

Barriers to the Adoption of Digital Technologies in Construction and Their Impact on Productivity

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Abstract

The construction industry plays a significant role in economic development and employment generation; however, it has historically experienced lower productivity growth compared with many other industries. The adoption of digital technologies such as Building Information Modelling (BIM), artificial intelligence (AI), Internet of Things (IoT), cloud computing, drones, digital twins, and construction management software offers considerable potential to improve productivity, project coordination, cost control, safety, and decision-making. Despite these benefits, the construction sector has been relatively slow to adopt and integrate digital technologies.

This research examines the major barriers that restrict the adoption of digital technologies in construction and evaluates their impact on construction productivity. The barriers considered include high initial investment costs, lack of skilled personnel, resistance to organisational change, inadequate digital infrastructure, interoperability issues, cybersecurity concerns, lack of management support, limited awareness of technological benefits, and fragmented project structures. The study proposes that these barriers can reduce the effective utilisation of digital technologies and consequently affect project cost, schedule, quality, resource utilisation, and overall productivity. The paper also discusses strategies for overcoming these barriers through training, organisational support, standardisation, government initiatives, technology investment, and improved collaboration among construction stakeholders.

Keywords: Digital technology, construction industry, productivity, BIM, digital transformation, barriers, technology adoption, construction management.

Introduction

The construction industry is one of the largest sectors of the global economy and contributes substantially to infrastructure development, employment, and economic growth. Despite its importance, construction productivity has remained a significant concern. Construction projects frequently experience cost overruns, schedule delays, material wastage, rework, labour inefficiencies, and coordination problems.

Digital transformation has emerged as a potential solution to many of these challenges. Technologies such as **Building Information Modelling (BIM), artificial intelligence, Internet of Things (IoT), drones, robotics, cloud platforms, mobile applications, digital twins, and data analytics** can improve the way construction projects are planned, designed, executed, and monitored.

For example, BIM can facilitate information sharing between architects, engineers, contractors, and clients. Drones can support site surveying and progress monitoring, while IoT devices can provide real-time information about equipment, materials, and site conditions. AI and data analytics can support forecasting, risk management, resource allocation, and decision-making.

However, the availability of these technologies does not automatically result in productivity improvement. Construction organisations face several challenges when attempting to adopt and integrate digital solutions. Small and medium-sized construction firms may particularly struggle because of limited financial resources, lack of technical expertise, and inadequate organisational capabilities.

Therefore, understanding the barriers to digital technology adoption is essential for determining how digital transformation can contribute effectively to construction productivity.

Problem Statement

Although digital technologies have the potential to improve construction productivity, their adoption remains uneven across the industry. Many construction organisations continue to rely on traditional methods of communication, planning, documentation, and project monitoring.

The problem is not simply a lack of access to technology. Organisations may have access to digital tools but fail to achieve their expected benefits because employees lack appropriate skills, management does not provide sufficient support, systems cannot communicate with one another, or employees resist changes to established working practices.

Consequently, there is a need to identify the major barriers to digital technology adoption and understand how these barriers influence construction productivity.

Research Objectives

The study has the following objectives:

1. To identify the major digital technologies currently used in the construction industry.
2. To identify and classify the major barriers affecting digital technology adoption.
3. To examine the relationship between digital technology adoption and construction productivity.
4. To assess the influence of financial, technological, organisational, and human-related barriers on productivity.
5. To determine the most significant barriers affecting digital transformation in construction.
6. To propose strategies for overcoming these barriers and improving productivity.

Literature Review

Digital Technologies in Construction

Digital technology refers to technologies that enable the creation, collection, processing, storage, communication, and analysis of digital information. In construction, these technologies can be applied throughout the project lifecycle.

