Sachetas
सा विद्या या विमुक्तये
An International, Peer Reviewed, Open Access & Multidisciplinary Journal
E-ISSN: 2583-312X

METAVERSE AND INDUSTRY 5.0: RECONFIGURING THE DIMENSIONS AND COMPONENTS OF FUTURE BUSINESS INTELLIGENCE AND PRACTICES

Dr. Sugandha Verma

Assistant Professor
Department of Commerce, Rajkiya Mahavidyalaya Chinyalisaur, Uttarkashi, Uttarakhand
Email: the.sugandha.verma@gmail.com
ORCID ID: https://orcid.org/0000-0001-7623-7213

Abstract

Antecedent paradigm has witnessed many unexpected instances and modifications in the mechanism of business operations in the last few years. During the time of COVID-19 industries and workplaces underwent through several unprecedented hardships that were beyond imagination and the pandemic destroyed the conventional production and servicing models of industries. Although Industry 4.0 technologies have been strengthening the adaptability capacities of businesses and economies as well, yet the transition towards Industry 5.0 has started producing manifold positive results on multi-dimensional basis. Metaverse is the concept that has its evolving roots in Industry 5.0 application. The noble characteristics, human centric, sustainable and resilient, of Industry 5.0 are shaping and designing the metaverse, which is a digital world with the ultimate serving abilities for the humanity more than ever. 'Man-machine' collaboration is the crux of these novel developments. This research paper explains the concept of metaverse, explores its main components and examines its implications for future business paradigm in a comprehensive manner. This paper also attempts to highlight various metaverse technologies and innovations, based on the review and extensive content analysis of previous investigations. Discussion of the key application domains of metaverse is also there. In addition, present paper addresses the corresponding elementary arguments regarding metaverse and Industry 5.0 that could be the foundational motivation for future research and discussion. The study talks about the challenges and probable issues as well in order to better understand the scenario.

Keywords: *Artificial intelligence, Futuristic business, Industry 5.0, Innovation, and Metaverse*

Editorial Record

First submission received:
August 09, 2024

Accepted for publication:
August 17, 2024

Cite this article

Verma, S. (2024). Metaverse and Industry 5.0: Reconfiguring the Dimensions and Components of Future Business Intelligence and Practices. Sachetas, 3(3), 15-26. https://sachetas.in/index.php/Sachetas/article/view/307

INTRODUCTION

Technological advancement has been the key factor behind societal progression. Change, innovation and modernisation have contributed towards wellbeing of mankind. Creating the new world with improved infrastructure, better facilities and comfortable life have been the objectives of different stages of industrialisation. Since the inception of human life on our planet regular, gradual and continuous improvements are witnessed by various ages. Evolution of new methods and technologies has created different paradigms over the time. The purpose of discoveries and inventions always consist of reduction of human labour, and fast, accurate and safe methods of performing the tasks leading to a high quality life. Therefore, automated, simplified, mechanised and advanced processes and techniques are easily visible throughout the never-ending journey of industrial development. The shifting phases of different interconnected stages of industrialisation have shown the far reaching impacts on upcoming generations. From the early stages of survival to the present state of universal explorations, human race is also progressing from food gatherer-hunter societies to super smart societies. Earning of livelihood through business, profession, employment or any other medium with maintaining human dignity has been the core of modern society. Furthermore, with the passage of time, respecting the human rights, environmental and ecological concerns, sustainable work methods and other similar issues are also added in the scenario of industrial progress. On the economic front, developed, developing and under-developed economies have also been categorised on the basis of their industrial and technological advancement (Galeeva & Zinurova, 2016).

CONCEPTUAL BACKGROUND

Starting from the sixteenth century, industrial revolutions paved the way of more safe and comfortable workplace infrastructures, efficient and cost-effective work methods, optimum utilisation of resources, and higher level of profitability and customer satisfaction. In the year 1784, the invention of steam power changed the entire scenario and created the age of Industry 1.0 as "steam age". It was featured with mechanisation and rapid-fabricating manufacturing systems. With the quick move of electrification in the late nineteenth century assembly lines and mass production prominently dominated the scenario and this phase was evolved as Industry 2.0. Later in the 1970s, the phase of automation (Industry 3.0) and computerisation emerged including the characteristics of automated production system, use of Information Technology (IT), basic robotics and computerised numerical control (CNC) machines. This third phase coincided with the phase of globalisation and major collaborations among countries in the form of "green field", "brown field" and "foreign institutional investments" (FIIs) under "foreign direct investment (FDI) agreements". Furthermore, establishment of the "World Bank", "International Monetary Fund" (IMF) and "World Trade Organisation" (WTO) revitalised and revamped the scenario of global trade. In the year 2011, the vision of "Industry 4.0" was introduced officially at "Hannover Messe fair" by Germany highlighting the digitalisation aspects. The core features of "Industry 4.0" are full-fledged use of Information and Communication Technology (ICT), smart factory, machine learning, networking, cyber-physical systems and innovations. More specifically, "Industry 4.0" may be defined as "transforming the business system about its manufacturing style, offering of goods and services, making use of data analysis, cloud computing, machine learning with other innovative technologies" (Alojaiman, 2023; Lampropoulos et al., 2019). Additionally, some core elements of "Industry 4.0" have been outlined as information security, waste reduction, resource optimisation, cost effectiveness, increased consumption of electricity and raw material for mass production, expanded product life cycle, etc. The concept of "Industry 4.0" is still growing and developing and the main thrust is seeking international cooperation in order to ensure collaborative efforts, smooth adaptability to change, maximum capacity utilisation of production and organisation systems, and use of technological innovations as a tool of economic progress (Majumder & Tripathi, 2021). Even during the prevalence of pandemic COVID-19 and amid the difficulties of regional lockdowns, social distancing protocols, and work from home arrangements most economies were able to guarantee the continuity of organisational functions only through the digitalisation of industry (Bianzino, & de Yonge, 2022). However, experts have been continuously arguing about the lack of vision within the framework of "Industry 4.0" (Alyami et al., 2022).

