International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 334-341
Published Online February 2021 in IJEAST (http://www.ijeast.com)

OPERATIONAL READINESS OF PAKISTAN TEXTILE INDUSTRY TO IMPLEMENT INDUSTRY 4.0 (A STUDY OF HYDERABAD TEXTILE)

Sohrab Ali
Mehran University Institute of Science Technology and Development,
Mehran University of Engineering and Technology, Jamshoro

ABSTRACT— **Any industrial revolution starts with the aim of increasing efficiency. Previous technological movements have concentrated on the manufacturing structure at the factory floor level. Industry 4.0 is the 21st century's industrial revolution, and it will be the next manufacturing paradigm. In the first revolution, industries achieved high efficiency by steam engines, in the second revolution, industries used energy and production lines, and in the third revolution, industries have shifted from analogue to digital technologies. Industry 4.0 is the 21st century's industrial revolution, and it will be the new business model. In the packaging industry, mass production is giving way to customised production. Internet of Things, Industrial Internet, Smart Manufacturing, and Cloud-based Manufacturing are some of the terms used. The key goal of this research is to see how technologies can help manufacturing companies get ready for Industry 4.0. The study illustrates an examination of preparation for Industry 4.0 deployment, which was measured using a University of Warwick model. Quantitative approaches were used to determine the relationship between organisational readiness and deployment by asking 35 workers of manufacturing companies closed-ended questions. His final result reflects a keen interest in the challenges that the Fourth Industrial Revolution poses to companies. While the majority of respondents see Industry 4.0 as a wonderful opportunity for increased competitiveness and development, the status of proposals for its implementation varies widely based on country, sector, and even individual firms.**

Keywords—**Industry 4.0, Cyber Physical System, Pakistan Textile Automation, Productivity Automation, Productivity, readiness**

I. INTRODUCTION

Technology is transforming our lives, including the way we create, purchase, and communicate with one another. Everywhere, digitalization is changing business models, and a single breakthrough will wipe out an entire industry.

Products are changing as they get smaller, smarter, and more dependent on embedded apps. Around the same time as product demand rises, customers demand individualized goods, which they can buy electronically and get shipped in a timely manner. If you are unable to provide this service to a client, anyone else can. As a result of the increased pressure, the industry must reduce time costs, improve flexibility, and improve consistency and performance. The only way out is to start a digital company. For today's automotive producers, Industry 4.0 I 4.0) is a solution. Since the invention of steam power machine production, mass production with electricity, and automatic production with electronics, this is the fourth industrial revolution. I4.0 is a modern approach to manufacturing in which conventional methods are combined with technology. It uses CPS (cyber-physical system), IoT (internet of things), sensors, and the internet to link humans with machines and machines with machines. Pakistan's textile industry is one of the country's most important manufacturing industries. It accounts for 57 percent of the country's exports and employs the second-largest number of people. Pakistan is the world's eighth biggest exporter of textiles. However, the growth of textiles has slowed in recent years. The main factors include a shortage of research and development, a lack of modernizing facilities, a rise in manufacturing costs, and so on. Due to a variety of factors, the textile industry is experiencing a downturn in exports, and it is losing market share globally.

II. LITERATURE REVIEW

2.1 PAKISTAN TEXTILE INDUSTRY:

Pakistan's textile industry is one of the country most significant. It contributes significantly to the country's economy through industrial activity, strong job opportunities, and foreign exchange inflows. Globalization and numerous economic challenges are causing significant changes in the industry. The textile industry's contribution to exports, GDP, employment, foreign exchange earnings, investment and value added, and revenue generation have combined to make it the country's single largest manufacturing sector. Cotton production in the country, which is one of the top ten textile exporting countries in the world, is a major contributor to the textile industry's massive growth. With a spinning capacity of 5% of global production. Pakistan is the world's fourth-largest producer of cotton yarn and cloth, and Asia's third-largest. It is also the world's second-largest wool exporter, third-largest cotton

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 334-341
Published Online February 2021 in IJEAST (http://www.ijeast.com)

exporter, and accounts for 3% of global textile trade. Pakistan, which has one of the world's largest textile and garment manufacturing industries, is rapidly establishing itself as an Asian hub for textile and garment trade.

Cotton's availability in the agriculture sector is critical to the country's economy, making textile and apparel production the largest industry in the country.