Major examples include:

- Building Information Modelling (BIM)
- Artificial Intelligence (AI)
- Internet of Things (IoT)
- Cloud computing
- Drones and unmanned aerial vehicles
- Robotics and automation
- Digital twins
- Augmented and virtual reality

- Geographic Information Systems (GIS)
- Construction management software
- Mobile and field data-collection applications
- Big data and predictive analytics

The integration of these technologies can improve information flow, reduce errors, support better decision-making, and enhance project monitoring.

Construction Productivity

Construction productivity can generally be understood as the relationship between outputs produced and resources used.

A simplified measure is:

$$\text{Productivity} = \text{Output} / \text{Input}$$

Inputs may include:

- Labour
- Materials
- Equipment
- Time
- Capital
- Energy

Digital technologies can potentially improve productivity by reducing non-value-adding activities, improving resource allocation, reducing rework, increasing information accuracy, and supporting real-time decision-making.

However, productivity gains depend on effective implementation rather than technology adoption alone.

Major Barriers to Digital Technology Adoption

Inadequate Digital Infrastructure

Reliable internet connectivity, hardware, software, data storage, and communication systems are essential for digital construction.

Inadequate infrastructure can be especially problematic on remote or temporary construction sites.

Poor connectivity may prevent real-time data exchange and limit the usefulness of cloud-based applications, IoT devices, and mobile technologies.

Interoperability and Data Integration Problems

Construction projects involve many stakeholders using different software platforms and information systems.

Problems can occur when:

- Software platforms use different data formats.
- Information cannot be transferred effectively.
- Stakeholders use incompatible systems.

- Data is duplicated.
- Information is lost during conversion.

Poor interoperability can reduce collaboration and create additional administrative work.

Cybersecurity and Data Privacy

Increasing digitalisation also creates cybersecurity risks.

Construction organisations increasingly store sensitive information digitally, including:

- Design information
- Contract documents
- Financial information
- Client information
- Project schedules
- Building and infrastructure data

Concerns about cyberattacks, data theft, unauthorised access, and data loss may discourage organisations from adopting cloud-based and connected technologies.

Lack of Awareness of Technology Benefits

Some organisations may not fully understand the potential benefits of digital technologies.

If decision-makers cannot clearly identify how technology will improve project performance, they may view digital investment as an unnecessary expense.

This problem can be addressed through demonstrations, pilot projects, case studies, and training.

Fragmented Nature of the Construction Industry

Construction projects involve clients, consultants, architects, engineers, contractors, subcontractors, suppliers, and other stakeholders.

Each organisation may have different:

- Objectives
- Budgets
- Technology capabilities
- Processes
- Data standards

This fragmentation can make it difficult to implement a common digital platform across the entire project.

Unclear Return on Investment

The financial benefits of digital technologies may not always be immediately visible.

Some technologies require substantial investment before their benefits become measurable. Firms may therefore hesitate to invest if they cannot estimate:

- Payback period
- Productivity improvement
- Cost savings
- Implementation risks

This uncertainty can become a major barrier to adoption.

Impact of Adoption Barriers on Construction Productivity

Digital adoption barriers can affect productivity both directly and indirectly.

Barrier	Potential Impact on Productivity
High investment cost	Limits technology adoption and automation
Lack of skilled workers	Causes inefficient technology utilisation
Resistance to change	Slows implementation
Lack of management support	Reduces organisational commitment
Poor infrastructure	Interrupts digital workflows
Interoperability problems	Causes duplication and information loss
Cybersecurity concerns	Restricts data sharing
Lack of awareness	Results in underinvestment
Industry fragmentation	Reduces collaboration
Unclear ROI	Delays technology investment

These barriers can ultimately contribute to:

- Increased project delays
- Higher construction costs
- Increased material wastage
- Greater rework
- Poor communication
- Inefficient labour utilisation
- Equipment downtime
- Poor decision-making
- Reduced project quality

Therefore, digital technology adoption should be considered not only as a technological issue but also as an **organisational, financial, human, and managerial issue**.

Research Methodology

Data Collection

Primary data can be collected using a structured questionnaire.