The latest concept of "Industry 5.0" tries to fill that gap and delivers a vision of human centricity, resilience and sustainability. "Industry 5.0", basically, is repurposing the fundamental objectives of "Industry 4.0" and its application is not limited to the industries only, rather it is extended to every organisation and every sector of economy. In 2018, the European Union (EU) proposed the concept of "Industry 5.0" that integrates the high precision and high speed machines with cognitive thinking of human beings (Mehdiabadi et al., 2022). According to the EU, "Industry 5.0 provides a vision of new industrial paradigm that goes beyond the mere objectives of productivity, profitability and efficiency and reinforces the contribution and reconfigures the role of industry towards the society. Moreover, Industry 5.0 puts the employee wellbeing at the core of production process and emphasises the use of sophisticated technologies for the sake of social prosperity along with respecting the planetary limits." Thus, the concept of "Industry 5.0" is complementary in nature to "Industry 4.0" by placing research, development and innovation at the service of mankind and universe. In a nutshell, "Industry 5.0" represents a paradigm shift and transition of focus from economic utility to social utility and more particularly towards a value driven industry. Industry 5.0, as a concept, is built upon the core components of enhanced customer experience (CX), high level interactive products, hyper customisation, proactive, and intelligent supply chain, and return of human resources back to the factory floors. The key characteristics of "Industry 5.0" are being identified as artificial intelligence (AI), Internet of Things (IoT), cyber-physical cognitive-cum-interactive systems, big data analytics, human-robot compatibility and personalisation. The EU signifies three prominent thrust areas of "Industry 5.0":

1. Human centralism – promoting talent, empowerment and diversity of human resources, considering manpower as means rather than ends for achieving production, using implicit and explicit human knowledge, skills and abilities (KSAs), enhancing, maintaining and retaining of human capital, and developing the production systems that are capable of leveraging these factors as compared to their replacement.
2. Resilience – designing more agile, flexible and adaptive technologies so that they might be able to go beyond profit, efficiency and job creation, and capacity building of system for developing anticipatory reactive and learning qualities.
3. Sustainability – reducing waste, carbon emissions, energy consumption and environmental damages, reusing and recycling of residual materials, improving respect for environment and planet, green washing of the industries, shifting focus of industry from being part of problem towards being the part of solution, and most importantly, alignment with the United Nations' "Sustainable Development Goals (SDGs) 2030".

The remainder of this study is outlined as follows. Section 2 depicts the observations of relevant research papers from the similar field, identifies the research gap, frames the research questions and objectives, and signifies the rationale of the study as well. Section 3 presents the data sources and methodological aspects of the proposed study. Section 4 describes the concept and structure of metaverse with reference to Industry 5.0. Section 5 explores some prime components of futuristic business in metaverse of Industry 5.0. In Section 6, the reconfigured dimensions of business intelligence and practices have been summarised. Section 7 highlights the implications of metaverse

for future business scenario. Finally, Sections 8 and 9 finish the paper with explicating the limitations and future research directions along with concluding remarks respectively.

REVIEW OF LITERATURE

Present study reveals that the entire sphere of human activities has undergone tremendous shift and reconfiguration during the last several years. Modernisation of management working models, increasing rate of globalisation and more than ever changing customer preferences have pushed business units to adopt latest technologies. The transforming circumstances from Industry 4.0 to Industry 5.0 emphasise the need of accurate predictions, prompt decisions, proactive behaviour, and fast data analyses in business operations leading to alterations in job designs and tasks, drastic changes in the nature of employment and professions and disappearance of many job positions resulting in unemployment. This new approach demands for the twenty first century knowledge, skills, abilities (KSAs) and talents, which are in tune with the elements of Industry 5.0 and metaverse. In order to identify the gaps in the concerned literature, and to establish the validity, rationale and case for this study, author revisited and evaluated the antecedent work in this regard. For this, the terms and phrases like "Industry 5.0", "recent trends in industrial scenario", "artificial intelligence" and "metaverse" were searched in reputed international databases and journals following the timeline from 2017 to 2023.

Skobelev and Borovik (2017) focused on the new paradigm being created by the application of Industry 5.0 and supported this concept and its structure for the benefit of human welfare.

Ozkeser (2018) presented the concept of lean innovation that can help in making Industry 5.0 technologies smoother. This study also conferred that research and development, value management, simplicity, flexibility, and pure innovation are the elements that may act as a bridge between yester and modern technologies.

Demir et al. (2019) put thrust on the environmental sustainability and protective IT concerns while implementing the technologies of Industry 5.0.

Another detailed study by Nahavandi (2019) discussed about the strengths of Industry 5.0 in meeting various present and future challenges. Author's technical dreaming posed Industry 5.0 as a major roadmap and destination as well for future issues.

Aslam et al. (2020) suggested about "Absolute Innovation Framework" through which businesses can exploit and explore more opportunities and become more responsive, sensitive and agile for attaining competitive advantage in more sustainable manner.

Motienko (2020) discussed about the potential applications of Industry 5.0 like cloud generation, smart production systems, smart healthcare, intelligent logistics and inventory management, etc.

Carayannis et al. (2021) presented a comprehensive framework of nuclear fusion power and argued for the establishment of global financial support system for protecting the intellectual assets shifting towards a "Future Fusion Economy".

Farsi and Erkoyuncu (2021) opined on the basis of survey analysis that Industry 5.0 is creating the shared values between business and society. It is not limited to manufacturing goods and services just for earning profits. They also recommended about functionality, availability and reliability aspects to be put in product and servicing contracts by the business organisations.

Orlova (2021) came forward with a new methodological strategy of evaluation of the corporate human capital management (CHCM) in context of digital transformation. The system of CHCM consists of descriptive data analytics, assessment techniques, survey and expert evaluations that facilitate merited decision-making in the business.

Shloma and Volotka (2021) examined the consequences of industrialisation on society and environment. They opined that every phase of industrial transformation left an imprint on the history of mankind. They further stated that looking back and investigating the history is the best method for making the most accurate predictions about the future.

Adel (2022) explained the concept of Industry 5.0 and its implementation in the fields of production line, healthcare, industrial output, logistics, warehousing, etc.

A comprehensive study was conducted by Fatima et al. (2022) and they addressed the usage of IoT in business and its progression. Additionally, their study presented a gist of several scientific research papers that talked about integrated analytical system, relevant challenges and future agenda of IoT.

Kasinathan et al. (2022) investigated the impact of innovations on marketing strategies, healthcare advancement, product development and growth of smart cities in context of SDGs. Their results found the technological innovations positive.

Literature examination done by Mourtzis et al. (2022) justified the contemplating structure of Industry 5.0 for promoting cooperation and peace in business and dealing with sociological and environmental issues.

Survey based study from Poland, critically reviewed the literature as well and recognised the social expectations from Industry 5.0. Researchers emphasised the government policies and investing strategies to foster industrial growth on the ground of human-centric technological advancement and economic development (Saniuk et al., 2022).

Alojaiman (2023) reviewed the literature on the concept of innovation in context of IoT and Industry 5.0 and proposed the innovation concept as a strategy to solve the problems of discontinuation and tough survival of business units.

