Ergonomics and Industry 4.0 - Review and Prospectives in Bangladesh

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Abstract:

Industry 4.0 implementation based on Ergonomics in the economy of Bangladesh is presented with a comprehensive analysis of the interplay between I4.0 and ergonomics, with a specific focus on its implications in the context of Bangladesh. The review begins by examining the global landscape of I4.0 components and their far-reaching impacts on ergonomics, emphasizing the industrial sectors where ergonomics and human factor studies play a crucial role in ensuring both productivity and worker comfort. The review then delves into the driving sectors of Bangladesh's economy, as dictated by their contribution to the GDP. Furthermore, it assesses the current state of Industry 4.0 implementation in Bangladesh with a sector-specific focus, exploring the practical implications of this technological transformation. Lastly, the paper discusses the emphasis placed on Industry 4.0 in Bangladesh's future economic development plans, shedding light on the nation's vision for embracing this technological revolution.

Keywords
Industry 4.0, Ergonomics, Bangladesh Economy, Sector-Specific Implementation, Economic Development Plans

1. Introduction:

The term "4th Industrial Revolution" is used to describe a significant and transformative shift in the way society, economies, and industries operate due to advancements in technology. It is called a "revolution" because it represents a fundamental change in how we live and work, akin to the previous industrial revolutions in history (Schwab K. 2017)**.**

The term "4th Industrial Revolution" was introduced by Klaus Schwab, the Founder and Executive Chairman of the World Economic Forum, in his book "The Fourth Industrial Revolution." This pivotal work was published in 2016 and has since become a cornerstone of discussions surrounding the profound changes brought about by emerging technologies. Schwab emphasized the disruptive and far-reaching implications of the 4th Industrial Revolution on industries, economies, and society. He stressed the need for governments, businesses, and individuals to adapt and embrace these technological shifts to harness their potential for positive change while mitigating potential risks and challenges **(**Schwab K. 2017).

To have a brief overview of the previous industrial revolutions, the First Industrial Revolution began in the late 18th century with the mechanization of the textile industry and the development of steam power which marked the shift from agrarian economies to industrialized ones. Occurring in the late 19th and early 20th centuries, The Second Industrial Revolution was characterized by the widespread adoption of electricity, the internal combustion engine, and mass production techniques, leading to the rise of factories and mass production. The Third Industrial Revolution

started in the mid-20th century with the advent of computers and automation, which significantly changed manufacturing and information technology, and gave rise to the digital age (Allen 2017).

The Fourth Industrial Revolution builds upon the foundation of the Third, but it is distinct in that it blurs the lines between physical, digital, and biological domains. It encompasses advances in areas like artificial intelligence, the Internet of Things, 3D printing, biotechnology, and more. The term "revolution" is used because the pace and scale of change in the Fourth Industrial Revolution are expected to be disruptive and transformative, affecting almost every aspect of our lives, from how we work to how we communicate, to how we produce and consume goods and services **(Schwab K. 2017)**. So, the term "revolution" is used to emphasize the profound and revolutionary impact that the ongoing technological advancements and digital innovations are having on the world, making it a distinct and transformative era in human history.

Academically, this nomenclature streamlines research and scholarly analysis, aiding in a deeper understanding of the era's impact. In essence, the naming of historical events, like the "Industrial Revolution," serves as a powerful tool that directs perceptions, discussions, and research. It functions to encapsulate and categorize a complex period, providing a framework for analysis and discussion. Since its inception, the term "4th Industrial Revolution(4IR)" has gained widespread recognition and has become a central concept in discussions related to the profound impact of technology on our world. It has inspired governments, businesses, and institutions to adapt and prepare for the transformative changes associated with this new era of innovation and connectivity. 4IR is developing more quickly than the others—it is moving from a linear to an exponential trajectory. Not only that, but it's disrupting practically all industries worldwide. Furthermore, these changes' magnitude and scope portend the complete overhaul of governance, management, and production processes. (Schwab K. 2016)

The name ergonomics “the science of work” is derived from the Greek ergon (work) and nomos (laws). The phrases ergonomics and human factors are often used interchangeably or as a unit of practice that is accepted by the IEA. The definition of ergonomics adopted by the IEA in 2000 is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance (The International Ergonomics Association is a global federation of human factors/ergonomics societies, 2022). It can also be defined as ergonomics is the process of designing or arranging workplaces, products, and systems so that they fit the users. It is widely understood to have something to do with seating or with the design of car controls and instruments. However, the scope of ergonomics extends much beyond this and is applicable to the design of everyday things around us that involve people and workspaces, sports, leisure, and health and is aimed at improvising usability and safety related to the product, process, and systems (Meister 2018).

The 4IR is ushering in significant changes in industries, leading to increased discussions on ergonomics and human factors. As automation, digital technologies, and artificial intelligence become integral to industrial processes, there is a growing emphasis on optimizing the interaction between humans and machines. This shift prompts concerns about workplace design, safety, and worker well-being, including the ergonomic aspects of human-robot collaboration, data visualization, and remote work environments. **(Coetzee, 2019)** Industry leaders and policymakers are increasingly addressing these issues to ensure that the benefits of technological advancements are balanced with the protection and efficiency of the workforce.

Now it is subject to look into, whether the economic progress is along with the pace of the rest of the world where technology-based startups are reaching their peak in generating revenue and grabbing the driving seat of their respective country’s economy. Before that, it is a matter of inquisition that what are the driving sector of the economy of Bangladesh and which/whose sector(s) are going to depend on. Bangladesh has shown some spectacular improvement during the past decades. Economists and analysts also reviewed the economic plans taken by the government (worth mentioning Mr. Shamsul Alam). Here the study of the work environment is based on the study of ergonomics and human factors in such a country with a huge low-cost labor market.

