

Swift Rising Pattern of New Emerging Construction Technology Trends in the Construction Industry

Ar. Gayatri Mahajan



Abstract: Construction technology is a collective term for types of technology that have a specific use within the construction industry. Adoption of recent digital transformation technology is the need of today to speed up the business and is also the basis of construction improvement. Incorporating and practicing the technologies such as cloud-based communication and collaboration solution, Mobile Apps and 5G, 3D printing, Building Information Modelling (BIM) and Digital Twins, CAD/CAM, Augmented Reality (AR)/ Virtual Reality (VR), Big Data, Internet of Things (IoT), Wearables, Blockchain (BC), Modular Construction (MC), Offsite Manifesting, Prefabrication (PF), Robotic, Drones and Global Positioning System (GPS) controlled equipment expedite the progress in the Construction industry (CI). Resources used are journaled research articles, web/net surfing, books, thesis, reports/surveys, magazines, etc. The outline of the research organization for this study is framed at four distinct levels in context to conceptualization, resources, innovative and emerging trends in CI, and better methods for completion of the construction projects. The present study conducted during 2020-2022 reveals that implementing these technologies improves the level of standards, planning, security, well-being, sustainability, and economics too. Application uses, benefits, impact, advantages/disadvantages, limitations and challenges, and policies are dealt with to provide information to architects and builders for smooth completion of the project. Results explain that construction technology trends vary from 4 to 15 for CI, and eventually, it reaches 27 for Civil Engineering (CE). The perspective of the most recent innovations, trends, tools, challenges, and solutions is highly embraced in the field of construction. The incorporation of the above said technologies in the pandemic Covid -19 and post-pandemic might lead to a focus on finding out effective ways to adopt new-age technologies for CI.

Keywords: BIM, Drones, GPS, Mobile Apps and 5G, Modular Construction, Robotics, 3D Printing.

I. INTRODUCTION

Construction is important sector that contributes greatly the economic growth of the nation. The construction Industry (CI) is an investment-led sector where government shows higher interest. Construction Technology (CT) in India, despite its large-scale rollouts, remained rather sluggish in adopting new techniques and tools.

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However; it is the second largest industry in India and has manifested evorable development in the past year with a re-energized output of around 8%. It builds notable contribution to national economy and large sector of the community. There are actual, practical uses and benefits to streamlining the present processes. The number of trends in case CT/CM varies from 4-to 15, a slight rise in trends, tools, and techniques may be either advanced communication and design technology or a crisis in construction problem. Construction company needs to remain competitive, therefore, it always finds a way to integrate fresh approaches into the current master plan and schedule. These cutting-edge technologies are drastically changing the industry operations, and hence future projects can be worked out easily. In 2020, the global Covid 19 pandemic caused unusual interference. Some issues along with ten construction trends like safety, living material, remote technology, 3D printing, Modular Fabrication (MF), design technology, BIM, Virtual Design and Construction (VDC), work disruption, pavement disputes, supply chain diversity multifariousness and drop in non-residential starts are leading aspects for 2021 [1], [2]. The CI is historically considered a slow adaptor of technology as compared to other industries. Now it is well known fact that the adoption of innovative technologies is raising in the construction business with considerable speed and orient the results towards high efficiency and profitability. Drones, immersive technologies enabling better design, improving safety with robotics, prefabricated buildings for faster construction, and green building technology are five new trends in CT [3]. Earlier reviews and information on the impact of emerging technology on the value of CPs [4], implementation of technologies in the CI [5], a technical report [2], facilitating digital transformation in construction [6] various trends in construction for early 2022 [7], are available in the literature concerning the implementation of construction technologies tools, techniques, and trends in construction. An exhaustive list is available in the literature that includes 15 top new construction trends (<https://cedreo.com/blog>) and stays competitive during this period (2020-2022) of change. These are Construction Trends in Project Planning & Management, Virtual design and construction, Digital project management, Supply chain disruption, Labor shortages, Worker safety technology, Modular and offsite construction, Drone technology (DT) and robotics, use of space, Construction Trends in Sustainability,



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Green building, Efficient Design, Eco-friendly landscapes, Refurbishing and repurposing, Contemporary conservatories, chief-ready kitchen, and Multifunctional spaces. Very recently, [8] has laid down 4 recent trends namely: (i) use of *Enterprise Resource Planning (ERP)* software to manage construction business (ii) help of robots in the construction process(iii) Mobile Apps integration in CI, (iv)Automate construction process. The CI is assured of regrowth, but labor scarcity and rising construction costs will challenge governing person to obtain creativity while still reducing costs. All these trends can improve construction business productivity and efficiency as the ecosystem improves substantially.