Revisiting the existing literature makes it crystal clear that several investigations are being conducted to popularise and increase awareness in the context of fifth phase of industrialisation. Numerous research papers discussed about the theoretical and practical implications of Industry 5.0. But, the unique concept of metaverse has acute shortage of research globally despite of huge potential and its comprehensive application. Moreover, the possible indicators and practical implications of metaverse about future of business have not been discussed so far. In addition, empirical aspects of Industry 5.0 and metaverse are still missing in the previous studies. Therefore, this study attempts to find the answers of the following questions:

- What is the concept and structure of metaverse with reference to Industry 5.0?
- What are the prominent components of futuristic business in metaverse shaped by Industry 5.0?
- What will be the implications of metaverse and Industry 5.0 regarding future of business?

Accordingly, the present study explores the background and structure of metaverse with reference to Industry 5.0, identifies the key components of future business in the metaverse of Industry 5.0 and discussing the possible pros and cons of both concepts.
To the best of author's knowledge, global academic platform still lacks of much discussion on Industry 5.0 and particularly metaverse. Therefore, it becomes relevant and academically feasible to highlight and initiate deliberation among academicians about future of business in the metaverse shaping by Industry 5.0. So that the employees, business owners, government, authorities and stakeholders may be able to learn about new required skills, predict opportunities and threats, and anticipate future happenings well in advance.

RESEARCH MATERIAL AND METHODS

Identifying and collecting the required information from published research papers and databases was a crucial step in the abstraction procedure. As Management and Commerce databases were lagging behind in producing the appropriate number of searches, consequently, some scientific databases were referred to collect the information for this study. The database, namely, Emerald, Google Scholar, MDPI, Sage, Science Direct, Scopus and Taylor and Francis were used to find previously published papers in English language. The most prominent and required keywords "Industry 5.0" and "metaverse" were employed for locating and exploring the publications. Since both these terms were exact and did not have any synonymous phrases, so it became the limiting factor for locating the relevant material. Another constraint was the paid nature of some databases, so full papers could not be accessed. Therefore, only fully available and open access research papers were downloaded and considered for the purpose of knowledge extraction. Moreover, qualitative content analysis technique was applied for finding the answers of research questions framed by the present study. Data collection, data mining and information extraction was the process to unearth and reveal the implied information and knowledge. Additionally, pattern recognition, text classification and segmentation, discovery of knowledge, and retrieval and exploration of the underlying concepts were among other techniques applied in this study.

CONCEPT AND STRUCTURE OF METAVERSE

Neal Stephenson, in his science fiction novel "Snow Crash", firstly used the term "metaverse" in 1992 in the sense of a giant virtual environment analogous to the real world, wherein users interface through digital clones "avatars" (Stephenson, 2003). The meaning of the word "metaverse" is semantically derived from the word "universe" in combination between the past and present that depicts "through different worlds". In etymological sense, "metaverse" reflects a phenomenon that is beyond the universe. Therefore, "metaverse" may be defined as "three-dimensional internet space wherein physical and real persons interact, move and share with virtual and illusive objects" (Chen et al., 2021). In addition to the Neal Stephenson's concept of metaverse, it is subject to various interpretations and explanations. Philip Rosedale defined "metaverse" as three-dimensional internet, populated with real and live people. Similarly, Matthew Ball clarified the concept of "metaverse" as "an enhanced network of regular, steady and real-time generated three-dimensional simulations that upholds and fosters the continuity of history, entitlements, identities, payments, objects, and it can be experienced even synchronously by a large number of users having the individual presence of each subject " (Ball, 2021). As per the Cambridge Dictionary, "metaverse is a virtual world where humans, as avatars, interact with each other and other objects and creatures in a three-dimensional space that is similar to reality" (Cambridge Dictionary, 2023). Realising the relevance of "metaverse", in October, 2021 Mark Zuckerberg (Chief Executive Officer) renamed his company name from Facebook to Meta, with a precise and clear purpose of making more novel and healthier connections between the latest technology of metaverse and people (The Guardian, 2021). Basically, the "metaverse" integrates the actual and physical reality with virtual and artificial verity. In fact, virtual reality, augmented reality, mixed reality and digital currencies have been recognised as the core elements of metaverse. Moreover, in a hyper-connected space, human beings are able to do everything just with single and simple equipment. "Metaverse" is the extreme front of technology that promotes interactive learning facilities, advanced use of internet, work outcomes, e-commerce, mass audience experience, systematic and logarithms based decisions, healthcare, fashion, banking, finance, real estate and so on (Csaky & Koltay, 2020). The metaverse technology interconnects the physical and virtual worlds where inhabitants are able to do various habitual activities, but without any physical move. Practically, the "metaverse" enables business organisations in

elevating their potential in monitoring, buying and warehousing raw materials, marketing, forecasting, rendering services, etc. (Schiavone et al., 2021). In other words, the activities of business units are like digital facsimile with unlimited potential within the structure of "metaverse" (Akkucuk & Asugman, 2022). With the perspective of "Industry 5.0", "metaverse" should be well-fitted to the requirements of sustainable, efficient and socially responsible framework of businesses. Additionally, smooth and safe work environment and procedures, empowered and satisfied human resources, maintained, developed and engaged human capital, and other elements of just and equitable society should be in tune with metaverse agenda. It becomes really important to mention at this juncture that "metaverse" should be engineered according to the "Industry 5.0 approach" respecting the working conditions, human rights, labour dignity, and environmental, social and universal obligations (De Giovanni, 2021b). Therefore, business units should not exclusively rely on "metaverse" and digitalisation for boosting the economic benefits. Rather, they should determine critically and carefully the implications of "metaverse" activities in terms of social, environmental and sustainable cases.

KEY COMPONENTS OF FUTURISTIC BUSINESS INTELLIGENCE IN METAVERSE

The implementation phase of Industry 4.0 is not over yet and the era of Industry 5.0 has already begun. Metaverse and Industry 5.0 are the fresh, innovative and unique ways of thinking about manufacturing, data analysis, marketing, finance, human resources and every dimension of managerial functions. Thus, organisations that do not move with the pace of technology, change and latest customisation, they would soon become outdated, obsolete and backward in their industrial sectors. Furthermore, these businesses would also be unable to take the comparative advantages and opportunities of the new trend. The ever-rising pace of technological advancement forces the business units to adapt these changes as quickly as possible for their survival and viability. This section of the study highlights some of the key components and technological aspects that would be prominent for future businesses operating in metaverse shaping by Industry 5.0.