2. Literature Review:

Some important papers were reviewed and given in the table.

Author	Objective	Considered field for data collection	Used Methodologies For literature review For collecting data For data analysis	Result & Finding Demonstrated method	The Attained Conclusion	Paving the way for future study	Limitation & Drawback
1. (Kadir, 2019) Denmark	To present the findings of a literature review investigating to what extent, what type, and how academic publications on Industry 4.0 integrate human factors and ergonomics	About 40 academic papers on industry 4.0 up to 2019.	The search strategy included combinations of several keywords that are relevant to HF/E in Industry 4. Microsoft Excel to organize the quantitative data. Systematic Reviews and Meta-Analysis (PRISMA).	Quantitative: keywords Industry 4.0 and Cyber Physical System are the most reoccurring in academic publications. Qualitative: effects on the physical, cognitive, and organizational ergonomics related to human work in Industry 4.0.Pareto, column & pie chart and table overviews.	A low percentage of the publications come from HF/E-related publications outlets recommends for future research approaches to HF/E in Industry 4.	Emphasizing empirical evidence to set a baseline for challenges and opportunities in new digital technologies and Industry 4.0, broadening research to cover all organizational levels: strategic, tactical, and operational.	Other academic publications may employ different terminologies to describe the concept. Some may focus solely on specific technological aspects, avoiding terms associated with the broader concept of Industry 4.0.
2. (Reiman, 2021) Finland	Reviewing the current research on HF/E in Industry 4.0 via a scoping review to summarize findings and develop HF/E maturities amidst rapid technological advancements.	existing literature and relevant studies about the inclusion of HF/E in the Industry 4.0 context.	Modified version of the scoping review process of five stages as depicted by Arksey and O'Malley. scoping review.	Microergonomics challenges in Industry 4.0, focusing on human, technology, work task, work environment, and organizational levels, along with Macroergonomics perspectives on technology, organization, and personal aspects. Includes table and graphical summaries..	HF/E needs to be better positioned in strategic design and management practices and processes and Organizational capabilities needed to the maturity.	Assessing the applicability of the organization-centric capability model in structuring individual capabilities in the Operator 4.0 context linked to Industry 4.0.	Organizational capabilities should be discussed as a holistic entity.
3. (Broday, 2020) Brazil	To performe a literature review about the existing studies on the relationship of Industry 4.0 and Participatory Ergonomics.	a more detailed analysis was performed with the 10 most recent articles published in Journals	Bibliometrics method combination of keywords in the SCOPUS database	Results presented based on 9 criteria: Detailed search results; Annual scientific production; Average citations per year; Citation growth in main sources; Main countries; Most cited countries; Most frequent terms, etc. Includes data table and source growth diagram..	In implementing participatory ergonomics programs, new technologies can be used early enough, making users need to adapt to them so that the financial benefits are available to pay upfront costs, which can be high.	Future research should address industry-specific concerns, long-term technology impact, and in-depth evaluations of participatory ergonomics in the Fourth Industrial Revolution.	The study may have overlooked intricate effects and industry-specific variations in technology adoption and ergonomics.
4. (Longo, 2021) Italy & USA	To conduct a bibliometric analysis of the extant literature on HF/E in the O&G industry.	Elsevier's Scopus database for the collection and screening of the peer-reviewed literature.	A query consisted of a combination of three sets of keywords. A Microsoft Excel database with the bibliometric details of these papers. Performance indicator extraction for the bibliometric analysis.	simulation has become a relevant area of interest in the O&G sector. the broad spectrum of HFs and the complexity of O&G activities, mapping how I4.0 technologies may support the field is therefore still a gap. Histogram, data tables and keywords network chart.	This paper demonstrates a holistic understanding of the changing role and responsibilities of workers in the 4.0 industrial age, especially for critical and hazardous environments, such as the O&G industry.	Further research will focus on a more in-depth content analysis of the HF/E literature in the O&G sector, as well as mapping new digital technologies and Industry 4.0 with HFs.	Integration of Industry 4.0 in Human Factors/Ergonomics (HF/E) literature for O&G is limited. The emphasis is on simulation-based training, while specific applications of Industry 4.0 technologies are overlooked.
5. (Rauch, 2020) Italy & UK	The field of data collection described in the text is related to Industry 4.0 and its transformation of physical and cognitive aid systems in production.	The methodology used in this paper is a qualitative research approach, including a literature review and case study analysis.	The results show that cognitive and sensorial aid systems are crucial for future factories, as the operator will have to carry out complex cognitive tasks such as coordination, supervision, and decision-making.	The results show that cognitive and sensorial aid systems are crucial for future factories, as the operator will have to carry out complex cognitive tasks such as coordination, supervision, and decision-making.	This paper conducts a systematic literature review (SLR) on anthropocentrism in production pre and during Industry 4.0. The authors identify anthropocentric perspective clusters through content analysis of SLR references.	Future research should focus on advancing assistance systems for cognitive and sensory support. Training is essential to prepare both existing and new operators for the future factory..	The research is focused solely on the anthropocentric perspective of production before and within Industry 4.0, comparing the transformation of research fields in this area. It does not address other perspectives or aspects of Industry 4.0.