II. LITERATURE RESEARCH REVIEW

The global speedy transformation from traditional methods to digital technologies authorizing the industry. Digital innovative technologies which may offer new opportunities to resolve issues of poor productivity and performance in the CI. The present paper comprises different literature sources. It includes studies pertaining to recent aspects based on literature sources. A literature survey was done by studying collected references from journals, webs, conference papers, books, theses, and surveys/ reports related to these digital

technologies routinely practiced in construction processes. The highest number is occupied by Webs and blogs, followed by journals, conferences/proceeding papers, reports/surveys &thesis. It has been observed and it is the author's experience that a maximum number of reference resources were found since 2015. However, more application is noted with available CTT and their adoption in the last three year. With intensified capabilities, there is an enhanced demand for greater r standards, more security, and execution of projects within the stipulated period. Figure 1 depicts 10 digital trends in CT and is nowadays routinely practiced in building construction, CM, and civil engineering to complete and deliver CPs(Construction Projects) with lesser andoffendable costs.

Eric et al., (2020) [9] focus on three core areas while describing 13 CTTs implementations in CI:(i) Design-oriented digital technologies(ii)Industrialized and componentized construction advances(iii)Construction automation—supporting work through digitization(www.apqc.org). This influx of technological solutions is reducing risks and well-organizing the building production process. This research finding provides a high-level overview of the technology landscape and the potential future state of the industry.

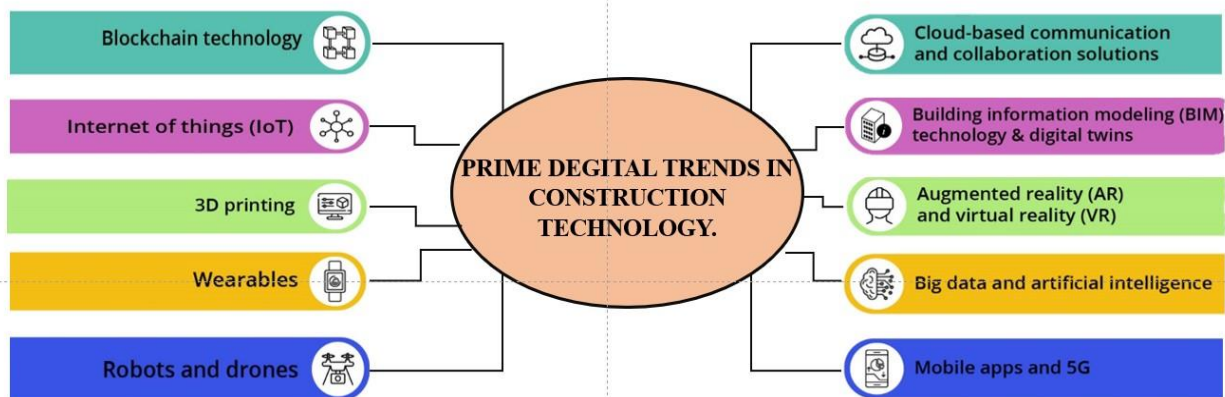


Figure 1: Digital Transformation Trends In Construction (www.onix-systems.com).

The Top 10 CI Trends significantly improve efficiency, worker safety, construction speed, and implement sustainability practices. Collaborative robots, autonomous equipment, drone-based inspection, and laser-based terrain mapping reduce labor costs and increase accuracy. Recent digital technologies have been categorized into five groups in terms of functionality in the construction process, namely: (i) data acquisition (ii)analytics (iii)visualization (iv)communication, and (v)design and construction automation [5] ,[10].Engineering Technology is the future of construction, not just for dealing with pandemics, but for improving productivity, improving quality, providing jobs for skillful younger workers, and building Jobsite safe thus the industry becomes more competitive and placed its position in the market[11] .Exploiting the following five trends will prove valuable for any rental or construction firm: (i) protective equipment (ii) efficient Technology (iii) growing need for workers (iv) remote worksites and mobile access and (v) CM software. By adopting recent practices,

exploiting fresh technologies, and investing in new projects, business owners can mitigate the risk, join more customers and enjoy[12]. We have already stated that CTT numbers vary from 4 to 15 (Table 2). Here are some examples: 7 CT trends [9].BIM uses for risk mitigation in an international CP[13],and the impact of advanced CT on the workforce in the CI [14];5 top construction trends [15],and 6 CI trends with examples [16]. It is worth to note their role and implementation improve the quality, speed, and productivity in construction. The application of some recent and sophisticated equipment, new techniques, and advanced materials is summarized in CI [17]. An excellent review of computer-aided design and manufacturing process design and architecture is given by [18] The CI has made a notable recovery from stagnation on the back of a powerful residential market in 2021.