1. Artificial Intelligence (AI), Internet of Things (IoT) and Cobots

The concept AI does not replace human intelligence; rather it supports and complements the same. Although, the notion of Industry 4.0 already consists of AI, but it is Industry 5.0 that has the extreme level of potential to take the advantage of the latest technologies. Moreover, AI reduces human fatigue and saves precious time by performing tasks of repetitive and hazardous nature. Along with robotics, AI is helpful in undertaking duties in the extreme temperatures, anti-human conditions, space, underground and ocean expeditions, dangerous and death-prone fields, combat and anti-terrorist missions, etc. Likewise, IoT is regarded as network of several inter-connected devices that exchange data with other cloud and devices. Even this exchange of information is going to cross the borders of real world to the metaverse. As per the purview of Industry 5.0, human-machine association will be achieving the extreme level of synchronisation, and the technique of collaborative robots, also known as Cobots, which is expected to replace the simple robots. Cobots have the capabilities not only to perform the command able and repetitive tasks, but also to think, decide and create on the basis of their AI. The horrific times of COVID-19 pandemic cannot be forgotten in which social distancing, isolation activities and quarantine facilities were the only choices to survive for humans. The world of metaverse could face these conditions at more ease with such cobots and technologies. After realising the potential of Industry 5.0 and metaverse, Japan came forward with the concept of Society 5.0 in 2017 where mobility, health and productivity are the key pillars. Japan's concept of Society 5.0 envisions an inclusive and sustainable socio-economic system wherein digital technologies, cobots, AI, IoT and metaverse could create a world for humans having the utmost comfort, high quality safety, prosperity and happiness. Additionally, Japan's cabinet views Society 5.0 as means for fulfilling and achieving the global agenda 2030 regarding SDGs.

2. Blockchain Technology

Blockchain technology is, being the base of metaverse, a distributed ledger of information and records which is uncontrollable by a single entity and no one can rewrite its logarithms unilaterally. Its network is made up of "everyone-together validators". This technology totally relies on mathematical and scientific certainties and has nothing to do with human trusts and beliefs. The metaverse with blockchain technology may assist the business units to streamline their manufacturing and operational activities, establish total transparency into their logistics and human resource practices, and manage their financial and investment activities. Policy making, drafting competitive strategies, cost effective production and distribution of products, removal of intermediaries and unwanted human intervention, extra-ordinary levels of productivity, all these operations and regular business transactions can be made intelligently and instantly with the minimum consumption of time, resources and human energies.

3. Metadata Analytics

Industry 4.0 and Industry 5.0, both talk about "Big Data Analytics", but it is the metaverse that has a leaning tendency towards "Metadata Analytics". The concept of metadata was firstly described by David Griffel and Stuart McIntosh in 1967 who were the experts of Centre for International Studies at "Massachusetts Institute of Technology (MIT)", United States. Later, in the year 1968 the term "metadata" was officially coined by Philip Bagley. In simple words metadata means data about data. It is the concept of providing information or highlighting one or more aspects of data in hand. Technically, metadata talk about 'granularity', that is, how much details can be extracted

from the available data. Similarly, structural metadata is the description of containers of data. It can be easily understood with adjoining the fact, many government organisations in different countries collect and store metadata regarding phone calls, internet protocol (IP) connections, emails, video traffic, mobile phone locations, website browsing histories, and records to summarise and track the basic information. Advanced forms of ICT, information science and management, geographic information system (GIS), librarianship, and business intelligence systems may be designed and developed by using "Metadata Analytics". Moreover, the application of business metadata can possibly help in determining what type of information that organisations have, what are their sources of this information, what these data do really mean and reflect, and what is their relationship with hidden and implied data placed in data warehouse. Additionally, the cloud and edge computing techniques are also assisting together for developing more sophisticated "Metadata Analytics". By all this, more accurate predictions, estimates and decisions could be possible for ensuring higher levels of business intelligence, environmental and market scanning, strategic actions, and productivity.

4. Digital Twins Technology

A digital twin may be referred as a digital clone or an imitative identity that acts, behaves and functions the same as its real counterpart in the actual physical world. Several business operations, particularly production activities may take superior advantage of digital twins technique by simulating working conditions, procedures, methods and objects to read, understand and forecast that how will they perform, react and operate. Additionally, machine learning, metadata analytics and IoT can be incorporated for better solutions and advanced results. Simulated items, machines and even human organs can be tested in advance in metaverse about their reliability, consistency and safety before their actual implantation and installation.

5. Virtual, Augmented and Mixed Realities

The virtual and augmented realities are created with computer softwares, smartphones and mobile devices. These days, healthcare, fashion and entertainment industries are providing virtual and augmented experiences to their consumers. But in metaverse, the notion of mixed reality can be developed with head-mounted spectacles. Mixed reality denotes the combination of actual physical reality and virtual reality for designing new visualisations and environments wherein real and digital objects and creatures coexist, communicate, share information, and perform tasks in real time. Microsoft, the software and system developer giant company introduced this term 'mixed reality' in 2016 when they released a novel product, that is, Microsoft Holo Lens (Blanchard et al., 2022). They proved mixed reality superior to augmented reality in the sense that the former consists of more advanced and sophisticated description of the physical area and capacity to plant holographic images in that field. Also known as hybrid reality, mixed reality makes it possible that digital objects can interact with real things and real persons can interact with digital objects or digital creatures just like it is happening in the actual world. The sectors of engineering, education and healthcare in many developed countries are already using the mixed reality applications for reaping benefits in diverse range. Online digital displays, advanced computer softwares, three-dimensional projections and basically the human-computer interaction adjoins the real and virtual realities by using gestures, voice commands, interface and direct looking through headsets and other equipments (Franze et al., 2022; Holden et al., 2022).

6. 6G Communication

In the metaverse, the upcoming generation of wireless communication '6G' would attempt for advancing educational environments, tele-workplace relationships, autonomous transportation, software utilities and tele-health services. The older versions from 1G to 4G facilitated the communication between people to people, present version 5G is promoting interactions between people and machines and the next version 6G would allow interactions between people and every virtual object, item or creature (Khan et al., 2022; Li et al., 2022). Business organisations, universities, hospitals, finance and banking institutions, and even governments may provide faster, dedicated and customised services to their customers and clients and may resolve their issues, grievances, queries and online services just in no time.

