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Research Article

Adopting Industry 4.0 Practices in Technical Education: Aligning Academic and Library and Information Science Training with Industry Needs

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ARTICLE INFO	ABSTRACT

As Industry 4.0 has shaped new dimensions for industry and education, education, and specifically technical education, must be cultivated to provide better outcomes that meet the demands of modern industry. In this paper, we discuss approaches to embedding Industry 4.0 practices in academic training, specifically in the area of Library and Information Science (LIS), in an effort to ensure that many of the new technologies break into our university curricula. By examining current academia and industry as well as identifying forces and needs beyond the boundaries of our profession, this study reveals substantial gaps between technical education post a STEM degree and Librarianship and information science (LIS) training programs. These categories can be umbrellaed for application in educational institutions that have already required their shift by adding each industry change to their framework, such as practical-oriented or project-based learning contribute by including real-world projects related to AI, big data, and the sort changes wrought by the IoT, Industry 4.0, etc.; study the collaboration between industry-academia to become a manufacturer of the human resources needed to manufacture industry 4.0 (ownership of curriculum); kind of a cross-sectional study, changing the study results between technical fields of business, and social sciences; preparing the academic library as a learning hub (with an overview of some approaches to change in semantic networks entities). The results highlight the need to combine approaches to equip students with the skills needed to prosper in the Fourth Industrial Revolution.

***Index Terms*—**Industry 4.0, Library and Information Science, technical education, big data, Internet of Things, interdisciplinary teaching, project-based learning, education transformation.

I. INTRODUCTION

The fast pace of technological development driven by Industry 4.0 is transforming the industrial and educational sectors. Industry 4.0 encompasses the subsequent phase in the evolution of operational processes, marked by the widespread incorporation of cyber-physical systems, the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and automation to drive greater efficiencies and foster innovation. Having these innovations changes the status quo of industries and offers more new opportunities for them, but creates more challenges concerning the preparedness of the involved workforce. Thus, the education sector must find a way to make curricula relevant to the vision to unlock the potential of these new technologies, particularly their application in technical education fields and LIS programs.

While the rise of Industry 4.0 technologies has challenged educational institutions, especially those responsible for technical and LIS education, to be responsive to this change, they tend to lag behind the evolution of this change. Emerging technologies are not adequately integrated into traditional educational models, and students are often underprepared for Industry 4.0 real-world ground realities. This mismatch between academic preparation and market demand underscores the critical importance of curricular overhauls that prioritize state-of-the-art technological training, multidisciplinary collaboration, and practical, industry-relevant skill-building.

In light of this, this paper explores how Industry 4.0 principles are being incorporated into academic structures, particularly in technical educational outfits and LIS curricula. By closely examining the academic landscape against the aspirations of the stakeholders in the industry, this research paper aims to reveal the areas lacking in knowledge delivery and services. It addresses the gaps and suggests new methods to better prepare students within the framework of Industry 4.0 to enhance the educational system. Such approaches involve implementing project-based learning, enabling industry-academia collaboration, and instilling cross-cutting teaching practices. Additionally, the paper writes about the importance of academic libraries in promoting lifelong learning and Industry 4.0 skills development, arguing that libraries could play a major role in the educational transformation.

This paper demonstrates concrete recommendations for schools and libraries to adjust their practices to ensure students are obtaining the desirable skills to excel in the ever-automated and data-oriented world (Saunders). This study intends to support the efforts of preparing a workforce of skilled professionals that align educational programs with the technology of the Fourth Industrial Revolution.

The remaining part of this paper is structured as follows: Section II reviews the literature related to Industry 4.0 and its various technologies with respect to the significance of technical education and LIS education. Th is is followed (in Section III) by the research methodology, in which we detail our mixed-methods approach to collecting qualitative and quantitative data from a range of stakeholders, including educators, students, industry professionals, and library and data experts. Section IV holds the experimental analysis. Finally, Sections V and VI end the paper with a discussion and summary of the main findings and a call for continuous partnership between academia, industry and libraries to prepare students for success in the Fourth Industrial Revolution.

II. Related Works

Industry 4.0, or the fourth industrial revolution, is a new age of profound change marked by the widespread use of data-driven decision-making, automation, and cutting-edge technological integration. A reevaluation of instructional frameworks, course outlines, and institutional approaches is necessary in light of the far-reaching consequences of this paradigm shift on technical education and LIS training. In order to better understand how academic practices and LIS training may meet business demands, this literature review takes a critical look at important research and publications that investigate the effects of Business 4.0 on libraries and education.

