IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 18, Issue 1 Ser. I (Jan. – Feb. 2021), PP 44-53
www.iosrjournals.org

To study various techniques which can help to overcome negative impact of Covid-19 in construction industry in Indian context

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Abstract:
Background*: Indian construction industry is growing nicely till Covid-19 happened; as this affected construction industry in negative manner. There are lockdown and workers are forced to migrate to their home town or to stay in labor camps because of fear of infection. This result in increase of labor cost for skilled and unskilled labors and also after pandemic sites cannot employ number of workers as before Covid-19.*
Materials and Methods*: Hence construction industry need technology help to solve this problem of shortage of labor and increasing cost of labor and decreased productivity. Also, construction industry needs to move towards pre fabrication and construction project needed to be assembly site and use more off-site prefabrication. In this paper authors explored various techniques which can be used for various stages of construction assembly process. RFID (Radio frequency identification); Internet of Things (IoT); BIM; and AI (artificial intelligence); Augmented reality/virtual reality (AR/VR), Automated guided vehicle (AGV), Drone. During this paper these technologies are considered how these can help in four stages of construction assembly process, i.e., identifying; conveying and aligning; connecting; and inspecting.*
R***esults****: RFID, IoT, BIM, Drones and AI can help all phases in one or other form as these can also be clubbed to get smart construction activities. AR/VR will help more in case of identifying and connecting. Whereas AGV can help mainly in conveying and aligning. However, if this technology is connected with robot to act as base of it then it may help in some more stags i.e., identifying, connecting and inspecting as robot can use its sensors to scan at actual model which is then compare with BIM model to find progress and errors also.*
Conclusion: *Thus, though Covid-19 has negative impact of construction industry but it makes it more technology savvy and in future construction project will use more technology-based solutions and overall construction industry will become technology driven.*
Key Word*: Covid-19, construction assembly, Indian construction industry.*

Date of Submission: 29-12-2020 Date of Acceptance: 10-01-2021

I. Introduction

Indian construction industry is very important to India's economy and contributes around 8% of India's GDP[1]. Indian government want to become USD 5 trillion economy will depends on completion of critical infrastructure projects under National infrastructure plan. Construction sector in India employ 49 million people which is around 12 of total national working population and real estate is one of main player in employment generator and had multiplier effect on 250 allied industry[2]. Indian construction industry is booming because of continuous urbanization, various infrastructure projects and growth in population bases. There are many flagship programs by government such as smart city, make in India, housing for all, and Atal Mission for Urban Rejuvenation and Transformation (AMRUT). Because of these there is increase in public private partnership with many foreign companies and also will attract more foreign investment[3]. India needs Rs 50 trillion investment in infrastructure by 2022 for sustainable development in country[4].

This is situation before Covid-19 as Infrastructure and construction sector of India is impacted by Covid-19 in negative manner[5]; As per KPMG, which is global professional service firm construction project which are underdevelopment cross country and has worth more than 59 lakh crore will be impacted due to Covid-19[6]. As per KPMG analysis construction sector in India will suffer an estimated loss due to Covid-19 is Rs 30000 crore per day; and pandemic will reduce investment in case of construction related project around 13-30% that will impact employment (11-25%) and gross value added (15-34%) if compared to pre-crisis projection for FY21. As per CREDAI before lockdown there are around 20000 ongoing projects across country. And work is done in 18000 sites but more than 30% of workers are staying away from site because of fear of infection. It is estimated that 6 lakh workers walk to their village and 10 lakh workers are stuck in relief camps. As per KPMG labor cost for skilled worker such as carpenter, welder, plumber, fitter, riggers and electricians

will rise by 20-25% and for semi-skilled and unskilled worker it may be 10-15% rise and project will be delayed by 2-3 months depends on geography and spread of corona virus in and around project sites[7].