2.2 FOURTH INDUSTRIAL REVOLUTION:

The term "industry 4.0" was first used in 2011 at the Hanover Fair in Germany, and its blueprint, titled "The establishment of intelligent Products and Manufacturing Processes," was published in 2013. (Brettel, et.al, 2014). Internet of Things (IoT), cyber-physical processes (CPS), and embedded software are all part of Industry 4.0. CPS creates a network that monitors, controls, and integrates users with machines and vice versa in the presence of an internet network. IoT, on the other hand, collects data and exchanges it with users or machines in the presence of an internet network using sensors and other smart components. When these advances are combined with current business technologies, the industry can be fully transformed.

According to a (Pwc, 2016) report, 55 percent of businesses expect Industry 4.0 to pay for itself in two years; according to their survey, Japan and Germany are the most digitalized countries in the world; by 2020, global digitalization is predicted to hit 72 percent, which is twice what it is now. It focuses on e-applications in the textile industry's production chain, from orders to delivery (Görçün, 2018). Just 25 countries are in a position to profit from Industry 4.0, according to the World Economic Forum (WEF). These 25 countries account for more than 75 percent of global Manufacturing Value Added (MVA) and are well poised to grow their share in the future (Bhunia, 2018)..Figure 1 describes the previous industrial revolutions. The internet of things (IoT), big data, cyber-physical networks, automated factories, and robots are all part of the fourth industrial revolution. If the garment and apparel industries can keep up with technical advancements, they can gain a number of competitive advantages.

2.3 OPPORTUNITIES IN INDUSTRY 4.0

Any industrial revolution starts with the aim of increasing efficiency. The floor level manufacturing structure has been the subject of previous industrial revolutions. Steam power, energy, and the transition from analogue to digital technologies have helped industries achieve high efficiency. The fourth industrial revolution has a broader impact; it affects both primary and indirect departments (Hercko, Hnat, & Slamková, 2015). Thanks to a quicker, more scalable and reliable operation, Industry 4.0 can capture, gather, and interpret data from computers, allowing for the production of high-quality products at a low cost. This would boost productivity, economic income, manufacturing expansion, and workforce expertise. According to (Rüßmann, et al., 2015), industry 4.0 will be introduced by more companies in Germany in the next five to ten years, boosting production from €90 billion to €150 billion. According to a study conducted by (Pwc, 2016), businesses plan industry 4.0 to decrease operating expenses by 3.6 percent per year while increasing total sales by 2.9 percent per year; in reality, (Naylor, 2002) stated that increased efficiency leads to an improvement in living standards. Productivity is a general metric on how well an economy is doing. Productivity growth often adds to the country's GDP, although it varies by region.

Agriculture and textile sector development in Pakistan have a significant effect on the economy (Naz, Khan, & Syyed, 2017). Since operations management focuses on ensuring the optimum use of a company's available resources, it considers not only efficiency but also other factors involved with manufacturing that, when combined, produce value for the company. Mckinsey's Figure 1 depicts some of the industry 4.0 possibilities.

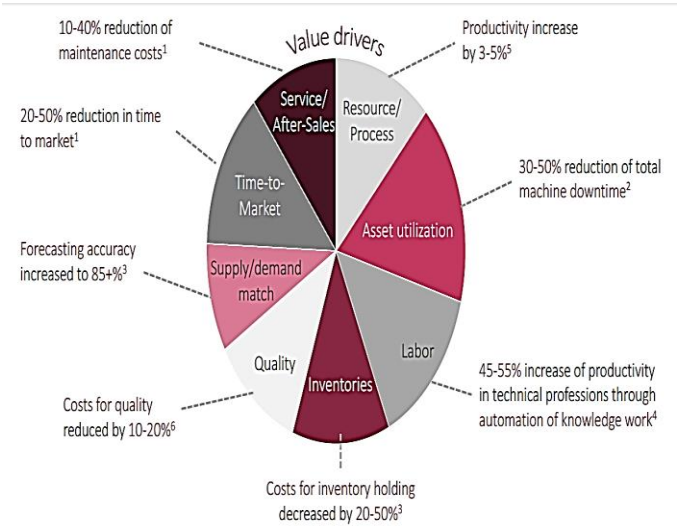

Figure 1 Value Drivers for Potentials according to McKinsey

2.4 CHALLENGES IN INDUSTRY 4.0

Industry 4.0, without a doubt, brings numerous new possibilities, but it also brings a number of new challenges. The past and future revolutions were both concerned with production and efficiency, but the Fourth revolution alters the industrial process by combining physical and digital technologies, transforming the conventional factory into a smart factory. (2018, Julian Marius Müller) Employee qualifications, approval, and organisational fit were found to have a negative impact on manufacturing firms' ability to adopt Industry 4.0.