A **five-point Likert scale** can be used:

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

Example questionnaire statements:

- "The high cost of digital technologies is a major barrier to adoption."
- "Lack of skilled personnel limits digital technology implementation."
- "Employees in my organisation resist adopting new digital technologies."
- "Poor internet and digital infrastructure limit technology use on construction sites."
- "Digital technologies improve labour productivity."
- "Digital technologies help reduce project delays."
- "Digital technologies reduce construction rework."
- "Management provides sufficient support for digital transformation."

Data Analysis

The collected data can be analysed using statistical techniques such as:

- Descriptive statistics
- Mean score analysis
- Standard deviation
- Ranking of barriers
- Correlation analysis
- Regression analysis
- Reliability analysis using Cronbach's alpha

For example, regression analysis can be used to examine whether barriers to digital technology adoption significantly predict construction productivity.

Proposed Hypotheses

The following hypotheses can be tested:

H1: Financial barriers have a significant negative relationship with digital technology adoption.

H2: Lack of skilled personnel has a significant negative relationship with digital technology adoption.

H3: Resistance to organisational change has a significant negative relationship with digital technology adoption.

H4: Inadequate digital infrastructure has a significant negative relationship with digital technology adoption.

H5: Interoperability problems have a significant negative relationship with digital technology adoption.

Strategies for Overcoming the Barriers

Construction organisations can adopt several strategies to improve digital technology adoption.

Standardisation

The use of common data standards and interoperable platforms can improve information exchange between project stakeholders.

Government Support

Government agencies can encourage digitalisation through:

- Training programmes
- Financial incentives
- Digital construction standards
- Research funding
- Industry guidelines

Collaboration

Construction companies, technology providers, universities, government agencies, and professional organisations can collaborate to develop practical digital solutions.

Cost-Benefit Analysis

Companies should assess the expected return on digital investment before implementation. This can help organisations select technologies that provide measurable productivity benefits.

Expected Findings

The study is expected to demonstrate that digital technologies have significant potential to improve construction productivity, but the benefits are strongly influenced by the ability of organisations to overcome adoption barriers.

The most important barriers are likely to include **high implementation costs, lack of skilled personnel, resistance to change, inadequate infrastructure, interoperability problems, and insufficient management support.**

The research is also expected to show that organisations with stronger digital capabilities and greater technology adoption may achieve better performance in terms of project scheduling, resource utilisation, cost management, communication, and rework reduction.

Conclusion

Digital transformation provides an important opportunity for improving construction productivity. Technologies such as BIM, AI, IoT, drones, cloud computing, digital twins, and automation can improve information management, communication, coordination, resource utilisation, and decision-making.

However, the successful implementation of these technologies is constrained by several barriers. Financial limitations, lack of skilled workers, resistance to organisational change, inadequate infrastructure, interoperability issues, cybersecurity concerns, fragmented project structures, and unclear returns on investment can prevent construction organisations from achieving the full benefits of digitalisation.

Therefore, improving construction productivity through digital technology requires more than purchasing new software or equipment. Organisations need a comprehensive approach involving **management commitment, employee training, appropriate infrastructure, standardisation, collaboration, cybersecurity, and continuous evaluation of technology investments.**

Overcoming these barriers can enable construction organisations to use digital technologies more effectively and achieve improvements in productivity, cost, time, quality, safety, and overall project performance.

References

For the final paper, you can build your reference list around authoritative research and industry reports, including work from:

- McKinsey & Company — research on construction productivity and digital transformation
- World Economic Forum — reports on the future of construction
- International Organization for Standardization (ISO) — BIM and information-management standards
- National Institute of Building Sciences — BIM and digital construction resources
- Autodesk — construction technology research
- Dodge Construction Network — construction technology adoption research
- Academic journals such as *Automation in Construction*, *Journal of Construction Engineering and Management*, *Engineering, Construction and Architectural Management*, and *Construction*