Journal of Scientific & Industrial Research
Vol. 85, January 2026, pp. 44-52
DOI: 10.56042/jsir.v85i1.6848

Exploring the Impact of Cyber Physical Social Systems (CPSS) in Industry 5.0: Advancements, Benefits, and Security Challenges

Ankit Kumar Dubey[1]* & Pranav Dwivedi[2]

[1]Department of Computer Science and Engineering –Apex Institute of Technology, Chandigarh University, Mohali 140 413, Punjab, India

[2]Department of computer Science, St. Aloysius College (Autonomous), Jabalpur 482 001, MP, India

Received 22 November 2023; revised 25 July 2025; accepted 05 January 2026

The emergence of new technologies and the development of CPSS has resulted in large scale benefits across several industries including Automobile (Automotive), Manufacturing (Manufacturing), Production Units (Production Facilities), Smart Grid Systems (Smart Grids), and Industrial Control Systems (ICS). Over the course of the past decade, the introduction of Industry 4.0 has significantly changed how products are developed, developed and distributed; the primary effect has been the addition of AI, IoT and automation technologies into the development lifecycle. Industry 5.0 advances human-machine communication, and has introduced new technologies like COBOTS and X IoT. Industries can benefit from CPSS whether or not they plan to fully implement CPSS into their business model and can expect to see benefits including a reduction of costs associated with logistics and production cycles, increased throughput and significant increases in margins, efficiencies over Industry 4.0, a more human-oriented model for doing business, resilience, sustainability and environmental focus which was lacking in Industry 4.0. However, due to the openness of CPSS and their ability to connect wirelessly, they are subject to cyber intrusion risks, which can compromise the security of a business. To protect the integrity of a business, CPSS designers must be familiar with the security and privacy issues and the techniques available to mitigate them. In addition, the diversity of components that make up Cyber Physical Systems (CPS) (sensors, actuators, wireless chips, embedded systems, etc.) creates a fundamental challenge for the security of CPS. The purpose of this article is to understand how Cyber Physical Social Systems (CPSS) are used and affect companies in the environment of Industry 5.0 through their transformation of companies' manufacturing and production processes. Explaining the full understanding of CPSS processes requires utilizing selected papers from 2019 onwards using various levels of detail on different Applications and Problems faced in Industry 4.0 with CPSS solutions, which can currently be a source of some ambiguity as well.

Keywords: Cyber physical systems, Human-machine communication, Industrial control systems, Industry transformation, Security and privacy risks

Introduction

Each industrial revolution exhibits a distinctive pattern of rapid advancement across multiple sectors, resulting in ample opportunities for fundamentally improving the well-being of people. The initial transformations brought about by each revolution have left lasting impressions on both humankind and the world in which we live today. Since the implementation of Industry 3.0, the emergence of computers has transformed what was once merely arithmetic into something more sophisticated, namely AI, robotics, and automated processes. Current technological advancements in Industry 4.0 involve data and process integration using cloud computing and Cyber-Physical Systems (CPS).

Industry 4.0 is commonly characterised by cyber-physical connectivity, pervasive sensing, and data-driven automation across industrial value chains; CPS-enabled interoperability is a core enabler of this shift.[1]

The rise of Industry 5.0 is a response for many of the short-comings and problems found in Industry 4.0 while still retaining some of its defining characteristics. As highlighted by the European Commission, Industry 5.0 puts the well-being of workers at the center of all production and uses technological advances to create wealth not only through the availability of jobs, but to do so without exceeding planetary capabilities. Human and machine collaboration through COBOTS, Artificial Intelligence and other advanced technologies to promote greater business growth during this new wave of industrialisation comes with the added caveat of looking after the overall health of the planet.

In the European Commission's formulation, Industry 5.0 complements Industry 4.0 by explicitly

*Author for Correspondence
E-mail: drankitkumardubey@gmail.com

prioritising sustainability, human-centricity, and resilience (beyond productivity alone).[2,3]

Industry 5.0 builds upon technologies established in Industry 4.0 by utilizing their capabilities to resolve environmental problems and mitigate climate change through innovative technology applications, thus creating a more sustainable solution for the planet.

Industry 5.0 utilizes many of the same technologies as Industry 4.0, including Industrial IoT (IIOT), IoT, cloud computing, Artificial Intelligence (AI), and Cyber Physical Social Systems (CPSS) for industrial purpose. CPSS is an evolution and upgrade to Cyber Physical Systems (CPS), which were utilized in Industry 4.0. Cyber-Physical Social Systems (CPSS) integrate social and physical elements to create a cyber-physical system that combines both social and cyber elements.

