## Index

Accelerated strategic computing initiatives (ASCI), 62 Accuracy, 128 Active radio frequency identification, 113 Activities performed, 22 Actuators, 40 Aerospace sectors, 22-23 Aesthetics, 88 After-sales marketing, 23 Airbnb (business model), 80 Analog technologies, 47-48 Apache (Operating system), 64 Appliances, 40 Architectural engineering and construction (AEC), 70, 99, 119 Artificial intelligence (AI), 5, 29, 38, 68, 90, 94, 96, 118, 123, 126-127, 135 AI-based software systems, 96 attacks, 121 Assisting in monitoring, 22 Audio-visual communication, 93–94 Augmented reality (AR), 4-5, 38, 47-48, 87-88, 118 Automated building component operations, 128 Automated Construction System, 128 Automation, 23, 41, 60, 76 Automotive sectors, 22-23 Autonomous vehicles, 128 Banks, 50-51 Bayesian algorithm, 136 Benchmarks, 22–23 Beneficial cyber technology, 18 - 19**Benefits** 

of connected machines for construction projects, 43-44 of cyber technology for construction project, 122 of digital technology for construction projects, 32-33 of digital transformation for construction project, 20 of DT in construction, 137 of EE, 53-54 of implementing smart contracts in construction industry, 81-82 of MCC in construction management, 69-70 of mechatronics in construction projects, 128-129 of RFID, 113-114 of smart computing for construction project, 99-100 Better future, 18–19 Big data, 5 Biomimicry, 5 Bit, 85-86 Bitcoin, 76-77 Blockchain, 5, 78 technology, 79, 87 Bluetooth, 39 Bring Your Own Device Policy (BYOD Policy), 121 Budget, 29, 36, 99, 170 Building, 68 sites, 67-68 industry, 113-114 **Building Information Modelling** (BIM), 5, 23–24, 29, 38, 42, 47-48, 68, 88, 123, 135 Building information processing, 119 Built industry, 20, 49-50 Business, 18-20, 76

model, 80 strategies, 97-98 Business Intelligence (BI), 97 applications of smart computing in construction using, 97-99 Cambridge Technology Partners, 101 - 102Capacity gaps, 10-11 Capital-intensive equipment, 134 Carbon emissions, 6-7, 12 Central processing units (CPUs), 100 Centre for Digital Built Britain (CDBB), 136 Challenges in adoption of MCC in sustainable construction, 70-71 of connected machines, 42-43 of cyber technology in construction, 121 - 122of digital technology, 31-32 of digital transformation for construction project, 22-23 of ecological economies, 51-53 of GC, 64 of implementing smart contract in construction industry, 81 of mechatronics in construction projects, 129-130 of quantum computing, 91 of SIM, 10-11 of smart computing, 100-102 Chemical dyes, 22 Cisco, 89 Clean development mechanisms (CDM), 50-51 Clients' demands and expectations, 19 Climate change adaptation, 7, 11 mitigation and adaptation, 12 Cloud computing (CC), 69 Cloud-based smart mobile computing, 97 Clusters, 57-58 Cognitive radio application, 107

challenges, 107-108 in construction, 106 spectrum sensing techniques, 106-107 Combinatorics, 90 Common component architecture (CCA), 62 Communication networks, 119 Community engagement, 9 Competitive necessity, 18–19 Competitors, 18–19 Complexity of structures, 27 Component XML (CXML), 62 Computational infrastructure, 57-58 Computer numerical control (CNC), 126 Computer-aided design (CAD), 68-69, 126 Computers, 93-94 Connected machines, 39-40 benefits for construction projects, 43-44 challenges of, 42-43 in construction, 40-41 digitalisation in construction, 38-39 drivers of connected machines application in construction, 41 - 42for sustainable construction, 41 Connectivity, 23, 72 Construction, 17, 300 application of DT in, 90-91, 135-136 applications of smart computing in construction using BI, 97-99 AR, 87–88 barriers of DT in, 136-137 benefits of DT in, 137 business, 87 challenges of cyber technology in, 121 - 122cognitive radio in, 106 connected machines in, 40-41 drones, 87 cyber technology changing, 119, 122 - 123