7. Additive Manufacturing

Present style of manufacturing applies the subtractive way of producing a product, wherein a solid block of material is cut down till the finished product is carved out of it. Metaverse has inverted this production style and facilitating Industry 5.0 by additive manufacturing. In the era of resource optimisation, additive manufacturing involves the fabrication of a product at a single level at a time. It means, a computerised layout is designed and then its dimensions are created layer-by-layer by the machine until the final product is completed. There was more wastage in subtractive method of production because the material had to be cut ahead. In the form of small granules and powder of the base metal, polymer, etc., the raw material is adjusted in consecutive layers. Software assisted machines arrange these layers in no time and consequently the production time may be reduced to the unexpected levels.

8. Exoskeleton Technique

For increasing workers' efficiencies and productivity levels in the production units, various techniques have been implemented and developing, viz., 5S, six sigma, lean manufacturing, ergonomics, etc. These techniques have their focus on reducing human fatigue and exertion and improving work methods along with quality of employees' work life. Similarly, the artificial support structures, exoskeletons, have been designed recently and their application in factories accommodates through covering and supporting several body parts like upper and lower body, hands, shoulders, back and legs for increasing human physical capabilities. Carrying raw materials, spare parts and tools, their transferring and movements have become comfortable than ever before. This technique of metaverse is bringing drastic changes in performing the manufacturing operations and activities. It is adding another beneficial dimension to Industry 5.0 by minimising hazardous work procedures, unnecessary physical movements and carrying costs in the production lines of businesses (Tröster et al., 2022). In addition, defence industry is also adopting this technique for the safety, shrewd movements and operational activities of the personnel in tough terrains. Undoubtedly, the exoskeletons are immensely proving beneficial to differently-able persons.

9. Green Supply Chain Management and Logistics

The superiority of metaverse has converted many dreams of innovation into reality. Now one can easily imagine, in near future, human less aerial machines, drones and self-driven robotic vehicles which need only instructions about destination and successfully delivering and transporting the consignments at the minimum cost. Multiple linked production lines and long distance carriers may be combined together with AI, IoT, and robotic devices within the structure of Industry 5.0 (Heidari et al., 2022). Lesser fuel consumption, saving of human energies and time for driving, pollution control, effective traffic management, all this is now revolutionising the scenario of transportation and logistics. Therefore, e-logistics and green supply chain management are the concepts of metaverse and Industry 5.0 that are energy efficient, backed with super smart technologies, lesser prone to accidents, eco-friendly, and safer, faster and more economical. Wider networks across the globe are increasing and geographical boundaries and disparities are tumbling down with the application of metaverse techniques. Moreover, the field of inventory management is also witnessing positive changes like lower stock piling, decreased carrying and holding costs of material, improved and timely purchase management, better order processing and so on. Thus, metaverse has significant contribution towards optimising inventory, warehousing, free flows and just in time operations of supply chain, saving human energies, and 24/7/365 continuous monitoring of logistics.

10. Digital Marketing, Virtual Assistants and Chatbots

Last but worth mentioning, digital marketing is another dimension of metaverse. It is the augmented aspect of e-marketing and consists of digital advertising, branding, positioning, and enhancing customer experiences (CX). The times of lockdown during COVID-19 pandemic accelerated the necessity of online and e-commerce platforms, but the metaverse consists of manifold diversified forms and potential in this area. Sales may be cannibalised in vast volumes through omni-channel solutions, access to remote regions, developing virtual markets and interactions with avatars. The present configurations of store management, physical deliveries, customisation of products and services, and many other aspects might be changed in metaverse as there may no longer be any need to physically visit to the stores. As a result of this, congestion will be reduced, emissions will be minimised, time availability will be increased, and a hassle free buying experience will be realised by customers. Traditional stores could be transformed into metastores providing continuous range of facilities and services to customers. Moreover, the existing business models might be boosted by approaching and exploring new markets. Furthermore, metadata analytics and AI have the investigating, recognising and interpreting capacities of human sentiments, facial emotions, speech emotions, kinesics and physical signals along with text, images, voice, etc. Internet browsing and searching histories, content watched, text and articles read about, and online orders placed for buying products, acquiring services, food deliveries and even booking tickets of movies confer and provide the relevant information about customers' tastes, preferences, biases, likes and dislikes. These metadata details prepare the base and background for further recommendations for higher CX. The human computer interaction is leading towards new horizons of Virtual Assistants (VAs) and chatbots these days. On the basis of natural language processing, these two techniques have been changing the scenario of customer insight, education, healthcare, automotive, fashion, and entertainment sectors. Several VAs and chatbots of reputed companies are assisting customers and clients for improving their personal customisation and satisfaction levels. To name some of those, Indian Railways Enquiry (IRCTC) chatbot Ask DISHA 2.0 (Digital Interaction to Seek Help Anytime), Dom by Dominos, Dr. Lal Pathlabs VA, Whatsapp chatbots developed by Disney Hotstar, Jio Mart, My Gov Corona Helpdesk from Government of India during the hardships of pandemic of COVID-19, Jeep Support for four-wheelers purchase, Electronic VA (EVA) of HDFC, Zoop India Whatsapp chatbot for Railway Food Order, Tally's VA, Zoom AI companion, Kaya VA of Kotak Life Insurance, BoMY VA of Bank of Maharashtra, MANI app-cum-chatbot of Reserve Bank of India (Mobile Aided Note Identifier) for visually impaired persons to recognise the denomination of Indian currency notes, and many more are successfully serving and transmitting personalisation to the public at large.

Sachetas
सा विद्या या विमुक्तये
Sachetas
An International, Peer Reviewed, Open Access & Multidisciplinary Journal
E-ISSN: 2583-312X

RECONFIGURED DIMENSIONS OF BUSINESS INTELLIGENCE AND PRACTICES

After understanding the concept of metaverse and discussing the key components of futuristic business, the reconfigured dimensions of business intelligence and practices may be summarised as shown in Table 1.