2.4.1 LACK OF A CLEAR DIGITAL STRATEGY:

According to a global Industry 4.0 survey commissioned by PwC in 2016, the lack of a coherent digital solution in value-creating processes remains the biggest hurdle to adopting Industry 4.0, according to (52 percent) of 2000 experts from 26 nations. (Moktadira, 2018) The most pressing challenge in implementing Industry 4.0 in Bangladesh's leather industry, according to analysis, is a lack of technological capital.

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 334-341
Published Online February 2021 in IJEAST (http://www.ijeast.com)

2.4.2 HUGE INVESTMENT:

Industry restructuring is not only a technological problem, but also a financial one. Industry 4.0, according to (Zhou, Liu, & Zhou, 2015), necessitates significant capital spending in the industrial sector. Automation can save company money for a long time, but since a startup requires a large commitment, they must devise a strategy for launching this innovative solution while saving some money and ensuring good management in order to be competitive.

2.4.3 EXPERIENCE AND SPECIALIST:

(Wyrwicka & Mrugalska, 2018) State that the issue of competence arises during industry execution. In terms of ability and knowledge, competence. New technological sectors, such as Industry 4.0, necessitate new expertise from employees. Not only for mechanically repetitive tasks, but also for creative, exploring, situational appraisal, architecture, organization, and reengineering abilities. Governments must invest in training to build a professional, competitive workforce in order to foster Industry 4.0.

i.4.4 DATA SECURITY:

In industry 4.0, textile machinery is combined with software to create digital manufacturing, which is carried out by a network known as a cyber-physical system. Because data is shared between software and hardware, there is a risk of cyber security, and because it is connected to the main system, manufacturing companies face a significant challenge in implementing industry 4.0. (Zhou, Liu, & Zhou, 2015).

III. RESEARCH METHODOLOGY

. This research used a quantitative approach to catch the views of Pakistan's textile industry on the idea of Industry 4.0, which is gaining traction around the world. For quantitative data collection, a quantitative questionnaire focused on the WMG industry readiness model with a 4-point readiness evaluation was adapted from previous studies. When surveys are used as the primary means of data collection, questionnaires are widely used, but they can still be used for tests and case studies. The word "questionnaire" is used in this study to denote "self-completion questionnaires," which indicates that respondents fill out the questionnaire on their own... The sample is made up of people who worked in the textile industry at the top and middle levels of management, where they were involved in the whole process. the year 2018 Hameed, Imran, and Haque (Hameed, Imran, and Haque) Random samples from 5-7 textile manufacturing firms in the Hyderabad, Kotri, and Nooriabad clusters were taken to collect data because the textile industry is Pakistan's largest manufacturing sector and is divided into different regions. According to the survey size rule of thumb (Schmidt, et al., 2015), an acceptable sample size is greater than 30 but less than 500 respondents (Hamzeh, Zhong, & William, 2018). (2016, Arnold, Kiel, and Voigt) Yin (2014) defines evaluating as "the process of observing, categorizing, tabulating, measuring, and recombining data to obtain scientific results." The importance of each dimension and the level of implementation of each dimension were measured in this survey by asking businesses to rate the importance of each dimension and the level of implementation of each dimension. A company the measurement is performed on a four-point scale of 4.0. (1-beginner, 2-intermediate, 3-experienced, 4-expert)

1. Services and products
2. Chain of distribution
3. The business plan
4. Organization and strategy
5. Legal issues to remember
6. Production and service

The statistical analysis of total and average score of each dimension is done, through this the readiness of each dimension as well as weaknesses are able to be detected

IV. DATA ANALYSIS

CURRENT SITUATION OF THE TEXTILE INDUSTRY

The textile industry, Pakistan's single largest export earner, has ramped up production to pre-Covid-19 levels of maximum output, as a major increase in pandemic control in the country prompted world buyers to redirect some orders to domestic producers.

The textile industry has recovered to pre-Covid-19 levels, thanks to government-led precautionary steps to protect citizens from the virus and industry-specific economic measures," is according to the All Pakistan Textile Mills Association. Full-capacity output excludes certain textile units that closed down during the crisis... They are few in number and are attempting to eventually return to work. Overall, Pakistan's textile industry is doing admirably, well outperforming international competitors. World consumers have diverted orders from China, India, and Bangladesh to Pakistan for a variety of reasons, including the US-China trade war and a pause in demand in India as the Covid-19 crisis worsens. To transcend and seize current opportunities, it is important to upgrade. To do that, it is necessary to assess the current state of the market...

4.2 INDUSTRY 4.0 READINESS SUB-AREA DATA ANALYSIS

4.2.1 PRODUCT AND SERVICES

The survey's findings (shown in fig 2) revealed some intriguing insights into the kinds of practices that are actually being used. Since there is no facility for data processing, the majority of products are produced in broad batch quantities with little distinction, using 20-50 percent commodity data details obtained from customers. As a result, it does not currently share sales.

