The Studio Integrated Construction Practices is designed to simulate the process of Integrated Project Delivery and Global project Collaboration using appropriate software tools. Integrated Construction Practices encompasses the concepts and principles of Building Information Modeling(BIM), Lean Construction, and Integrated and Collaborative practices of project delivery.

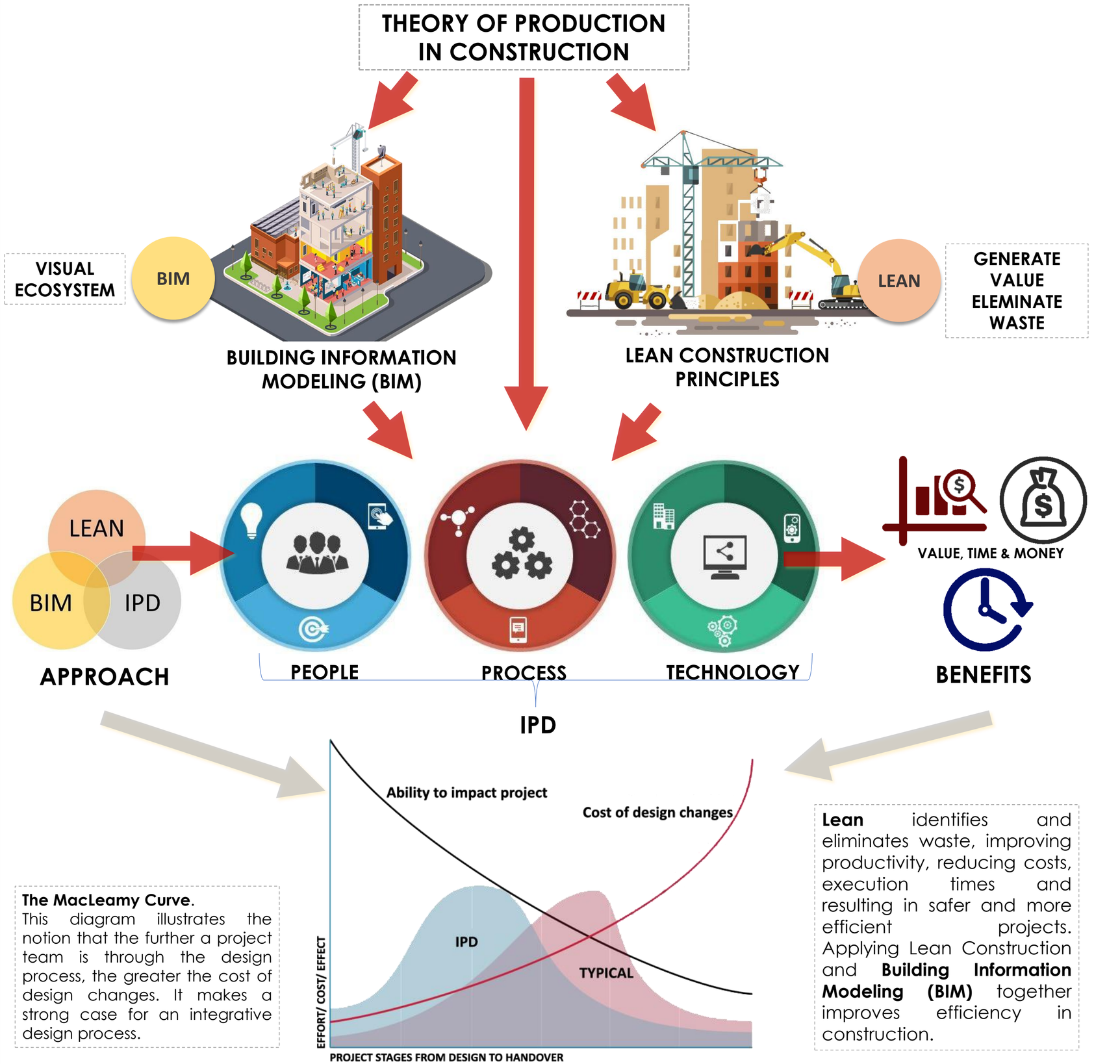
DIGITALIZATION & LEAN INTEGRATION IN CONSTRUCTION- A GAME CHANGER

REDEFINING CONSTRUCTION PROJECT MANAGEMENT PROCESSES

Dr. Jyoti Trivedi
Senior Asst.Professor and
Co-ordinator M.Tech(CEM)
program CEPT University

Dr. Bhargav Dave
Founder and CEO at
VisiLean Oy

INTEGRATED CONSTRUCTION PRACTICES



The MacLeamy Curve.
This diagram illustrates the notion that the further a project team is through the design process, the greater the cost of design changes. It makes a strong case for an integrative design process.

