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INTERDISCIPLINARY RESEARCH: TRENDS, SYNERGIES, AND PRACTICAL APPLICATIONS

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DIGITAL TWINS AND INTERNET OF THINGS FOR MONITORING AND PREDICTING THE TECHNICAL CONDITION OF BRIDGES WITHIN THE INDUSTRY 5.0 CONCEPT

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Bridges are critically important elements of a country's transport infrastructure; therefore, continuous assessment of their condition is essential for their secure and stable operation. Throughout their life cycle, bridge structures are subjected to significant traffic loads, vibrations, temperature fluctuations, moisture, corrosion and other things that can gradually alter their performance characteristics. Therefore, to ensure the durability and safety of bridges, it is not only proper design and construction that play a key role, but also an effective system for tracking and forecasting their condition throughout their entire life cycle.

Traditional visual inspections of bridges are subjective and do not allow hidden internal defects to be identified at an early phase. Structural health monitoring (SHM) systems must be robust and reliable [1]. The evolution of digital tools is shaping new innovative methods to the management of complex engineering structures. In particular, the Industry 5.0 concept envisages the further advancement of the digital evolution of manufacturing and infrastructure systems, with an emphasis on human-centricity, sustainability and resilience [2, 3, 4]. Consequently, technologies are considered not simply as means of automating individual operations, but as tools for ensuring the safer, more sustainable and highly optimized functioning of physical systems throughout their entire life cycle. For bridge infrastructure, this strategy paves the path to a shift from periodic inspections of bridges' technical condition to digital monitoring – the ongoing collection, analysis and application of operational data to predict their condition and make engineering decisions regarding their continued safe operation. Digitalisation helps engineers to make right decisions, not just simply automating monitoring (human-centricity); it ensures the timely detection of deterioration and improves resilience to extreme conditions; and it helps to extend the life cycle of structures and optimise repairs and resources (sustainability).

In this context, the synergy between the Internet of Things (IoT) and digital twins could become a key tool for guaranteeing the sustained and reliable functioning of bridge structures.

The aim of our study is to summarise current approaches to the use of the Internet of Things (IoT) and digital twins for monitoring and predicting the technical condition of bridges, to identify the opportunity for their implementation in predicting changes in the operational characteristics of bridge structures, and to formulate a methodology to the digital management of bridge infrastructure in the context of Industry 5.0.

One of the crucial technologies for implementing this conceptual approach is the Internet of Things (IoT). The Internet of Things is generally based on the following technologies: identification methods (radio-frequency, optical and infrared tags, etc., for automatic identification. To ensure the individuality of identifiers of different classes, further work is necessary to normalize them); measuring instruments designed to transform details about the environment into data suitable for transmission to processing systems (these may be either individual sensors or complex measuring systems); data transmission systems (wireless or wired networks), data processing systems (cloud-based systems providing high throughput and rapid response to specific situations, as well as fog computing); actuators, which are often structurally integrated with sensors [5, 6].

In bridge engineering, a distributed web of detectors integrated into the bridge's structural elements can collect data on deformations, displacements, vibrations, stresses, temperature, humidity, inclinations and other parameters that characterise the actual behaviour of the bridge structure. Transmitting this data to information systems enables real-time monitoring of the bridge's condition, the detection of abnormal changes and the creation of a cumulative database of operational data.

The next level of integration of technological solutions is the digital twin of a bridge structure. Unlike a static digital model, a digital twin involves linking the virtual model of an object to data on its actual condition and, provided the system is organised appropriately, the ability to incessantly update this information. Combining a digital twin with IoT sensors gives a opportunity to create a digital framework in which the geometric and information model of the bridge is supplemented with up-to-date data on its operational behaviour. This provides a basis for analysing changes in its technical condition, identifying deviations from expected parameters and predicting potential problems.

The application of digital twins in the Industry 5.0 concept is also changing the approach to decision-making regarding the operation of infrastructure facilities. Data obtained from IoT systems can be used by specialists to assess the actual condition of a structure, prioritise maintenance and plan further engineering measures. Thus, the digital twin serves not only as a means of visually representing the bridge, but also as the data foundation for communication between the physical structure, digital technologies and the decision-maker.