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 334-341
Published Online February 2021 in IJEAST (http://www.ijeast.com)

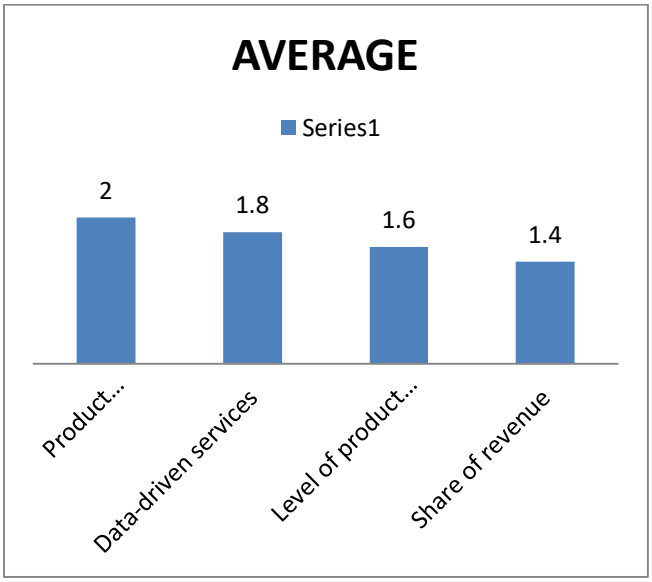

Figure 2 average readiness of product and services

4.2.2. BUSINESS MODEL

Figure 3 from the survey demonstrates that IT-enabled enterprise is a key enabler for the growth of new business models. Currently, 80 percent of businesses get IT help in certain ways for their processes. This results in a lack of data-driven decisions. It's surprising to learn that industry 4.0 assists all sectors with real-time monitoring and scheduling, which is actually at an intermediate stage but will be completely implemented in the next few years. The graph below reveals that the majority of the industries studied are at an intermediate stage.

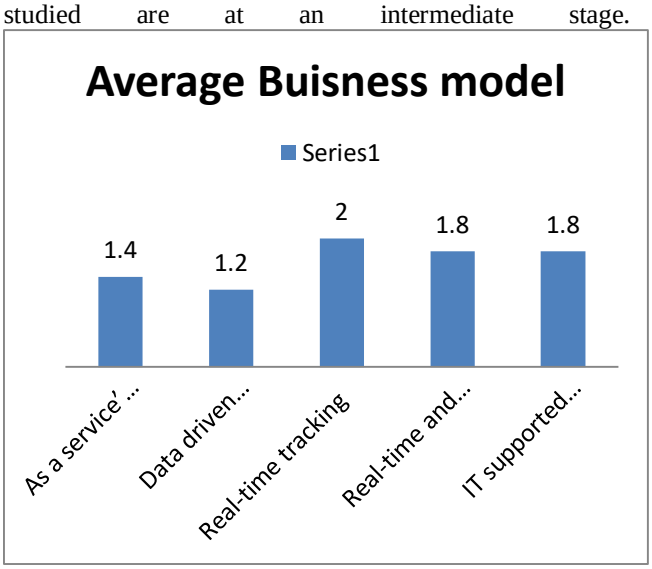

Figure 3 average readiness of business model

4.2.3. LEGAL CONSIDERATION

According to the findings, contracting structures are a deterrent to industry 4.0 adoption because they require third-party entry into the scheme. As a result, data security and legal risk are likely to occur. The average legal concern dimension for all of the surveyed sectors is below moderate, which can be strengthened by proper legal configuration and cyber protection.

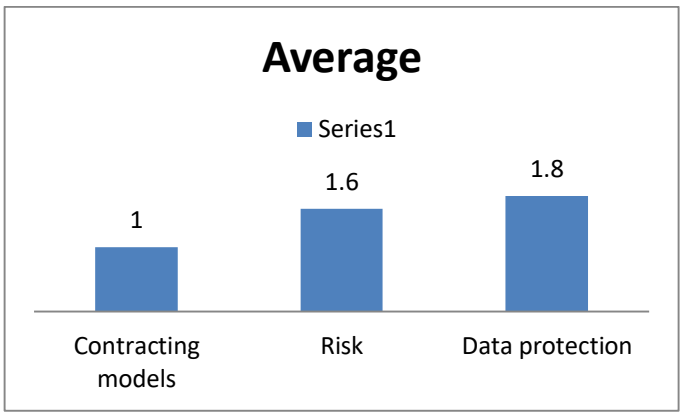

Figure 4 average readiness of legal consideration

4.2.4. STRATEGY AND ORGANIZATION

Industry 4 must be integrated into the corporate plan and built on a solid foundation of digital culture and expertise in order to be competitive. As assessed, the Strategy and Organization segmenting fig 5 has the INTERMIDIATE sophistication level of all fields in the survey: most sectors are focusing on investments in people capacity and new world implementations. It is apparent from the average graph that it primarily collaborates each individual in each department in order to maximize productivity.