Industry 4.0 was introduced by Kagermann et al. (2013), who offered strategic suggestions for using its concepts. In order to equip students for the dynamic nature of the modern workplace, their research highlighted the significance of cross-disciplinary teams and the need for schools to include smart technology in their course offerings.

The impact of virtualisation, decentralisation, and network construction on manufacturing was addressed by Brettel et al. (2014). The importance of these principles in technical education was highlighted by their research. This will ensure that graduates can successfully traverse the complicated surroundings of Industry 4.0.

Industry 4.0 presents both future possibilities and problems, as pointed out by Zhou et al. (2015). They contended that schools should change to meet these problems by teaching students the abilities necessary for the modern industrial age: sophisticated analytics, AI, and machine learning.

Pfeiffer (2016) looked at how automation and robotics fit into Industry 4.0, specifically how they would affect human workers. In order to achieve seamless integration, the report stressed that schools should teach students not only technical skills but also how to manage human-robot interaction.

Design concepts for Industry 4.0 scenarios were reviewed in the literature by Hermann et al. (2016). They recommended that technical education curricula include fundamental concepts like decentralisation, real-time capabilities, and interoperability.

Industry 4.0 was investigated by Morrar et al. (2017) via the lens of social innovation. They called on schools to take a more comprehensive strategy that incorporates social responsibility into technical education, praising the revolutionary power of Industry 4.0 technology to solve societal problems.

Aligning educational practices with industry demands was emphasised by Pereira and Romero (2017), who explored the meanings and consequences of Industry 4.0. Their research indicated that classroom instruction would benefit from a greater emphasis on real-world application and partnerships with relevant businesses.

The pros and cons of Industry 4.0's sustainable value generation in industry were studied by Kiel et al. (2017). Based on their findings, educational institutions should encourage students to think and behave in a sustainable way.

Opportunities and threats were highlighted by Müller et al. (2018), who investigated the factors pushing Industry 4.0 adoption. In particular, they highlighted the need for education in preparing the next generation of professionals to address these issues via innovation and sustainability.

Research by Chigwada and Nwaohiri (2021) looked at how academic libraries may be affected by Industry 4.0. To keep up with the times, they said, LIS schools should teach students data analytics and digital technology so that librarians of the future can keep libraries running smoothly.

In the framework of Industry 5.0, Holland (2022) compiled a detailed manual on LIS technology advancements. Educational institutions will need to change in order to train workers for the new human-centric paradigm that has emerged as a result of the work's emphasis on Industry 4.0's development.
A book on Industry 4.0 technologies for education was published by Kaliraj and Devi (2022), with an emphasis on transformational applications. They encouraged educators to embrace new pedagogical techniques by providing practical insights into how emerging technology might improve teaching and learning processes.
Taken as a whole, the literature study highlights how Industry 4.0 is changing the face of technical and library science education. The findings highlight the need to proactively incorporate Industry 4.0 ideas into academic activities, from basic techniques to specialised applications. Both the present and the future of our industry depend on this alignment in order to keep up with the demands of technology. Institutions can help students prepare for a future driven by Industry 4.0 by encouraging multidisciplinary cooperation, hands-on learning, and sustainability-focused education.

III. PROPOSED WORK

This study aims to analyze the construction of technical education integrating features of Industry 4.0, based on the development of data of mixed-methods research aligned with literature and documents review for Library and Information Science (LIS) training. The framework for this study included the use of literature review, survey research, interviews, and case studies. This study is guided by a purposive sampling strategy in order to attract respondents who have specialized knowledge of Industry 4.0 and how that can be applied in an educational context. Information on the sampling population and sampling criteria is summarized in the table below.

A. Sampling Strategy

For this study, a purposive sampling method is used as it is relevant to the type of research that is designed to identify, as the target population, participants who are specialists in the field and experienced in the integration of Industry 4.0 technologies into technical education and Library and Information Science (LIS) training. Participants will be recruited through the purposive sampling method.

Four main groups of the sampling population include educators and curriculum developers, students, industry professionals, and library professionals. The choice of each category for the purpose of this article was based on specific criteria related to the Industry 4.0 impact on education and LIS practices. A detailed outline with the structure of the categories, criteria, and sample size can be found as follows in Table 1.