Table 1: Dimensions of Business Intelligence and Practices and their Reconfiguration

Dimension	Past	Present	Future
Production and Technical	Traditional factories, labour intensive, mechanisation, assembly lines, fixed workplace, mass production, well-engineered but old patterned work-stations	Electrification, digitalisation and automation, intelligent factories, programmable machines, machine learning, use of ICT, cyber-physical systems, 3D printing, robotics, virtual reality, human-machine interface, nano technology, resource optimisation, tele-working, work from home	Smart factories, independent machine thinking, partner machines, multi-service platforms, capacity enhancement, digital twins, flexible modules of workplace, intelligent sensors, augmented and mixed reality, cloud computing, AI, human-machine collaboration (cobots), sustainable and smart resource utilisation, ideal workplaces and methods
HRM	Efficient use of human resources, work-life intervention, task learning, specialisation of jobs, bureaucratic, respect of human labour	Employee satisfaction, employee engagement, work-life balance, job and career learning, advanced training in one's job, democratic, respect of human dignity	Maximum wellbeing of human resources, work-life enjoyment, life-time learning, interdisciplinary training, humanistic, respect of human intelligence
Economic and Profitability	Profit oriented approach, emphasising domestic and national profitability	Wealth maximisation approach, international or universal profitability	Symbiotic approach, considering environmental and social costs, real prosperity, FinTech, metaversal profitability
Commercial and Marketing	Manufacturer is the king of market, selling and after-sales servicing, product specialisation, quality products and services, physical markets, salesmen and shops	Customer is the king of market, logistics and supply chain management, product diversification, smart products and services, online markets	Customer experience (CX) and personalisation are prominent, multiple use of products, virtual assistants (VAs) and Chatbots, green supply chain, green products, interactive products, personalised and instant services, virtual and customised markets
Security	Physical protection and safety	Digital security	Cyber space security, data security
Communication and Information Exchange	Information exchange and management, general softwares and programmes, physical communication	Information and Communication Technology (ICT), industrial internet, fast communication, SMS, email, etc.	Internet of Things (IoT), Big data analytics, Blockchain technology, data mastery, cloud generation, 6G communication, instant response and feedback, edge computing
Strategy, Social Responsibility and Values	Resistant to change, change-opponent (avoiders), passive identification of problems, serving society through machines, thrust upon economic value	Welcoming and adoption of change, change agent (reactive and preventive), identification of solutions, serving society through digital machines, thrust upon ethical values	Modifying the change, change leader (proactive and sensitive), green washing, sustainability, being the part of solution, serving society through smart and interactive machines, machines as service providers, thrust upon humane, ecological and planetary values

*Source: The Author

IMPLICATIONS OF METAVERSE AND INDUSTRY 5.0

The technologies of metaverse and Industry 5.0 offer amazing opportunities and open new avenues of prosperity, happiness, comfort and economic wellbeing for human life. The metaverse guarantees the financial and monetary viabilities for business organisations. Putting it differently, business units can reap economic benefits through metaverse by furnishing wide range of innovative and creative services. On the positive side, metaverse is diversifying business models and approaches by focusing on human centric techniques, integrating and developing human-machine collaborative environment, by augmenting user experience and engagement, by creating new values for customers and by harnessing improved competitive strategies. Additionally, offering unique and innovative services in the fields of banking, healthcare, hospitality, education, insurance, consultation, etc. induces new business ideas and opportunities. In metaverse, businesses may offer virtual experiences and virtual goods and services at comparatively lower costs as to the physical ones. Besides this, shorter production cycles, material savings and reduced wastage, optimum storage of inventory, reduced levels of fatigue, and minimised risks to human life are some of the operational advantages offered by Industry 5.0 and metaverse. In addition, full disclosure of information about products, transparency in business dealings and transactions, and removal of middlemen and intermediaries also result in decreased counts of consumer complaints, duplicity of products, malpractices and manipulations in metaverse (Fu et al., 2022). Furthermore, digital certificates, digital currencies and other digital collectibles characterise another dimension of business success in future world of metaverse (De Giovanni, 2021a; Shen et al., 2021). Unique and innovative experiences offered by various technologies such as Samsung 'e-skin', Nike 'cyber shoes', virtual wristbands, watches, glasses, gloves, headsets and visors are the keys or entry points to go through the world of metaverse. Not only this, smart education, smart medical and health services and smart governance have also been provided to people by many developed countries by applying these advanced technologies. Hence, it can be rightly stated that metaverse is creating meta-economies in which meta-businesses and meta-consumers, both are going to enjoy and pick economic, physical, social and virtual benefits in near future.

However, the implications of metaverse and Industry 5.0 for society and populace include some negative aspects also. Firstly, in order to achieve the minimal level of latency and delay in data processing and to successfully implement the metaverse technology, business organisations require huge investments for establishing data centres, maintaining data privacy and security, managing data storage, and computing infrastructure. In addition, to deal with and to serve meta-customers, companies need enormous cloud generating and analytical capacities for large amount of data and manifold expansion of computational abilities (Dhelim et al., 2015). Consequently, it may become a giant players' game, leaving behind small and medium sized business organisations. Secondly, on the part of customers, again it may remain as elite community's area of dominance. In fact, society in the real world has the unequal distribution of wealth and resources between rich and poor, gender, racial, regional and language discriminations, communal unrests, and many other crucial and social issues (Bibri, 2022). Moreover, an idealistic virtual reality may negatively impact people's psychology and their lives. Therefore, it becomes the responsibility of government, regulatory authorities and business units that they should establish proper social balance and try to control the amplified adverse effects of metaverse before its actual implementation (Kshetri, 2022). Another downside aspect of metaverse may be viewed as isolation. Vulnerable people, particularly, attempt to live longer hours in virtual reality that results in isolation in most cases (Yu, F.R., & Yu, A.W. 2022). In general, these people get addicted to metaverse easily and become soft target for hackers, cyber attackers and fraudsters (Dahan et al., 2022). After all, spending the precious time in artificial and digital world generates a momentary satisfaction. Paranoid addiction, depression, loss of identity, psychiatric disorders and even suicides among teenagers and youngsters are rapidly becoming the issues of great concern among scientists and researchers (Thomason, 2021). This is not the end, anti-social elements can exploit metaverse platform to fulfil their bad intentions by conducting serious crimes, such as human trafficking, prostitution, child abuse, terrorist attacks, money laundering, etc. Moreover, metaverse and Industry 5.0 are also creating needs of learning new skills and gaining extra qualification, training and technical maturity on the part of employees so that they can be able to perform newly designed sophisticated jobs or otherwise may result in job loss (Kshetri, 2022). Besides economic, social and health issues, there may be some immense environmental consequences of metaverse and Industry 5.0. Enormous consumption of power and electricity, huge amount of carbon emissions and rising bulk of e-waste (Bianzino & de Yonge, 2022) have emerged as burning issues among ecological activists. Activities like larger cloud generation, voluminous data processing, establishing big data warehouses and data centres, and expanding web of networks, if not regulated properly, might become drawbacks of metaverse.