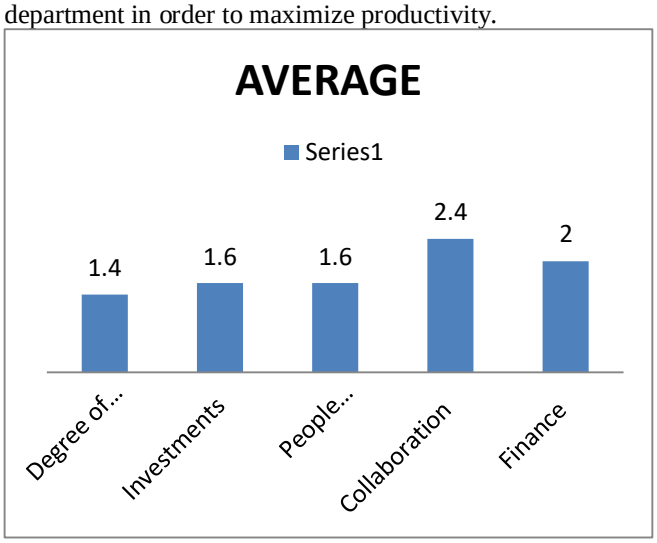

Figure 5 average readiness of strategy and organization

4.2.4. SUPPLY CHAIN

According to those who responded to the survey, their businesses are concentrating their attention on using real-time data to monitor and enhance their overall business planning and manufacturing processes, accompanied by efforts to improve supply chain resilience to respond to shifts in the consumer climate and individual consumer needs. Sees techniques, though, are just the beginning. With relatively little sharing and integration with vendors and consumers, real-time, high-quality data is mostly used

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 334-341
Published Online February 2021 in IJEAST (http://www.ijeast.com)

to drive segmented business decisions.

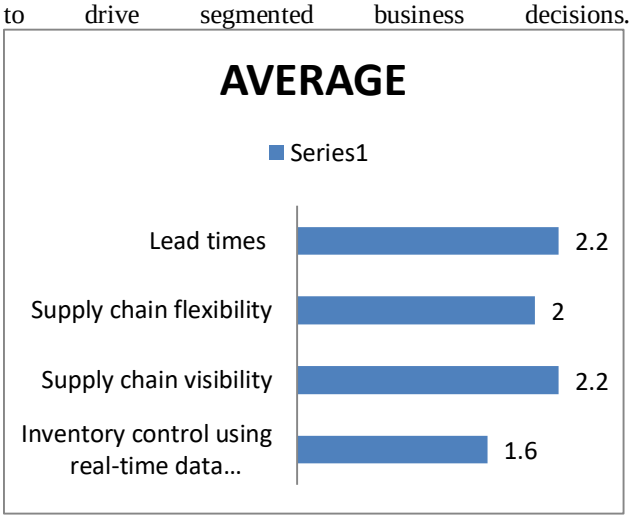

Figure 6 average readiness of supply chain

4.2.5 MANUFACTURING AND OPERATION

The survey's cumulative findings showed that this was the second lowest degree of preparedness. On the one side, it's surprising, considering that this is the essence of the original Industry 4 definition (see fig 7). In the other hand, part of the difficulty could be navigating the vast array of options and determining where to begin.