digital technology in, 29-30 digitalisation in, 18-19, 28, 38-39, 48, 77-78, 118 drivers of connected machines application in, 41-42 drivers of cyber technology application in, 119–120 drivers of digital technology application in, 31 drivers of digital transformation application in, 19-20 drivers of DT in, 136 drones, 4, 87 enterprises, 50 GC work in, 60-62 market. 68 new trends in, 86-89 quantum computing and drivers in, 90 remote worksites and mobile access. 88 rising material costs, 88-89 smart cities. 89 smart contracts, 87 waste recycling, 6 Construction 2025, 30 Construction industry, 3, 18, 28, 47-48, 68, 76, 93, 122, 127 benefits of implementing smart contracts in, 81-82 challenges of implementing smart contract in, 81 patterns, 89 Construction information management, 67 Construction management, 4, 12 benefits of MCC in, 69-70 Construction practices, 22-23 Construction process, 22, 33, 40, 86 Construction projects, 41 connected machines benefits for. 43-44 cyber technology benefits for, 122 digital technology benefits for, 32-33

digital transformation benefits for, 20 mechatronics, 127-130 smart computing benefits for, 99 - 100digital transformation challenges for, 22–23 RFID in. 112–113 Construction sector, 17-18, 38-39, 118 application and technological solution of digital transformation in, 21-22 Construction site, 21-22, 43, 86-87 Construction work, 22, 40, 127 Construction workers, 21, 29–30, 67 - 69Consumer experience, 23 Contemporary technologies, 28 Continuous friction welding, 40 Contract administration process, 81-82 Contract budget and duration, 20 Contract change management (CCM), 77 - 78Contractors, 76, 81, 129 Contractual arrangement concept, 79 Contractual period, 28 Controlled Demolition, 128 Cost of implementation, 137 maximisation, 12 reduction, 99 Cross-domain, 59 Cryptocurrencies, 5, 76 Customers' satisfaction, 19, 38 Cutting-edge construction management, 112-113 Cyber security, 5 Cyber Technology. See also Digital technology, 117 benefits of cyber technology for construction project, 122 BYOD policy, 121 challenges of cyber technology in construction, 121-122 changing construction, 122–123 in construction, 119

digitalisation in construction, 118 drivers of cyber technology application in construction, 119-120 drones. 123 enabling technologies, 119 ML and AI attacks, 121 mobile devices, applications and project management software, 123 possible unemployment, 122 robotics, 123 wearable technology, 122 Data, 22, 40 location, 101 storage and management, 20 Decentralisation, 63 of administration. 63 Decision support systems (DSS), 47-48 Decision-making, 11 Delivery, 5 and management, 5 Demand, 3, 6, 17-18, 88, 134 Design process, 6 Deterministic contracts, 81 Devices, 39 Digital access, 23 Digital advancement, 18-19 Digital construction, 5 Digital data, 23 Digital disruption, 18-19 Digital enterprise, 19 Digital enthusiasm, 23 Digital orientation, 18–19 Digital platforms, 21 Digital strategies, 19, 33 Digital technology. (see also Cyber Technology), 4, 27–29 adoption, 28 benefits of digital technology for construction projects, 32-33 challenges of, 31-32 in construction, 29-30 digitisation in construction, 28

drivers of digital technology application in construction, 31 for sustainable construction. 30–31 Digital transformation, 4, 18, 28 application and technological solution in construction sector. 21-22 benefits for construction project, 20 challenges for construction project, 22 - 23digitalisation in construction, 18-19 drivers in construction, 19–20 Digital twin (DT), 134 application of DT in construction, 135 - 136barriers of DT in construction, 136 - 137benefits of DT in construction, 137 drivers of DT in construction, 136 origin and evolution of, 134-135 Digitalisation, 21, 86, 133-134 construction, 18-19, 38-39, 48, 77-78, 118, 133 Digitisation in construction, 28 Dirichlet tessellations, 106 Disruptive technology, 18–19 Drivers of connected machines application in construction, 41-42 in construction, 90 of cyber technology application in construction, 119-120 of digital technology application in construction, 31 of digital transformation application in, 19 - 20of EE, 54 Drones, 5, 22, 29-30, 119, 123, 128 Duration, 29, 99 Dynamism, 59 Eco-citizenship, 50 Ecological economics (EE), 48