6. (Gualtieri, 2021) Italy	Evaluate the current state of designing safe and ergonomic collaborative robotic work cells in Industry 4.0. Identify and analyze recent scientific literature themes on safety and ergonomics for industrial collaborative robotics, pinpointing emerging research challenges in the field.	Utilized a systematic literature review methodology to examine 67 recent technical scientific papers on safety and ergonomics in industrial collaborative robotics published from 2015 to 2018.	recent technical scientific bibliography, review methodology involves a systematic and thorough search and analysis of existing literature in a specific field in order to identify key themes	four sub-clusters: Contact Avoidance, Contact Detection and Mitigation, Physical Ergonomics, and Cognitive and Organizational Ergonomics. The research interest in HRI ergonomics leads to a balance in the production of annual papers in both safety and ergonomics	64.2% of the papers were related to safety and 35.8% to ergonomics. The data showed that the actual research interest in HRI ergonomics is leading to a balance in the production of annual papers in both safety and ergonomics categories.	the themes in Physical and Cognitive and Organizational Ergonomics are emerging and attractive research fields, with significant growth in annual paper production.	Study limited to 2015-2018. Considered only journal-type documents in Engineering and Computer Science. Excluded impact on Small and Medium-sized Enterprises (SMEs). Categorized into safety and ergonomics, with four clusters and 11 sub-clusters.
7. (Virmani, 2021) India	Analyzing Roadblocks of Industry 4.0 Adoption	Big data from an integrated IoT-based manufacturing system. Ergonomics in Industrial Revolutions from selected Industry 4.0 references	Keyword search from research database and categorizing according to key roadblocks, building up interdependency structure with 15 experts opinion, Graph Theory and Matrix Approach(GTMA) methodology	Roadblock diagraph, variable permanent matrix (VPM) by MATLAB computation of I4.0 roadblocks, RADAR diagram for the intensity of roadblocks.	The roadblocks in decreasing order of priority are listed as management roadblock, operational roadblock, human resource roadblock, procedural roadblock, and behavioral roadblock, who can be used by managers, industrialists, practitioners, and policymakers.	total interpretive structural modeling technique can be used; other sectors, such as power or electronics, can be considered; the roles and skill sets of smart operators required to work in a I4.0 environment need to be further explored.	I4.0 is a vast and emerging domain of research, as such, listing and analyzing all potential roadblocks simultaneously be tedious and subject to errors.
8. (Bortolini, 2021) Italy	to make a Reference Framework and Full–Scale Prototype using adaptive automation assembly systems (A3Ss)	Relevant literature in advanced assembly, featuring a prototypal A3S, the Self-Adaptive Smart Assembly System (SASAS), with real-time control and reconfiguration managed by PLC (Bosch Rexroth XM type).	Selected and classified key research contributions based on human, automation, or integrated human-automation perspectives. Integrated full-scale A3S prototype, SASAS. MATLAB-based GUI for real-time SASAS reconfiguration management, along with a marker-less motion capture (MOCAP) system for human motion.	the ANOVA analysis of gap percentage of the cycle time between the two configurations DELTA vs MT, ART, RN, M%. configuration tracking tables with REBA ergonomic index, Spaghetti chart for two configurations.	To increase the productivity and the ergonomic performances of manual assembly systems (MASs), maintaining flexibility, next-generation MASs are required to introduce higher automation.	This paper expands the lacking research on A3Ss proposing a reference framework guiding toward their effective design and validation.	inclusion of the economic and environmental dimensions to the proposed framework, embracing a holistic multi-objective methodology.
9. (Battini, 2020) Italy & Norway	Human-Oriented Assembly Line Balancing and Sequencing Model in the Industry 4.0 Era	wearable 4.0 devices that can be used to evaluate ergonomics conditions	Qualitative methods with subjective evaluations, based on verbal estimations made by the operators during execution of the task. The other approach involves quantitative methods, which are related to the real measurement of the load using existing devices. HR monitoring systems.	Precedence graph, multiple approach to evaluating the VAM, numerical analysis with SALBP and MALBP frontiers.	Efficient assembly systems necessitate integrating ergonomics for operator well-being, enhancing final product quality, and reducing costs linked to absenteeism and employee turnover from accidents or injuries.	Future research in the field could explore similar approaches for various human activities, such as material storage, handling, parts feeding to assembly systems, and machine loading and unloading.	Using a multi-objective balancing model, SX-E and SX-T are minimized,

3. Methods:

Firstly let's see how developed countries have changed their industrial sector through i4.0. Then we will review is Bangladesh in the same way or not according to the government's 'perspective plan 2021-2041' and '8th fiscal year plan 2020-2025'. Including the review of the lack of proper planning on i4.0 implementation in industries and how the plans were limited only to the ICT sector according to perspective plan 2010-2021' and previous fiscal year plans. Prior to reviewing the implementation of i4.0 as being a 'first world country', let's have a glance on what are the components of i4.0 in an industry context. A review of the current state and implication of industry 4.0 components worldwide and then the significance in Bangladesh was first done.