Real estate sector of India will have mixed opinion regarding impact of Covid-19. There will be decline in sale of housing by 30% on average in main metropolitan cities say in Mumbai (42%) whereas Pune, Bangalore and Hyderabad (25%). There will be around 15-20% decrease in new project launches even during festive season first quarter[8]. In case of construction sector gangs of workmen work together to achieve timeline but now because of restriction which are put by government construction activity across country is stopped. Lockdown will have many consequences that will give more trouble to sector includes reverse migration, shortage of raw material and labors, and disruption in supply chain[9]. Risks related to Covid-19 for completing project includes material and labor inflation; resource availability and social distancing guidelines; limited productivity; more PPE along with sanitizing needs[10]. For home construction sector main challenge is shortage of labor due to pandemic; and though if construction activities will be allowed partially there is challenge because of lack of mobility and restriction on number of personal which are allowed to work at any given site[11].

Roads and bridge, digital infrastructure, urban, irrigation sector and railways will account around 94% of INR 82.5 trillion investments from 2008 to 2017. Projects may have at various stages i.e., under implementation (40%); under development (20%); at conceptual stage (30%); unclassified (10%)[12]. The impact of covid-19 of project at various stage indicate that there may be decrease in cost in raw material in all types; though there will be increase in cost in case of supply chain, hiring charges for P &M and labor cost, but near completion project is exception where supply chain and hiring charges for P & M are not affected.

This pandemic has result in change and transform the way in which construction industry will function prior to outbreak, i.e., technology will be going to be integral part of entire construction lifecycle. When Workforce will be there is adequate number, then effort will be there to minimize human effort in area where technology can help. Digital technology integration will give sense of safety along with reduced risk due to Covid-19 to all stakeholder. Technology will make more efficiency and transparency as it is possible to make and track payments, monitoring of progress of work from remote areas and material consumption by digital tool such as CCTV cameras which can be connected to smartphones apps and it is possible to have online payment option[11].

Post covid-19 world will shift towards localization; digital will get real push; cash will be king for business; there will be a move towards variable cost models; building sensing and control tower capabilities; supply chain resilience will be key; and also building agility. Here key levers of change will be ownership of value chain, technology push, variable cost model and operating flexibility[13].

Owner need to consider digitization of tendering and contracts; go for making construction project as assembly site and not execution site hence uses off site prefabrication; consider to make firm more automate type similar to international firms; try to remove interface bottleneck with external stock holders for short term in case of compliance and protection i.e., 1-2 months. For medium term revival and recovery i.e., 3-6 months owner need to use BIM which can be updated by drones and online platform and GIS satellite-based imaginary for project process reviewing so that physical present is not needed on site, also use more IT for developing remote working facility, promote tele-work regularly; set up rapid response teams (RRT) for monitoring and solve problem.

EPS contractor can also consider for short term to move towards design for manufacturing and design for assembly thus leads prefabrication and implement digital platforms; artificial intelligence and machine learning will be considered for prediction of safety incidence with more accuracy; project staff training is done. For medium term EPC contractor can do risk management for events and do simulation for lean period or crises; hire for monitoring and keep track of employee using IoT platform and drone; adopt mechanized solutions to avoid more labor need; for sub-contractor use mutual risk along with reward sharing contract; give platform for skill up gradation to employee during lockdown period[12].

Thus, in post covid-19 it is needed that construction industry will transform and adopt technology especially: digital technology, digital tool such as CCTV cameras, IoT and IoT based platform, BIM, Drones, and AI along with construction project as assembly site i.e. offsite prefabrication can help both owner and EPS contractor in short term and medium term. Hence in this paper we consider these technologies in detail and how these will help in construction assembly.

II. Material And Methods

Here we initially review various technologies which are used in construction and then consider construction assembly in detail.

Current technologies:

Industry 4.0 is a new concept in manufacturing and there are various technologies which are used in this and these technologies can also be used in construction industry. One of researcher has identified many

technologies which can be used in construction industry, these include: RFID (Radio frequency identification); Internet of Things (IoT); BIM (Building information modeling); and AI (artificial intelligence); Augmented reality/virtual reality (AR/VR)[14]. Also material must be handled safe, less cost and efficiently, and with accurately so that material will not get damage; here Automated guided vehicle (AGV) can help[15]. Drone can be unmanned aerial vehicle (UAV) and can be applied in many civil engineering applications[16]. Let us consider these technologies in detail.