The probability is possible because construction companies found solutions and overcome labor shortages, and supply chain disruption, saving them time to delay project completion, and reducing costs. Secondly, expert managers appointed the right people, and trained workers to replenish the building construction process. Considering impact of Covid-10 on construction ,2022 is anticipated one more year edifying, but demanding year and industry itself to be assured to reflect widening scope.(www.deloitte.com 2022). The most important disruptive developments to keep a close eye on to make sure construction company businesses deal with all the challenges in 2022 are (i) the emergence of smart, connected cities, (ii) the skill gap is becoming a real problem(iii) great need for workflow automation (iv) digitalization speeds up the industry (vi) offsite construction growing in relevance. And 3D printing finally become thin. (www.europeanbusinessreview.com). Emerging technologies such as AI and IoT are helping construction companies eliminate long-standing insufficiencies and low productivity [19]. The Covid 19 pandemic threw industries across the globe into chaos last year, and the effects will be

felt for years to come. Twelve new challenges are presented by [20] during this period along with 6 templates required for CM. [21] has explored the latest strategic trends, research, and analysis, where he emphasizes 3D printing and blockchain technology for CI. Very recently, [22] has provided valuable and commendable predictions based on his experience in the construction and engineering industry. These predictions are(i) the number of construction companies that deliver service and maintenance to increase to 50% by 2025, (ii) advanced construction trends to be used in 85% of projects by end of 2022. and (iii)integrated project planning will be a must-have by the end of 2022. More recently, Following is the descriptive study [23] on the impact of early Covid-19(March 2020) and the pandemic era (2020-2022 to date) on embracing CTTs in construction locally and globally. It is seen from Figure 2 that a progressive rise in the number of references occurred in the literature. These numbers are for the total for two years and the quarter of the 2022 year. The projected value may reach near 50 at the end of this year

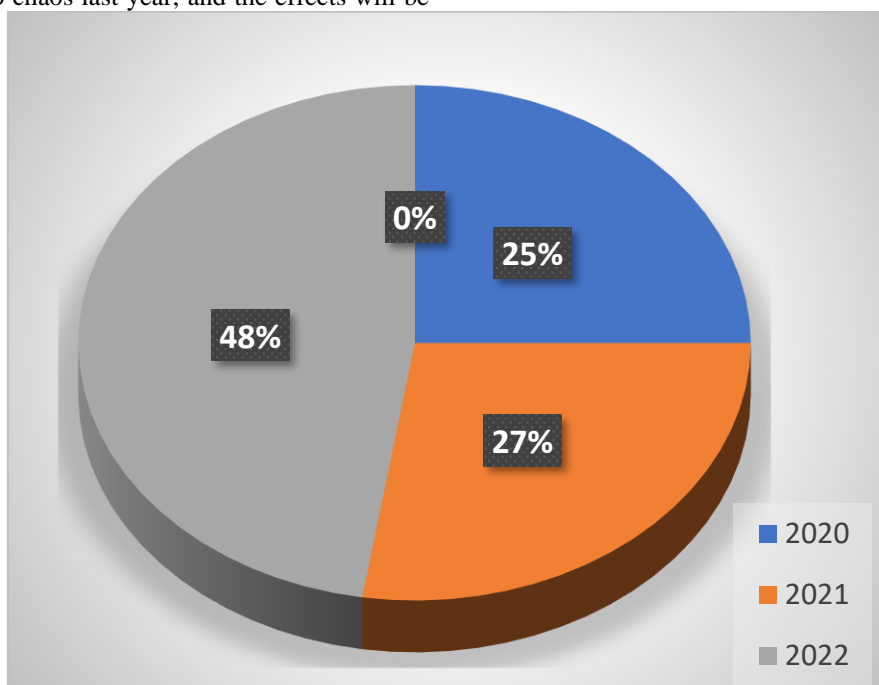


Figure 2: Year-wise distribution of references

Table 1: Frequency and recording of CTT in number.

Number of CTT	Reference Number in the list	Number in web list
Four	36	
five	5,15,17,24,29,31,35,3	Web-[1],Web-[6]
Six	56,20,28	
Seven	9,10,21,26,32	
Eight	-	
Nine	3,33	
Ten	8	Web-[1], Web-[10], Web-[11],[12],[15]
Eleven	23	
Twelve	27	
Thirteen	14	
Fourteen	18	
Fifteen	-	Web-[13]
Twenty seven (CE)	1	Web-[12]

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Table 1 exhibits the number of CTT with the corresponding frequency of reference. 5 trends occupy the highest number, and it reaches 15 in CI, and 27 in CE. It is very clear from this table that 25 references have a definite number of trends, while the rest of the references have descriptions of CTTs, without a definite number however, they include relevant text along with their applications in the construction field. The objective of this article is to provide emerging technologies/tools and techniques deployed in the last two

years by construction companies. Thus, it is expected it would fill the knowledge gap on these technological aspects that have been implemented in construction during this period. This article is the extension of the author's previous study on the exploration of new emerging trends during midyear 2020. Figure:3 explains the research methodology and outline of the research organization for the completion of the CP for simplicity four distinct levels of the organization are depicted in the same figure.