Lean identifies and eliminates waste, improving productivity, reducing costs, execution times and resulting in safer and more efficient projects. Applying Lean Construction and **Building Information Modeling (BIM)** together improves efficiency in construction.

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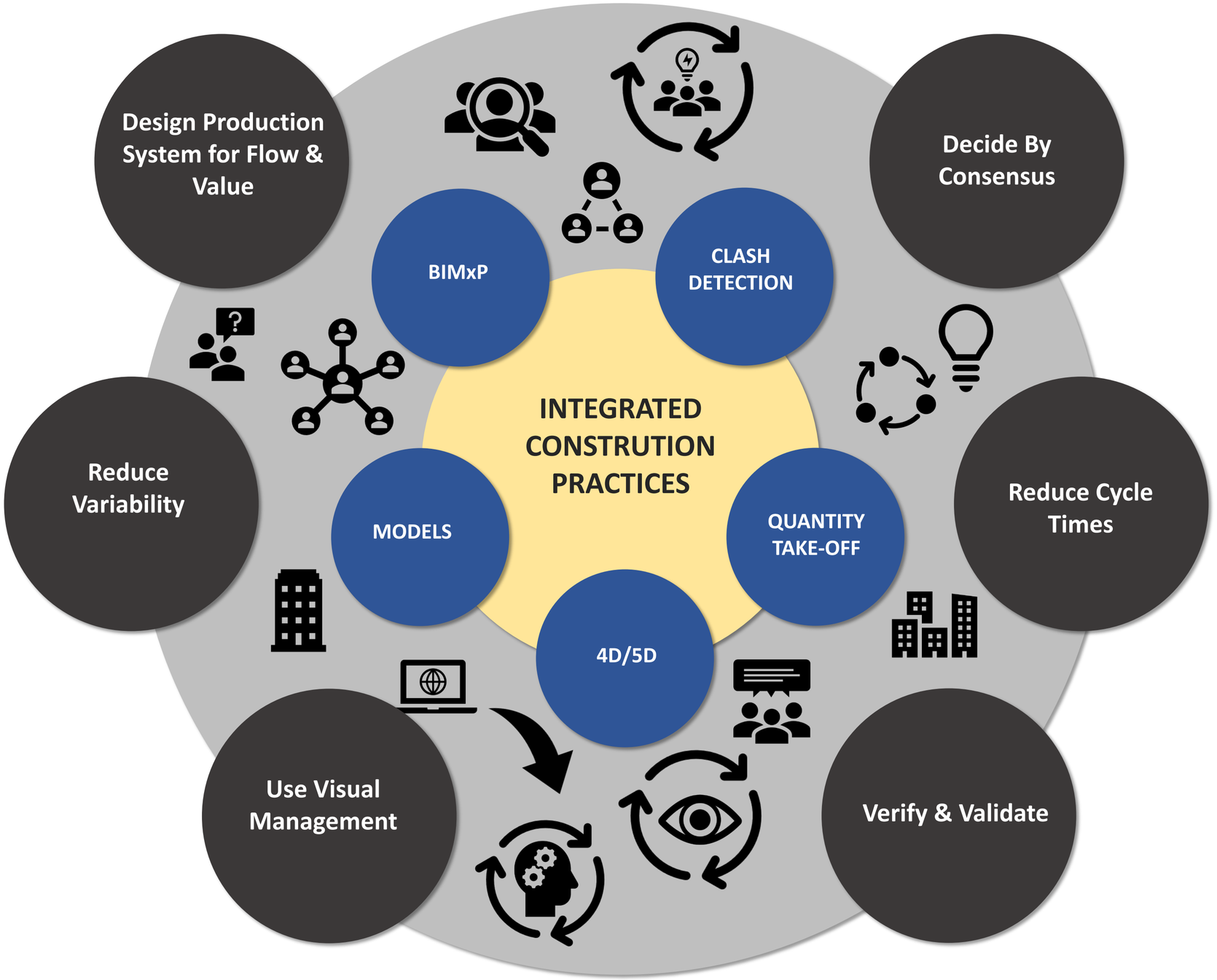
STUDIO PEDAGOGY

With post pandemic transformations in different sectors, establishing technological and process transformations in the construction sector is the need of the hour. The studio course focusses on application of BIM, Lean and integrated collaborative processes and practices to generate value to the client and stakeholders also enable real-time cost and time savings.