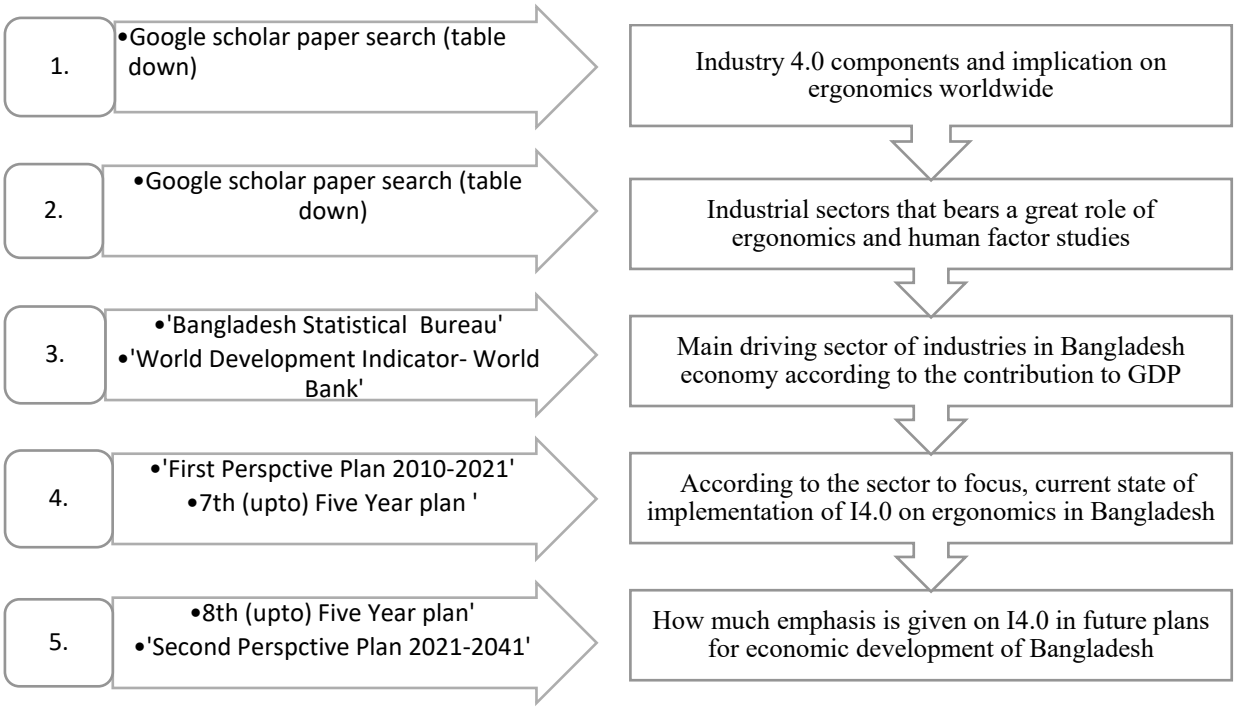

Figure 1. Relational flow chart of literature review.

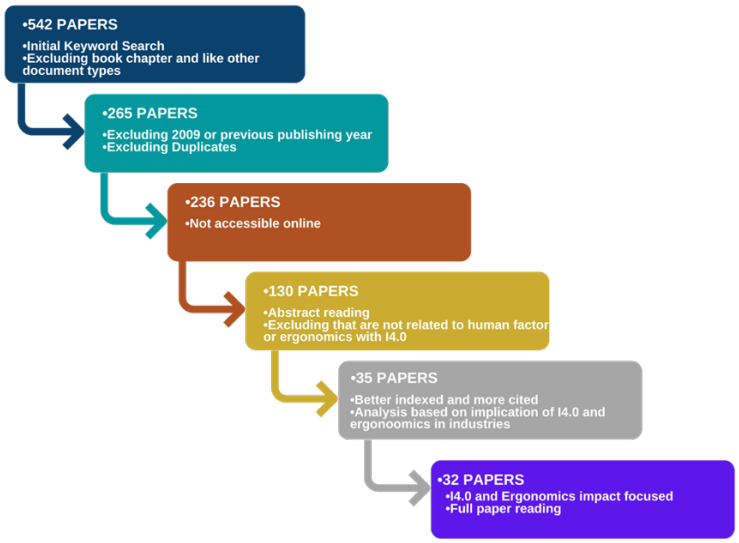

Figure 2. Flow chart of systematic paper chart.

To review and assess Bangladesh's I4.0 current state and future prospects, the reference sources were

1. BBS- Bangladesh Bureau of Statistics ((BBS), 2023)
2. WDI- World Development Indicator Databank based on World Bank (World Development Indicators, 2023)
3. FYP- Five Years Plannings based on Ministry of Planning, Bangladesh Government (General Economics Division (GED), Bangladesh Planning Commission, 2020)
4. Perspective Plan 2010-2021- Vision 2021 (General Economics Division(GED), Bangladesh Planning Commission, 2012)
5. Perspective Plan 2021-2041- Vision 2041 (General Economics Division (GED), Bangladesh Planning Commission, 2020)
6. Bangladesh Delta Plan 2100 (General Economics Division (GED), Bangladesh Planning Commission, 2018)

3.1 Data and Information Collection And Analysis

According to the systematic process of reviewing the current state of implementation and scope of Industry 4.0 concerning ergonomics, the review can be discussed in the following segments.

3.2 I4.0 Components & Ergonomic Implications Globally

In the book "The Fourth Industrial Revolution", Schwab coined the phrase to describe the ongoing fusion of advances in various fields, including artificial intelligence, robotics, the Internet of Things, genetic engineering, quantum computing, and other transformative technologies. From the scenario of I4.0 adopted countries and the advancements made in the field of technology, several key components of the Fourth Industrial Revolution are being implemented on a global scale. These components include:

1. Cyber-physical systems: The integration of physical and virtual systems enables real-time data monitoring and analysis, allowing for optimized decision-making and automation in industrial processes. (Sackey, 2017)
2. Internet of Things: The connectivity of physical devices and objects allows for the exchange of data and communication between machines, leading to more efficient and coordinated operations within industrial systems. (Türkeş, 2019) (Kamolov, 2019)
3. Cloud computing: The utilization of remote servers for storing and processing data enables easy accessibility, scalability, and flexibility in managing large amounts of information and applications. (Niu, 2019)
4. Cognitive computing and artificial intelligence: The implementation of advanced algorithms and machine learning techniques enables machines to analyze and interpret data, make autonomous decisions, and continuously learn and improve their performance over time. (Sader, 2019)
5. Big data analytics: The ability to collect and analyze vast amounts of structured and unstructured data (Ed-daoudy, 2019) in real-time allows for the identification of patterns, trends, and insights that can drive innovation and informed decision-making in various industries.
6. Advanced robotics: The use of intelligent machines and robots that can perform complex tasks with precision and efficiency, reducing human intervention and enhancing productivity in manufacturing and other industrial processes. (Tsai, 2018)
7. Edge computing: The distribution of computational power and storage closer to the edge of the network enables real-time processing and analysis of data at the source, reducing latency and improving response time in industrial operations. (Bajic, 2019)
8. Robotics and automation: The integration of robotic systems and automated technologies enhances production efficiency, quality control, and safety in industrial settings. (Ahmad, 2020)
9. Cybersecurity: With the increasing connectivity and data exchange in the Fourth Industrial Revolution, ensuring the security and protection of industrial systems, networks, and data is paramount. (Bajracharya, 2020)
10. Additive manufacturing: The ability to create three-dimensional objects by adding layers of material enables faster prototyping, customization, and production of complex and intricate designs in various industries, revolutionizing traditional manufacturing processes. (Razavykia, 2020)

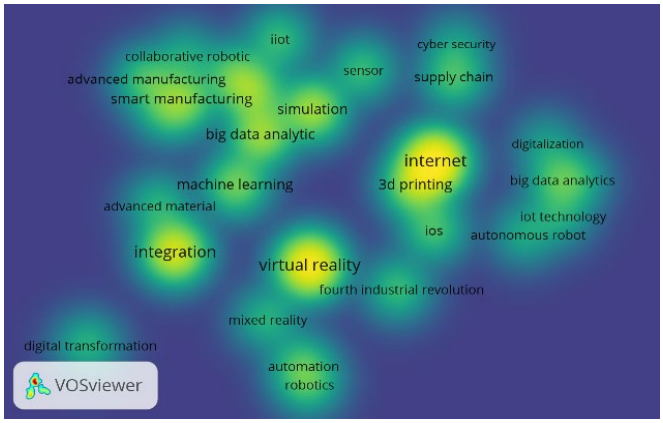

Figure 3. Density diagram of how many times the components of IR4.0 were mentioned in papers.

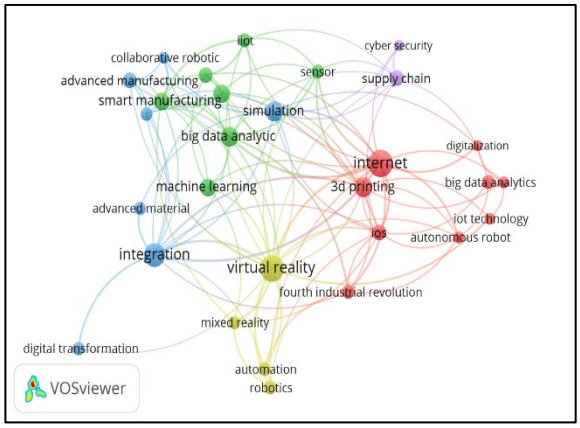

Figure 4. Bibliometric view of how many times the components of IR4.0 have been discussed in papers from 2005 to 2023.

The developed economies broadly comprise Northern America and Europe, Israel, Japan and the Republic of Korea as well as Australia and New Zealand. (classifications., n.d.) They are also called “more developed country" (MDC), "more economically developed country" (MEDC), "Global North country", "first world country” and "post-industrial country" for their ongoing industrialization process started with industrial revolutions.

3.3 Ergonomics and I4.0 In Key Industrial Sectors

Understanding the critical importance of ergonomics and human factor studies in various industrial sectors is essential for optimizing productivity, worker well-being, and safety. A brief view of industrial sectors is given where these disciplines play a pivotal role, in promoting efficient and sustainable work environments. Additionally, it highlights the contribution of Industry 4.0 components in developed countries, showcasing the technological advancements enhancing these sectors. This table presents a comprehensive overview of the outcomes influenced by ergonomics stemming from Industry 4.0 adoption across various regions and companies, showcasing the real-world impact of Industry 4.0 on the workforce and industrial landscape.

Table 1. Region-wise Industry 4.0 adoption (company-based) and impact

Regions		**Examples of Companies Implemented (one example)**	**Outcomes Based on Ergonomics**
North America		**General Electric (GE)**: Known for its "Brilliant Factory" initiative, GE has embraced Industry 4.0 to enhance manufacturing efficiency.	Improved safety and productivity through ergonomic workplace designs and a reduction in workplace injuries.
South America		**Valeo**: A French automotive supplier with a presence in South America, Valeo employs Industry 4.0 in its automotive technologies.	Enhanced worker safety and comfort in automotive manufacturing through ergonomically designed technologies.
Europe	Western Europe	**Siemens**: A leader in Industry 4.0, Siemens offers products and solutions for automation, digitalization, and data analytics.	Enhanced worker well-being and safety through ergonomically optimized production processes and human-robot collaboration.
	Northern Europe	**ABB Group:** ABB applies Industry 4.0 principles in robotics, automation, and power technologies, improving industrial processes.	Implementation of ergonomic designs in robotics and automation solutions has reduced injuries and discomfort.