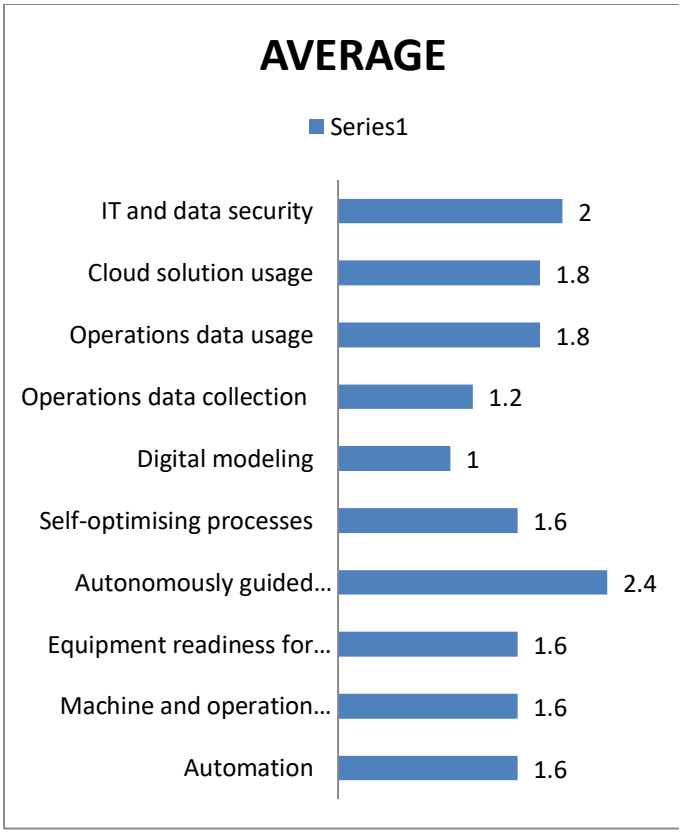

Figure 7 average readiness of manufacturing and operation

4.3 MAJOR OBSTACLE WHICH NEEDS TO BE OVERCOME FOR THE IMPLEMENTATION OF INDUSTRY 4.0.

The aim of this thesis was to undertake a systematic literature review on Industry 4.0 and the challenges associated with its implementation. In the theoretical context, the results were identified and discussed. Previous study findings were grouped into technical, functional, and environmental problems, which were then operationalized in the frame of reference. The operationalization aided in the creation of a shared awareness of these issues, allowing for a high level of standardization. Following that, the interviewees were asked which issues they see as the most important to their organizations. The most pressing issues of Industry 4.0 implementation are identified based on these responses.

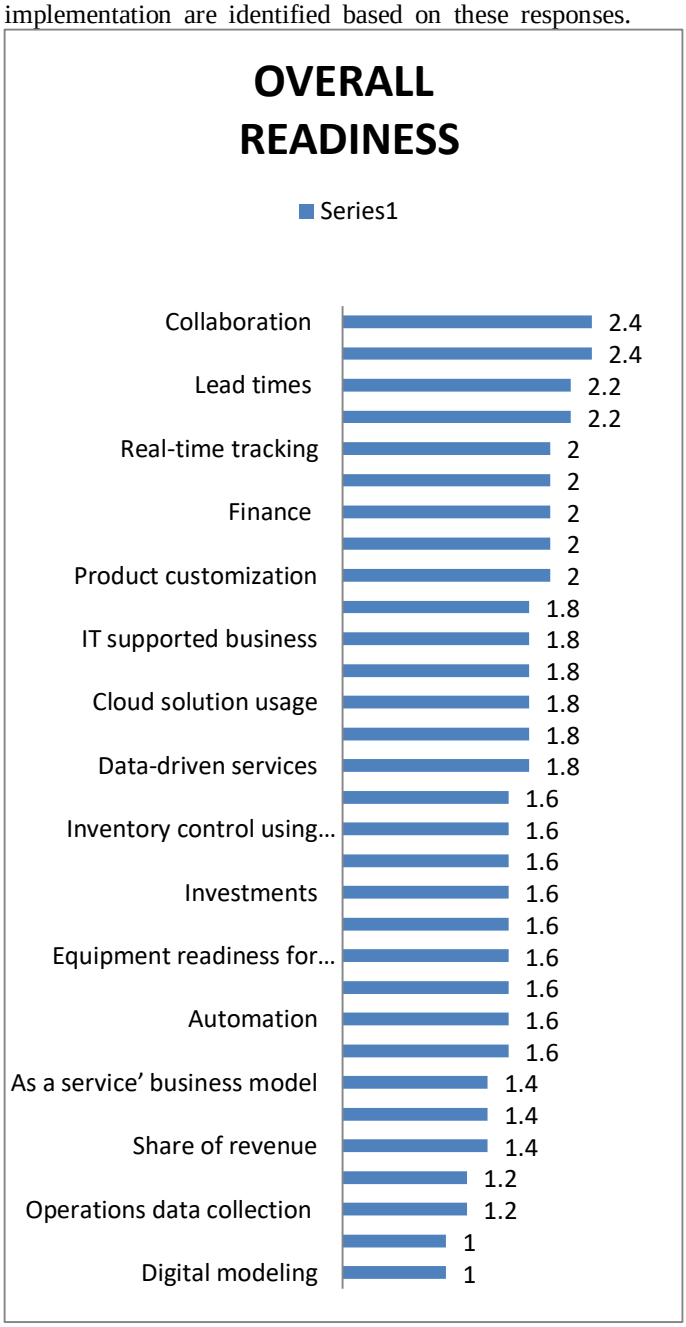

Figure 8 average overall readiness in all parameters

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 334-341
Published Online February 2021 in IJEAST (http://www.ijeast.com)