KEYS TO INTEGRATED PROJECT DELIVERY

- Integrate people. Include all stakeholders - consultants, contractors
- Creating visual ecosystem via BIM models
- Facilitate collaboration of people process and technology
- Minimize wastes in construction. Increase value, facilitate time and cost savings
- Create mutual trust and sharing
- Mix of top down and bottom up management practices

BIM LEAN INTEGRATION



INTEGRATED CONSTRUCTION PRACTICES

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STUDIO PADEGOGY

The students worked in groups of 4 and 5 on Live projects, currently under execution in India. The projects range from residential, hospital, large scale to small scale commercial, recreational recently at varying stages of execution. The online studio working was focused on a collaborative approach, instead of a silo-based model, and hence, defined roles were undertaken by students in the groups to ensure a sense of responsibility, as well as dependency on other members for integrated studio execution.

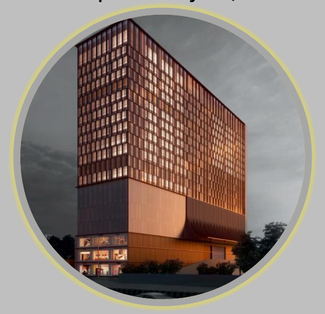
APPLICATION OF BIM LEAN SYNERGIES ONTO LIVE PROJECTS

Residential Project, Ahmedabad

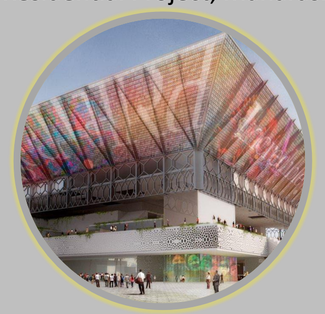
Railway Station Project, Ahmedabad

Hospital Project, Kerala

Residential Project, Maharashtra



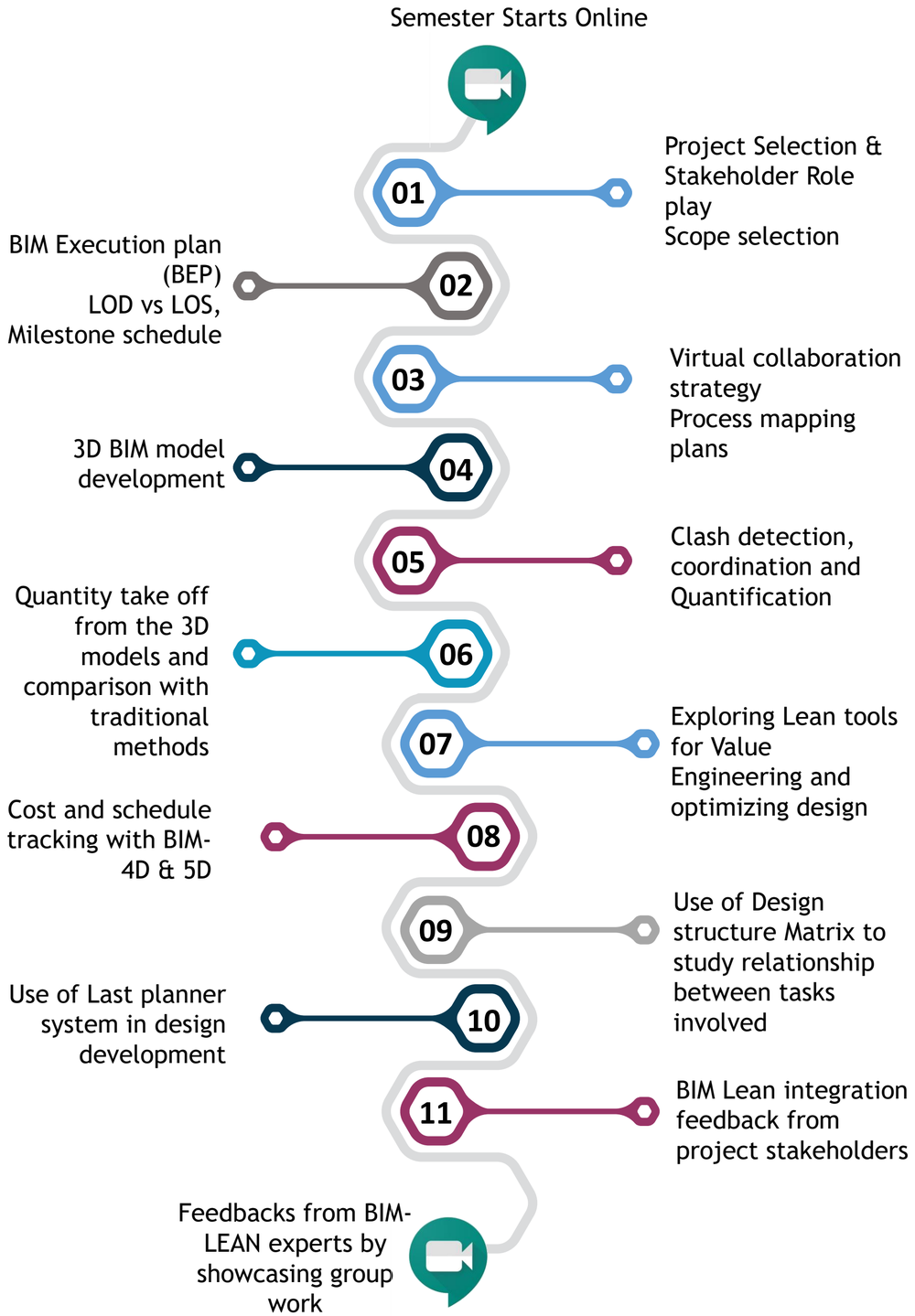
Commercial Project, Ahmedabad



Convention Centre, New Delhi

INTEGRATED CONSTRUCTION PRACTICES

TIMELINE OF KEY DELIVERABLES



INDUSTRIAL SUPPORT- Guest Lectures

Kevin Mchugh
Associate Director at Mace

Sonali Dhopte
Excelize Group of Companies & BIM Expert

Amarnath CB
BIM-Head Strategy at L&T

Cecilia Gravina da Rocha
Lecturer in Construction Management, University of Technology Sydney

Hrishikesh Joshi
Dave construction, Gujarat

Llewellyn Rozario
Blinc360 solutions Pvt.Ltd.