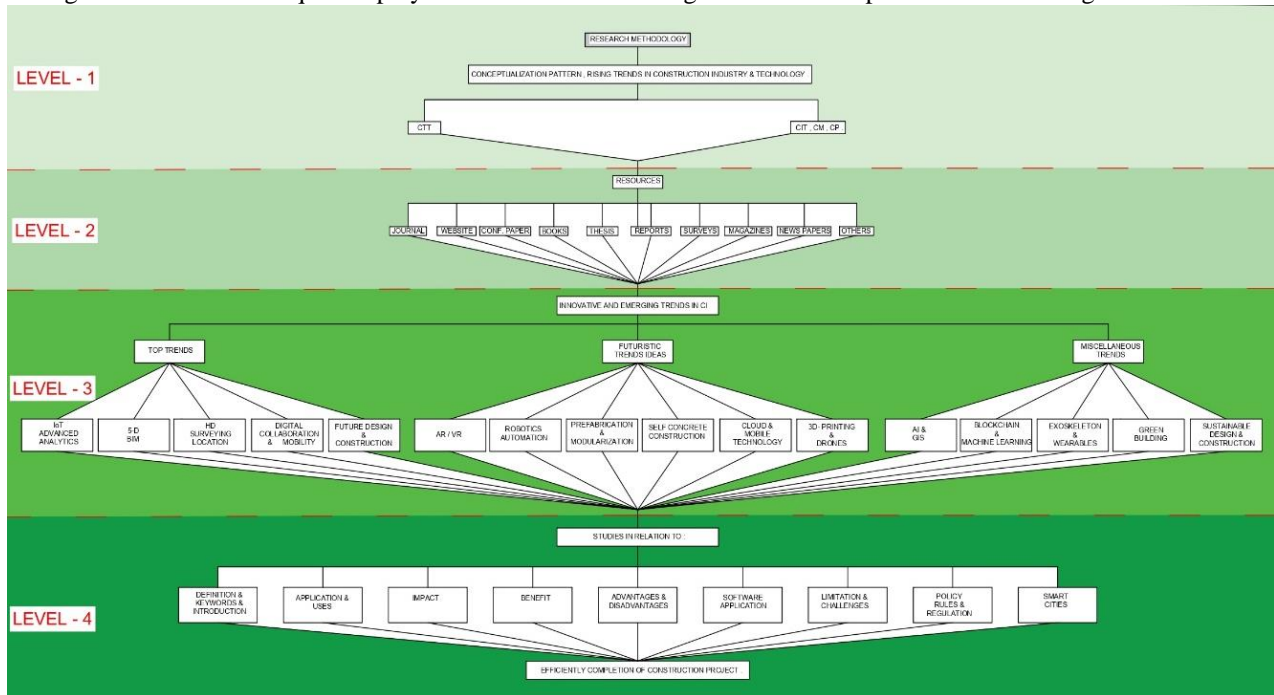


Figure:3. Outline of research organization for completion of construction project.(https://qrcgcustomers.s3-eu-west-1.amazonaws.com/account20106919/28987103_1.pdf?0.2778416569397024) compiled by Author.

III. MAJOR STUDIES ON NEW EMERGING CTTs IN CI, CM, and CE

CT (CT) is a collaborative word for types of technology that have a particular application within the CI [24]. Building planning and designing is also a collective process that essential inputs from manifold stakeholders including engineers, architects, builders, and clients. among others. Levering the latest technology has become a necessary part of driving growth, increasing efficiency, boosting production, reducing risks, and evolving with the changing needs of the industry and market. Green technology, wearable high-tech safety equipment, modular building software and hardware, BIM, and autonomous building technologies are CTT of 2020 point out how companies can leverage new technologies to improve their existing process (<https://www.sbc.com>). The disruption in construction is reshaping the world's largest ecosystem and economic status. A report of (www.mckinsey.com) appeared in literature and describes very well account on future aspects in construction business and the construction company provides directives for the new next to normal. Six construction trends for 2021 are illustrated in Figure 4, eventually also implemented during Covid -19. Since the pandemic, taking part in the digital transformation is unsafe, moving with speed endeavor.

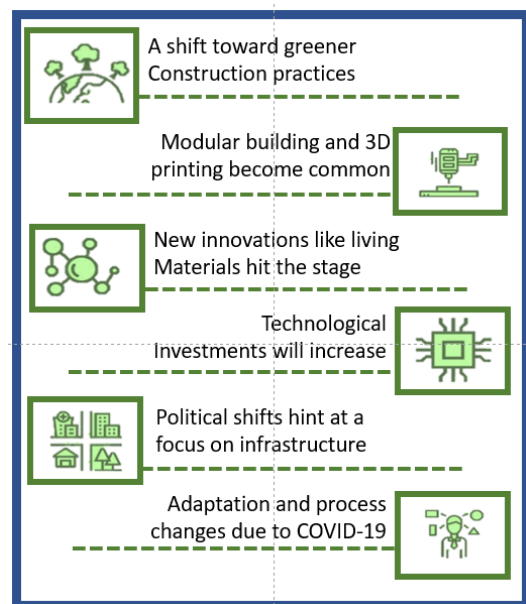


Figure 4: Implementation of six construction trends (2021) during COVID-19

Creative CT allows enormous growth in the welfare, well-being, effectiveness, and yield of large-scale CPs. [25] has published a paper on a systematic review of DT adoption in off-site construction: present status and future direction toward industry 4.0, which is fueled by technological advancement and innovations for improving efficiency and productivity in the construction field. Digital Technologies adopted by Of-Site Construction (OSC) as pointed out by the authors are RFID, BIM, GPS, AR /VR, photogrammetry, laser scanning, AI, 3Dprinting, robotics, big data, and Blockchain. This review also provides potential, better adoption to improve OSC practice in future. While studying nine recent CTT, [26] has added digital twin, sustainable construction and AR/VR/MR resulting from BIM adoption