Table 1 Sample analysis

Category	Description	Sampling Criteria	Sample Size
Educators and Curriculum Developers	Academics and educators involved in the development of technical and LIS curricula.	Participants should have experience in **curriculum design**, particularly in relation to **Industry 4.0 technologies**.	10-15 educators
Students	Students enrolled in **technical education** or **LIS programs** with an interest in Industry 4.0 technologies.	Students must be enrolled in programs that incorporate or could benefit from **Industry 4.0 technologies**.	50-100 students
Industry Professionals	Industry experts in fields such as **smart manufacturing**, **automation**, and **data analytics**.	Participants should have expertise in **Industry 4.0 technologies** and hands-on experience in applying these technologies in industrial settings.	15-20 industry experts
Library Professionals	Library and information science professionals involved in **digital transformation** initiatives within libraries.	Participants should be engaged in the integration of **digital tools** and **technologies** in library management, particularly those relevant to **Industry 4.0**.	10-15 library experts

Category 1: Educators And Curriculum Development

Description: This group consists of academics and educators who are among the practitioners involved in the planning of technical education and LIS curricula. The participants are infinitely important in terms of integrating Industry 4.0 notions into academic programs; They tell us how curricula are being written, created and updated to keep up with the changing demands of technology in the workplace.
In the case of sampling, students of curriculum designing with basic knowledge of weaving industry 4.0 Technologies including AI, big data, IoT, and Automation into the curriculum would be included. These individuals may help in developing Industry 4.0 programs for both undergraduate and graduate degrees.
Sample Size: A stratified purposeful sample of educators comprising 10 to 15 individuals will be drawn from institutions offering technical education as well as LIS programs The participants should be from various

types of institutions, including universities, colleges and vocational education, to ensure broad academic perspectives.

Category 2: Students

Description: This group includes students who are currently enrolled in technical education programs or LIS programs specializing in Industry 4.0 technologies. Students are the end recipients of the curricula and they can give insights on how effectively the current education system can prepare them for Industry 4.0.
Sampling Criteria: Students who will be chosen for this group are expected to be students who are either involved in technical education programs or LIS programs that already utilize or would benefit from the adoption of Industry 4.0 technologies. They must be exposed to technologies like AI, IoT, and big data analytics — via formal courses or extracurriculars.
Sample Size: 50 to 100 students, to get a decent spectrum of the views from students engaged in such programs The number will create diversity in terms of educational background, experience, and future passions across the industry.

Category 3: Industry Professionals

Description: Industry professionals are experts in smart manufacturing, automation, data analytics, etc. They are examples of Industry 4.0 in action and provide valuable insight into the skills and competencies needed in the workforce.
Sample Criteria: Experts working in the field should be experienced in industry 4.0 technologies, as well as applying these technologies in industrial environments, including automated production 4.0 IoT-based systems and data-driven decision-making. Their expertise will provide a practical understanding of the current and future technology demand across different sector industries.
Sample Size: The target population size will be 15 to 20 industry professionals. The plan will involve participants across different sectors and services and will include smart manufacturing, data analytics, automation, and many other areas of technological application.

Category 4: Library Professionals

Sampling Requirements: Respondents should work on integrating digital tools and technologies into library services such as those regarding Industry 4.0. While advancing library functions with Big data analytics, AI-driven systems, and digital resource management systems
Sample Size: 10 to 15 library professionals will be chosen from institutions in which libraries have been actively participating in digital transformation initiatives. Through their discussion, these professionals will provide insights into how libraries can integrate to help with Industry 4.0 through access to new technologies and resources.

Reasons for Purposive Sampling

The utilizable sampling technique means that researchers can utilize a selected grouping of people based on their contribution to the widespread development of Industry 4.0 through education, technology usage, or industry. The data should then be collected only from research aligned with the study's focus on the integration of Industry 4.0 technologies into education for the technical and LIS sectors.
Such a design ensured that the selection of participants was predominantly based on their individual areas of specialization and relevant experiences so that the study could reflect specific insights into the opportunities, challenges, and best practices with respect to aligning academic frameworks to the fast-paced technology world.

B. Data Collection Methods

Combining both quantitative and qualitative data collection methods, this study adopted a mixed-methods approach to investigate the application of Industry 4.0 technologies in technical education, especially a portion of higher education known as Library and Information Science (LIS) training. Methods of data collection include literature review, survey research, semi-structured interviews, and case studies. The research was conducted using these methodologies to get an in-depth view of the present scenario of educational practices and find out the impediments and opportunities to the incorporation of emerging technologies in academic entities. Next, we describe each method in detail.