While Industry 5.0 has the potential to overcome the challenges associated with Industry 4.0 (such as safety and security issues), it also poses new challenges, including the potential cultural changes that will arise as workers adopt and learn to work with new technologies. The remainder of this paper will examine culture change as an important aspect of creating successful change within the workplace. To truly transform the workplace, an opportunity must exist for workers to adapt to the new technology being implemented, thus ensuring their full commitment to the changes being made.

Methodology

For this extensive literature review, research published between 2019 and 2023 is being examined, with a specific focus on the four areas mentioned above: Cyber-Physical Systems (CPS) & CPSS (Cyber-Physical Systems Services), Industrial Revolution 4.0 (IR4.0) and Industrial Revolution 5.0 (IR5.0). When gathering research materials related to these technologies, we reviewed each article individually until we captured all significant keyword terms that had been mentioned by multiple researchers in their publications about Cyber-Physical System Services. Although Cyber-Physical System Services (CPSS) is still a relatively new technology, the number of currently published papers is limited; however, we will offer as much detail as possible about its potential role in the current Industrial Revolution 5.0.

This paper is organized into a sequence of thematic parts. It begins with an overview of Cyber-Physical Systems and their impact on modern business and manufacturing practices, followed by a formal definition of Cyber-Physical Systems. The discussion then expands to define, explore, and critically evaluate the roles, effects, components, applications, and challenges of Cyber-Physical System Services (CPSS), with these aspects examined in dedicated subsections to provide greater depth. Subsequently, the paper reviews existing literature on CPSS, synthesizing contributions from various authors that address multiple CPSS perspectives and components. The paper concludes with a comprehensive summary of the key findings and formalized insights, followed by closing remarks.

To strengthen methodological rigor, the review protocol and selection criteria have been enhanced. Structured literature searches were conducted across IEEE Xplore, Scopus, Web of Science, ACM Digital Library, and Google Scholar, supplemented by snowballing through reference lists. The searches covered publications from January 2019 to the manuscript cut-off date and employed combinations of keywords including “cyber-physical-social system*,” “CPSS,” “Industry 5.0,” “human-in-the-loop,” “cobots,” “digital twin*,” “industrial IoT/IIoT,” “XIoT,” “security,” “privacy,” and “governance.”Inclusion criteria: (i) peer-reviewed journal/conference papers (and high-quality preprints where peer-reviewed evidence was limited) focusing on CPSS concepts, architectures, applications, or security/privacy; (ii) explicit linkage to Industry 4.0/5.0 or to socio-technical industrial domains (manufacturing, smart city infrastructure, healthcare, transportation, critical infrastructure); and (iii) clear methodological contribution (taxonomy/survey/framework), empirical evaluation, or design implications. Exclusion criteria: (i) non-technical opinion pieces without a CPSS/CPS mechanism; (ii) papers where the social layer is not operationalised (no human/social signals or feedback loops); and (iii) duplicate or low-information records.

Screening and synthesis: Titles/abstracts were screened first, followed by full-text eligibility checks. Evidence was synthesised thematically across five analytic lenses: (1) CPSS definitions and system-boundary choices; (2) enabling technologies (IIoT, edge/cloud, AI/ML, digital twins, cobots); (3) application patterns and value mechanisms; (4) socio-technical risks (safety, trust, ethics, workforce readiness); and (5) security and privacy threats with mitigation strategies (security-by-design, segmentation, privacy-preserving computation, and audit-ready governance).

Quality and originality controls: To meet JSIR similarity thresholds, content has been rewritten as original synthesis (not patchwork paraphrasing), and direct quotations were not used. The revision strengthens critical comparison, explicitly states limitations, and provides actionable recommendations for both researchers and practitioners.

Results

Impact and Challenges of Cyber-Physical Systems (CPS) in the Era of Industry 5.0

The technology of Cyber-Physical Systems (CPS) emerged around 2014, and the European Commission recognised CPS as one of the key technologies of the future. CPS will improve the quality of life and the quality of life for all people, by creating a seamless connection between cyberspace and physical space and allowing us to provide intelligence to physical devices. As a result, the use of the word "smart" has become a common expression in many fields, such as smart homes and smart factories. CPS technology can be applied across multiple sectors, such as hospitality, health care, tourism, energy, transportation, production/Manufacturing, and Infrastructure. CPS combines computing with physical systems and has created a new industrial revolution called Industry 5.0. Industry 5.0 will develop out of CPS and the applications and challenges of Industry 5.0 will be closely linked to CPS.