for building construction. [27] examined the CT of 2021 aiming to coordinate safe job sites, adapt to new realities, and automate processes with computer-vision technology in his review on midyear 2021. As 2021 marches on, builders have looked for innovative methods to keep people safe under current conditions, removing them from physical sites while speeding up their ability to work together. He has considered timely importance and explored more of them in practice: (i) packet LIDAR, (ii)charging up the construction site, (iii)eyes on or in the site from anywhere, (iv)XR for construction applications, (v)Hardhat drones (vi)contact tracing for safety and efficiency, (vii)construction site robots, (viii)Greener asphalt, (ix)self-healing concrete, and(x) circular business models



Figure 5: image by the 3D printing industry (source: google.com)

Technology will carry with to understand substantial adoption as construction leaders hand out with increasing productivity, removing inadequacy and adopting a younger workforce of digital natives that expect to work with technology. Maxwell (2021)[24] has outlined 5 CTTs to look out for in 2021, namely: big data, cloud technologies, IoT, BIM, and AR /VR. Adoption of innovative technologies as identified above have an immense benefit for construction. The CI is coming out of the challenges of 2020 and 2021 into a thriving new decade of industry-wide advancements. [15] has suggested 5 issues as a new era for construction for 2022 He expected that these CTTs would create a more welcoming and environmentally, eco-friendly industry. Better PPE for women, increased use of automation and robotics, increased use of 3D printing widespread digital transformation, and a greater focus on sustainability are five digital tools, techniques and trends to be adopted for 2020 greater productivity and sustainability. Three-dimensional (3D) printing is an additive manufacturing technique, which is based on the addition of layers of material to each other according to 3D geometric data. Construction is one of the largest employment generators and has large association to other related industries such as paints, tiles cement, chemicals etc. The most common type of printer is based on a robotic arm that moves back and forth while extruding concrete (Figure 5). Technologists and entrepreneurs have off-site printed bridges in metal, concrete, or clay on-site(<https://www.technologycards.net> and <https://yoursstory.com,2020>)

India’s population and size of its cities and rapid growth of civilization leading huge demand for CI, CM, and CP. Physical distancing, personal protective equipment, adopting contactless tools and digital tools, site logistics, working remotely, work education, and trading are 5 important points identified by construction firms, these points have to be honored by everybody working in construction and stated “5” to restore the next new normal to too. Industries firms and owners recommend remedial measures 5 “R” to restore, the global economy. These are: resolve, resilience, return, re-imagination, and reform [29] It is expected and today’s need to include the above-stated technologies in the curriculum in graduate and postgraduate courses of architectural engineering is advocated in Indian universities although some private universities have started educating architectural students.

Very recently,[10] has cited five efficient and easily available digital technology innovations for the CI. He also has provided some examples and descriptions of various benefits and applications. In his article, he quoted 5 leading digital trends in CT such as:(i) Cloud-based communication and collaboration solutions, (ii)Mobile Apps and 5G(iii)BIM and Digital Twin(iv) AR VR(v) Big Data and AI. Figure (6) illustrates features of CM software where 16 steps are well displaced along with 6 benefits of cloud technology likely to be applied in CM.

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This saves time on various negotiations and minimizes misunderstanding (<https://onix-systems.com/blog/>). Cloud-based solutions secure a perfect connection between back offices and workers in this sector. The real-time inputs of critical project data are particularly

appropriate for managing geographically dispersed equipment and personnel. To access construction software anywhere by the user, an internet connection is a must.



Figure:6. Construction management software features (Milla and Writer,2022).

Technological advancements are introducing and paving the way for digital transformation in the CI. Today, there are several examples stating the importance of technology revolution in the construction sector. [30] has described seven CTTs namely (i) modular & prefabricated construction(ii)persistent labor shortage(iii) collaboration technology, (iv) sustainability and green CT(v) increased safety measures(vi) automation and design-builduse to fight the claims and leverage ongoing opportunities for

construction growth. Table 2 shows various emerging trends adopted in construction for 2020-2022(till date) and their impact of them on construction. Cloud computing is another useful tool for to be integrated with new trends in CT, such as BIM, IoT, BDA in CI/CM (<https://onix.systems.com>). Six benefits of cloud technology are given in Figure 7 applicable in CI/CM/CP.