Literature Review

Related to that a comprehensive literature review has been performed to check previous studies and papers related to the implementation of Industry 4.0 technologies in technical education and LIS training programs. The following literature review laid the groundwork for further examination of existing frameworks related to Industry 4.0 in the context of curriculum development, teaching methodologies, and educational goals. It was an important device for:

- Recognising shortfalls in current educational approaches

- These include identifying the technologies that should be integrated into curriculums like AI, big data, and IoT.
- Case studies on the adoption of Industry 4.0 technologies in educational settings
- Working with the literature to build the research questions and hypotheses in order to analyze the challenges and success stories.
- This review also informed the landscape of Industry 4.0 adoption in education and influenced the research methods used in the later stages of the study.

Survey Research

A questionnaire was carefully structured, and distributed to generate quantitative data from a comprehensive cross-section of stakeholders in technical education and LIS training. The survey tried to analyse the common level of knowledge between participants about Industry 4.0 technologies and their incorporation within the education system. The survey explored major s such as:

Awareness of Industry 4.0 technologies: Respondents were asked to express their familiarity with key technologies e.g., AI, IoT, and big data and their relevance in modern industries and educational paradigms.

Alignment of curricula with the needs of industry: This item examined the extent to which the existing curricula being taught to students in technical education and LIS training bear relevance to the skills, knowledge and competencies demanded by industry heads under Industry 4.0.

The survey aimed to identify gaps in student skills: They sought to identify areas where students were lacking proficiency in key Industry 4.0 enabling technologies and practices, encompassing both traditional content and interoperability.

Extent of technology adoption in teaching and learning environments: This covered the questions on the implementation of Industry 4.0 technologies that were used in teaching and the adoption of AI-driven tools, data analytics, and virtual learning platforms.

Comprehensive questionnaires were designed and comprised closed-ended and Likert-scale items for the measurement of categorical and ordinal data, respectively. The answers to these questions were used to summarize patterns and to conduct trend analysis based on curricular alignment and educational institutions' preparation for new technologies.

Interviews

Semi-structured interviews with academic leaders, LIS professionals, and industry experts were utilized for qualitative insights on integrating Industry 4.0 technologies into academic curricula. The interviews were conducted as an open-ended conversation with participants providing in-depth answers on the topics of:

Opportunities for integration of computer teaching in the curriculum: Participants voiced their concerns regarding some challenges such as faculty training, curriculum redesign, funding and technological infrastructure.

What are the good practices to include Industry 4.0 technologies: This involved seeking examples of successful practices such as project-based learning, a real collaboration with industry, and interdisciplinary teaching approaches, which promote Industry 4.0 skills and competencies.

Role of academic libraries: The interviews probed the evolving role academic libraries play in supporting the concept of lifelong learning and supporting students in accessing Industry 4.0 resources such as big data tools, AI-based learning platforms, and Internet of Things (IoT) research

Interviews were recorded, transcribed and analyzed thematically to extract common themes, insights and recommendations. It was able to shed more light on the integration of Industry 4.0 into education as qualitative data was collected to add context to the quantitative results of the survey.

Case Studies

Case studies of institutions that have successfully integrated Industry 4.0 technologies into their universities were also analyzed. Several important themes emerged from the case studies:

Smart manufacturing-based education by educational institutions: These case-study surveys explored the adoption of smart manufacturing practices and AI-based systems by educational institutions, particularly in technical education programs.

Digital transformation in academic libraries: Academic libraries and their role in digital transformation were investigated, focusing on how libraries are utilizing AI-driven search tools, data analytics, and cloud-based resources to promote students and faculty in an Industry 4.0-driven atmosphere.

Analysis of successful examples of Industry-academia partnerships with a focus on the role of these partnerships in curriculum development, real-world training opportunities, internships, and apprenticeships in Industry 4.0 technologies.

These case studies demonstrate how institutions can realign their paradigm of education to meet the changing needs of industry and provide students with hands-on experiences with new technologies.

C. Data Analysis

Quantitative Data: The survey data was analyzed using descriptive statistics such as mean scores and counts/percentages to give a general overview of the awareness and perceptions of Industry 4.0 within education. Correlation analysis and regression analysis for inferential statistical tests were also performed to identify the relationship of factors like the match between curricula with industry demand and students' perceptions of their employability.

Qualitative Data: The qualitative data obtained from the interviews and case studies are analyzed using thematic analysis. This was done by coding the data into key themes and categories, identifying patterns between responses, and synthesising the findings to provide rich insights into the practical barriers, successful strategies, and recommendations for the implementation of Industry 4.0 technologies in education.