Ergo Pikas
PhD Researcher, Aalto University

Peter Demian –
Digital Transformation Construction, Loughborough University

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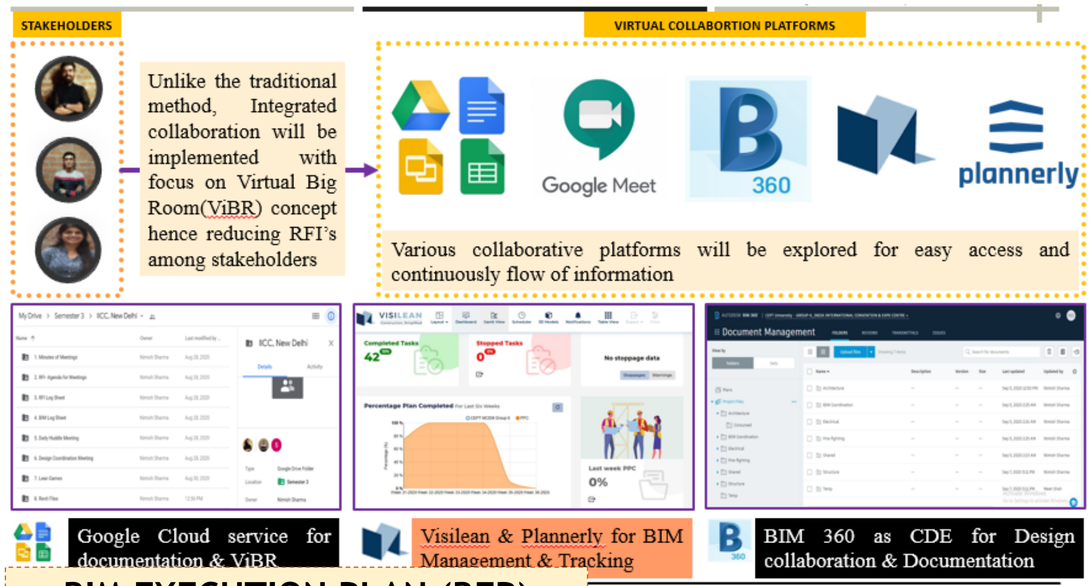
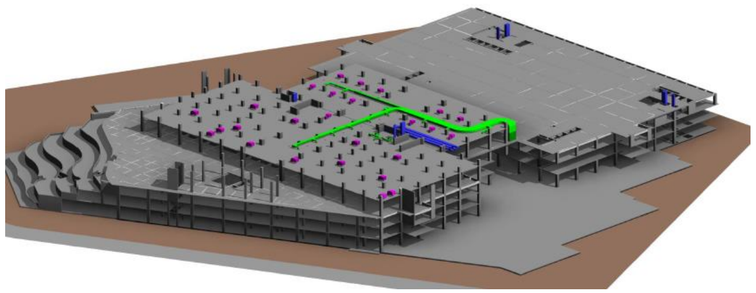
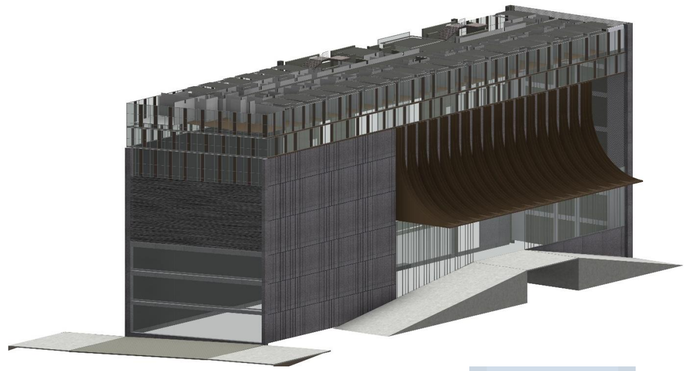
STUDIO WORK



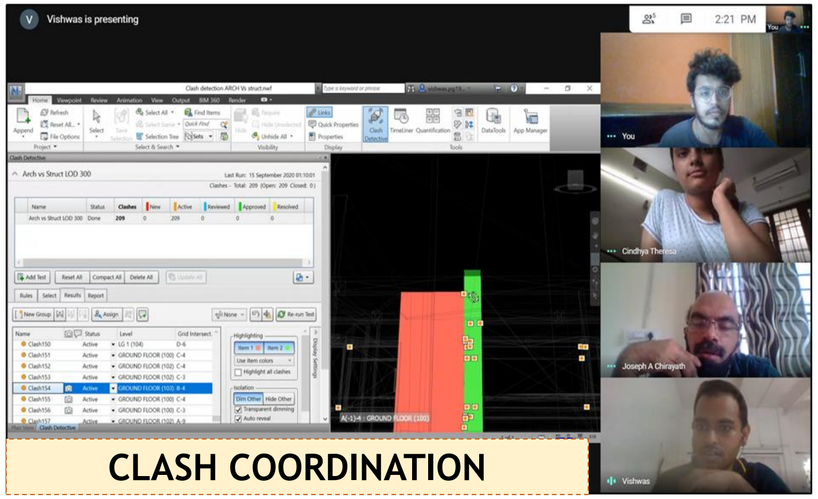
Sr. No.	Model/Task	Software	File extension	File naming format
1	File storage	Google Drive	-	-
2	BIM Collaboration and Work-sharing	BIM 360 & ProjectWise	-	-
3	Site Layout Model	Revit 2020	.rvt	WP_SLM_R1<DD-MM>
4	Architectural Model	Revit 2020	.rvt	WP_AM_R1<DD-MM>
5	Structural Model	Revit 2020	.rvt	WP_SM_R1<DD-MM>
6	Mechanical services Model	Revit 2020	.rvt	WP_MM_R1<DD-MM>
7	Plumbing services Model	Revit 2020	.rvt	WP_PM_R1<DD-MM>