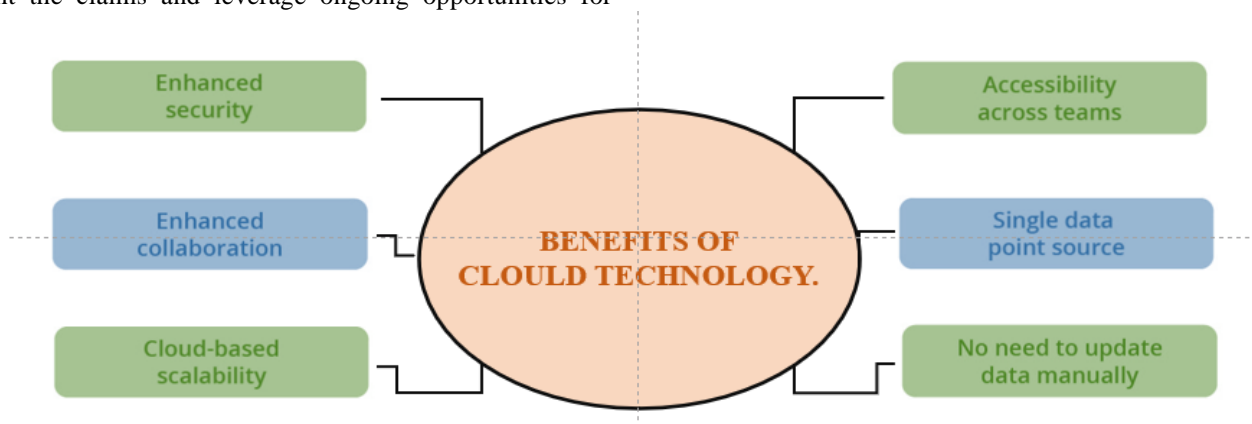


Figure:7. Various benefits of cloud technology in construction [Reference 29]

Table 2: Emerging CTT for CI/CM studied during 2020-2022

Sr. No	Author / Year/source	Title of paper	Trend No.	Abbreviation	Impact/ response/role	Reference Number
1	Admin March 10, 2022 www.constructionplacement.com	“Top 27 emerging technology to watch in 2022”	27	See in text	2022 is expected a breakthrough year for the CI.	[23]
2	C. Lauter,2022.www.geoweeknews.com	“AEC technology trends that will define 2022”	5	Virtus; collaboration, AM,5G, interoperability, AR	Strategic automation,5G support, and distributed workforce change the AEC industry in 2022	[34]
3	D. Gaioshko, https://fluix.io/blog,2022	“The impact of engineering technology on the value of CPs”	7	MF, and PF,SC,GB,AM, WE, design-Build	Overcome labor shortage, face and found solutions for challenges and opportunities for construction growth	[30]
4	D. Jean, March 17, 2022	CT trends! What’s ahead for 2022/	7	IoT, DA, AR, RB, MB, Contact ARB, enterprise integration	Driving growth, increasing efficiency, greater production, reducing risk,	[33]
5	M.Crowford, Oct. 18, 2022	‘11 CI trends for 2022”	11	AI,BIM,3D printing, digitalization, digital twin DE, robots, WE, new construction material, MF, finding and retaining workers	Highest quality material and methods, faster build speeds, skilled workforce safety, and security of workers are issues for successful construction	[35]
6	M. Gustafson,Jan 4,2022,www.redshift.atodesk.com	“6 trends in architectural, engineering, and construction in look for 2022”	6	IoT, Data strategies for remote and hybrid firms, embodied carbon, digital twins, visualization, automation	Interactive design visualization, green steel, and carbon capturing cement, extended reality, automation services for labor and supply chain, more resilient buildings	[36]
7	M.Slesar, Writer and S. Holin(2022) https://onix-system.com	“Innovations in construction:5 trends to embracing in 2022”	5	Cloud-based communication, mobile Apps and 5G, BIM and digital twins, AR/VR BD and AI	Increased safety, going green, smooth running daily operator, help to complete project, and connect with consumers.	[10]
8	N.Doniin Jan17,2022	“Top 7 CT trends for 2022”	7	3D, DE, AM, new construction material, Digital transformation, modularity,	Robotics and automation mitigate job decline, stabilize the workforce and lead to more skilled employees	[37]
9	Newsdesk. January 11, 2022 https://surveygroup.com	“5 key technology trends for CI beyond 2020”	5	AR, PA, digital twins 5D BIM Robotics and automation	Trends expected to dominate the industry in 2022 and beyond	[39]
10	B. Long 2020 [28]	“6 types of construction technology to be used in future	6	DN,BIM,3Dp,AI,VR, wearables, data collection apps	Greater faster, more accurate ,high quality of data, time saving ,reduce errors, workflow enhanced	[31]
11	N. Duggan Dec 7,2021 https://www.siplilearn.com	“Top 9 technology for 2020”	9	RB,5G,AI,VR AR, ML ,IoT, BC. edge computing, cyber security	These trends from suffering from a shortage of skilled workers	[38]
12	K. Jones https://www.constructconnect.com 2021	“Top 7 CT trends for 2021”.	7	Collaborative software solutions., AI, BIM ,DE.,VR AR ,MF PF	Automation increases the productivity of CP, reduces the duration and laborious work, and increases the quality of work. Design-build -project delivery system used in CI	[11]
13	M. Georgiou (2020).imagination.net	“7 digital technology trends for the CI”	7	MT.,BIM,PF,WE,AR/VR.3DP,AN	Provoke use of digital technologies trend for CI	[40]
14	J.Gerardi, 11 January, 2022	“Construction technology trends”	13	AI, DN, RB, WR, BIM,AR/VR, Mobile Cloud, 5G, SHC, IoT, 3DP, Biometrics, MD/PF.	Emerging technologies have positive impact on CI/CM.	[32]
1	Big Rentz January 7,2022,www.bigrentz.com	“CT to watch 2022”	10	AR, CW, CE Construction robots, DE, MC, AI, M,3D, BIM BC.	Innovative CTT Provides appreciable growth, in security effectiveness, and productivity of CPs	Web [15]