	Southern Europe	**Bosch**: Bosch has implemented Industry 4.0 practices in manufacturing, focusing on smart factories and IoT-enabled devices.	Improved worker comfort, well-being, and productivity through ergonomic principles in smart factory designs.
East Asia		**Fanuc Corporation**: A Japanese company specializing in industrial automation and robotics, Fanuc has implemented Industry 4.0 in its production lines.	Ergonomic design of industrial robots has enhanced safety, worker well-being, and reduced physical strain.
South Asia	India	**Tata Consultancy Services (TCS):** TCS has applied Industry 4.0 principles in IT services, offering digital transformation solutions to various industries.	Improved ergonomics in digital transformation solutions, enhancing user interfaces and worker well-being.
	Bangladesh	**PRAN-RFL Group:** A prominent Bangladeshi conglomerate, PRAN-RFL, has integrated Industry 4.0 practices in its manufacturing processes.	Integration of ergonomic practices has improved worker comfort, safety, and overall workplace ergonomics.
Africa		**Dangote Group:** Dangote Group, a Nigerian conglomerate, has adopted Industry 4.0 in various sectors, including manufacturing and agriculture.	Implementation of ergonomic designs has improved safety and well-being in the manufacturing and agriculture sectors.

Providing a concise overview of the pivotal role ergonomics and human factor studies play in a range of industrial sectors, contributing to both worker well-being and operational efficiency, an inquiry may arise on whether the current economy or economic plans of Bangladesh are driven by these or not.

3.4 Bangladesh's GDP-Driving Sectors

In the 2022-23 fiscal year, the share of industries in Bangladesh's gross domestic product was 35.55 percent. ((BBS), 2023)Targets, strategies, and policies for the Manufacturing Sector have been designed in economic plans to meet the challenges of industrialization of Bangladesh in a competitive world because Manufacturing is the predominant and leading sector and it is and will remain the driver of industrial growth and employment for years to come. (General Economics Division(GED), Bangladesh Planning Commission, 2012) Among the manufacturing activities sectors such as 'food processing'; 'leather and footwear', 'textile and clothing', 'pharmaceutical', 'shipbuilding', toys, ceramics, and furniture are likely to be the main growth generators and also have shown very strong growth.[Bangladesh Bureau of Statistics]

Amongst them, at the fiscal year 2018, Bangladesh was able to garner US$36.67 billion in export earnings by exporting manufactured goods, of which, 83.49 percent came from the apparel manufacturing sector. (Hossian, 2019) With over two million jobs employing about 6.5 million people and accounts for over one-half of manufacturing production 40 and 77% of export earnings from the RMG sector, too much of the nation's fortune is riding on this one sector. (General Economics Division(GED), Bangladesh Planning Commission 2012)

Bangladesh has a strong track record of growth and development, even in times of elevated global uncertainty. A robust demographic dividend, strong ready-made garment (RMG) exports, resilient remittance inflows, and stable macroeconomic conditions have supported rapid economic growth over the past two decades. (Bangladesh Overview: Development news, n.d.)

The GDP is estimated to have expanded by 6.03 percent in the fiscal year 2022-2023 ending in June, it comes as the industrial sector has been grappling with a sharp fall in the value of the taka against the US dollar, and lower investment, exports and import of raw materials. (Rejaul Karim Byron, 2023) ((BBS) 2023)

Table 2. Contributive View of Bangladesh's Economy

Series Name	2020	2021	2022
GDP (current US$)	3.73902E+11	4.16265E+11	4.60201E+11
Industry (including construction), value added (current US$)	1.23057E+11	1.38683E+11	1.56101E+11
Manufacturing, value added (current US$)	77017614240	88396632156	1.00162E+11
Industry (including construction), value added (% of GDP)	32.91156508	33.31609439	33.9200805
Manufacturing, value added (% of GDP)	20.59833159	21.23567299	21.76481936
Industry (including construction), value added (annual % growth)	3.611090383	10.28711502	9.855663436
Manufacturing, value added (annual % growth)	1.680819158	11.58513879	11.41082771

The industrial sector's growth dropped by 1.68 percentage points to 8.18 percent in 2022-23. It was 9.86 percent a year ago. ((BBS), 2023) (Rejaul Karim Byron, 2023)

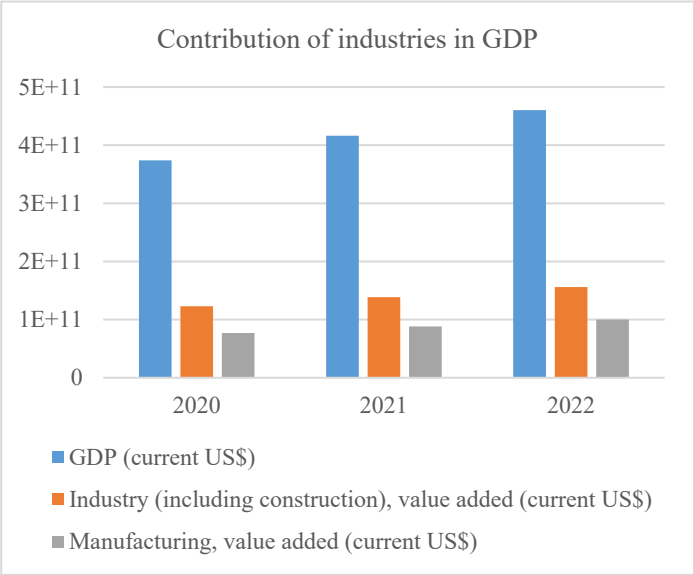

Figure 5. Contribution of manufacturing and other industries in GDP.

Despite of the scenario, apparel industry had always been the driving sector in the industrial sector's contribution to country's GDP. Now we will see how importance is given to industrial and energy sector with Industry 4.0 given into account according to some previous and ongoing masterplan.