4.4 DETERMINANTS OF ADOPTION

The aim of this subchapter is to come up with a credible response to the question, "What are the determinants of new technology adoption in the manufacturing sector?" The distinctions and similarities of the five studied firms will be illustrated, explored, and interpreted in depth in order to address this research query. As a result of the study, it became clear that. Productivity improvements is one of the most commonly cited reasons. Another reason that came up often was the need to cut expenses. The third response, which was frequently given, was a willingness to keep up with the new technical developments. The findings revealed that productivity gains, cost reductions, consumer demand, and the need to keep current with technical advances were the most commonly mentioned factors influencing new technology adoption.

V. DISCUSSION

The results of this research suggest that the 4.0 theory and its primary technologies are not well understood. More than 60% of participants in this survey had an average or low understanding of Industry 4.0. It is important for producers to identify methods to reach the next frontier of value development rather than following incremental improvements. They must also grasp the developments brought on by the fourth industrial revolution and develop their comprehension of how to integrate these advancements into business strategies in order to exploit prospects and minimise risks.

Industry 4.0 has the power to completely transform how companies operate and open up new revenue sources. To make this move, manufacturing companies and their executives should learn what there is to know about the Industry 4.0 model and how it will benefit their operations. 4.0 is more specific to production and logistics systems, according to the participants in this study. This outcome is entirely compatible with Industry 4.0's core principle and ultimate goal of improving smart manufacturing processes. Industry 4.0 aims to maximise productivity, continuity, and flexibility. That makes it possible to meet the challenges of mass customization with a limited time to market.

VI. CONCLUSION

According to a recent survey, many businesses are unprepared for the 4.0 revolution. They are willing to change their individual components or departments, but not the whole system. However, it is important to understand the capabilities of modern equipment, how they can interact with other devices, and whether or not they will be combined in the future at the time of purchase. The pace of process automation is even higher than expected.

It is a catalyst of transformation and growth in terms of operation and technology in Industry 4.0, but it is not a requirement. To manufacture goods that follow quality requirements, the manufacturing system includes computer models, simulations, and study of vast data sets. A mathematical method and IT technology are needed during the design and construction stages. Furthermore, topics such as Industry 4.0's assumptions for scalable and effective manufacturing, intelligent factories, and remote access to equipment, connectivity protection, 3D printing, and even energy quality are all very important.

VII. RECOMMENDATIONS

1 Owing to the pandemic condition, only five sectors have been chosen for the realistic part of this study. As a consequence of the limited number of samples, the data presented cannot be generalized. As a result, since the sample is so small, it's easy to get different results if the same approach is used by other businesses in the same area.

2 Another thing to keep in mind is that this work is mostly concerned with the garment processing industry. As a result, when the same analysis is applied to other markets and industries, the results may be drastically different.

3 This study includes useful content such as an outline of the subject, Industry 4.0 and digitalization, as well as self-conducted interviews with manufacturing firms. Since there is a scarcity of recent studies in this area, this work may be considered an addition to what is already known. Interviews with executives from industrial firms, in particular, may be a reliable source of information for potential analysis.

VIII. LIMITATION OF STUDY

1. This study must take into account analysis delimitations as well as any other constraints that might arise. The large number of cases and interviewees can help to mitigate the impact of possible participant bias and errors. The various interpretations of the words used to characterize the established Industry 4.0 problems represent a constraint. The study centered on the complexities of implementing Industry 4.0, with a particular emphasis on manufacturing... Furthermore, this study focused on textile manufacturing processes in particular areas of Hyderabad and Kotri, Sindh, with an emphasis on spinning and weaving.

2. Future study may require several observational experiments with a statistically meaningful number of involved firms, based on the limitations of this thesis. As a consequence, subsequent scientific findings may be extended. Furthermore, prospective interview partners or study subjects should preferably share the same knowledge base.

3. In addition, the interview partners' backgrounds in experience are uneven, since some of them serve in various roles. As a result, they may have very different perspectives on the subjects of digitalization and 4.0. This ensures that the answers given by the industry come from a variety of sources.

ACKNOWLEDGEMENT

I would like to thank all the participants who responded enthusiastically and co-operated at every stage of data collection for this research. Also, I would like to thank all my teachers for their support and devotion in completing the work by the time.

IX. REFERENCES

1. Dar, Z. (2017, December 26). *The Fourth Industrial Revolution: Implications for Pakistan.* Retrieved from https://www.ips.org.pk/fourth-industrial-revolution-implications-pakistan/.