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2	The Rumbix blog www.rhumbix.com/(2021)	10 new construction trends to watch in 2018	10	PF,3DP, GT, WE, AR/VR, RB, CC, BI, PA, ABM + mobility	Better collaboration, discovery, and analytics tools driving the industry	Web [16]
3	UK Connect: (2021) www.ukconnect.com	“ The 10 CT Trends impacting the industry”	10	BIM, DE, AN, AI, BC IOT,,AR/VR,MC,GP S,3DP,SC	Better collaboration, and project evolution results in real-time	Web [17]
4	https://www.status-insights.com 2021	“Top 10 CI trends in 2022”	10	BIM, ROBOTICS, CPM, ABM PF, MF, construction monitoring, workers safety, GB,3D printing, connected construction site	Trends notably improve efficiency, workers’ well-ness, and fast, implement sustainability practices.	Web [8]
5	https://10xds.com February 7,2020	“5 top technology trends 2020 in India”	5	Hyper automation, AI, Autonomous things, storage technologies, natural language processing	Technologies to help companies grow, their products, services, efficiency, and performance enhance customer experience, expand new market	Web [18]
6	https://careers.snclavalin.com 2022	“The top CT trends to prepare for 2022”	4	WE ARE, DIGITAL TWINS, DE	CTT will change the industry for the better.	Web [19]
7	Bent renz (2020) https://www.bigrentz.com/	“ CI trends you must know”	10	GB,DE,3DP,AN,MT, AR,BIM,CS,MC,PF +OTHERS	The overall outlook for CI is positive, companies are moving away from megaproject	Web [15]
8	Building Radar (2020) Buildingradar.com	“20 Interesting trends to watch in 2020	20	ALL	Humans will continue to play the decisive roles but construction will become more digital –	Web [20]
9	Biblus.com (2020) www.biblus.accasoftware.com	“10 CI trends to watch in 2020”	10	MT,DE,3DP,PF,RB,AN,WE,GB,,SHC+CA +scanner	Revolutionize the CI in 2020	Web [1]
10	CT (2020) pbctoday.co.uk	“5 CI trends to watch in 2020”	5	RB,GC,CS,EX,BIM	Making life easier	Web [21]

Note: Abbreviation: Mobile Technology:(MT); Drones:(DE); Building Information ;5G, Modelling:(BIM); Prefabricated:(PF); Robotics:(RB); Automation:(AM); Cloud Computing:(CC), Internet of Things:(IoT): Artificial Intelligence:(AI); Wearables:(WE); Augmented Reality/Virtual Reality :(AR/VR);3-D-printing:(3-D-P); Green Building:(GB); Modular Construction;(MC); Sustainable Construction:(SC) ;Global Positioning System;(GPS);Blockchain Technology;(BCT), Autonomous vehicle(AV),Predictive Analytics(PA).a

Advancements in technology have always been the cornerstone of the development of the CI. Just as another industry is undergoing a transformation due to the innovation of the digital world, construction is no exception. [16] has enumerated very important construction trends useful for CI for next three years (2022-2025). These trends

are given in Table 3, indicating the name of CT activity and the impact on the industry. He also proposes a solution for environmental sustainability via the adoption of software for themes undertaken in the study. Interestingly, these themes also tend to result in cost-saving and help accelerate the rate of adoption.

Table 3: Most important trends CI of 2022

Sr. No.	Particular issues	Process/activity	Features/Impact on construction
1	Prefabrication and Modular construction	Convert	The nature of structures is built
2	Smart cities	Change	The method of construction companies works or run
3	Green Building	help issues	Tackle environmental issues
4	Living building materials	Proceed	Mainstream, common
5	The CI	Take advantage from	Drone Technology/UAVs
6	The virtual construction market	Notice	Rapid growth, saves time and cost

Source: Josh Howarth (2022) <https://explodingtopics.com>

The CI is constantly evolving. 2020 is predicted to be a breakthrough year for CI. It is under a big paradigm shift. The expert expected 2022 is the most noteworthy year to observe the net reflection of CTTs as the next future. The author has published an article base on an exploration of CTTs in the mid-year term of 2020 for construction, where the pandemic was initiated and has been persisting with three/fourth waves [31]. Not only that it is still existing in some parts/countries. Therefore, the content of Table 2 is the continuation of earlier findings with the addition of new emerging CTTs. Engineers and architects have started construction of green building concepts keeping the wellness and health of communities somewhat a serious problem during pandemics. Figure 8 shows the structure of the green building to suffice such a problem of the mass

population. Nowadays people are adopting it both in developing and developed countries.