DISCUSSION

To fulfil the objective of the present study, the most commonly keywords were identified and searched in the previous publications related to Industry 5.0 and metaverse by applying a method of extraction. Largely and repeatedly occurring keywords were identified as, AI, big data, digital world, innovation, machine learning, metadata, and virtual reality. Thus, a consistency and uniformity were found within the frameworks of Industry 5.0 and metaverse. AI and machine learning try to simplify and replicate the repetitive jobs along with assisting to human cognition and intelligence. Big data, innovation and metadata are expected to fabricate a data-rich foundation and scenario that will be supporting resource optimisation and personal customisation of goods and services. Likewise, digital reality presents the world of

metaverse having virtual items and objects, which have the capacities of serving the human requirements. In exact sense, it is clear that scientific and business communities are showing their keen interest in the thought of metaverse and Industry 5.0 that may bridge the gaps between human and machine intelligence, interaction and collaboration. It means that it is expected to see humans and machines working together at a common workplace in our near future.

Limitations and Challenges

No doubt, the concepts of Industry 5.0 and metaverse will take present scenario of business, industry and society to another level. But, the challenges, issues and limitations are also associated. Learning the entirely new aspects for employees about knowledge, skills and abilities (KSAs) with the perspective of metaverse, Industry 5.0 and smart machines may arise new challenges and threats for the workforce. Furthermore, learning and implementation of totally unique technologies always demand dedication and time. Moreover, the cost and expenditure aspects also cannot be overlooked and ignored. The adoption of Industry 5.0 and metaverse technologies necessitates huge investment from business owners. Alongside, the ethical, moral, legal, environmental and social concerns are also there. As the empirical research and studies are in acute shortage in the field of Industry 5.0 and metaverse till now, it is not possible to arrive at the concrete conclusions, theories and models and other academic aspects.

Future Research Directions

In future, research and investigations should have their focus on resolving the concerns as discussed in this study regarding the implementation of Industry 5.0 and metaverse technicalities for employees, business organisations, governments and society at large. Apart from this, policy makers and practitioners are required to work for making metaverse and Industry 5.0 techniques more ethical, responsible and safe for all stakeholders. Additionally, future researchers are expected to collect evidences, to make comparisons, to derive conclusions, and to assess impacts of Industry 5.0 and metaverse in empirical terms.

CONCLUSION

This study enquires about the concept, structure, components and implications of metaverse techniques along with Industry 5.0. The comprehensive and exhaustive approach adopted to analyse the possibilities and workability of metaverse are guided by the progression of Industry 5.0 techniques that respect human beings, human rights, human knowledge, human intelligence and human dignity. Thus, the present study attempts to present a broad perspective of metaverse framework, which drives individuals, business organisations, policy makers, researchers and other stakeholders in a general way towards the path of digitalisation and transition to Industry 5.0. As the literature revealed, AI, three-dimensional printing, collaborative robots (cobots), VAs and chatbots, digital twins, blockchain technology, exoskeleton structures, IoT, 6G communication, big data and metadata analytics, augmented and mixed realities, additive manufacturing, and eco-friendly supply chain management and logistics facilitate and allow business processes to revolutionise production, servicing and marketing efficiencies keeping human wellbeing at the core. Nevertheless, metaverse and Industry 5.0 have some downside aspects related to job losses, data and information misuse, privacy deficit, threat to ecosystem, social disturbances, psychological disorders, physical and health degradation, expensive implementation, and costly infrastructure. Conclusively, the present study puts forth a concise summary of utilising and gaining benefits from metaverse and Industry 5.0 technological novelties. The most important thing is the implementation of Industry 5.0 and shaping of metaverse should be in the responsible manner.

REFERENCES

Adel, A. (2022). Future of Industry 5.0 in society: Human-centric solutions, challenges and prospective research areas, *Journal of Cloud Computing, 11,* 40.

Akkucuk, U., & Asugman, G. (2022). Metaverse marketing: Exploring the potential of metaverse for marketing, *International Journal of Marketing Studies, 14,* 52-63.

Alojaiman, B. (2023). Technological modernizations in the Industry 5.0 era: A descriptive analysis and future research directions, *Processes, 11,* 1318.

Alyami, H., Ansari, M., Alharbi, A., Alosaimi, W., Alshammari, M., Pandey, D., Agrawal, A., Kumar, R., & Khan, R.A. (2022). Effectiveness evaluation of different IDSs using integrated fuzzy MCDM model, *Electronics, 11,* 859.

Aslam, F., Aimin, W., Li, M., & Ur Rehman, K. (2020). Innovation in the era of IoT and industry 5.0: Absolute innovation management (AIM) framework, *Information, 11,* 124.

Ball, M. (2021). *The metaverse primer*. Retrieved from https://www.matthewball.vc/the-metaverse-primer2020/12/02

Bianzino, N.M., & de Yonge, J. (2022). Metaverse: Could creating a virtual world build a more sustainable one? *EY Report, 4,* 22.

Bibri, S.E. (2022). The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart Cities: A study in science, technology, and society, *Smart Cities, 5,* 832-874.

Blanchard, J., Koshal, S., Morley, S., & McGurk, M. (2022). The use of mixed reality in dentistry, *British Dental Journal, 233,* 261-265.

Cambridge Dictionary (2023). Retrieved from https://dictionary.cambridge.org/dictionary/english/metaverse

Carayannis, E.G., Draper, J., & Bhaneja, B. (2021). Towards fusion energy in the Industry 5.0 and Society 5.0 context: Call for a global commission for urgent action on fusion energy, *Journal of the Knowledge Economy, 12,* 1891-1904.

Chen, Y.H., Lin, C.Y., & Wang, T.I. (2021). Exploring consumer experience in the metaverse: The role of brand experience and self-identity congruity, *Journal of Business Research, 133,* 27-38.

Csaky, M., & Koltay, T. (2020). The metaverse: Potential future developments and ethical issues, *European Journal of Futures Research, 8,* 1-12.

Dahan, N.A., Al-Razgan, M., Al-Laith, A., Alsoufi, M.A., Al-Asaly, M.S., & Alfakih, T. (2022). Metaverse framework: A case study on e-learning environment (ELEM), *Electronics, 11,* 1616.

De Giovanni, P. (2021a). *Blockchain technology applications in businesses and organizations,* IGI Global: Hershey, PA, USA.

De Giovanni, P. (2021b). Smart supply chains with vendor managed inventory, coordination, and environmental performance, *European Journal of Operational Research, 292,* 515-531.

Demir, K.A., Döven, G., & Sezen, B. (2019). Industry 5.0 and human-robot co-working, *Procedia Computer Science, 158,* 688-695.

Dhelim, S., Kechadi, T., Chen, L., Aung, N., Ning, H., & Atzori, L. (2015). Edge-enabled metaverse: The convergence of metaverse and mobile edge computing, *Journal of Latex Class Files, 14*(8), 1-8.