RFID (Radio frequency identification):

RFID is radio frequency identification and it is technology in which digital data encoded in RFID tags or smart labels will be captured through radio waves. RFID is same as barcode where data from tag or label will be captured by device which store data in database. RFID has many advantages over system which uses barcode. RFID tag data will be read outside the line of sight but in bar code it must be aligned with optical scanner.

Working of RFID will belong to technology group which is automatic identification and data capture (AIDC); this method automatically identifies objects, collect data regarding object and enter this data directly to computer system with less or no need of human intervention. RFID method will use radio waves for this work. At simple level RFIS system include three components, i.e., RFID tag or smart label, an RFID reader, and antenna. Here RFID tag includes integrated circuit and antenna that will be used for transmit data to RFID reader also known as interrogator. Reader will then convert radio waves into more usable form or data; and information collected from tag will be transferred by communication interface to host computer system in w which data will be stored in database and analyzed latter on.

RFID tags and smart labels: RFID tag has integrated circuit and antenna and also have protective material which hold pieces and shields them from different environmental conditions. Here protective material depends on application. For instance: employee ID bag with RFID tag will be made from durable plastic and tag will be embedded between layers of plastic. RFID tag can be of many shape and size and it may be either passive or active. Here passive tags will be used more as they are small and less expensive, passive tags need to be powered up by RFID reader before they will transmit data. Whereas active RFID tags will have on board power supply i.e., battery hence permit data transmission at all times.

Smart label differs to RFID tag as they have RFID and barcode technology both. They will be made of adhesive label embedded with RFID tag inlay and also has feature of barcode and other printed information. Smart labels may be encoded and printed on demand by use of desktop label printer whereas programmable RFID tag will take more time and need more advanced equipment.

RFID applications: These can be Inventory management; Asset tracking; Personnel tracking; Controlling access to restricted areas; ID Badging; Supply chain management; and Counterfeit prevention (e.g. in the pharmaceutical industry)[17].

IoT (Internet of Things):

It is a concept and paradigm that considers ubiquitous presence of many things or objects in environment by wireless and wired connection. Main goal of IoT is to permit things to be connected anytime, with anything any place and by anyone using any path or network to any service. It is revolution in internet in which object will permit itself to be recognized and will get intelligence by doing or allowing decision such that they will communicate information regarding itself. Object can access information which is aggregated by other things and this information can be associated with cloud computing capability and may be transition of internet to IPv6 with limitless addressing capability. Hence in future computation, communication service and storage will be more universal and distributed for example people, machines, smart object, platform, surrounding space that maybe wired or wireless sensor, RFID tags or M2M devices.

IoT has various technologies like sensor network, M2M, semantic data integration, RFID, mobile internet, IPv6, and semantic search. These will be clubbed in three types such as: technology that permit things to get contextual information; technology that permit things to process contextual information; and technologies that increase security and privacy. In this case first two will be functional blocks which are required to build intelligence into things whereas as third will help in case of penetration of IoT.

Internet will not be just a network of computer but also evolved in future to network of device of all type of size, smartphones, vehicle, toys, home appliance, medical instruments, cameras, industrial system that are connected and can communicate and share information. Thus, leads to internet of everything.

IoT has many levels of abstraction as per value chain i.e., form lower-level semiconductor to service providers. Hence IoT will be a global infrastructure to information society that permits advanced service by interconnecting physical along with virtual things based on existing and evolving communication technology and interoperable information.

IoT can be used to develop smart city, smart transport, smart buildings, smart energy, smart living, and smart health[18] .

