RGC Ref. No.: UGC/IIDS16/E02/20 (please insert ref. above)

## RESEARCH GRANTS COUNCIL COMPETITIVE RESEARCH FUNDING SCHEMES FOR THE LOCAL SELF-FINANCING DEGREE SECTOR

## INTER-INSTITUTIONAL DEVELOPMENT SCHEME (IIDS)

## **Completion Report**

(for completed projects only)

<u>Submission Deadlines</u> :	1.	The unspent balance, if applicable, and auditor's report: within		
		six months of the approved project completion date.		
	2.	Completion report: within <u>12</u> months of the approved project		
		completion date.		

## **Part A:** The Project and Investigator(s)

## 1. Project Title

The International Symposium on Virtual / Augmented Reality (V/AR) Inspection Training

and Education in Modular Integrated Construction (MiC)

## 2. Investigator(s) and Academic Department(s) / Unit(s) Involved

<b>Research</b> Team	Name / Post	Unit / Department / Institution
		Department of Science,
Principal Investigator	Ir Dr. I I Chi-ho	School of Science and
Timeipai investigator	II DI. LI CIII-IIO	Technology, Hong Kong
		Metropolitan University
		Department of Science,
	Ir Dr. TANG Fanny Wai fan	School of Science and
	II DI. TANG Paliny wal-tan	Technology, Hong Kong
Co Principal Investigator(s)		Metropolitan University
CO-I Inicipal investigator(s)		Department of Science,
	Ir Dr. MAK Shu lun	School of Science and
	II DI. WAK Shu-luh	Technology, Hong Kong
		Metropolitan University
		Department of Science,
		School of Science and
	DI. CHIU WIIIIIe Wai-Ilang	Technology, Hong Kong
Co Investigator(s)		Metropolitan University
Co-mvestigator(s)	Prof I EUNG Prion Hou you	HKCT Institute of Higher
	PIOL LEUNG BIIall Hau-yall	Education
	Dr. HO To sum	Department of Supply Chain
	DI. IIO IO-Suili	and Information

		Management, School of
		Decision Sciences,
		The Hang Seng University of
		Hong Kong
		Department of Science,
	Ms. KWOK Celia Sze-nga	School of Science and
		Technology, Hong Kong
		Metropolitan University
		Department of Science,
	Mr. CHAN Eddy Hei-shing	School of Science and
		Technology, Hong Kong
		Metropolitan University
Others	N/A	N/A

# 3. **Project Duration**

	Original	Revised	Date of RGC / Institution Approval (must be quoted)
Project Start Date	1 Jan 2021	-	-
Project Completion Date	31 Dec 2021	30 Jun 2022	3 May 2021
Duration (in month)	12 months	18 months	3 May 2021
Deadline for Submission of Completion Report	31 Dec 2022	30 Jun 2023	3 May 2021

4.4 Please attach photo(s) of acknowledgement of RGC-funded activities.

## **Part B:** The Final Report

	Name	% of	DistinctiveElement(s)oftheInstitutioninResponsible
	of Institution(s)	Participation	Project
Applying	Hong Kong		Organized and hosted the seminar,
Institution	Metropolitan University	90%	3-day symposium and webinar.
Collaborating	The Hang Seng		Co-organized and promoted the 3-
<b>Institution(s)</b> University of Hong		5%	day symposium.
(If any) #	Kong		
	HKCT Institute of Higher Education	5%	Co-organized and promoted the 3- day symposium.
Total:		100%	

5. Collaboration with Other Self-Financing Degree-Awarding Institutions

<sup>#</sup> If no other eligible local self-financing degree-awarding institutions are involved, please input "N/A" in this table.

### 6. Project Objectives

- 6.1 Objectives as per original application
  - 1. To broaden the knowledge of VR/AR technology in quality control and project management for MiC method.
  - 2. To organize research seminars for students, academics, industrial practitioners and professional institutions in order to provide insights on the emerging VR/AR technology topics of MiC method.
  - 3. To organize an international symposium as a collaboration platform for sharing ideas and knowledge of VR/AR technology in quality control and innovative project management for MiC method and publish the selected papers.
- 6.2 Revised objectives

Date of approval from the RGC:	N/A		
Reasons for the change:	N/A		

6.3 Realisation of the objectives

(Maximum 1 page; please state how and to what extent the project objectives have been achieved; give reasons for under-achievements and outline attempts to overcome problems, if any)

Objective 1 was achieved by inviting speakers from Hong Kong and the overseas (including China, Australia, the United Kingdom and Taiwan) to share their experiences on applying V/AR in construction, education and quality management.