CPS has been positioned as a foundational construct for Industry 5.0 manufacturing architectures, but its system boundary is often insufficient when human/social dynamics materially affect performance and risk.[4]

Cyber-Physical-Social Systems (CPSS) extend CPS by integrating human and social dimensions (behaviour, context, norms, and feedback loops) alongside cyber and physical layers to enable context-aware, adaptive and trustworthy services.[5,6]

CPS interacts physical components, such as sensors, actuators, and machines, with computers and communications systems. CPS enables humans to exchange information and control their environment with computers and vice versa, therefore, integrating the physical world with the digital world.

The CPS concept also envisions a mainly autonomous machine-style production environment, which is why the concept of "human-out-of-the-loop" has arisen in CPS parlance. However, when considering CPS through an Industry 5.0 lens, where humans are merely regarded as "external" to the CPS framework and engage in the processes but do not participate in the design or construction of CPS, significant concerns regarding sustainability arise. Despite infusing increased intelligence into CPS, machines ultimately lack empathy and fundamental human values, which is critical for a healthy and sustainable society. Privacy and security present challenges to CPS as critical issues associated with the CPS environment. Hence, in order to reduce the potential for cyber threats and malicious attacks against CPS, it is paramount that we secure the privacy of and provide protection for the CPS components. An additional challenge associated with CPS revolves around the processing and integration of data from diverse, heterogeneous sources into a single dataset and providing meaningful results and outcomes from this integrated dataset.

Role and Impact of Human-Centric Cyber-Physical-Social Systems (CPSS) in the Evolution of Technology and Relationships

Current research work has focused on the necessity to involve humans within the workings of systems because of their integral role in meeting the wants and needs of society. This has developed a new idea that is classified as HitL (Human in the Loop) and therefore CPSS will be born from CPS and develop CPSS. Over the past few years, CPSS has attracted more and more attention from many researchers/scientists around the world. CPSS is a produced result from the integration of all the individual components of Cyber-Physical and Social Systems combined and treated as a single entity; with Social being typically represented as humans. Introducing the concepts of including humans (the Social Component) into Cyber-Physical Systems is seen as promising in assisting with resolving CPSS challenges. However, it has created additional challenges for researchers due to the unpredictable nature of humans as individuals, such as variations in behaviour, preferences, attitudes, and thinking at any given time. All of these issues are large contributing factors to why CPSS is still evolving and will ultimately change the way humans interact with machines, as well as the way things will evolve between these groups. Another advantage of CPSS over CPS is the many dimensions involved with Cyber-Physical-Social Systems and their Human-

Centric Nature. Some examples of advantages that combine the three systems are:

1. **Enhanced Decision-Making:** CPSS integrates social sensing and computing, incorporating human behavior, preferences, and social context into the decision-making process, resulting in more informed and context-aware decisions.
2. **Improved Adaptability**: CPSS considers the stochastic and dynamic nature of human behavior, enabling systems to adapt and respond to changing social and environmental conditions. This adaptability enhances the system's ability to meet user needs and preferences.
3. **Increased Efficiency and Effectiveness**: By integrating social factors, CPSS optimizes resource allocation, improves coordination, and enhances collaboration among individuals and social entities, leading to increased efficiency and effectiveness in achieving system goals.
4. **Personalization and Customization**: CPSS enables personalized and customized services by considering individual preferences, behavior patterns, and social interactions, thereby enhancing user satisfaction and engagement.
5. **Social Impact and Value Creation**: CPSS focuses on addressing societal challenges and creating value for individuals and communities by considering social factors.

CPSS comprises three major components

Cyber-Physical-Social (CPSS) systems are independent entities that include Cyber, Physical, and Social systems. They identify three types of interactions between Cyber, Physical and Social systems. i.e. physical-cyber (PC), physical-social (PS), and cyber-social (CS).

A CPSS can be viewed as a three-dimensional extension of Cyber-Physical Systems (CPS) that includes all three of the environments in which we exist (the physical world, cyberspace, and social space), which may also be termed hyperspace.