Ethical Considerations

Ethical considerations were an integral part of this research. The study was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Participants were thoroughly briefed on the study objectives, and informed consent was obtained prior to participation. They had also been told that their participation was voluntary and that they had the right to withdraw from the study at any time without penalty. Data that could identify individuals was not recorded in order to ensure the confidentiality and privacy of all participants. All collected data were stored securely and accessible only to the research team, following data-security protocols.

IV. PERFORMANCE ANALYSIS

This research intends to investigate the incorporation of Industry 4.0 technologies into technical education and Library and Information Science (LIS) training. The study results (based on surveys, interviews and case studies) offer new insights into the awareness, skill gaps, and implementation of Industry 4.0 technologies in educational settings. The key findings based on the data collected are below:

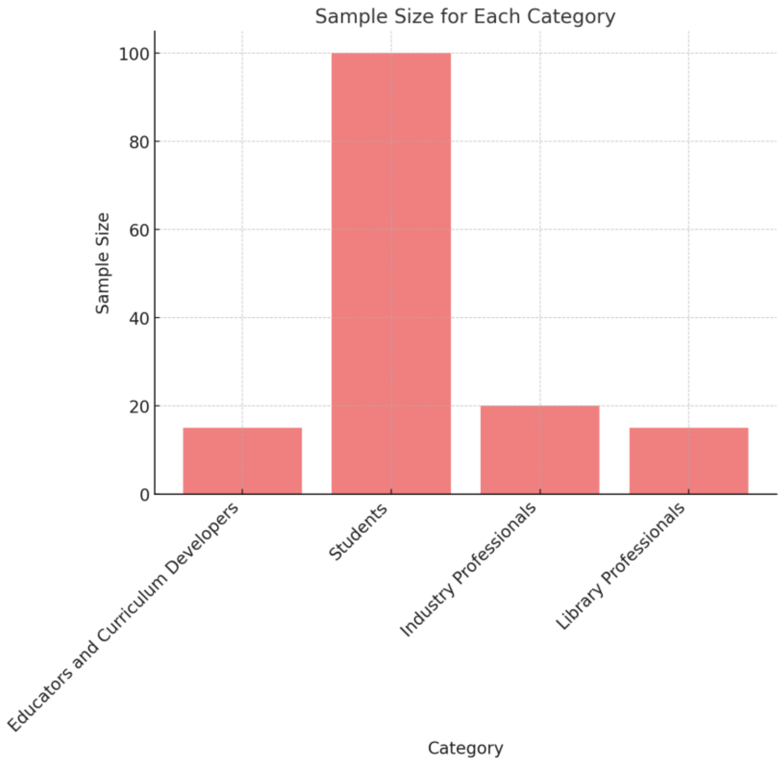

Figure 1 Sample size analysis

The above graph shows the number of participants in each group. It reveals that Students have the biggest sample size, with a sample size of up to 100. The rest of the sectors, Educators and Curriculum Developers, Industry Professionals and Library Professionals, have smaller sample sizes, around 10 to 20 participants. This distribution acknowledges the importance of obtaining a diverse cross-section of student viewpoints while maintaining representation from the fields of education, industry, and library science.

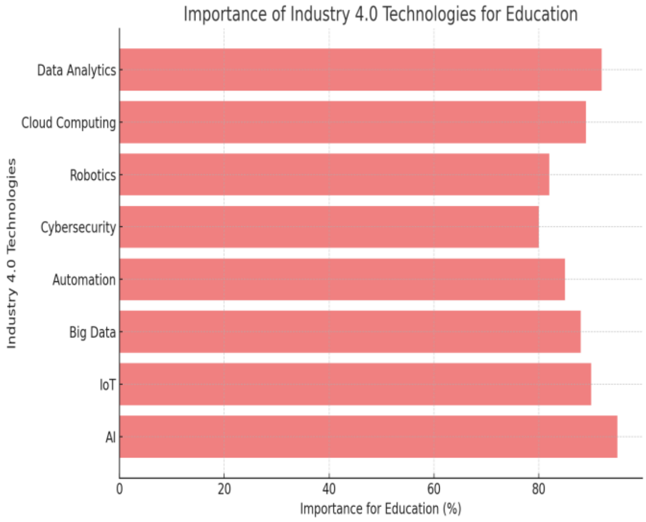

Figure 2 Importance analysis

The graph named "Importance of Industry 4.0 Technologies for Education" shows the differences in the importance of the new technologies in designing the curricula of education. It also reflects on the beginning transition toward the future where we see Data Analytics and Cloud on top of the education map, as they take center stage in the upcoming demand in terms of generation of knowledge and enabling knowledge workers access to analytical resources in a SaaS form. Number three is Robotics and Cybersecurity, highlighting the significance of automation and securing digital frameworks. Automation, Big Data, IoT, and AI are also considered important, but to a greater extent. It highlights the need to merge such technologies into the curriculum to help students build the necessary skills to survive in the coming Industry 4.0 world.