According to Perspective Plan Of Bangladesh 2010-2021 that is Vision 2021 planned to be stipulates middle income status for Bangladesh by 2021 required superior double digit performance for manufacturing taking its share in GDP to 28 percent by 2021, and that of industry to 37% percent (General Economics Division(GED), Bangladesh Planning Commission, 2012) likely closed to what is achieved, that is 33% (World Development Indicators, 2023).

Thus, economic development is quite impossible. without upgradation and improvement of this sector and that is why, the implementation of i4.0 is time demand.

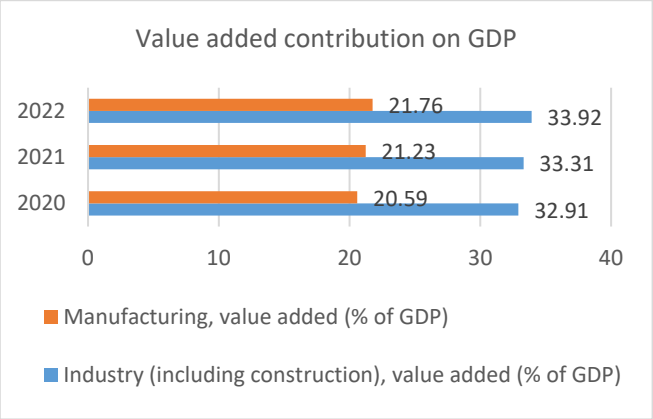

Figure 6. Value-added contribution to GDP.

3.5 Prior I4.0 Plans In Bangladesh

Although Bangladesh is a developing country, the country is not less aware of development plans. During the former Pakistan period, several development plans were adopted from 1947 to 1971. The first Five Year Plan of Bangladesh was prepared for the period from 1973 to 1978. Then the Second Five-Year Plan was replaced by an Interim Biennial Development Plan (1978-80). From 1980 to 1995, the Second, Third, and Fourth Five Year Plans were published. The fifth five-year plan started after 2 years i.e., for the period 1997-2002. For 2003-2011, the government formulated the Poverty Reduction Strategy Paper (Interim and Comprehensive) in lieu of the Sixth Year Plan. From 2011 to 2020, the Sixth and Seventh Five Year Plans were published. On 29 December 2020, the National Economic Council (NEC) gave final approval to the country's eighth five-year plan (2021-2025).
In 2016, World Economic Forum founder Klaus Schwab mentioned the name of the Fourth Industrial Revolution in his book of the same name. Here a glance is given on how much emphasis has been placed on industry and digital technologies in allocating budget in the previous plans up to Seventh Five Year Plan and First Perspective Plan (2010-2021).

Table 3. I4.0 emphasizes in previous economic plans of Bangladesh.

Economic Plans	Goal	State of Industry and Digital Technology Emphasis
First Five-Year Plan-1st FYP (1973-1978), Biennial Plan (1978-1980), 2nd FYP (1980-1985), 3rd FYP (1985-1990), 4th FYP (1990-1995), 20 Years Perspective Plan (1990-2010)	Economic development of war-torn Bangladesh improve the standard of living of rural life. Expansion of [productive employment Self-employment & Industrialization	Up to influence & expansion of industrialization only
Fifth Five-Year Plan (1997-2002)	Accelerating the rate of economic growth to alleviate poverty	Giving importance to R&D of new generation technologies (including electronics & genetic engineering)
Sixth Five Year Plan (2011-2015)	Accelerating economic growth by growing small & medium enterprises and agriculture sector	Development of IT sector to build Digital Bangladesh.
Seventh Five Year Plan (2015-2020)	Making supportive macroeconomic environment by trade & privet sector development	Increasing digital communication through telephone and broadband services
Perspective Plan 2010-2021-Vision 2021	ensuring of macroeconomic stability making annual GDP growth rate to 10% and turning Bangladesh into a middle-income country by 2021	Emphasis on fulfilling goal to Digital Bangladesh by making improved vibrant and effective transport and communication network only.

According to the papers, there were merely any field to have the data on the budget and expenditure report on implementation of digital technologies, thus relevant quantitative data could not be shown.

3.6 Future Emphasis on I4.0 In Bangladesh

Later than, '8th Five Years Plan 2020-2025' and 'Perspective Plan 2020-2041' which is called 'Vision 2041' published and several development budgets have been set. The plans are formulated with the aim of poverty alleviation, economic structuring and achieving high economic growth rate to reached to the milestone of being a developed economy. Here the concern is whether the plans are on the base of I4.0 implementation on the driving industrial sector of Bangladesh like RMG or not.

4. Results and Discussion

The following aspects are drawn from this review.

4.1 Bangladesh's I4.0 Assessment

According to chapter 3 of 'End Evaluation of the 7th Five Year Plan' published in May 2023, employment states and shortcomings of the 7th FYP have been discussed and come to realization that enhancing the quality of the labor force required to be in priority. The workforce's productivity must be boosted due to the growing automation of the fourth industrial revolution (4IR) and the waning significance of regular, labor-intensive tasks. Given the growing automation of industries and the significance of 4IR-related technologies, more focus is required on updating the training programs' current curricula, offering trainers skill development, incorporating 4IR-related sophisticated skills into education and training, and-above all-addressing the problems associated with skill mismatch. But with increased challenges of automation and 4IR, a relatively low level of endowment of skills of the workforce is given. (General Economics Division (GED), Bangladesh Planning Commission 2023)