8	Firefighting services Model	Revit 2020	.rvt	WP_FM_R1<DD-MM>
9	RFIs	MS Excel	.xls	WP_RFI1<DD-MM>
10	Coordinated Model	Revit 2020	.rvt	WP_CM_R1<DD-MM>
11	Energy Analysis	Revit 2020	.rvt	WP_EA_R1<DD-MM>
12	Clash Detection Model	Navisworks Manage 2020	.nwd	WP_CDM_R1<DD-MM>
13	Clash Report	Acrobat reader	.pdf	WP_CR_R1<DD-MM>
14	Clash-free Coordinated Model	Revit 2020	.rvt	WP_CFCM_R1<DD-MM>
15	4D Simulation Model	Navisworks Manage 2020	.nwd	WP_4DSM_R1<DD-MM>
16	Project Schedule	MS Project 2013	.mpp	WP_PS_R1<DD-MM>
17	Milestone Schedule	MS Project 2013	.mpp	WP_MS_R1<DD-MM>
18	PPC Schedule	MS Excel	.xls	WP_PPCS_R1<DD-MM>
19	Cost Estimation	Revit 2020, MS Excel	.rvt + .xls	WP_CE_R1<DD-MM>
20	Cost Report	Acrobat reader	.pdf	WP_CR_R1<DD-MM>