BIM (Building Information modelling):

BIM is a process which begin with creation of intelligent 3D model and it allow document management, simulation and coordination during full lifecycle of project like building or infrastructure i.e. Plan (BIM will inform project planning through combining reality capture and real world data so as to generate context models of existing natural environment or buildings); design (here BIM help in conceptual design, detailing, analysis and documentation, here BIM data helps in preconstruction phase to inform scheduling and logistics); build (here BIM specification help in fabrication, it is possible to share project construction logistics with trades along with contractors so as to make sure optimum efficiency and timing); operate (here BIM data will be used for operation and maintenance of finished assets, also data helps in cost effective renovation or deconstruction)[19].

BIM will include multiple CAD (computer aided design) and technical specification of projects. BIM uses CAD as 3D modelling portion of BIM model. These 3D images can be manipulated by designer and others so as to verify configuration and produce better buildings. BIM models will be used by designer for showing how building will wear in time and BIM is a 4D render tool as it can show time effect and 3D model. BIM models will be easy to share than paper design plan and designer may turn these 3D model to 2D drawing for clarification. BIM helps in collaboration among designer and subcontractor, it will be done in early phase of construction; as user will collaborate early with BIM hence rework in project will be reduced drastically.

BIM can have benefits to construction industry: BIM reduces rework; Designer can create design in CAD and use BIM to see clash; BIM improve communication among designer and contractor that help both sides to produce better product. For architecture and designer BIM helps in Conflict reduction along with less rework. For estimator BIM model will be database of information and can be used for storing individual cost which is associated to every element in building; hence single piece in model will have associates cost which can be totaled up by BIM software in easy manner and hence help estimators. For project manager BIM help project manager to decrease final project cost and project schedule. For Subcontractor BIM help subcontractor in same manner like project manager but also help in change order management. As BIM will be easy tool for subcontractor to use in change order, also subcontractor may attach BIM files with change order to show why change is needed. Subcontractor may overlay various plans to see what will be added, changed or deleted so as to stay up to date on plan[20].

AI (Artificial intelligence):

AI is cloning or imitation of human intelligence which permit machine (especially computer system) to perform in intelligent manner; John McCartthy coined this term in 1956 and consider it as a science and engineering of making intelligent machines; here machine will thick and do work same as humans. AI can be classified based on number of tasks it can handle i.e., weak AI or Narrow AI; and strong AI or general AI. Here weak AI can handle single task for example speech recognition. Whereas strong AI can handle more tasks and learn and improve itself for example AlphaGo which is computer program that can play board game Go[21].

Table no 1: Shows various types of AI as per Arend Hintze[21]

Reactive Machines	Reactive machines will not store memories or learning from past experiences but simply react to the surroundings and select the most optimal solution amongst available alternatives. For example, IBM's Deep Blue which is a super computer which play chess and has capability to identify piece on chessboard and predict what can be next move. But it cannot retain memory of past to make decision.
Limited Memory	Limited memory machines will retain data as transient manner i.e., its memory will be for short period; hence system can use some past experience which is more recent for decision but cannot add experience to database or library. For example, self-driven car will store speed and pattern of changing lanes of cars which are around it and do navigation but these observations will not be stored.
Theory of Mind	This type is yet to develop which can simulate human emotions, desires and beliefs which can impact future decisions.
Self-Awareness	An AI will be self- aware when it is able to form representation about itself, and hence, be conscious about itself. A self-aware machine can understand its current state and then use the information to suppose the emotions of others. As per AI researchers and enthusiasts this can be the ultimate goal of AI development. When it is achieved than AI can operate like a human and will start predicting its own needs and demands along with start thinking of others as an equal. Such an AI does not exist yet.

There are many advantages of AI i.e., it does not tired and wear out easily; can do rational decision; can be used in medical industry; make accurate decisions; it is selfless and don't have breaks. There are many disadvantages of AI i.e., high cost; may results in unemployment; there is no improvement with experience; lack of creativity[21].