benefits of, 53-54

challenges of ecological economies, 51 - 53digitalisation in construction, 48 drivers of, 54 for sustainable construction, 48-51 Economic development, 12-13 Economic industries, 47-48 Economic objectives, balancing, 11 Economical mobile smart phones, 69 Ecosystems, 12, 48 Efficiencyc, 8, 22, 72 Electronic devices, 27 Embedded multimedia cards (eMMC), 95–96 Emergence of new digital world, 19 Enablers, 31 End-of-pipe technologies, 51 Energy efficiency measures, 6 Energy-saving technologies, 6 Enhanced market, 20 Environmental conservation, 12 Environmental management systems (EMS), 50 Environmental objectives, balancing, 11 Equipment, 21-22 improved utilisation of, 43 eScience, 57-58 EU governments, 101 European Network and Information SecurityAgency (ENISA), 100 Expenditure, 22–23 Expertise, 8 Face recognition, smart computing and, 97 Facial expression recognition system, 97 Fields, 29, 126–127 Financial services, 18-19 Financing, 10 Firms, 23, 29, 72 Flywheel friction welding, 40 Fourth Industrial Revolution (Industry 4.0), 5, 41, 48, 120

Functional aspect of technology, 127 Funding, 10 Fuzzy timestamps, 60 Gadget, 40, 112 RFID gadget, 113-114 Gamification technologies, 5 Global positioning system (GPS), 22, 112, 119 Globus, 59 Goods and services, 19-20 Governance, 9 Governments, 51 Green building, 52–53 practices, 6 Green construction materials, 52–53 Green Investment Bank, 51 Green transportation, 6–7 Grid infrastructure, 62-63 middle-wares, 59 workflow system, 59 Grid computing (GC). (see also Quantum computing; Mobile cloud computing (MCC); Smart computing), 58 challenges of, 64 characteristics of, 63-64 community, 62 devices, 62-63 in today's world, 59-60 work in construction, 60–62 Gridbus, 59 GridFlow, 59-60 Gross domestic product (GDP), 17-18, 29 Growth, 19, 57-58 Hard disk drives (HDDs), 95-96 Heating, ventilation and air condition (HVAC), 41-42 High altitudes, 22 High-resolution camera, 22 Humans, 22, 128, 130 knowledge, 37-38

Hybridised techniques, 94 IBM (technological organisations), 89 Image-capturing technologies, 119 Inclusivity, 12 Industrial revolution, 97-98, 134 Information, 28, 112–113 Information communication and technology (ICT), 18-19, 21 ICT-related industry, 122 Information security, 70–71, 100 Information Systems Audit and Control Association (ISACA), 100 Information technology (IT), 22–23, 68, 99, 137 cloud survey, 69-70 Infrastructural developments, 17-18 Infrastructure as a service (IAAS), 100 Infrastructure retrofitting, existing, 11 Innovation, 9 technological advancements and, 10, 13 Intelligent building systems, 125 Intelligent monitoring, 22 Interconnected systems, complexity of, 10 International commitments, 13 International Data Corporation (IDC), 69–70, 100 International Data Group (IDG), 19 - 20Internet of everything (IoE), 18, 47–48 Internet of Things (IoT), 5, 21, 37, 39, 47-48, 80, 107, 119 IoT-connected machines, 40 Interserve's Construction Delivery Application, 29-30 Investments, 10, 30-31 Just like pandemic, 86–87 Key performance indicators (KPIs), 98 Knowledge gaps, 10-11 sharing, 8

Kriging method, 106 Lean construction, 128–129 LED. 6 Lending agencies, 50–51 Level of literacy, 43 Linux (Operating system), 64 Live Mesh (Microsoft), 97 Logistics, 23, 97–98, 123 Long-term cost savings, 13 Long-term planning, 11 Loss of data, 23, 70 Lower environmental footprint, 6 Lowest possibility, 21 Machine learning (ML), 5, 121 attacks, 121 Machine system, 127 Machines, 21, 37-38 Mainframe computing, 94 Maintenance and repair, 18 management, 3–5 Manufacturing industries, 112 Matched filter, 106 McKinsey Global Institute industry digitisation index (2015), 22 - 23Mechatronics, 126–127 accuracy and precisions, 128 benefits of mechatronics in construction projects, 128 - 129challenges of mechatronics in construction projects, 129-130 in construction projects, 127-128 evolution of mechatronics engineering, 126–127 high-quality productions, 128-129 minimising financial loss, 129 reduction of wastes, 129 time saving, 129 Microsoft, 89 Migration, 29 Miners, 78–79