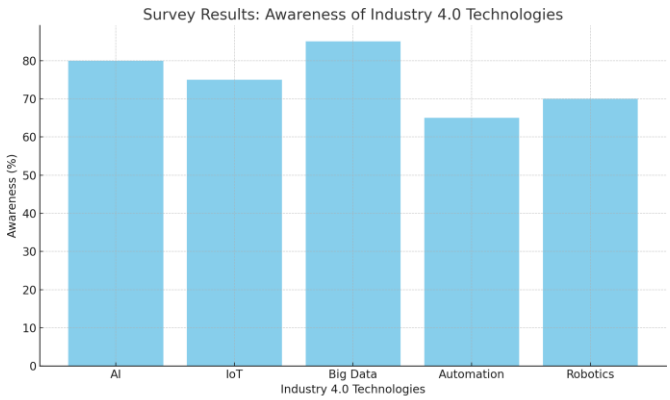

Figure 3 Awareness of Industry 4.0 Technologies

Results of the survey indicate that respondents demonstrated a high level of awareness of Industry 4.0 technologies, including AI, the Internet of Things, and big data. The key findings are that AI (80%), big data (85%), and IoT (75%) are the most recognized technologies. But much less awareness of automation and robotics scored 65% and 70% respectively. It is therefore imperative that we start leveraging emerging technologies such as automation and robotics, as part of our academic curricula.

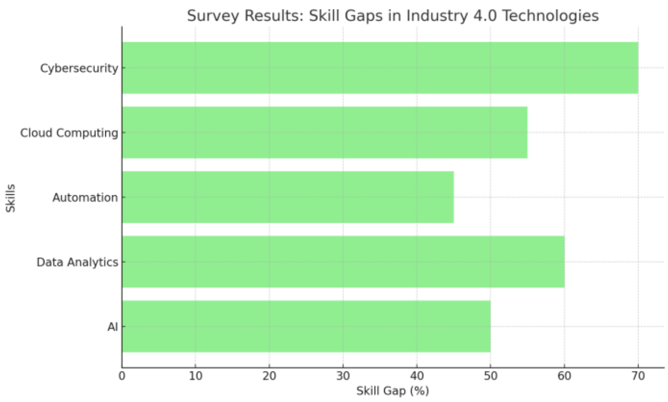

Figure 4 Skill Gaps in Industry 4.0 Technologies

Significant skill gaps in most key areas of Industry 4.0 technologies were also identified by participants. The biggest skills gap was for cybersecurity (70%), followed by data analytics (60%) and cloud computing (55%). Same as above, the relatively lower skill gaps in AI (50%) and automation (45%) indicate these areas are to some extent being covered in their skill provision at present. Despite this, cybersecurity is a weakness and a threat, however, and universities need to find ways to prioritize it in their technical education and LIS programs.

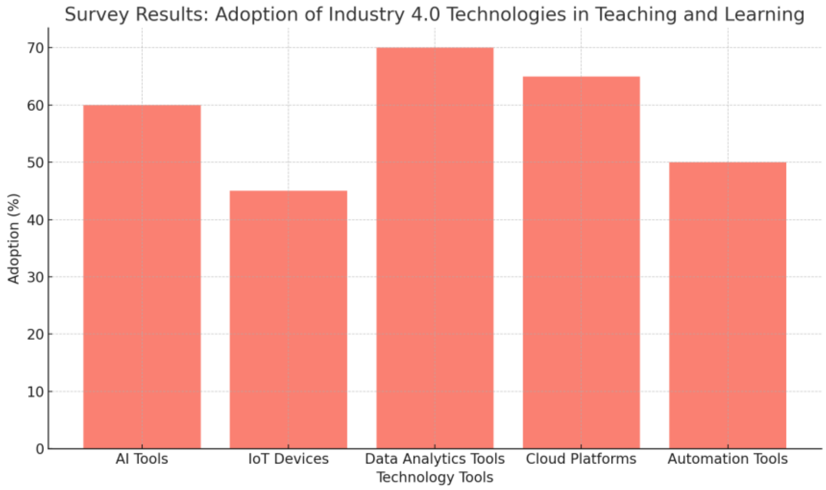

Figure 5 Adoption of Industry 4.0 Technologies in Teaching and Learning

While Data Analytics Tools (70%) and Cloud Platforms (65%) emerged as the most adopted technologies in teaching and learning environments. Though AI Tools were moderately adopted at 60% and Automation Tools at 50%, IoT Devices had the lowest adoption rate at 45% Education should focus on IoT and automation sector to be synonymous with Industry 4.0,' reflects the need for universities to adopt new technologies and work on implementations end demands.