AR/VR (Augmented reality/ Virtual reality):

AR is interactive experience of real-world environment in which objects which reside in real world will be enhanced through computer generated perceptual information across many sensory modalities like visual, haptic, auditory, olfactory and somatosensory etc., and Three basic feature will be fulfilled by AR as a system i.e., combination of real and virtual world; accurate 3D registration of virtual and real object; and real time interaction. In case of virtual reality (VR) user will have perception of reality as per virtual information. In case of AR user will get more computer-generated information which improve perception of reality. Hence in architecture VR will help in developing walk through simulation in case of inside of new building whereas AR will help to show structure of building and system which are super imposed on real life view.

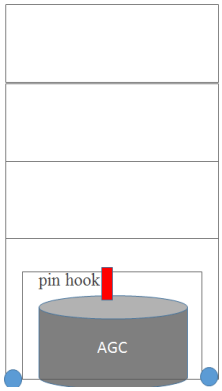
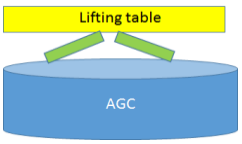
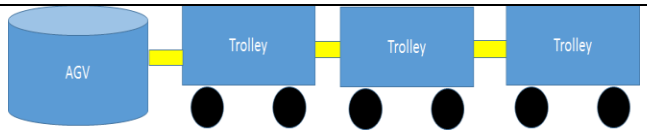
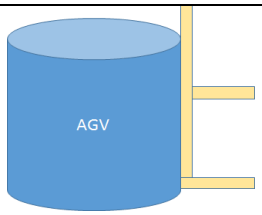
AR will have many hardware components i.e., processor, sensors, display and input devices as modern smartphone has these components along with camera along with micro-electro-mechanical system sensor like accelerometer, solid state compass, GPS hence can be used as AR platform[22].

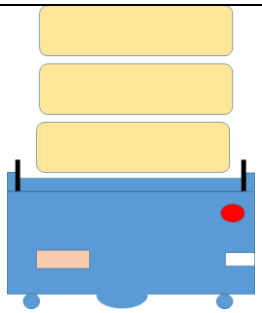
In construction project AR and VR will reduce design error and also eliminate changes which are waste; AR will revolutionize visualization of BIM through clear presentation of data and allow virtual collaboration. AR headset will allow users to see through walls virtually and project virtual information can be observed. Thus, AR and VR will improve speed of construction project and also minimize cost and errors along with delays[23].

AGV (Automated guided vehicle):

Automated guided vehicle (AGV) is a programmable mobile vehicle which is used for moving material in case of industrial application. These can perform transportation task with low expense and fully automated. Delivery task must be allocated to minimizing the waiting time at load/unload station. The traffic control managed by AGV using on board vehicle sensing and zone control[15].

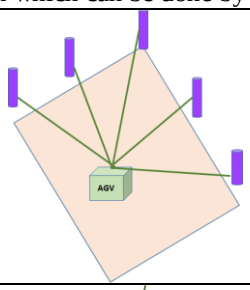
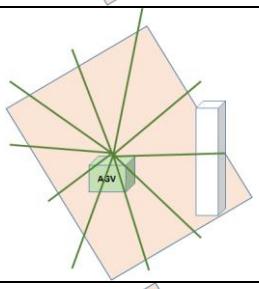
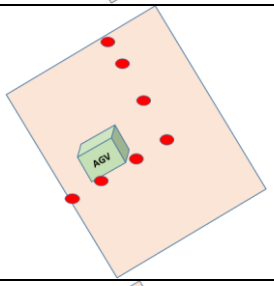
Table no 2: Shows various types of AGV[24]