The world's existing transport infrastructure is under severe strain due to ageing structures, increasing traffic volumes, the effects of climate change and armed conflicts, it is very important that virtual solutions for monitoring and forecasting the

condition of infrastructure can be implemented both to new bridge structures – for which sensor systems and digital representations can be integrated as early as the design and construction stages – and to existing ones. For facilities that are already in operation, a digital twin can be created on the basis of design and operational documentation, the outcomes of engineering assessments, geometric data, laser scanning, photogrammetry and additional inputs, supplemented by data from installed sensor systems. This makes it possible to gradually incorporate technological solutions into the existing infrastructure without the necessity of build a new facility.

To observe the real-time condition of bridge structures and answer the question of what is happening to the bridge at any given moment, a logical sequence is established: IoT technology involves the aggregation and relaying of data (readings from sensors, in accordance with the architecture of the IoT system); the digital twin provides a visual representation of the bridge's condition, analyses its current state and detects anomalies; and finally, a specialist assesses the structure and makes a decision.

A more complex area is the prediction of the condition of bridges. It is not enough simply to collect technical data; rather, it is necessary to use the accumulated data to make a forecast regarding the future condition of the structure. In this case, the logic would be as follows: data is collected and transmitted in real time using IoT sensors; the Digital Twin then creates a digital representation of the physical bridge and historical data is accumulated; an analytical/AI model is subsequently engineered to forecast changes in the condition of the object under study; the final stage involves supporting decisions regarding the bridge's maintenance. Such an integrated system can predict: the development of deformations; changes in vibration characteristics; the occurrence or progression of damage; the remaining service life of individual components; the need for maintenance; and so on [7, 8, 9].

The integrated IoT–Digital Twin concept for bridges can be illustrated using the diagram shown (figure 1).