Objective 2 was achieved by organizing a research seminar and a webinar with topics on the new V/AR projects on MiC methods such as the trends and the current applications supported by case studies.

Objective 3 was achieved by organizing a 3-day symposium hosted by each of the collaborating institutions, which encouraged discussion on innovative project management and the potential research topics.

## 6.4 Summary of objectives addressed to date

Objectives	<b>Addressed</b> (please tick)	<b>Percentage Achieved</b> (please estimate)
1. To broaden the knowledge of VR/AR technology in quality control and project management for MiC method.	~	100%
2. To organize research seminars for students, academics, industrial practitioners and professional institutions in order to provide insights on the emerging VR/AR technology topics of MiC method.	~	100%
3. To organize an international symposium as a collaboration platform for sharing ideas and knowledge of VR/AR technology in quality control and innovative project management for MiC method and publish the selected papers.	~	100%

# 6.5 Project progress

Original Implementation Schedule	Revised Implementation Schedule (Date of RGC's Approval)	Updated Progress
International Seminar on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC)	N/A	Completed (25 Jun 2021)
International Symposium on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC)	N/A	Completed (24-26 Nov 2021)
International Webinar on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC)	N/A	Completed (7 Jun 2022)

## 6.6 Speaker(s)

<b>Title / Name</b> (Surname in Capital Letters)	Post / Institution	Title / Topic of Presentation / Course	Previous Research Links with Hong Kong Institutions (Nature and Date (Month / Year))
Prof. TAN Kim- Hua	Professor of Operations and Innovation Management	Incorporating Virtual Learning in Operations Management via Second Life	Keynote speaker in OUHK International Conference on Testing and Certification 2019 (October 2019)
	University of Nottingham, United Kingdom	A Plug and Play (PnP) Interactive Simulation for Classroom Teaching	
	Managing Director,	Digital Twin for Total Building Quality Management	
Mr. Stephen AU	MTECH Engineering Co., Ltd., Hong Kong	Reimagining the way we validate in between virtual and physical by AR/ BIPS	-
Dr. Thomas	Founder & Head, Cyber- Human Lab, Department of Engineering	How the Cyber- Human Lab augments human capabilities	-
BOHNE	University of Cambridge, United Kingdom	Perception engineering learning with immersive technology	
Prof. Alan LAU	Pro Vice- Chancellor (Research Performance and Development), Swinburne University of Technology, Australia	The development of industry 4.0 and how it leverages our research education with international partners in Construction Industry	Professor, The Hong Kong Polytechnic University, Department of Mechanical Engineering
Dr. Anne O'GRADY	Principal Lecturer, Nottingham Trent University, United Kingdom	The role of adult continuing education globally	Keynote speaker in OUHK International Conference on Testing and Certification 2019 (October 2019)

Dr. CHAN Lai- Kiu,	Business Director, EasyVR Ltd., Hong Kong	Re-invent buildings and construction with AR/ VR	-
Mr. Simon NG,	BIM Director, China State Construction Science and Technology Limited, HK	V/AR inspection in action – Quality Inspection in China State Construction	-
Mr. Terence	Founder & CEO, Motive	VAR-based training and education to enhance operation efficiency and safety in the Construction Industry	
TSENG	Force Technology Limited, HK	V/AR training in quality control technologies innovative project management techniques in the MiC and construction projects	-
Chair Prof. Timothy JUNG	Founder & Director, Creative AR & VR Hub, Manchester Metropolitan University, UK	Current applications and trends of education and training using VR/AR in the construction and engineering sectors	-
Dr. YM TANG	Deputy Lab-in- charge, Ng Tat Lun (NTL) Digital Factory (DF), The Hong Kong Polytechnic University, HK	Evaluating the effectiveness of training design with mixed reality (MR) in higher education and the construction industry	-
Mr. Ken HO	Business Development Director, HUAWEI Cloud BU, HK	How to embed VR in cloud development and application?	-