BIM EXECUTION PLAN (BEP)

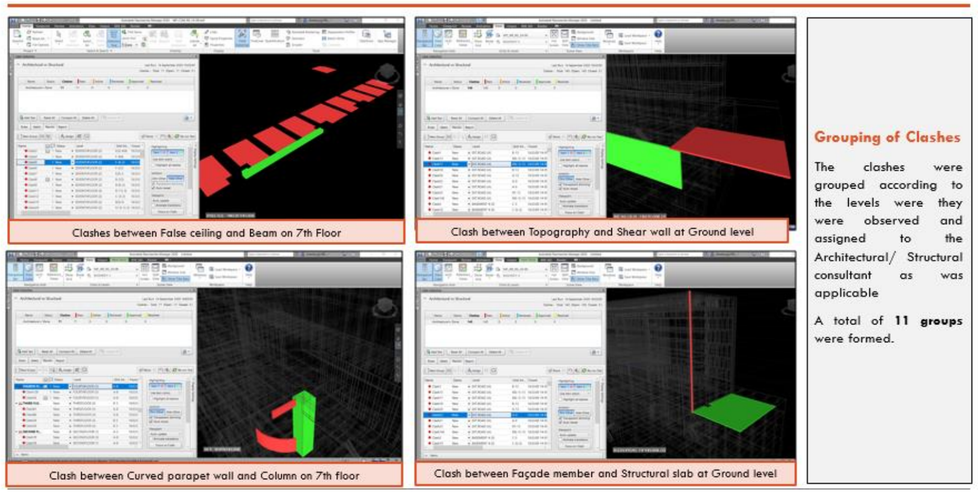




BIM 3D MODELLING



CLASH COORDINATION



INTEGRATED CONSTRUCTION PRACTICES

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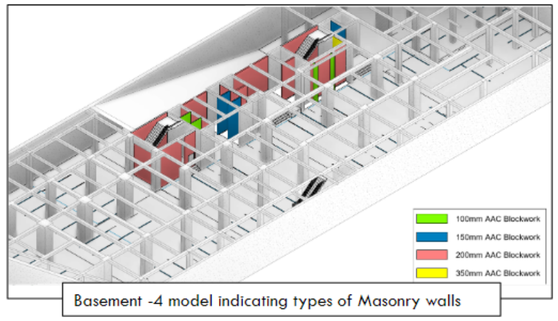
STUDIO WORK

QUANTITY TAKEOFF – MASONRY WALLS

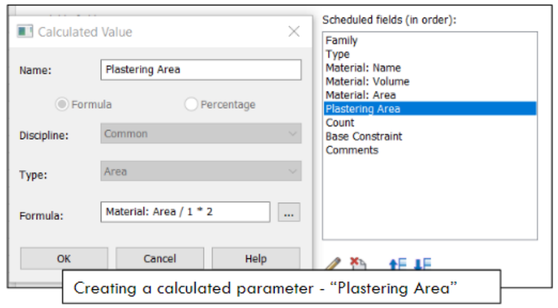
- Schedule filtered by "Base constraint" to obtain Basement -4 masonry walls
- A calculated parameter called "Plastering Area" was created to indicate the total area to be plastered for each wall.