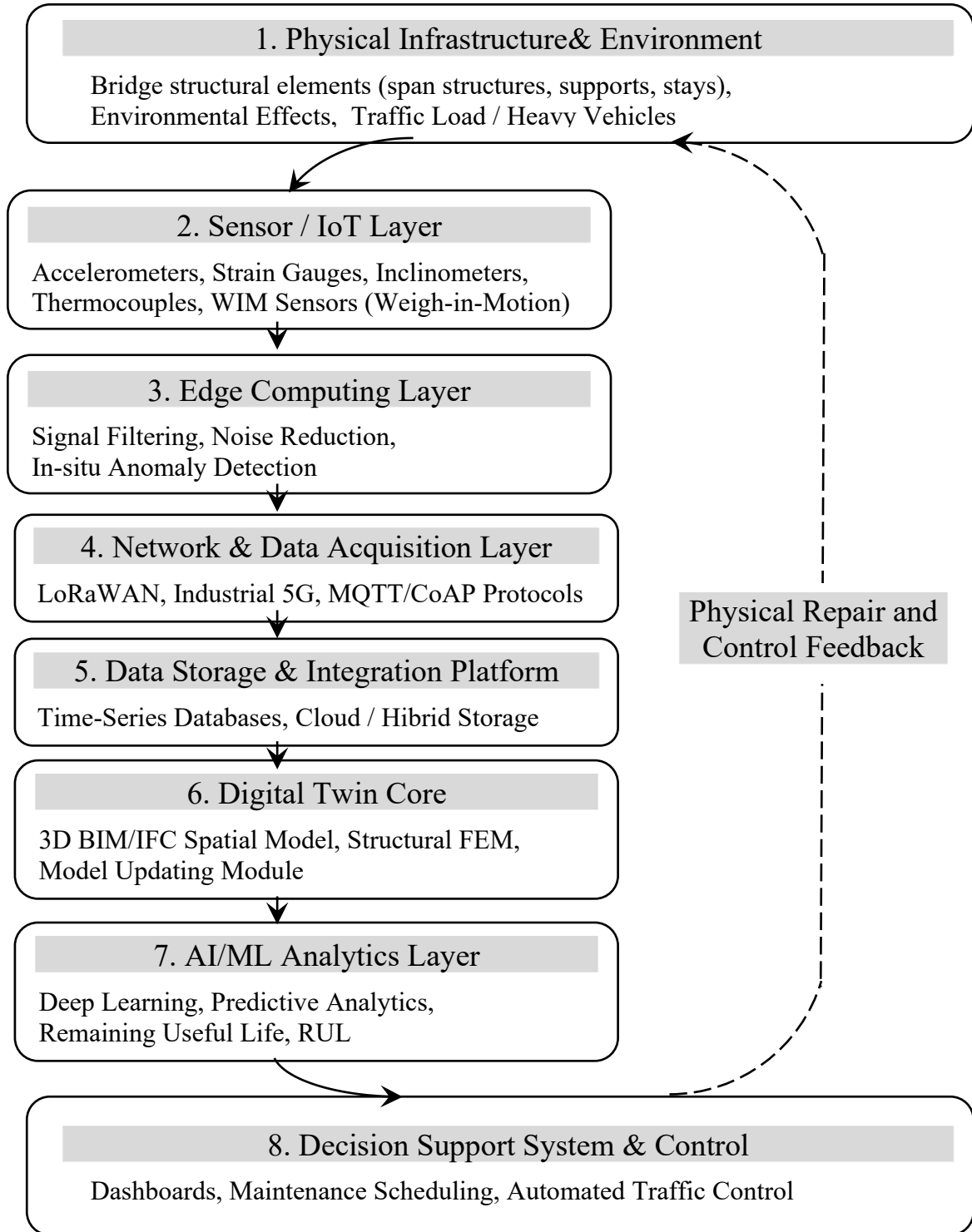


Figure. 1. Architectural and conceptual model of an integrated IoT–Digital Twin system for bridge structures

Source of the figure: compiled by the author based on analysis [7-11, 16]

The functional levels in the conceptual model presented are:

1. *Physical Infrastructure Layer*: This comprises the bridge structure itself, consisting of its structural elements (span structures, supports, cable-stayed systems, abutments), as well as the external environment (weather conditions, seismic activity, traffic loads). At this level, stress-strain states, deformations, vibrations and

degradation processes occur due to the effects of meteorological factors and dynamic traffic.

2. *Sensor/IoT Layer*: Comprises a distributed network of sensors and transducers (strain gauges, piezoelectric accelerometers, inclinometers, fibre-optic sensors, thermocouples, as well as Weigh-in-Motion (WIM) systems). At this level, continuous monitoring of the primary physical parameters of the build and the environment is ensured, covering the following main groups of parameters: deformation (deformations, displacements, deflections), dynamic (accelerations, vibrations, natural frequencies), force-related (stresses, strains, forces), geometric (inclination, support displacement), climatic (temperature, humidity), environmental (wind, precipitation, water level), and special (corrosion, condition of cables, cracks).

3. *Edge Computing Layer*: Performs initial processing of sensor data directly near the object. Bridge sensors (accelerometers for measuring vibrations, acoustic emission) generate a massive amount of data (High-Frequency Data). Transmitting all "raw" data to the cloud is expensive and inefficient. Therefore, the trend toward implementing Edge/Fog Computing between the sensor level and data collection is appropriate. It is used to filter out high-frequency noise, aggregate data, and detect local anomalies in real time in situ, sending only aggregated metrics or anomalies to the cloud, which significantly reduces the load on communication channels and cloud infrastructure.

4. *Data Collection and Transmission Layer (Network & Data Acquisition Layer)*: Sends important information safely without drops from outside sensors up to the cloud using secure wireless connections (LoRaWAN, Industrial 5G, Cellular IoT) or wired communication channels via MQTT, CoAP, or HTTP/REST API protocols.

5. *Data Storage & Integration Platform*: This is a scalable cloud-based or hybrid storage solution. It uses time-series databases to organize telemetry streams, as well as relational and document-oriented databases to store the facility's technical and operational data.

6. *Digital Twin Core*: The core module of the system, consisting of interconnected components:

- *Spatial-Information Model (BIM/GIS)*: A three-dimensional geospatial model of a structure (based on the IFC open standard for the modelling and transfer of BIM data) containing up-to-date information on structural elements and geometric deviations. The standardization of the Building Information Model (BIM) and the IFC format for the core of the Digital Twin complies with standard [10].

- *Physics-Mathematical Model (FEM)*: An adaptive finite element model that simulates the mechanical behavior of a structure under load.

- *Calibration Module (Model Updating)*: Ensures regular adjustment of the FEM model parameters (stiffness, damping parameters) based on actual telemetry data, thereby preventing model drift from the bridge's actual condition.

7. *Intelligent Analytics Layer (AI/ML Layer)*: It relies on machine learning and deep learning algorithms (in particular, LSTM recurrent neural networks, autoencoders, and ensemble methods). AI/ML uses past and current records to find patterns and anomalies and to predict probable degradation of the infrastructure. Designed to identify hidden degradation patterns, detect structural damage, and assess

the structure's remaining useful life (RUL).