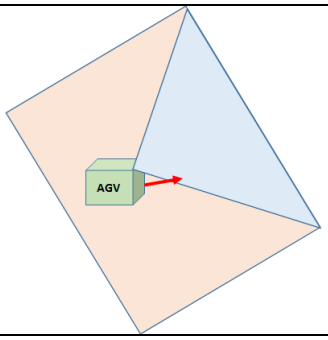
Automated guided carts (AGC) These are also called as lurking AGV, tunnel AGV, under cart AGV or under ride AGV. These are basic types and used to do task with simple loop circuits; these are less costly than other types. These has advantage as it can load and unload material automatically and hence do not require any operator; these can be used for 0.5 ton to 3 ton; has maximum speed of 40 m /min. There are two type of AGC i.e. AGC with pin hook (it has hook on top which pulls trolley, here there will be platform with wheel and has pulling capacity of 500 kg to 3000 kg); AGC with lifting table (here AGC will lift load and load weight will be supported by AGC itself, it is used as autonomous mobile robot in case of e commerce operation).	 AGC with pin hook  AGC with lifting table
Towing AGVs or Tugger AGVs These are generally used in case of automotive industry and AGV tugger will have may trolleys as convoy. Advantage of these over AGC is that it can transport more carts, but main problem is that it cannot hook trolley automatically and hence need operator. These are used for supplying raw material for line feed; finished product from production or assembly line; towing trucks in case of outdoor automated guided vehicles. Capacity of these may be 1000 kg to 3000 kg with right wheel and right floor. Speed of these can be 60 m / min.	 Tugger AGV
Automated guided Forklift: These uses Laser navigation system (LGV). Fork over AGV is used for transporting palletized loads in case of manufacturing. These can have 1000 kg to 3000 kg capacity; stacking height is 1.5 m but can even reach 3 m; these are generally used for floor-to-floor transportation.	 fork over AGV

Unit load AGV These can carry one or more-unit load at a time to and from stand, conveyors, end of line equipment (palletizer, robots, wrappers) and also in automated storage and retrieval system (AS/RS). These can be used for delivering pallet and big containers; these has integrated conveyor or lift decks; these will be best solution in case of flexible assembly lines by AGV.	 Unit loade AGV

Solving AGV had given various movers for navigation of customized system which can be used for continuous operation in case of industrial environment, here small AGV can handle few hundred kilogram and heavy duty AGV can handle hundred tons or more. There are many navigation systems which can be used for moving AGV and these depends on customer need, transportation frequency, cost of installation, existing facility, and future expansion. Here common system which can be used are as follows[25].

Table no 3: Shows various types of navigation which can be done by AGV system[25,15,26]

Laser navigation: These give customer more freedom as AGV do not require any track, wire and may be programmed easily for indoor and outdoor driving. Here driving route will change with software and rotating laser beam will detect reflectors which are placed in building and as per these location route will be calculated in real time.	
Counter navigation: These uses objects of existing environment hence all boundaries used for control of AGV drive path will be removed. Installation time will be minimum and also cost will be reduced along with minimum effect on operation. It is easy to expand system and new AGV path can be created. Counter navigation will be generally used along with another navigation system.	
Magnetic spot navigation: Here magnetic spot will be embedded in floor and sensor in AGV will be used for detecting spot. AGV position will be updated by measurement to spot magnet; this navigation can be used for complement to laser or contour navigation.	
Magnetic tape navigation: Here vehicle will follow magnetic tape on floor; vehicle movement will be tracked and position will be updated in a continuous manner. Here navigation will be active all time; but this type will be more suitable for indoor use.	

Vision based system: It is latest guidance technology that operates without defined pathway and can be used for reckoning navigation system given position heading and angular velocity in case of autonomous mobile robot. Navigation includes available external sensor which give information from work space by proximity measurement and visual image. AI can be used for designing mobile robot in case of dynamic environment; here fussy brain used for robot and will be integrated with both central system and sensor system for detecting obstacle in warehouse.	

Drone:

Drone can be unmanned aerial vehicle (UAV) and can be applied in many civil engineering applications. Main advantages: improved quality; rework minimization; safety improvement; mitigation of litigation; time saving; money saving. Drones can be classified as per aerial platforms as: multi rotor drone; fixed wing drones; single rotor drone; and fixed wing hybrid VTOL drones[16].