Additionally, according to chapter 13 of the same paper, it is acknowledged that, to materialize the vision-2041, it is critical to consider the lessons that were learned during the 7FYP period and to closely evaluate the new innovations that the fourth industrial revolution (4IR) has sparked. As Bangladesh adopted numerous acts, policies, guidelines, and strategies during FYP periods, the '4IR-Based Future Skills Policy' is taken as urgent. To remain competitive in the 4IR era, the nation must concentrate on creating a skilled labor force, enhancing connectivity and infrastructure, and encouraging innovation and research. As a result, preparedness for the 4th industrial revolution and innovation competency must be evaluated. The ICT industry in Bangladesh faces a skills mismatch, necessitating a focus on upskilling the workforce for 4IR technologies and innovation. This can be achieved through industry-aligned training programs on technical and soft skills, along with high-quality managerial training for managers and executives. Emphasizing Java and Python programming languages is crucial for immediate technical skills needs. Additionally, training on technologies for 4IR areas, such as ML/AI, cloud computing, data science, and big data analytics, is beneficial for global clients and firms already operating or planning to enter these areas. In a nutshell, to make the most of the 4IR era, Bangladesh needs to proactively build an innovation-based economy that can drive development.

4.2 Proposed Improvements

There are some economic plans- 8th Five Year Plan 2020-2025 and Perspective Plan 2021-2041 (Vision 2041) as part of government's initiative to making the economy developed. Giving priority on employment generation, the government intended to promote ICT-based entrepreneurship embracing the 4IR as an exclusive pivotal theme to 'Accelerating Inclusive Growth strategy'. In the first part of 'Macroeconomic strategy and Policy' section chapter of 'Strategy For Manufacturing Sector Development With Export-Led Growth' gives a brief statement about the 4IR implications for employment and the growing problem of labor displacement. The manufacturing sector in Bangladesh will eventually have to embrace the advantages of technological sophistication in order to maintain global competitiveness in the age of the fourth industrial revolution and boost productivity as the digital economy becomes more firmly established and digital technology permeates all facets of Bangladeshi life. The Fourth Industrial Revolution (4IR), mainly propelled by automation, robotics, and artificial intelligence (AI), has been revolutionizing our lifestyle, work, and production processes. 4IR unleashes a wave of Schumpeter's renowned "creative destruction" in the marketplace. Bangladesh faces a huge challenge in navigating this technological transition so that the benefits far outweigh the drawbacks as it quickly advances industrially, largely thanks to export-led growth. Unfortunately, there is a net loss of jobs because of growth's inability to keep up with the employment lost to automation. (General Economics Division (GED), Bangladesh Planning Commission, 2020)

Thus, another challenge is to reorganize the manufacturing sector so that it continues to grow and add jobs while mitigating the effects of technological advancement and rising capital intensity of production linked to the ongoing Fourth Industrial Revolution (4IR).

According to the chapter of Transport And Communication Development Strategy (chapter 6), after the success on development and adaptation of satellite and cellular transmission network infrastructure during 7FYP, realization come out on the necessity of changes to the current regulatory and policy frameworks because the telecommunications sector must be ready to support other industries in realizing the potential of 4IR amongst the goals, targets, and strategies for telecom sector during the 8FYP. Considering IoT and M2M has become an integral part of the contemporary digital infrastructure and cloud services infrastructure being on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service, proper legal bindings, technical standards-guidelines, and proper guiding documents must be formulated within a very short period are yet to be made to enable a 4IR compliant digital connectivity ecosystem regarding service standards, privacy, data protection, and information security.

In the second part named 'Sector Development Strategies', health sector digitization and reduction of the lack of interest in STEM (Science, Technology, Engineering, and Mathematics) as preparedness for 4IR in the education sector (chapters 10 & 11 respectively) are discussed. Adapt to lifelong learning models, the skill for employment and investment (SEIP), making market-oriented training and curriculum have also been included to address the skills constraint and to accelerate growth under the 4IR.

Lastly, the Digital Possibilities for Coping up and Leveraging 4IR is discussed dedicatedly in chapter 12 named 'Leveraging Digital Bangladesh and ICT Strategy for Higher Growth' Strategic recommendations have been stated according to 11 different observations for coping up the 4IR and addressing the recently raised challenges like COVID and climate issues, an exclusive domino effect of policy implicating action agenda has created across 2021 to 2025 fiscal years. (General Economics Division (GED), Bangladesh Planning Commission, 2020)
In the documentation on Vison 2041(Perspective Plan 2021-2041), 'Industrialization Export Diversification and Employment Generation in A Futuristic World Order' is focused on chapter 7 and before the discussion about the race of trade and industrialization and dynamism of RMG exports amongst Asian tigers, the paradigm of job losses in some cases and job gains in others will be going on. (General Economics Division (GED), Bangladesh Planning Commission, 2020) Overall, Creating an Innovation Economy is emphasized by Moving from a factor-driven stage to an innovation-based economy and Leveraging the Fourth Industrial Revolution as stated in 8FYP.

5. Conclusion

Amidst the dynamism of RMG, keeping concern and focus on 4IR in the advancement of Bangladesh's innovation-based and industrial-based economy will have a significant impact on Bangladesh's industrial infrastructure. The way it affects the infrastructure of the developed world has created a competitive environment and makes 4IR a must in the visionary plans of developing countries like Bangladesh. As a result, there will be a radical change in the interactive environment of man and machine in the industrial infrastructure and there will be a huge application of innovative technology elements in the study of ergonomics and human factors. Bangladesh's concern about the global wave of 4IR and its reflection in various economic plans is quite rightly reflected. In the fluctuations of Job loss and Job creation, it can be said that the use and effect of 4IR on the human factor, ergonomic, and workplace environment in the industrial establishments of Bangladesh is going to witness the country's economy positively.

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