructs for collecting the data from the respondents of Principals, Deans and Heads of the departments of the Institutions. The collected data was analyzed by using simple frequency test to know the literal knowledge on Industry and institution adoption on industry 4.0 and their mutual collaboration.

5. Findings and Discussions

5.1. Institutional Attributes

The results and findings are derived from the collected data by using simple frequency analysis and the table is exhibited in **Appendix-1**. This analysis gives the first-hand information about the awareness, adoption and impact of Industry 4.0 technologies across the institutions.

The survey data is categorized into distinct academic fields, providing insights into the **distribution of respondents across various streams**. The largest category by a significant margin is from Engineering and Allied Streams, comprising 72% of the respondents. This suggests a substantial representation of individuals from engineering-related disciplines. Following this, "Science and Allied Streams" make up 14% of the respondents, indicating a notable presence from the scientific community. Arts and Allied Streams account for 8%, reflecting the participation of individuals from the arts and humanities domains. Lastly, "Medicine and Allied Streams" constitute 6% of the respondents, indicating a smaller yet significant presence from the medical field. This categorization offers valuable context for analyzing the survey data in a way that considers the specific perspectives and expertise of respondents from these distinct academic backgrounds.

The survey data reveals a significant differentiation in the backgrounds of the respondents based on the **accreditation status** of their educational institutions. A substantial majority, accounting for 81% of the total, come from accredited colleges or universities. This indicates a strong representation of individuals who have received education from recognized and accredited institutions, which often signifies a certain level of quality and adherence to academic standards. Conversely, 19% of the respondents have backgrounds from non-accredited colleges or universities. This smaller but still notable segment likely represents individuals who may have pursued education from institutions that may not have undergone the accreditation process or do not meet the criteria for accreditation. This diversity in educational backgrounds adds an interesting dimension to the survey data, potentially reflecting variations in the quality and nature of education received by respondents.

The survey data reveals a nearly **balanced distribution between urban and rural respondents**, with 53% hailing from urban areas and 47% from rural regions. This distribution showcases a diverse representation of both urban and rural perspectives within the surveyed population. Such a balance is particularly important when analyzing data as it considers the potential differences in experiences, attitudes, and challenges faced by individuals from these distinct geographic settings. It underscores the importance of conducting research and surveys that account for the diversity in living environments to ensure a comprehensive understanding of the study's findings.

The survey data illustrates a high **level of collaboration** between institutions and industries, with 86% indicating that they have engaged in collaborative efforts with various industrial sectors. This robust percentage suggests that the majority of respondents have experience working in conjunction with industries, which is often indicative of partnerships, projects, or initiatives aimed at mutual benefit. Conversely, 14% of respondents fall into the non-collaborative category, implying that they have not participated in collaborative endeavors with industries. These

individuals may work in settings or roles that do not typically involve interactions with industrial sectors or have not had the opportunity for such collaborations. Overall, the data underscores the widespread practice of collaboration between institutions and industries, reflecting the importance of cooperative efforts in various professional contexts.

The survey data provides valuable insights into the diverse purposes **of collaboration between institutions and various industries**. Several key purposes stand out:

Placements (72%): A significant majority of respondents indicate that one of the primary purposes of collaboration is for placements. This suggests that collaborations with external entities, likely including businesses and industries, play a crucial role in facilitating job placements for individuals, emphasizing the practical and employment-oriented aspects of collaboration.

Internship (69%): Internships are another prominent purpose of collaboration, with 69% of respondents identifying them as a key motivation for collaborating with industries. This highlights the significance of practical work experience and the role of collaborations in providing opportunities for hands-on learning and skill development.

Skill Development (76%): Skill development emerges as a highly emphasized purpose, with 76% of respondents citing it as a primary motivation for collaboration with industries. This underscores the importance of collaborative efforts in enhancing the skills and competencies of individuals, aligning with the ongoing need for upskilling and professional growth.

Research (50%): Research collaborations, while still significant, are mentioned by half of the respondents. This indicates that research-oriented collaborations are a prevalent but somewhat less dominant purpose compared to the other three mentioned above. Research collaborations likely involve joint studies, projects, or academic pursuits that contribute to knowledge generation and advancement.