Table no 4: Shows various types of Drones which can be used in construction[16,27]

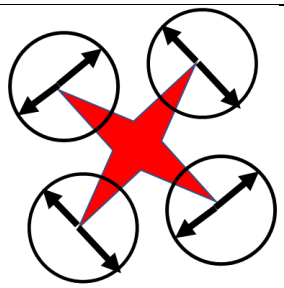
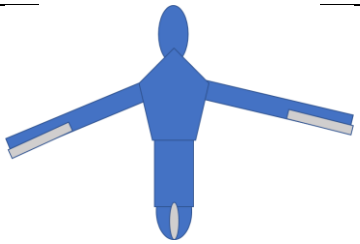
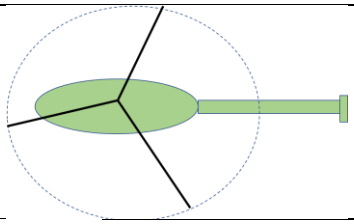
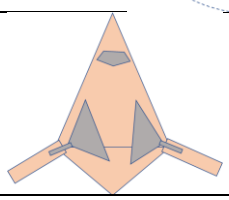
Multi rotor drone Here multi rotor drone will be most used i.e., for professional aerial mapping, aerial photography, aerial surveying and video recording. These can be further classified as per number of rotors, i.e., quadcopter (4 rotor); tri-copter (3 rotor); octo-copter (8 rotor) and hexa-copter (6 rotor). These has problem of limited endurance along with speed and hence may not be used for large scale aerial mapping in case of highways, pipelines, power lines etc.	
Fixed wing drone Fixed wing drones will operate with similar principle of passenger airplanes and thrust will not be generated by vertical rotor but has lift by fixed wings. These drones require energy for moving forward and not for keeping them in air and hence more efficient in case of topographic mapping of large area and can cover longer distance than multi rotor drones. But this drone has problem that they are unable to stay in air in one place hence cannot create detailed aerial mapping for example as built buildings; also drone need runway or catapult launcher to get them in air and runway for safe landing.	
Single rotor drone In case of single helicopter drone there is one rotor only and may be powered by gasoline engines and hence can be more in air than multi rotor drone. These can also take more payload i.e., with LIDAR scanner and if needed can do long endurance of flight with forward flight. But main problem is complexity, vibration, cost and need more mechanical maintenance.	
Hybrid drone Hybrid drone combine benefits of fixed wing and quadcopter; these can fly on pre scheduled flight route at a height which is specified by user and can collect data by use of its color and multispectral sensors. When mission is over it can land back to starting point in vertical manner.	

Table no 5: Drone can be used across project lifecycle as[28]

Conceptualization and design	Construction	Operation
Capture existing condition Risk identification Environment impact Asses and plan site preparation	Progress monitoring Asset management of stock and material Safety check and quality inspection Document site progress as build/ as designed comparison	Performance check (thermal analysis) Periodical inspection Rehabilitation / transformation projects

Drone can do many things on construction site, i.e., 3D modeling; volume calculation; position checking; progress monitoring; AI; clash detection; BIM integration for collaboration[28]; Building surveys; Topographic mapping and land survey; Construction site inspection; Thermal imaging recording; Equipment tracking and automating; Remote monitoring and progress reports[16] .

Construction assembly:

In case of Construction assembly which is a process of integration of disconnected building materials or prefabricated component in to complete structure. Here assembly work will not consider building activities which uses primary materials like masonry work, but focus on integration of prefabricated components which may include structural system, wall system, MEP systems etc[14]. Construction assembly will have four steps i.e., identifying; conveying and aligning; connecting; and inspecting.

Identifying:

Here component or unit will be located and picked out from stock yard; it is traditionally done manually and managed on paper record, it has many error and time needed is also more. Here many tools will be more useful, these includes: IoT (internet of Things) which uses wireless sensing technology like RFID, Ultrawide band, GPS (global position system) for connecting tags and sensor to target objects. Here information of site can be collected like position of material and equipment onsite, project process and working environment. In case any new material or equipment will be added to site they will be included in IoT through scanning their tags and hence site manager will know regarding onsite inventory dynamically in real time. Monitor able IoT will allow wireless identifying along with location of target object from a distance; also, IoT will reduce time which is required to figure out components. It will also reduce mistakes and thus less cost for reworks.