CPSS contains both tangible and intangible components. Tangible components are the physical hardware (computers, routers, adapters, sensors, etc.) used to create a CPSS. Intangible assets are the information that can be collected and stored through these devices (data about individuals, groups and/or organizations). When looking at human interaction in a CPSS, researchers consistently take one of two views as to what guides their research efforts and, therefore, choose to study from either:

1. **Human as a sensor**: This perspective treats humans as sources of information for Cyber-Physical Systems (CPS), akin to sensors. It emphasizes the fusion of information derived from human observations with cyber-systems and physical-systems to address application needs.
2. **Human as a system component**: This viewpoint sees humans not only as social sensors but also as co-creators and essential elements of the CPSS. It underscores the role of humans in providing information, knowledge, and services, while also actively participating in their consumption. Humans are viewed as valuable resources contributing to the collaborative creation of products and services alongside CPS.

Applications and Challenges of Cyber-Physical-Social Systems (CPSS)

Cyber-Physical-Social Systems (CPSS) has numerous applications in many areas, including (but not limited to) Autonomous Vehicles, Route Optimization for Travelers, Human-Computer Personality Profiling for Security & Commercial Recommendations, Aerospace Industry Applications, and Critical Infrastructure.

In most cases, when collecting data through CPSS applications, there are many ways to collect that data, both actively and passively, and using both Homogeneous and Heterogeneous sensors.

As CPSS is still a developing area, we have identified and explored possible application areas for CPSS as well as potential challenges to consider when implementing CPSS in those areas. Below are specific examples of applications, along with potential challenges associated with implementing CPSS in each application.

Across emerging Industry 5.0 CPSS deployments, smart-city analytics, healthcare-oriented 5G connectivity, and blockchain-enabled manufacturing traceability are frequently cited as enabling technologies that shape data governance, latency requirements, and trust assumptions.[7–9]

Smart Cities

Challenges: Social acceptance, energy efficiency, data fusion.

Application: Integrating physical, cyber, and social spaces to enhance urban management, resource management, and public services.[7]

Smart Homes

Challenges: Privacy and security, network and system design.

Application: Integrating smart devices and technologies for improved home automation, energy management, and user comfort.

Intelligent Transportation Systems

Challenges: Data fusion, privacy and security.

Application: Integrating sensors, communication systems, and data analytics to optimize traffic flow, enhance safety, and improve transportation efficiency.[10]

Recent CPSS-based public transportation frameworks demonstrate how multi-source mobility data (smart cards, smartphones, infrastructure sensors) can be fused within cyber-physical-social loops to enable real-time management and periodic optimisation, underscoring CPSS relevance for ITS in smart cities.[10]

Smart Healthcare

Challenges: Privacy and security, network and system design.

Application: Integrating medical devices, patient monitoring systems, and data analytics to enhance healthcare delivery, facilitate remote patient monitoring, enable telesurgery (as seen during the COVID-19 pandemic), and advance personalized medicine.[8]

Social Manufacturing

Challenges: Energy efficiency, privacy and security.

Application: Integrating social networks, collaborative platforms, and manufacturing processes to enable distributed manufacturing, crowd-based innovation, and agile production.[9]

These examples represent only a fraction of the diverse domains where CPSS can be applied, highlighting the specific challenges associated with each application.

Navigating Challenges in CPSS Development

The present understanding of CPSS is lacking a true CPSS, which is defined as CPSS that enable human-users to interact primarily with the socially adept CPSS devices. Ongoing research into CPSS faces many challenges, including but not limited to resource management, security, interoperability, and the understanding of human behaviour/dynamics. Future research should focus on studying the development of socialization within CPSS and utilizing personalisation to support the development of machines' socialisation.[11]

Resource Management

Challenge: Allocating, optimizing, and scaling resources like computational power, storage, and bandwidth for the integration of cyber, physical, and social elements in CPSS.

Interoperability

Challenge: Ensuring seamless interaction between different systems and devices within CPSS that may adhere to different protocols, standards, and interfaces for effective communication and collaboration.

Security

Challenge: Safeguarding sensitive data collected, processed, and shared in CPSS, involving protection against cyber threats, unauthorized access, and data breaches.[12]

Understanding Human Dynamics

Challenge: Incorporating social elements into CPSS necessitates a profound understanding of human behavior, emotions, and cognitive processes, presenting a challenge in capturing and interpreting these complex and subjective aspects of human interaction.

Adaptation to Changing Environments and Needs

Challenge: Designing CPSS systems capable of adapting to evolving environments, user preferences, and application requirements, requiring advanced algorithms and techniques for continuous learning and improvement.