The data provides an overview of the **extent of collaboration between institutions and industries**, categorizing it based on the number of industry partnerships:

A substantial portion of institutions, comprising **31%, engage in collaborations with fewer than five industries**. This suggests that a significant number of institutions have limited external industry partnerships, possibly due to resource constraints, scope, or a strategic focus on a select few industries. A noteworthy **22% of institutions have moderate levels of collaboration**, involving **partnerships with 5 to 10 industries**. This indicates a somewhat broader outreach compared to the first group, likely reflecting a deliberate effort to diversify their industrial connections. A **significant majority, making up 44%** of institutions, have established extensive collaborations, engaging with **more than 10 industries**. This category underscores a strong commitment to external partnerships, suggesting a broad network of industry connections, potentially across various sectors. A **small minority, comprising only 3%** of institutions, report **no collaboration** with industries. This is a relatively low percentage, indicating that the vast majority of institutions are actively involved in some form of collaboration with industrial partners. In summary, the data highlights a spectrum of collaboration levels between institutions and industries,

ranging from limited partnerships to extensive networks. These **collaborations play a pivotal role in bridging the gap between academia and industry, facilitating knowledge exchange, research, and practical applications.**

5.2. Industry 4.0 awareness attributes among institutional leaders

The **awareness of Industry 4.0 among the institutional leaders are** derived from the collected data by using simple frequency analysis and the table is exhibited in **Appendix-2**.

The survey data portrays a highly favorable scenario regarding the **awareness of Industry 4.0 among institutions**. The breakdown indicates that a substantial majority of institutions, precisely 92%, are actively aware of the concept and implications of Industry 4.0. This reflects a strong awareness and understanding of the ongoing industrial transformation within the academic landscape. In contrast, a mere 8% of institutions fall into the "not aware" category. While this segment is relatively small, it signifies that there are still some institutions that may need to enhance their understanding of Industry 4.0 and its relevance to academic and industrial endeavors. Overall, the data reflects a positive trend, with the vast majority of institutions being well-informed about Industry 4.0, which is **essential for aligning educational programs and research** with the evolving needs of the industrial sector.

The survey data indicates a strong level of awareness among respondents regarding one of the **key components of Industry 4.0, which is Artificial Intelligence (AI)**. Specifically, 86% of the respondents are aware of AI and its significance within the context of Industry 4.0. This reflects a robust understanding of the role that AI plays in shaping the future of industries and technology. Conversely, 14% of the respondents fall into the "unaware" category, signifying a smaller yet significant segment that may not possess a clear understanding of AI and its relevance in the Industry 4.0 landscape. These findings highlight the importance of continued education and awareness-building efforts to bridge the gap and ensure that a broader segment of the population is well-informed about the transformative power of AI in industry and technology.

The survey data indicates a noteworthy level of awareness among respondents regarding another crucial component of Industry 4.0, which is **Data Analytics**. Specifically, 78% of the respondents are aware of the significance of data analytics within the context of Industry 4.0. This high percentage demonstrates a solid understanding of the role that data analytics plays in the digital transformation of industries. Conversely, 22% of the respondents fall into the "unaware" category, signifying a smaller yet notable segment that may not have a clear understanding of data analytics and its importance in the Industry 4.0 landscape. These findings emphasize the need for ongoing education and awareness-building efforts to ensure that a broader population is well-informed about the pivotal role of data analytics in shaping the future of industries.

The survey data highlights a strong level of awareness among respondents regarding the component of Industry 4.0 known as the **Internet of Things (IoT).** Specifically, 81% of the respondents are aware of IoT and its significance within the context of Industry 4.0. This indicates a robust understanding of the role that IoT plays in revolutionizing how devices and systems interact and exchange data in various industries. Conversely, 19% of the respondents fall into the "unaware" category, signifying a smaller but noteworthy segment that may not possess a clear understanding

of IoT and its relevance in the Industry 4.0 landscape. These findings underscore the importance of ongoing education and awareness-building efforts to bridge the knowledge gap and ensure that a broader segment of the population is well-informed about the transformative potential of IoT in industrial applications.

The survey data reveals a significant level of awareness among respondents regarding the component of Industry 4.0 known as **Machine Learning**. Specifically, 67% of the respondents are aware of Machine Learning and its significance within the context of Industry 4.0. This reflects a substantial understanding of the role that Machine Learning plays in the automation, optimization, and data-driven decision-making processes within various industries. Conversely, 33% of the respondents fall into the "unaware" category, signifying a noteworthy segment that may not have a clear understanding of Machine Learning and its importance in the Industry 4.0 landscape. These findings underscore the need for continuous education and awareness-building efforts to bridge the knowledge gap and ensure that a broader segment of the population is well-informed about the transformative potential of Machine Learning in the industrial domain.

The survey data demonstrates an interesting balance in awareness among respondents regarding the component of Industry 4.0 known **as Digital Forensics**. Exactly half of the respondents, 50%, are aware of Digital Forensics and its relevance within the context of Industry 4.0, indicating that a significant portion possesses knowledge about the significance of digital forensics in the fourth industrial revolution. Conversely, the other 50% of the respondents are "unaware" of Digital Forensics within the Industry 4.0 landscape. This balanced distribution suggests that there is an even split in the level of understanding and recognition of Digital Forensics, possibly highlighting the need for educational efforts to raise awareness about its role in the context of Industry 4.0, particularly given the increasing importance of cybersecurity and data integrity in the digital age.