8. *Level of monitoring and decision support (Decision Support System, DSS)*: It transforms analytical data into formatted reports, visualizations (dashboards), and interactive alerts. It enables the comparison of current parameters with maximum permissible values in compliance with applicable building codes. In other words, it offers: real-time tracking of the present condition and alerts regarding critical limits, forecasting of degradation processes and assessment of fatigue accumulation, and giving recommendations every day and corrective maintenance.

9. *Closed-Loop Feedback Control*: A main element that connects real machine to digital software:

□ *Automated (fast) loop*: fast intervention in critical moments (for example, activating traffic lights or electronic signs to limit the speed or weight of vehicles when permissible vibration or wind load levels are exceeded).

□ *Organizational-technical (long-term) loop (Human-in-the-Loop)*: Authorizing operational interventions when it is necessary to fix things, make parts stronger, or take a quick look inside. Entering information about the work performed updates the BIM/FEM models, completing the cycle of adapting the Digital Twin to the structure's changed physical condition.

Feedback is a crucial necessity for digital twins. Without feedback, a model is merely a “digital shadow” rather than a “digital twin”.

The diagram shown corresponds to the classic multi-level architecture of IoT/Cyber-Physical Systems (CPS). The division into sensors, data transmission, modeling, and analytics follows the generally accepted standard for linking a real physical object with its digital representation and the data associated with it [11].

When creating a digital twin of a bridge structure, the approach to integrating IoT and digital models depends on whether the bridge is new or existing. In the case of a new bridge, the digital twin can be created in parallel with the design and construction determined by a BIM/BrIM model, with the necessary sensor equipment and monitoring parameters specified from the outset. Для існуючих мостів його створення передбачає попереднє накопичення й актуалізацію фактичних даних про геометрію, технічний стан та історію експлуатації, зокрема за результатами обстежень, лазерного сканування, фотограмметрії та ретроспективного встановлення IoT-сенсорів. Основні відмінності у формуванні цифрового двійника для нових та існуючих мостів узагальнено в таблиці 1.

Table 1.
Creating Digital Twins of New and Existing Bridges

Stage	New Bridge	Existing bridge
Initial data	BIM/BrIM	documentation + survey
Geometry	BIM	laser scanning / photogrammetry
Sensors	are provided in the project	applied retrospectively
Initial state	registered upon data entry	detected upon inspection
Digital Twin	created in parallel	based on actual data
Monitoring	integrated from the outset	gradually modernized
Forecasting	based on data collection	based on historical data + new data

Theoretical approaches to creating digital twins of bridges based on BIM/BrIM, IoT, and remote data collection technologies are being applied in real-world infrastructure projects (table 2). Global experience demonstrates various methods for integrating digital models, sensor systems, monitoring technologies, and analytical platforms, depending on the structural classification, its developmental phase, and the objectives set.

Table 2.

Examples of the Implementation of Digital Monitoring and Digital Twins for Bridges

Country	Example	Technologies	What is being monitored	Level of digitalisation
China	Yangpu Bridge	1100+ sensing points + Digital Twin	deformation, vibration, cables, temperature, etc.	comprehensive system
USA	SHM / Digital Twin systems	sensors, SHM, data analytics	condition of structures	practical application
Great Britain	SmartBridge	wireless sensors + digital twin	deformations, temperature, stress, etc.	research and applied
Singapore	LTA Digital Twin / Smart Infrastructure	GIS, BIM, 3D LiDAR, digital mapping, data analytics	infrastructure and operational parameters	integrated digital environment
Singapore	Digital Twin of Pedestrian Bridges — NTU	digital twin, FEM, field measurements, neural networks, wireless sensing	dynamic behaviour, influences, impact localisation, condition assessment	research and applied

A real-world example of the use of digital technologies is the Yangpu Bridge in Shanghai, which spans the Huangpu River. The bridge, which opened in 1993, was equipped with a “smart brain” in 2022. An official source describes more than 50,000 static objects and pieces of equipment for space management, as well as more than 1,100 monitoring points across 17 categories that collect data on wind, temperature, ground movements, stress, deformation, vibrations, cable forces, and displacement. The data is integrated with the bridge’s digital twin, which allows for the calculation and analysis of limit values and provides real-time information on the condition of the bridge structure. As a demonstration project for the “digital twin” of the “Cloud Road Center,” the city of Yangpu was the first to implement intelligent monitoring using a “digital twin” to advance the modernization of road transport management [12].