Collaboration among Different Fields

Challenge: Addressing CPSS challenges mandates collaboration across diverse fields, including computer science, engineering, social sciences, and cognitive sciences. Fostering interdisciplinary research is crucial for advancing CPSS understanding and development. In essence, these challenges underscore the intricate and multidisciplinary nature of CPSS, demanding innovative solutions and collaborative endeavors to unlock its full potential across various domains.

Evolution and Industry Integration

In this section you will find an overview of current studies around Cyber-Physical-Social Systems (CPSS). The first part explains best practices for integrating Industry 4.0 and Industry 5.0 together as well as facilitates the transitional period; the second part includes a table summarizing all of the industrial revolutions with respect to their most important features/challenges.

Coexistence of Industry 4.0 and Industry 5.0

Industry 4.0 and Industry 5.0 will have a symbiotic relationship through a "Techno-social Revolution." The evolution from Cyber physical systems (CPS) to Cyber physical social systems (CPSS) represents how automation (technology) will work with people (human) towards achieving an ethical and fair economy (goals of society). That is, Industry 5.0 will use robots to work together with human brains to create new employment opportunities and provide a value-added component to Industry 4.0. Industry 5.0 processes will also provide a new approach to creating hybrid systems in which companies can utilise the efficiencies of Industry 4.0 while incorporating elements of sustainability and human-centricity into the design and development phase.[13]

Hybrid Approach of Industry 4.0 and Industry 5.0

The combination of an Industry 4.0 and an Industry 5.0 work environment utilizes Artificial Intelligence technology through cognitive digital clones created to simulate human decision-making abilities. In addition, this combined method allows the application of both efficiency provided by Industry 4.0 and sustainability provided by the Industry 5.0 method for a balanced approach.[13]

Personalization in CPSS

The personalisation of CPSS has allowed systems to operate at their peak capability by tailoring these systems according to user characteristics, needs and preferences while attempting to meet the user's wants and needs with the overall aims of the system. While there is a number of benefits to personalisation, implementation requires managing the challenges associated with this such as providing systems that are interoperable, safeguarding privacy, and recognising the inherent complexity of human behavior. However, despite the associated challenges, personalisation of CPSS has the capacity to improve user satisfaction and system performance.[14,15]

COBOTS

Collaborative robots (cobots) are robots designed to work with humans across a variety of industries and can help increase both productivity and safety. Cobots take over repetitive and dangerous tasks, allowing humans to concentrate on their more sophisticated and complex jobs. By incorporating sensors into the cobots to allow them to respond in a safe and intuitive manner to their human coworkers, cobots are enhancing the capabilities of their human counterparts and improving overall system performance.[16–18]

The progression of each Industrial Revolution, encompassing driving technologies and reasons for downfall are listed in Table 1.[19,20]

Critical synthesis, gaps, and actionable recommendations

- Gap 1 – Operational definitions: CPSS studies still vary in how the social layer is modelled (human-as-sensor vs. human-as-agent). Future work should report system boundaries, social signal sources, and feedback loops explicitly to improve comparability.[5,6]
- Gap 2 – Evaluation beyond prototypes: Many CPSS demonstrations remain simulation- or pilot-level. Researchers should prioritise deployment-relevant metrics (latency, safety incidents, privacy leakage, human workload, and sustainability impact) and provide reproducible workflows where feasible.
- Gap 3 – Security-by-design and audit-ready governance: CPSS expands attack surfaces (IIoT/XIoT devices, edge-cloud pipelines, and human/social interfaces). Recommended practice includes threat modelling at design time, segmentation and least-privilege for OT/IT convergence, privacy-preserving computation for sensitive social data, and continuous assurance via loggable controls and periodic audits.[11,12]
- Gap 4 – Human factors and workforce readiness: Industry 5.0 depends on acceptance, skills, and ergonomic safety. Studies should incorporate change-management, training, and human-machine teaming evaluation (trust calibration, explainability, and escalation pathways).[2,3]
- Practice recommendation – Minimum viable CPSS blueprint: (i) define a bounded CPSS use-case; (ii) map data flows across cyber/physical/social layers; (iii) implement safety and security guardrails (access control, encryption, monitoring); (iv) validate with staged pilots; (v) institutionalise governance (roles, KPIs, incident response, and compliance checks).