The survey data reflects a notable level of awareness among respondents regarding the component of Industry 4.0 known as **Automation and Robotics**. Specifically, 78% of the respondents are aware of Automation and Robotics and their significance within the context of Industry 4.0. This indicates a strong understanding of the role that automation and robotics play in streamlining processes, enhancing efficiency, and transforming various industries. Conversely, 22% of the respondents fall into the "unaware" category, signifying a smaller yet significant segment that may not have a clear understanding of Automation and Robotics and their relevance in the Industry 4.0 landscape. These findings underscore the importance of continuous education and awareness-building efforts to bridge the knowledge gap and ensure that a broader segment of the population is well-informed about the transformative potential of Automation and Robotics in industrial applications.

6. Summary and Conclusion

The survey presents a comprehensive snapshot of awareness levels among respondents regarding various components of Industry 4.0. It highlights a significant variation in awareness across these components, with some being more widely recognized than others.

The survey results shed light on the varying levels of understanding among respondents about key components of Industry 4.0. While some components, like IoT and AI, enjoy a high degree of recognition, others, such as Digital Forensics and Machine Learning, are less universally acknowledged.

These variations in awareness emphasize the need for continuous educational and awareness-building efforts to ensure that a broader section of the population is well-informed about the transformative potential of Industry 4.0 technologies. Addressing this awareness gap is crucial for fostering innovation, competitiveness, and inclusive growth in an era defined by technological advancements and digital transformation. Additionally, organizations, educational institutions, and policymakers can use these insights to tailor their initiatives for Industry 4.0 readiness and knowledge dissemination to align with the evolving needs of industries and academia.

The findings of this research shed light on the awareness levels among stakeholders, highlighting areas for improvement and optimization of academic-industry partnerships. Additionally, it uncovers the tangible impact of these collaborations on career trajectories and the overall competitiveness of industries in the age of Industry 4.0. The insights garnered from this study offer valuable **guidance for educators, industry professionals, and policymakers seeking to harness the full potential of academic collaborations in the context of Industry 4.0, ultimately fostering innovation, growth, and sustainability.**

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Appendix -1

Appendix -1 Institute attributes		
Personal factor	**Frequency**	**Percentage**
Nature of the Institute		
Arts and Allied Streams	3	8%
Science and Allied Streams	5	14%

Engineering and Allied Streams	26	72%
Medicine and Allied Streams	2	6%
Total	36	100%

Educational Qualification		
Graduation	2	6%
Post Graduation	7	19%
Doctorate	27	75%
Total	36	100%

Total Years of Teaching Experience		
1-5 years	2	6%
6-10 years	4	11%
11-20 years	14	39%
>20 years	16	44%
Total	36	100%

Designation / Role		
Associate / Assitant Professor	20	56%
Professor	11	31%
CoE / Director	3	8%
Principal	2	6%
Total	36	100%

Type of the institution		
Government	10	28%
Private	26	72%
Total	36	100%

Accreditation		
Yes	29	81%
No	7	19%
Total	36	100%

Location		
Urban	19	53%
Rural	17	47%
Total	36	100%

Age of the Institution		
Less than 5 Years	2	6%
6-10 Years	14	39%
11-25 Years	14	39%
25-50 Years	6	17%
Total	**36**	**100%**

# of collaborations		
Collaborated	31	86%

Not Collaborated	5	14%
Total	**36**	**100%**

Collaborated with industries		
< 5	11	31%
5 to 10	8	22%
> 10	16	44%
No Collaboration	1	3%
Total	**36**	**100%**

Purpose of collaboration		
Placement	26	72%
Intern	25	69%
Skill Development	28	78%
Research	18	50%

Appendix - 2

Appendix - 2
Industry 4.0 Awareness attributes among institutions

Characteristics	Frequency	Percentage
Awareness on industry 4.0		
Aware	33	92%
Not aware	3	8%
Total	**36**	**100%**
Readiness on for I4.0		
Seminar/Workshop attended	28	78%
Not attended	8	22%
Total	**36**	**100%**
Awareness on I4.0 components- AI		
Aware	31	86%
Not aware	5	14%
Total	**36**	**100%**
Awareness on I4.0 components- Data Analytics		
Aware	28	78%
Not aware	8	22%
Total	**36**	**100%**
Awareness on I4.0 components- IoT		
Aware	29	81%
Not aware	7	19%
Total	**36**	**100%**

Awareness on I4.0 components-Machine Learning		
Aware	24	67%
Not aware	12	33%
Total	**36**	**100%**

Awareness on I4.0 components - Cloud Computing		
Aware	27	75%
Not aware	9	25%
Total	**36**	**100%**

Awareness on I4.0 components - Digital Forensics		
Aware	18	50%
Not aware	18	50%
Total	**36**	**100%**

Awareness on I4.0 components - Automation and Robotics		
Aware	28	78%
Not aware	8	22%
Total	**36**	**100%**