The U.S. Federal Highway Administration (FHWA) views digital twins as a promising means of integrating sensor monitoring data with a digital structural model to assess the current condition of a bridge and predict its future condition, as a tool for managing the technical condition of bridges. Their use involves combining a digital model of the bridge with data from electronic monitoring systems and sensors, which makes it achievable to evaluate holistically the structure’s current condition and model its future condition to support asset management. The official FHWA concept, “Digital

Twins for Bridge Asset Management,” proposes combining electronic monitoring systems with a digital twin to assess the current and future condition of a bridge [13].

A prime example of the practical implementation of a bridge’s digital twin is the British project SmartBridge—Smart Monitoring and Inspection of Bridges Infrastructure, funded by Innovate UK from 2017 to 2020. The project involved integrating multi-scale 3D models of the bridge with sensor data, inspection results, and operational parameters. The developed system underwent field testing on a London Underground bridge near Watford and provided an analysis of the structure’s technical condition, degradation, reliability, and remaining service life [14].

The Land Transport Authority (LTA) is developing a digital twin of road and related infrastructure based on GIS and 3D LiDAR. Laser scanning data is used to create high-precision digital models of road assets, structures, and other objects. The digital environment makes it possible to visualize the location of assets, analyze their condition, identify defects, and support maintenance. LTA integrates GIS and BIM through its proprietary portals, Ignite and InSIGHT. This integration is used to create a digital twin of the urban environment and perform comprehensive modeling [15]. Researchers at Nanyang Technological University have created a digital twin of a pedestrian bridge that replicates its dynamic behavior.

Recent scientific studies have already identified AI, IoT, and Digital Twin as interconnected components of the new generation of bridge SHM, but they also point to challenges related to the variability of operating conditions, scalability, and the reliability of the models. To create reliable, next-generation monitoring systems, the following areas for further development are proposed: the creation of machine learning models based on physical laws, the standardization of protocols, and the incorporation of crowdsourced monitoring projects [1]. Financial constraints and gaps in advanced modeling skills also pose significant obstacles to the implementation of BDT [16].

Despite the high potential for integrating the IoT and digital twins, scaling this concept in bridge construction faces a number of technical and organizational obstacles. The main financial and technological barriers are the high cost of full-scale sensor systems and the issue of sensor reliability, where the failure of a single component can critically distort the entire analytical system. At the level of information management, challenges arise due to the large volumes of heterogeneous data and the variety of formats, which complicates integration – in this regard, hybrid edge/cloud computing architectures and the implementation of uniform standards to ensure interoperability demonstrate significant potential. Particular attention must be paid to specific engineering conditions: the presence of a large number of old bridges for which no original BIM model exists (this is addressed using Scan-to-BIM technologies), as well as the lack of historical (long-term) data required for the effective training of predictive models. In addition to cyber threats, which create new points of vulnerability in IoT networks (requiring a ‘security by design’ approach), the human factor remains key: the final decision in critical situations is taken by an engineer, which highlights the relevance of the ‘human-in-the-loop’ paradigm within Industry 5.0 (table 3).

Table 3.
Potential obstacles to the integration of the IoT and digital twins

Problem	Essence	Promising area
high cost of touchscreen systems	multiple sensors and communication systems	low-cost IoT/MEMS
large amounts of data	complexity of storage and processing	edge/cloud computing
different data formats	problem of integration	standards ra interoperability
AI false alarms	effects of temperature, load, etc.	physics-informed ML
old bridges	lack of BIM	Scan-to-BIM
sensor reliability	sensor failure can distort the picture	sensor fusion
cybersecurity	IoT creates new attack vectors	security by design
lack of long-term data	It is difficult to train predictive models	long-term monitoring
human factor	engineer makes the decision anyway	human-in-the-loop

The analysis carried out therefore demonstrates that traditional methods of infrastructure monitoring no longer meet today's security and reliability challenges. Combining networks of IoT sensors with dynamic digital twins makes it possible to create a unified ecosystem for managing the life cycle of bridge structures.

The IoT enables the continuous collection of real-time data on the actual condition of structures (vibrations, stresses, corrosion); digital twins integrate these data streams with a digital model to simulate load scenarios. The use of AI and machine learning algorithms gives a important chance to move beyond simply monitoring or recording the current condition to in-depth prediction of structural behaviour and finding small cracks before they turn into serious breakdowns.