<Masonry Wall Material Takeoff>

A	B	C	D	E	F	G	H	I
Family	Type	Material: Name	Material: Volume	Material: Area	Plastering Area	Count	Base Constraint	Comments
Basic Wall	AAC - 100mm	AAC Blocks	1.37 m³	13.74 m²	27.48 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 100mm	AAC Blocks	1.37 m³	13.74 m²	27.48 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 100mm	AAC Blocks	0.50 m³	4.98 m²	9.96 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 100mm	AAC Blocks	0.50 m³	4.98 m²	9.96 m²	1	BASEMENT-4	B4 Masonry walls
AAC - 100mm			3.74 m³		74.87 m²	4		
Basic Wall	AAC - 150mm	AAC Blocks	2.10 m³	13.98 m²	27.96 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 150mm	AAC Blocks	2.10 m³	13.98 m²	27.96 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 150mm	AAC Blocks	2.44 m³	16.26 m²	32.52 m²	1	BASEMENT-4	B4 Masonry walls
AAC - 150mm			6.63 m³		88.44 m²	3		
Basic Wall	AAC - 200mm	AAC Blocks	8.77 m³	43.86 m²	87.71 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	4.19 m³	20.93 m²	41.86 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	4.98 m³	24.90 m²	49.80 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	5.83 m³	29.16 m²	58.32 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	5.62 m³	28.08 m²	56.16 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	5.99 m³	29.94 m²	59.88 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	2.83 m³	14.16 m²	28.32 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	7.92 m³	39.60 m²	79.20 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	8.77 m³	43.86 m²	87.73 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	4.98 m³	24.90 m²	49.81 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	2.80 m³	13.98 m²	27.96 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	1.94 m³	9.68 m²	19.37 m²	1	BASEMENT-4	B4 Masonry walls
Basic Wall	AAC - 200mm	AAC Blocks	2.46 m³	12.30 m²	24.61 m²	1	BASEMENT-4	B4 Masonry walls
AAC - 200mm			67.07 m³		670.72 m²	13		
Basic Wall	AAC - 350mm	AAC Blocks	3.87 m³	11.06 m²	22.13 m²	1	BASEMENT-4	B4 Masonry walls
AAC - 350mm			3.87 m³		22.13 m²	1		
Grand total: 21			81.32 m³		856.16 m²	21		

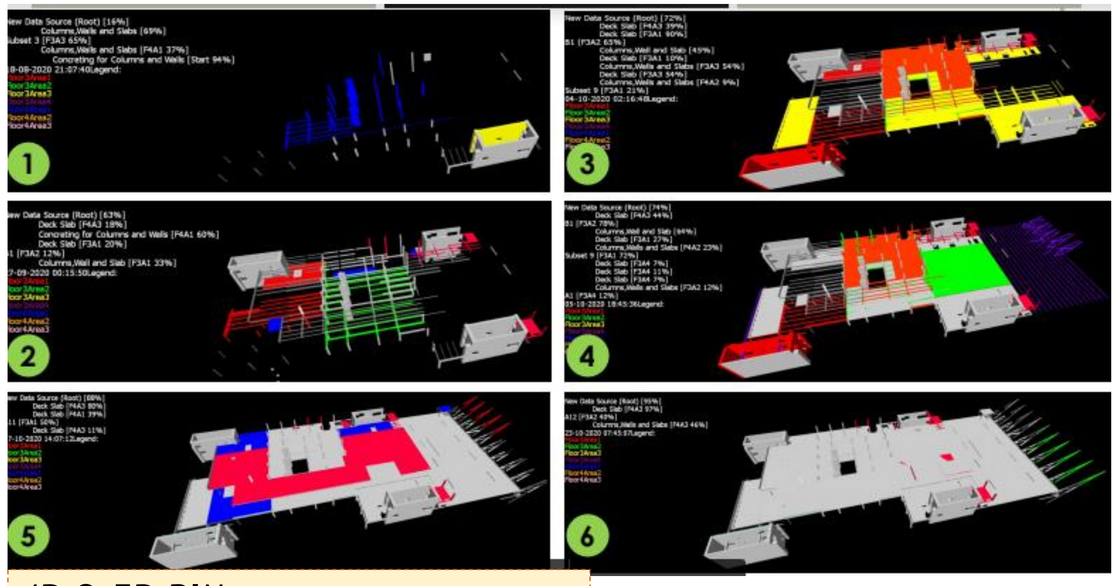


Basement -4 model indicating types of Masonry walls



Creating a calculated parameter - "Plastering Area"