Conveying and aligning

Here building component will be send to final position where they will be assembled and refined to position. Traditionally tower crane in open space and labour in indoor will be used. But tower crane is slow and wind will affect it; whereas it is costly to use human based conveying[14].

Table no 6: Shows various techniques which can eb used for conveying and aligning[14]

BIM and IoT	BIM along with IoT may be used for conveying process; as in starting of conveying process IoT will locate target object and then BIM model will give final position in case of building. It is possible to generate optimized conveying path; and movement of object can be monitored and traced. In case path is deviated from original then new path will be found as per current position. Automated tower crane can reduce conveying time by 10-50% and safety risk is also reduced.
Augmented reality (VR/AR)	AR will be used for visually superimposed digital 3D spatial data to real environment by mobile intelligent device; when BIM gives information then AR device will show final position along with to be assembled component status to operator on screen. This image will guide assembly task and operator need not to check 2D drawings. Hence time needed for assembly is reduced and also worker will not do mistake and hence rework is also prevented.

Connect:

When components are located at right position then they will be connected to existing structures in proper manner. Here single task robot (A&R) will help in bolting or welding. This application is done in manufacturing from long time but in case of construction it is less as final product is not similar and work is done in unstructured environment[14].

Inspecting:

This process will check if assembly work is as per design or not. Traditionally it is done manually and based on inspector judgement and has problem of inaccuracy and incompleteness. Here laser scanning and photogrammetry (L&P) can help in as it is quick and accurate, laser scanning-based method will be used for automating inspection and assessment process. Here 3D laser scanning is used for develop digital model of built environment in short time; and when scan is aligned for built environment and 3D BIM model will be done then deviation will be found easily. New method will need less time for inspection. In case of construction assembly laser scanning will also help in monitoring the process and steer deviation among as built and as designed in real time. It may be used for structure and MEP (Mechanical, electrical and plumbing) equipment assembly tasks. Photogrammetry is used as alternative in modelling as built environment. It uses many digital photos from various perspective and by using specific algorithm it will reconstruct 3D space in computer[14]. Here drones can help.

III. Result

Table no 7: shows how various techniques will help in different stages of construction assembly process

Technology	Identifying	Conveying and aligning	Connect	Inspecting
RFID	√	√	√	√
IoT	√	√	√	√
BIM	√	√	√	√
AI	√	√	√	√
AR/VR	√		√	
AGV		√		
Drones	√	√	√	√

IV. Discussion

During this paper many technologies are explored which can help in four stages of construction assembly process, i.e., identifying; conveying and aligning; connecting; and inspecting. Here RFID, IoT, BIM, Drones and AI can help all phases in one or other form as these can also be clubbed to get smart construction activities. AR/VR will help more in case of identifying and connecting. Whereas AGV can help mainly in conveying and aligning. However, if this technology is connected with robot to act as base of it then it may help in some more stags i.e. identifying, connecting and inspecting as robot can use its sensors to scan at actual model which is then compare with BIM model to find progress and errors also.

V. Conclusion

Covid-19 had impacted construction industry is negative manner. However pandemic leads to transformation of construction industry and technology will become integral part of construction lifecycle as digital technology helps in improving efficiency and also give sense of safety and less risk. Post Covid-19 owners needs to move towards digitization in tendering and contracting, make construction project as assembly site and use more off-site prefabrication, make firm more automate and use BIM along with drones and online platform and GIS satellite so as to reduce more physical inspections. Similarly, EPS contractor need to use digital platform and move to design for manufacturing and design for assembly type projects, use AI and machine learning for safety incidence prediction and use IoT platform and drone, also adopt more mechanized solutions.

In this paper various techniques are found useful to help in different stages of construction assembly process, these include: RFID, IoT, BIM, AI, AR/VR, AGV and Drones. Thus, though Covid-19 has negative impact of construction industry but it makes it more technology savvy and in future construction project will use more technology-based solutions and overall construction industry will become technology driven.

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