The Industry 5.0 paradigm sets out a broader value framework in which the latest technologies are aimed not merely at the blind automation of processes, but at ensuring occupational safety, environmental sustainability, the resilience of infrastructure and the support of effective human decision-making. Optimising maintenance cycles and predicting wear and tear reduce operating costs, lower transport emissions, minimise human error, and enhance public safety.

Promising areas include the development of uniform standards and protocols for the exchange of heterogeneous data, the deep integration of artificial intelligence algorithms to achieve fully autonomous decision-making, and the enhancement of cybersecurity for integrated bridge systems.

Overall, the combination of the IoT and digital twins within the framework of Industry 5.0 represents a qualitatively new stage in the evolution of bridge construction, ensuring the creation of a more reliable, safer and more adaptive transport infrastructure for the future.

References

1. Chaudhari, R. S., Nama, S., Narkhede, M. M., Bhangale, V. P., Gaikwad, R. B., & More, M. M. (2026). Next generation vibration-based structural health monitoring for bridges: A systematic review of AI, IoT, and digital twin integrations. *Journal of*

Building Pathology and Rehabilitation, 11, 136. <https://doi.org/10.1007/s41024-026-00810-0>

2. Breque, M., De Nul, L., & Petridis, A. (2021). Industry 5.0: Towards a sustainable, human-centric and resilient European industry. European Commission, Directorate-General for Research and Innovation. <https://doi.org/10.2777/308407>

3. European Commission. Industry 5.0. European Commission. https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en

4. Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0 – Inception, conception and perception. *Journal of Manufacturing Systems*, 61, 530–535. <https://doi.org/10.1016/j.jmsy.2021.10.006>

5. Internet of Things, IoT. <https://www.it.ua/knowledge-base/technology-innovation/internet-veschej-internet-of-things-iot>

6. International Organization for Standardization, & International Electrotechnical Commission. (2024). *Internet of Things (IoT) – Reference architecture* (ISO/IEC 30141:2024). <https://www.iso.org/standard/88800.html>

7. Leong, W. Y. (2026). Digital Twin and IoT Integration for Predictive Maintenance in Civil and Structural Engineering. *Engineering Proceedings*, 134(1), 19. <https://doi.org/10.3390/engproc2026134019>

8. Hoskere, V., Hassanlou, D., Rahman, A. U., Bazrgary, R., & Ali, M. T. (2025). Unified framework for digital twins of bridges. *Automation in Construction*, 175, 106214. <https://doi.org/10.1016/j.autcon.2025.106214>

9. Zhang, Z., Fu, Y., & Sun, Z. (2025). Advancements in digital twin-enhanced health monitoring and condition assessment of cable-supported bridges. *Structures*, 79, 109448. <https://doi.org/10.1016/j.istruc.2025.109448>

10. International Organization for Standardization. (2018). *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling* (ISO 19650:2018) <https://www.iso.org/standard/68078.html>

11. International Organization for Standardization. (2021). *Automation systems and integration – Digital twin framework for manufacturing* (ISO 23247:2021). <https://www.iso.org/standard/75066.html>

12. <https://english.shyp.gov.cn/ywb/latest/20220304/404440.html>

13. https://www.fhwa.dot.gov/innovation/stic/EDC-7_Summary_of_Innovation_Suggestions.pdf

14. TWI Ltd. (2021, January 7). *SmartBridge project seeks investors*. <https://www.twi-global.com/media-and-events/press-releases/2021/smartbridge-project-seeks-investors>

15. Khor, A. (2024). *Keynote speech by Senior Minister of State for Transport, Dr Amy Khor, at the High Level Panel 1 at 19th Intelligent Transport System Asia Pacific Forum 2024*. Ministry of Transport, Singapore. <https://www.mot.gov.sg/news-resources/newsroom/keynote-speech-by-senior-minister-of-state-for-transport--dr-amy-khor--at-the-high-level-panel-1-at-19th-intelligent-transport-system-asia-pacific-forum-2024/>

16. Nhamage, I. A., Horas, C. S., Dang, N. S., et al. (2025). Strategies for maximising the value of digital twins for bridge management and structural monitoring: A systematic review. *Archives of Computational Methods in Engineering*, 32, 4555–4586. <https://doi.org/10.1007/s11831-025-10280-1>

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