QUANTITY TAKE OFF USING BIM

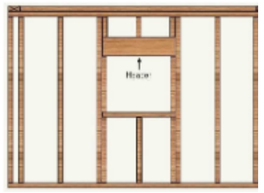


4D & 5D BIM

CHOOSING BY ADVANTAGE (DRYWALL FRAME)

Sr. No.	Factor and criterion	Metal Frame (Steel)		Wooden Frame	
1	Durability	Att.: 20 to 25 yrs		Att.: 25 to 30 yrs	
	Crit.: Higher is better	Adv.:	Imp: 40	Adv.: Approx. 5 yrs more	Imp: 60
2	Maintenance	Att.: Requires occasional repairs		Att.: Requires frequent repairs	
	Crit.:Lower is better	Adv.: Reduced maintenance	Imp: 40	Adv.:	Imp: 10
3	Strength	Att.: 400-500MPa		Att.: 8-15 MPa	
	Crit.: Higher is better	Adv.: Approx. 485 MPa more	Imp: 100	Adv.:	Imp: 60
4	Earthquake resistant	Att.: Earthquake resistant		Att.: Low earthquake resistant	
	Crit.: Higher is better	Adv.: More earthquake resistant	Imp: 50	Adv.:	Imp: 30
5	Fire resistance	Att.: Low fire resistance		Att.: Not fire resistant	
	Crit.: Higher is better	Adv.: More fire resistant	Imp: 75	Adv.:	Imp: 0
6	Water resistance	Att.: Low/No absorption of water		Att.: High absorption of water	
	Crit.: Higher is better	Adv.: More water resistant	Imp: 55	Adv.:	Imp: 5
7	Impact resistant	Att.: Very low/Not affected by impacts		Att.: Wear and tear due to impacts	
	Crit.: Higher is better	Adv.: More impact resistant	Imp: 60	Adv.:	Imp: 30
8	Acoustic (NRC)	Att.: Low NRC compared to wood		Att.: Medium NRC	
	Crit.: Higher is better	Adv.:	Imp: 0	Adv.:	Imp: 30
9	CO_2 emission	Att.: Steel has high embodied energy		Att.: Wood stores carbon and has a low	
	Crit.: Lower is better	Adv.:	Imp: 0	Adv.: Wood emits significantly less CO_2 than steel	Imp: 80
10	Weight	Att.: Density-7700Kg/cum		Att.: Density-850 Kg/cum	
	Crit.: Lower is	Adv.:	Imp: 10	Adv.: Low weight	Imp: 50


Metal Frame


Wooden Frame

430

355

Rs. 245/sq.m
Ref: USG Boral

Rs. 165/sq.m
Ref: USG Boral

Though Metal frame is expensive than wooden frame, its overall maintenance and life cycle cost is much less.

DESIGN OPTIMIZATION USING LEAN TOOLS

			Week - 8							Average Weekly PPC	100%		
		Day		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday			
S No.	Task Planned	Responsibility	Date	28-09-2020	29-09-2020	30-09-2020	01-10-2020	02-10-2020	03-10-2020	04-10-2020	Weekly PPC	Causes of Variance	Description of causes
1.8.3	**Development of LOD 300 model by Fire Fighting Consultant**												
1.8.3.1	**7th floor hotel**												
1.8.3.1.2	Pipework and Risers	Plumbing and Fire fighting consultant									100%		
1.9	Meeting 9: Review of LOD 300 MPF Model	Plumbing and Fire fighting consultant									100%		
1.10	Coordinated Model	Plumbing and Fire fighting consultant									100%		
1.11	**Clash Detection & Resolution - Basement Level 4**										100%		
1.11.1	Clash Detection	BIM Coordinator									100%		
1.11.2	Meeting 12: Review of clash detection report	BIM Coordinator									100%		
1.11.3	Clash Assignment	BIM Coordinator									100%		
1.11.4	Clash Quantification	All Consultants									100%		
						50%	-%	-%	-%	-%			

LAST PLANNER SYSTEM (LPS)