2. Arnold, C., Kiel, D., & Voigt, K.-I. (2016). How Industry 4.0 changes business models in different manufacturing. *The XXVII ISPIM Innovation Conference – Blending Tomorrow's Innovation Vintage.* Porto, Portugal: ResearchGate.

3. Bhunia, P. (2018). *Only 25 countries well-positioned to benefit from Industry 4.0.* Retrieved from https://www.opengovasia.com/only-25-countries-well-positioned-to-benefit-from-industry-4-0-according-to-new-world-economic-forum-report/

4. Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How Virtualization, Decentralization and Network Building Change the Manufacturing Landscape: An Industry 4.0 Perspectiv. *International Scholarly and Scientific Research & Innovation, 8*(1).

5. Görçün, Ö. F. (2018, April). The Rise of Smart Factories in the Fourth Industrial Revolution and Its Impacts on the Textile Industry. *International Journal of Materials, Mechanics and Manufacturing, 6*(2), 136-141.

6. Hameed, W., Imran, M., & Haque, A. (2018, November 23). Influence of Industry 4.0 on the Production and Service Sectors in Pakistan:Evidence from Textile and Logistics Industries. *Social Science*.

7. Hamzeh, R., Zhong, R., & William , X. X. (2018). A Survey Study on Industry 4.0 for New Zealand Manufacturing. *46th SME North American Manufacturing Research Conference* (pp. 49-57). Texas, USA: Elsevier B.V,Science Direct.

8. Jajja, S. (2017, December 15). *Pakistan unprepared for Fourth Industrial Revolution.* Retrieved from https://www.dawn.com/news/1376653.

9. Julian Marius Müller, D. K.-I. (2018, January 18). What Drives the Implementation of Industry 4.0? The Role of Opportunities and Challenges in the Context of Sustainability.

10. Khan , A., & Turowski, K. (2016). A Perspective on Industry 4.0: From Challenges to Opportunities in production system. *the International Conference on Internet of Things and Big Data* (pp. 441-448). Science and Technology Publications, Lda.

11. Khan, M., & Alam, A. (2010, May). Pakistan Textile Industry Facing New Challenges. *Research Journal of Internatıonal Studıes*(14), 21-29.

12. Lee, J., Bagheri, B., & Kao, H.-A. (2014, December). A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems. *Manufacturing*

13. Lichtblau, D., Stich, P., Bertenrath, D., Blum, M., Bleider, M., Millack, A., et al. (2015). *IMPULS-INDUSTRIE 4.0 READINESS.* Cologne Institute for Economic Research.

14. Memon, D. (2018, Feb). Pakistani cotton yarn exports continue its decline. *PAKISTAN TEXTILE JOURNAL*, 48-50.

15. Memon, D. (2018, May). Vast scope of enhancing Pak-German bilateral trade relations. *PAKISTAN TEXTILE JOURNAL*, 58-59.

16. Memon, D. (2018, June). Weaving sector: Pakistan lost clothing export market. *PAKISTAN TEXTILE JOURNAL*, 50-51.

17. Munir, A. (2018, January 29). *Productivity in the textile industry*. Retrieved from DAWN.COM: https://www.dawn.com/news/1385793/productivity-in-the-textile-industry

18. Naz, F., Khan, H., & Syyed, M. (2017). Productivity and Efficiency Analysis of Pakistani Textile Industry using Malmquist Productivity Index Approach. *Journal of Management and Research, 4*(2), 65-87.

19. Pwc. (2016). *Global Industry 4.0 Survey: Building the digital enterprise*. Retrieved from https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf.

20. Pwc. (2016). *The Industry 4.0 / Digital Operations Self Assessment.*

21. Qadri, A. (2017, January 20). *Roadmap for Pakistan Smart Industries, Industry 4.0*. Retrieved from https://demanddrivenpakistan.wordpress.com/2017/01/20/roadmap-for-pakistan-smart-industries-industry-4-0/.

22. Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., et al. (2015, April 9). *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries.* Retrieved from https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries.aspx.

23. WMG. (2017). *An industry 4 readiness assesment tool.* Retrieved from http://warwick.ac.uk/fac/sci/wmg/research/scip/industry4report/final_version_of_i4_report_for_use_on_websites.pdf.

24. Wyrwicka, M., & Mrugalska, B. (2018). "INDUSTRY 4.0"—TOWARDS OPPORTUNITIES AND CHALLENGES. *24th International Conference on Production Research (ICPR 2017).*

25. Zhou, K., Liu, T., & Zhou, L. (2015, August). Industry 4.0: towards future industrial opportunitiesand challenges. *12th international conference on fuzzy systems andknowledge discovery.*