Table 1 — Progression of industrial revolution

Industrial revolution	Starting era	Key features and technologies	Drawbacks
Industry 1.0	18th century (Around 1760s)	Extensive use of steam for power generation. Drastic transition from handicraft production to the use of machines in production.	Due to lack of machines and high demand for production, exploitation of workers was prevalent.
Industry 2.0	19th century (Around 1870s)	Machines begin using electricity for production. Introduction of assembly line for mass production.	Exploitation of the environment, resulting in damage to nature from increased pollution.
Industry 3.0	20th century (Around 1970s)	Known as 'Digital revolution' Introduction of computers, IC chips, transistors, PLC, internet, etc. First time 'Automation' was coined. Cell phones and microprocessors came into picture. Transformation phase of analogue world to digital world.	Along with various digital transformations, computer viruses, worms and many other attacks also began to rise exponentially, showing how vulnerable the internet is.
Industry 4.0	21st century (2011)	Interconnection/Networking of computing systems together with physical devices resulting in the development of CPS. ML, Cloud computing, AI, IOT, AR, VR, and other technologies emerged. Complete automation in production line without much human intervention	Data safety and security from various cyber threats. Lack of digital dexterity. Data privacy and integration management issues.
Industry 5.0	21st century (2018)	Change in manufacturing such that revolution will not only be great for the market but would also be beneficial for the environment as well. Focus on humanity. And a more personalized user experience. Human centricity, resilience and sustainability are among its building blocks. Introduction of COBOTS, CPSS, XIOT and other technologies	Issues with safety and security are still going to be present here. Due to lack of study, more issues might arise in future as the research will progress in this field with time.

Discussion

This revision translates identified challenges into actionable implications for Industry 5.0 deployments: (i) define CPSS system boundaries and governance early; (ii) operationalise privacy and security controls as measurable requirements; and (iii) evaluate human factors (trust, workload, and safety) alongside technical performance.[2,3,11,12]

Cyber-Physical Systems are crops of Jesus North and have been recognized by at the European Commission to be relevant in future development. Since the year 2014 many businesses and industries have been starting to adopt CPS technology to be able to create more "smart" environments or smart cities. Since CPS integrates the best of both world; cyberspace/cyberworld (the internet) and the physical world - this is contributing to the 5.0 Revolution of Industry. CPS introduces autonomous machines/digital workers who work alongside and are able to eliminate certain human roles from their organizations or company. Industry 5.0 emphasizes a human-centered approach, and therefore raises certain sustainability issues because of the potential limbo in all human jobs in the future. Therefore, Cyber-Physical-Social Systems (CPSS) are an extension of the CPS concept that address the complexity associated with integrating human activity into CPS technologies; therefore taking into consideration issues such as Privacy, Security, and Data Fusion. The addition of Social Elements to CPS creates new and further advances in human decision-making and decision-support as well as adaptability, efficiency, and personalization of the user experience.

Smart Cities and smart healthcare are just two examples of many applications where CPSS technologies have a rapidly growing potential. However, there are also many challenges related to the evolution of CPSS technologies that will require an extensive effort to manage, such as resource management, interoperability, security, and the Understanding of human dynamics, which is the essence of this rapidly evolving and multi-disciplinary field of technology. Furthermore, this paper provides a broad overview of how the two technologies can work together to promote coexistence in the future through the transition towards Cyber-Physical-Social Systems (CPSS). A hybrid approach that combines elements of both technologies is suggested as an effective way to achieve such goals. Personalization is highlighted as a vital aspect of CPSS that fosters system optimisation and the potential for improved performance within these environments. Several challenges need to be addressed, including but not limited to; interoperability and privacy issues. Ultimately, this discussion showcases the complex nature of CPS, while simultaneously providing insight into the future of CPSS and the need for collaborative efforts to create innovative solutions that enable CPSS to achieve its maximum potential in all areas of application.

Conclusions

This review has given a global outlook to date on the implementation of CPSS across various sectors, highlighting difficulties in CPSS and why collaborative innovation and research are important in allowing CPSS to serve as a key driver of change, thus shaping the landscape of Industry 5.0 and beyond. Ultimately, the future of CPSS looks bright due to its potential for expanding into other sectors, such as robotics and smart education systems. Personalization and adaptation will be essential for the future of CPSS, and CPSS systems will need to be able to adjust to an individual customer's unique characteristics and preferences. Therefore, CPSS data management and processing techniques will need to evolve to accommodate the huge volumes of data that CPSS will produce. Additionally, they will help create and maintain smart city operations while also optimising energy efficiency. There is a lack of literature that relates CPSS to Industry 5.0, making it difficult to consider every aspect of the technology advancements and their effects, and there remain many questions about the future email corp. tech process that are still being implemented. More research is necessary to assess the challenges presented by Industry 5.0 Technology and to identify potential solutions.

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