Farsi, M., & Erkoyuncu, J.A. (16-17 November 2021). Industry 5.0: Transition for an advanced service provision. In *Proceedings of the 10th International Conference on Through-Life Engineering Services,* Twente, The Netherlands.

Fatima, Z., Tanveer, M., Zardari, S., Naz, L., Khadim, H., Ahmed, N., & Tahir, M. (2022). Production plant and warehouse automation with IoT and Industry 5.0, *Applied Sciences, 12,* 2053.

Franze, A., Caldwell, G., Rittenbruch, M., & Teixeira, M.B.F. (28 November–2 December 2022). Employing AR/MR mockups to imagine future custom manufacturing practices. In *Proceedings of the 34th Australian Conference on Human-Computer Interaction,* Canberra, Australia, & Association for Computing Machinery (ACM): New York, NY, USA.

Fu, Y., Li, C., Yu, F.R., Luan, T.H., Zhao, P., & Liu, S. (2022). A survey of blockchain and intelligent networking for the metaverse, *IEEE Internet of Things Journal, 10,* 3587-3610.

Galeeva, G.M., & Zinurova, R.I. (2016). Technological modernization of industry, *Social Sciences and Interdisciplinary Behavior,* CRC Press: Boca Raton, FL, USA, 235-238.

Heidari, A., Navimipour, N., & Unal, M. (2022). Applications of ML/DL in the management of smart cities and societies based on new trends in information technologies: A systematic literature review, *Sustainable Cities and Societies, 85,* 104089.

Holden, R.J., Abebe, E., Hill, J., Brown, J., Savoy, A., Voida, S., Jones, J.F., & Kulanthaivel, A. (2022). Human factors engineering and human-computer interaction: Supporting user performance and experience, *Clinical Informatics Study Guide,* 119-132.

Kasinathan, P., Pugazhendhi, R., Elavarasan, R., Ramachandaramurthy, V., Ramanathan, V., Subramanian, S., Kumar, S., Nandhagopal, K., Raghavan, R.R.V., Rangasamy, S., et al. (2022). Realization of sustainable development goals with disruptive technologies by integrating Industry 5.0, Society 5.0, smart cities and villages, *Sustainability, 14,* 15258.

Khan, L.U., Saad, W., Niyato, D., Han, Z., & Hong, C.S. (2022). Digital-twin-enabled 6G: Vision, architectural trends, and future directions, *IEEE Communications Magazine, 60,* 74-80.

Kshetri, N. (2022). Policy, ethical, social, and environmental considerations of Web3 and the metaverse, *IT Professional, 24,* 4-8.

Lampropoulos, G., Kerstin, S., & Theofylaktos, A. (2019). Internet of things in the context of Industry 4.0: An overview, *International Journal of Entrepreneurial Knowledge, 7,* 4-19.

Li, O., He, J., Zeng, K., Yu, Z., Du, X., Zhou, Z., Liang, Y., Wang, G., Chen, Y., Zhu, P., et al. (2022). Integrated sensing and communication in 6G: A prototype of high resolution multichannel THz sensing on portable device, *EURASIP Journal of Wireless Communications and Networking, 2022,* 106.

Majumder, M., & Tripathi, A.K. (2021). Transformative power of technologies: Cultural transfer and globalization, *AI and Society,* 1-9.

Mehdiabadi, A., Shahabi, V., Shamsinejad, S., Amiri, M., Spulbar, C., & Birau, R. (2022). Investigating Industry 5.0 and its impact on the banking industry: Requirements, approaches and communications, *Applied Sciences, 12,* 5126. https://doi.org/10.3390/app12105126.

Motienko, A. (2020). Integration of information and communication system for public health data collection and intelligent transportation system in large city, *Transportation Research Procedia, 50,* 466-472.

Mourtzis, D., Angelopoulos, J., & Panopoulos, N. (2022). A literature review of the challenges and opportunities of the transition from Industry 4.0 to Society 5.0, *Energies, 15,* 6276.

Nahavandi, S. (2019). Industry 5.0: A human-centric solution, *Sustainability, 11,* 4371.

Orlova, E.V. (2021). Design of personal trajectories for employees' professional development in the knowledge society under Industry 5.0, *Social Sciences, 10,* 427.

Ozkeser, B. (2018). Lean innovation approach in Industry 5.0, *The Eurasia Proceedings of Science, Technology, Engineering & Mathematics, 2,* 422-428.

Saniuk, S., Grabowska, S., & Straka, M. (2022). Identification of social and economic expectations: Contextual reasons for the transformation process of Industry 4.0 into the Industry 5.0 concept, *Sustainability, 14,* 1391.

Schiavone, F., Gatteschi, V., & Lamberti, F. (2021). Exploring blockchain and metaverse for supporting smart tourism: A systematic literature review, *Sustainability, 13,* 6581.

Shen, B., Tan, W., Guo, J., Zhao, L., & Qin, P. (2021). How to promote user purchase in metaverse? A systematic literature review on consumer behavior research and virtual commerce application design, *Applied Sciences, 11,* 11087.

Shloma, O.K., & Volotka, V.S. (27–28 March 2021). What can we expect from Industry 5.0? In *Proceedings of the Матеріали сьомої Міжнародної науково-технічної конференції «Проблеми електромагнітної сумісності перспективних безпроводових мереж зв'язку (EMC-2021)»,* Kharkiv, Ukraine, 93-96.

Skobelev, P.O., & Borovik, S.Y. (2017). On the way from Industry 4.0 to Industry 5.0: From digital manufacturing to digital society, *Industry 4.0, 2,* 307-311.

Stephenson, N. (2003). *Snow crash: A novel*. Bantam Spectra: New York, NY, USA.

The Guardian, (2021, October 28). Enter the metaverse: The digital future Mark Zuckerberg is steering us toward. Retrieved from https://www.theguardian.com/technology/2021/oct/28/facebook-mark-zuckerberg-meta-metaverse

Thomason, J. (2021). Metahealth - how will the metaverse change health care?, *Journal of Metaverse, 1,* 13-16.

Tröster, M., Budde, S., Maufroy, C., Andersen, M., Rasmussen, J., Schneider, U., & Bauernhansl, T. (2022). Biomechanical analysis of stoop and free-style squat lifting and lowering with a generic back-support exoskeleton model, *International Journal of Environmental Research and Public Health, 19,* 9040.

Yu, F.R., & Yu, A.W. (2022). The metaverse and the real-world universe. In *A Brief History of Intelligence: From the Big Bang to the Metaverse,* Springer International Publishing: Cham, Switzerland, 105-109.