Figure 8: Green construction in India.www.google.com

The CI has notably recovered from the 2020 decline in economy. It seems digital technology will continue to produce multifold headwinds shaping the prospects and success of the industry. Very recently, [37] has narrated “7 CT trends for 2022”. In addition to 3D, Drones, Automation, and robotics which have been mentioned earlier, he has incorporated three new issues : (i) Use of new eco-friendly construction material, (ii) Adopting digital transformation - to provide intuitive tools allowing for effective collaboration to keep projects on track and budget, and (iii) A declining workforce- by 2030, the CI is expected to undergo a skills shortage crisis, largely due to the introduction of robotics and the decline in notable size performed by automation. Moreover, long-term predictions indicate the growth of a greener and more efficient industry. Simultaneously, [33] has described CTT and commented on the prospect of the construction business. He introduced a new trend, “enterprise integration” that helps contractors’ availability-related information and join via user-friendly applications across many devices. 5G is a collection of new spectrums, new technology new infrastructure supporting variety of application. The advantage is for project meetings no need for a person. In addition to this, contractors are also turning to Industrialized construction (IC) to reduce costs associated with waste. The price of plastic products, steel mills, other metal products, and number two diesel has increased significantly. In the IC processes, contractors use innovative and advanced materials. They employ sustainable and green procedures along with industrialized trends and thus expect results towards reducing carbon footprint. Digital technologies support E C firms in many ways such as climate change programmed, urban air mobility, smart cities. In addition to this, these technologies help to intensify the internal operational potentiality, reduce cost and profitability. Overall growth, profitability, and performance under pressure, connected construction, Mergers and Acquisitions (M and A), and never-ending labor charges are identified as new trends for the CI in 2022 by Deloitte (<https://coloradobuildermag.com>), (<https://www2.deloitte.com>). What is significant to note is that construction engineers expect 2022 is promising year for global development on adopting new emerging technologies and remain powerful tools for next coming years.

IV. CONCLUSION AND RECOMMENDATION

New emerging technologies and recent trends described in the text can drive innovations and thus orient towards efficient practices, better productivity, and adoption of methods for managing workflow in the CI/CM. Construction is part of the country’s overall economic indicators and is a long-standing industry. In this paper, we have summarized new emerging digital technologies and CTTs tools managed in CI during pre, pandemic and post-pandemic periods i.e., starting months of 2020, followed 2021, and update 2022 in the view of the following aspects:

(i) We have focused to attract the attention of readers to incorporate advanced technologies described above in the curriculum of universities, and academic institutions seeking to understand the importance of cutting-edge technologies in the CI and CM.

(ii) Industry 4.0 and the expanding digital economy has raised the demand for engineers skilled in emerging technologies. We have stated in our earlier publication various CTT, however, in the present article new devices/tools/trends like Design-build, as-Built, 5G, enterprise integration, new eco-friendly material in construction, and green technology have been incorporated along with their significance in construction.

(iii) The objective of sustainable construction leads to implementing 3” R” namely: (i) renewable and recycled resources, (ii) reducing energy consumption, and (iii) reducing waste are eco-friendly approaches to protect the natural environment. Priority has been paid to creating a healthy environment and promoting green building construction. It is also expected that there will be wider use of green technology in construction and CM in the future as companies realize the long-term efficiency and cost savings in construction. This helps to maintain the health and wellness of the owners and residents.

(iv) Today latest technologies in construction are being developed; connected equipment and tools, mobile Apps, 5 G, autonomous heavy equipment, drones/UAVs, RPI, AR/VR, IoT, AI, Cloud Computing. and 3D/5D printed buildings could be deployed and used on job sites across the world.

(v) The above-said tools/ technologies have to be adopted by construction engineers to remain competitive in the construction business, hence the implementation of these technologies in construction is a must to accept forthcoming challenges in the construction business. Thus, construction engineers could dominate the global market.

(vi) Altogether, 2020 is likely to be promising year for construction industry, and may have positive impact on the growth of economy of the nation. Construction companies should encompass digital in every feature of operations to reach the largest data-driven insight.

(vii) Large construction companies’ experts expect the situation in changing labor markets and construction cost trends may fluctuate due to supply and demand.

(viii) Many of the tools, techniques, trends discussed above are already in use in advanced work sites, training facilities, and manufacturing plants. Adoption of modern CTT will motivate engineers for the most success in the CI, CM, and CP in the future. It is learned from the last two years and six months that during Covid-19, more use of prefabrication and modularization, 3D, 5G, Mobile Apps, and green building technology are probable ways forward for many firms. Overcoming pandemics worldwide, will emerge new data and hope to build a new growth of innovative story for E and C firms.

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