Mobile accounting, 97 computer, 68-69 devices, 123 healthcare, 97 payment, 97 Mobile cloud computing (MCC). (see also Grid computing (GC); also Quantum computing; Smart computing), 4, 68, 97 benefits in construction management, 69–70 CC, 69 challenges in adoption of MCC in sustainable construction. 70 - 71MC in construction, 68-69 as solution to challenge of sustainable construction, 71 - 72Mobile computing (MC), 68 in construction, 68-69 Mobile phones, 29, 71-72 Mobility, 6-7 Monitoring and Discovery Services (MDS), 64 Motivation, 23 Motoblur (Motorola), 97 Multilateral environmental agreements (MEAs), 50 My SQL (Operating system), 64 Nanotechnology, 5 National Bureau of Statistics (NBS), National digital twin (NDT), 136 Near field communication (NFC), 39 Network accessibility, 43 Network computing, 94 Network of organizations, 18-19 Network-enabled tools, 70 New engineering contract (NEC), 77 - 78Nodes, 76-79 Noise uncertainty, 107–108 Non-deterministic contracts, 80-81

Normal working conditions, 22 On-site digital technologies, 29-30 Online transactions, 97-98 Operating systems, 64 Operation, 18, 32-33, 39, 50, 135 Operation efficiencies, 19-20 Oracles, 80-81 Output, 5, 29, 90, 118 Paradigm shift, 18-19, 27, 118 Paris Agreement, 13 Partnerships, 10 Passive radio frequency identification, 113 Peer-to-peer replication, 76-77 Performance monitoring and evaluation, 9 Personal computing, 94 Planning, 5-6, 135 Platform as a service (PAAS), 100 Policy, 9 barriers, 10 Population growth, 13 Portable devices, 119 Precisions, 128 Prefabricated and Modular Construction (PMC), 42 Preliminary, 22 Privacy, 41, 121 Process, 5 Productivity, 12–13, 22, 28 Professionals, 19-20, 29-31 Profit maximization, 38, 119 Programmable logic controllers (PLC), 41 - 42Programmable Sensitive Control Door (PSCD), 42 Project delivery, 12, 117, 119 Project duration, 19, 38, 81 - 82Project enhancement, 12 Project execution, 4, 69 Project lifecycle, 78 Project planning, 3, 14, 18, 68, 93, 120 Project quality, 12

Public and private organizations, 18-19 Public health and safety, 13 Quality, 5, 12, 18–19, 29, 129 Quantum bit (Qubit), 85-86 Quantum computer architecture, history evolution of, 86 Quantum computing. (see also Grid computing (GC); Mobile cloud computing (MCC); Smart computing) applications in construction, 90-91 challenges of, 91 details of. 89 history evolution of quantum computer architecture, 86 new trends in construction, 86-89 quantum computing and drivers in construction, 90 in today's world, 90 Quantum processing, 85-86 innovation, 86 Ouick and moderate recreation of compositional, 88 Radio frequency identification (RFID), 39, 111-112 active, 113 benefits of, 113-114 in construction project, 112–113 passive, 113 reality, 113 technology, 21 Rainwater harvesting, 6 Real estate sector, 18-19 Regulatory audit compliance, 101 Regulatory barriers, 10 Regulatory compliance, 101 "Regulatory" requirements, 22 Remote worksites and mobile access, 88 Resilience, 7, 9 adaptation, 11 Resources, 8, 18

consolidation and coordination of, 63 efficiency, 12 Revenues, 22-23 Risk, 9-10, 18-19, 50, 101-102 management, 9 Robotics, 5, 29-30, 47-48, 68, 118, 123. 127 Robots, 22–24 Safety monitoring devices, 128 Satellite, 39 Security monitoring devices, 128 Self-monitoring, analysing and reporting technologies (SMARTs), 95-96 Sensors, 40, 135 Service level agreement (SLA), 61-62, 101 Simulation models, 135 technology, 135 Skill, 28, 76 Small medium enterprises (SMEs), 99 Smart cities, 89 Smart computation, 18 Smart computing. See also Quantum computing; Grid computing (GC); Mobile cloud computing (MCC), 4, 96 additional risks and challenges, 101 - 102applications of smart computing in construction using BI, 97-99 availability and disaster recovery, 101 benefits of smart computing for construction project, 99-100 challenges of, 100-102 cloud-based smart mobile computing, 97 cost reduction, 99 data location, 101 environment, 99 information security, 100 privileged user access, 100