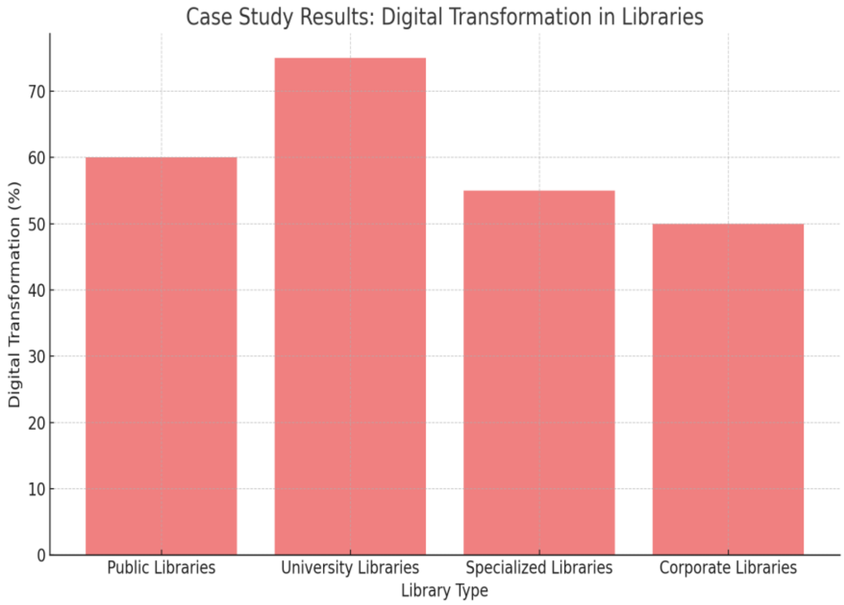

Figure 6 Digital Transformation in Libraries

A strong trend of digital transformation was shown by case study data from libraries, particularly university libraries, where at least 75% of libraries had adopted and integrated Industry 4.0 technologies [4]. Public libraries ranked at 60%, while specialized libraries and corporate libraries came in at 55% and 50%, respectively. That raises the possibility that university libraries may be leading the way in digital transformation and that corporate and specialized libraries need to catch up in their use of Industry 4.0 technologies.

Table 2 Output analysis

Category	Question	Input Data	Key Insight	Recommendation
Educators and Curriculum Developers	**Technologies Integrated into the Curriculum**	AI: 10%, Big Data: 20%, IoT: 30%, Automation: 40%	Lack of integration in AI and Automation due to resource and faculty training constraints.	Implement faculty training programs and foster industry partnerships to facilitate curriculum updates.
	Main Challenges in Integration	Lack of Resources: 50%, Insufficient Faculty Training: 30%, Curriculum Rigidity: 20%	Integration is hindered by insufficient resources and training.	Provide more resources and develop flexible curricula that can be updated with emerging technologies.
Students	**Exposure to Industry 4.0 Technologies**	AI: 40%, Big Data: 60%, IoT: 50%, Automation: 20%	Students are more exposed to Big Data and IoT, but less so to AI and Automation.	Increase hands-on project-based learning, especially in AI and Robotics.
	Confidence in Using AI or IoT	Very Confident: 30%, Moderately Confident: 50%, Not Confident: 20%	Many students feel moderately confident in technologies like IoT and Big Data.	Provide more practical training and workshops in AI and Data Analytics.
	Skills Missing in Current Curriculum	AI & Data Analytics: 40%, Robotics: 30%, Cybersecurity: 20%	Skills gap observed in areas like AI, Robotics, and Cybersecurity.	Integrate AI and Data Analytics more comprehensively into curricula.
Industry Professionals	**Technologies Expected in Graduates**	AI: 50%, Big Data: 60%, IoT: 40%, Automation: 30%	Industry expects proficiency in AI, Big Data, and IoT, but feels curricula are insufficient.	Strengthen academia-industry collaborations to align curricula with real-world technological needs.
	How Well Current Curricula Prepare Students	Very Well: 20%, Moderately Well: 50%, Poorly: 30%	Curricula are moderately aligned with industry needs, but significant gaps remain.	Improve practical training opportunities through internships and industry projects.
Library Professionals	**Library Support for Industry 4.0 Learning**	AI-driven Search Tools: 40%, Data Analytics Platforms: 30%, IoT Devices: 20%	Libraries are adopting AI and Data Analytics tools but need more resources and faculty training.	Expand library offerings with real-time industry tools and invest in continuous faculty training.
	Additional Needs for Libraries	More Digital Resources: 50%, Faculty Training: 30%, Access to Real-time Tools: 20%	Libraries require more cutting-edge resources and industry-specific tools for Industry 4.0.	Provide access to AI platforms, IoT research, and real-time industry tools for students and faculty.

This table summarizes the input data, insights, and actionable recommendations for each group involved in the study on Industry 4.0 practices in education.

V. Discussion

The research investigated composing industry 4.0 technologies in technical education and library and information science (LIS) training to help educational institutions stay up-to-date on academic curricula that keep pace with modern industries that find themselves significantly behind to leap into technological requisites. The study emphasized that though technologies related to AI, Big Data, IoT, and Automation have found their way into academic curricula and courses to some degree, deeper integration has faced challenges due to scarce resources and a shortage of well-trained faculty. Though sectors such as IoT and Automation are being covered, a significant gap exists for AI and Robotics, educators reported. The oversight of emerging technologies, however, can leave students ill-equipped for the industry's changing reality. Students on the other hand mentioned very little experience with AI and Automation and were mostly exposed to Big Data and IoT. While they were also fair with IoT and Big Data, even less confident with them in an AI and Robotics context. Nevertheless, they all concurred that AI, Big Data, and IoT should be mastered by graduate students, observing that present curricula are inadequate when it comes to preparing students for the technologies. The study also shows that while academic libraries are utilizing AI-enabled search tools and Data Analytics platforms, as well as advanced tools from real-time AI platforms to IoT-enabled research tools specific for supporting the learning process for Industry 4.0, demand still exists for more advanced tools. This research indicates the need for closer ties between academic programmes and industry to ensure curricula better match the skills required in today’s workforce. Academic libraries must also promote lifelong learning by introducing new technologies with active collaboration. We recommend that the implementation of Industry 4.0 technologies in education requires the involvement of educators, industry professionals, and trainees. Curriculum Data Mining -- The findings suggest an urgent need to revitalise curricula with emphasis on more hands-on learning opportunities, especially in areas like AI and Robotics, to prepare students for the evolving industry standards, alongside the importance of faculty development programs and partnerships with industry to fulfill the learning gaps in a fast-paced technology backdrop. This needs ongoing up-skilling, collaboration with industry, and flexible curricula to prepare students for future employers.

VI. Conclusion

In summary, the current educational systems, especially areas related to technical education and Library and Information Science (LIS) education, require a re-visit in terms of adopting Industry 4.0 technologies, which include AI, Big Data, IoT, Automation, and Robotics. These results show which technologies are already integrated into curricula and which ones still need to be integrated the most, such as AI and Robotics. These gaps are mostly due to limited funds and the lack of training for the faculty and a rigid curriculum. As for emerging technologies, students rated their confidence in their understanding of new emerging technologies moderately but reported a lack of exposure to critical areas like AI and Automation. Some industry practitioners stressed that students are being taught poorly aligned curricula, making them ill-equipped to deal with the challenges of the Fourth Industrial Revolution. Adult learning is supported by tools and resources available through academic libraries that play an essential role in the context of lifelong learning in an Industry 4.0 world.

Moving forward, it will be important for future work to aim for designing more flexible and adaptive curriculum models, with integrated Industry 4.0 technologies. Best practices for industry-academia partnerships could be further elaborated along with research that leads to constantly updated curricula meeting the new expectations of the industry. Furthermore, the professional development of educators must not be overlooked, as they need to be adequately trained to teach these new technologies. Please read about it to best learn how the evolving purpose of academic libraries can have a fluid transition to libraries of the future well. Additionally, more research could be conducted on the inclusion of project-based learning and internships as components of the curriculum so students are able to experience firsthand the differences between theory and practice. The ultimate goal is a robust educational landscape in which students are prepared for the challenges and opportunities of an increasingly digital and automated world.

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