regulatory compliance, 101 smart computing and AI, 96 smart computing and face recognition, 97 supporting programmes and applications, 96-97 system flexibility, 99 system maintenance, 100 system mobility, 99 works, 95-96 Smart computing technology (SCT), 94-96 Smart contracts, 4, 78–79, 87 benefits of implementing smart contracts in construction industry, 81-82 challenges of implementing smart contract in construction industry, 81 digitalisation in construction, 77-78 setup, 77 technology, 76-77 in today's world, 79-80 types of, 80-81 Smart Lighting System (SLS), 42 Smart phones, 70 Social equity, 9, 12 Software vulnerabilities, 121 Solid-state drives (SSDs), 95-96 Spectrum sensing techniques, 4, 106 - 107Stakeholder engagement and collaboration, 11 engagement and social considerations, 7 Standard of living, 29 Storing, 28, 69 Strategic flexibility, 20, 86-87 Subcontractors, 22-23, 76, 81 Supply chain management, 71–72, 97-98.135 Sustainability, 3-4, 30 in construction, 76 of construction industry, 48 goals, 13 indicators, 7-8

Sustainable construction, 3, 12, 76, 88, 117 challenges in adoption of MCC in, 70-71 concept of, 3-4 connected machines for, 41 digital technology for, 30-31 EE for, 48-51 practices, 9 Sustainable development, 4, 30, 77, 119 Sustainable infrastructure, 12-13 practices, 12 projects, 10 Sustainable infrastructure management (SIM), 4, 8 balancing economic and environmental objectives, 11 challenges of, 10-11 climate change mitigation and adaptation, 12 collaboration and knowledge sharing, 8 collaboration and partnerships, 10 complexity of interconnected systems, 10 concept of, 8-10 economic development and job creation, 12-13 economic viability, 8 energy efficiency measures, 6 environmental conservation, 12 environmental considerations, 8 existing infrastructure retrofitting, 11 financing and funding, 10 green transportation and mobility, 6 - 7innovation and technology, 9 innovative technologies and future trends, 8 international commitments and sustainability goals, 13 knowledge and capacity gaps, 10-11 long-term cost savings, 13 long-term planning and decision-making, 11

materials selection and waste management, 6 monitoring and performance evaluation, 7-8 need for, 11-13 performance monitoring and evaluation, 9 policy and governance, 9 policy and regulatory barriers, 10 public health and safety, 13 resilience and climate change adaptation, 7, 11 resilience and risk management, 9 resource efficiency, 12 social equity and community engagement, 9 social equity and inclusivity, 12 stakeholder engagement and collaboration, 11 stakeholder engagement and social considerations, 7 sustainable construction practices, 9 sustainable design and planning, 5-6 technological advancements and innovation, 10, 13 urbanisation and population growth, 13 water management strategies, 6 Sustainable practices, 3-5 Sustainable technologies, 28-31 Synchronizing, 21 System flexibility, 99 maintenance, 100 mobility, 70, 99 Technological innovations, 23 Technological organizations, 89 Technology, 9 Third-generation images (3D images), 122 3D construction technologies, 22 3D printing, 23-24, 47-48, 127 Time, 20 saving, 129

Tools, 27, 97 Torque converter, 40 Traditional methods, 27–28 Trend, 4, 86–87 Trust-based model, 76–77

United Kingdom, The, 51 United Nations Sustainable Development Goals (SDGs), 13 Unmanned aerial vehicles (UAVs), 38, 47–48 Urbanisation, 13

Value chain, 23 Values, 33 Ventilation and air condition, 41 Video streaming, 22 Virtual organisations (VO), 61–62 Virtual prototyping, 119 Virtual reality (VR), 5, 47–48, 68, 117–118, 136 Voluntary emission reductions (VER), 50–51

Waste management, 6 practices, 6 Wastewater recycling systems, 6 Water management strategies, 6 scarcity, 6 Wearable technology, 122 Web services flow language (WSFL), 62 Whole life cycle, 29, 48 Wireless fidelity (Wi-Fi), 38-39 Wireless local area network (WLAN), 105 - 106Wireless sensing, 23–24 Wireless sensors, 119 Without AI powered systems, 96 Workflow techniques, 59

Z-wave, 39 ZigBee, 39