	Visiting	MiC Trends and Perspectives	
Prof. Stephen LAU	School of Architecture & Urban Planning, Shenzhen University, China	The transformation of architectural design paradigm using MiC human oriented architecture	-
Prof. D. Daniel SHEU	Professor Emeritus, National Tsing Hua University, Taiwan	Problem-solving and opportunity identification by system transfer and causal analysis	Keynote speaker in OUHK International Conference on Testing and Certification 2019 (October 2019)
Dr. Alex TSE	Honorary Advisor, Institution of Occupational Safety and Health (Hong Kong Branch)	The Possibility using Apps for Safety Inspection in MiC Projects	-
Chair Prof. KAO Wen- chung	Research Chair Professor and Dean, Department of Electrical Engineering, National Taiwan Normal University, Taiwan	Smart Learning System with the Visible-Spectrum Gaze Tracker	OC member of International Symposium in Product Compliance Engineering-Asia 2019 (October 2019)
Prof. Tara BRABAZON	Dean, Graduate Research and Professor of Cultural Studies, Flinders University, Australia	From disruption to dark academia: the post-pandemic knowledge economy	-
Prof. Anthony STEED	Head, Virtual Environments and Computer Graphics Group, Department of Computer Science, University College London, UK	Technical Challenges of Mixed Reality Systems	-

	From ideation to	
Director	innovation.	
Smart City	how we can	
Research and	apply user	
Industry	centeric	
Collaboration	approach in	
MIT Hong	approach in	-
WITT HOUG	adopting new	
Kong	(VD / AD / MD) :	
Innovation	(VR/AR/MR) in MiC analysis at 2	
Node, MIT, US	MIC projects?	
	Case sharing	
Member of the		
Legislative		
Council of		
the Hong Kong		
Special		
Administrative	Guest speech	-
Region,		
representing the		
Engineering		
Functional		
Constituency.		
Project Director		
2, Architectural		
Services		
Department, The	Chief Guest	
Government of	speech	-
the Hong Kong	speech	
Special		
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Region		
Director, World		
Green Building		
Council / Hong		
Kong Green	Guest speech	-
Building a	_	
Council		
Limited, HK		
General		
Manager,		
Industrial		
Development,	Guest speech	-
Construction	L	
Industry		
Council, HK		
	Director, Smart City Research and Industry Collaboration, MIT Hong Kong Innovation Node, MIT, US Member of the Legislative Council of the Hong Kong Special Administrative Region, representing the Engineering Functional Constituency. Project Director 2, Architectural Services Department, The Government of the Hong Kong Special Administrative Region Director, World Green Building Council / Hong Kong Green Building a Council Limited, HK	Director,From ideation toDirector,innovation:Smart Cityhow we canResearch andapply userIndustrycentericCollaboration,approach inMIT Hongadopting newKongtechnologiesInnovation(VR/AR/MR) inNode, MIT, USMiC projects?Council ofMiC projects?the Hong KongGuest speechRegion,Functionalrepresenting theEngineeringFunctionalCouncil ofthe Hong KongFunctionalConstituency.Project Director2, ArchitecturalServicesDepartment, TheChief GuestGovernment ofthe Hong KongSpecialAdministrativeRegionChief GuestspecialAdministrativeRegionGuest speechDepartment, TheGovernment offue Hong KongGuest speechSpecialAdministrativeRegionGuest speechDirector, WorldGuest speechGeneralManager,Building aGuest speechCouncil + HKGuest speechDevelopment,Guest speechManager,Guest speechIndustrialGuest speechDevelopment,Guest speechCouncil, HKGuest speech

6.7 Please provide details of the activities organized, including the theme / objectives of the activities, targeted participants, attendance, analysis of participants, e.g. country of origin, research background, etc., evaluation forms of the activities and a summary of the participants' evaluation. Photos of the activities are preferred.)

A series of 3 international events (including a seminar, a 3-day symposium and a webinar) were organized with the theme of "Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC)". The events acted as a platform for the experts to share their experiences and to broaden the knowledge of V/AR technology applied in MiC methods. There were over 770 participants in the 3 events, who were delivered the remarkable resources shared by the invited speakers from different countries (including China, the United Kingdom and Australia). It also benefited other attendees with related academic backgrounds or industrial backgrounds from the companies providing associated services such as AECOM Asia Company Limited, Arup Group Limited and WSP Global Inc. During the panel discussion at the end of each event, there were noteworthy exchanges of ideas between the experts with different specialties. The following table shows the participants in each event.

Event	Date	Speakers	Number of
International Seminar on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC)	25 Jun 2021	<ol> <li>Prof. TAN Kim-Hua University of Nottingham, UK</li> <li>Mr. Stephen AU MTECH Engineering Co., Ltd., HK</li> <li>Dr. Thomas BOHNÉ University of Cambridge, UK</li> <li>Prof. Alan LAU Swinburne University of Technology, Australia</li> <li>Dr. Anne O'GRADY Nottingham Trent University, UK</li> <li>Ar Dr. CHAN Lai-Kiu EasyVR Ltd., HK</li> </ol>	301
International Symposium on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC)	24-26 Nov 2021 (3-day)	<ol> <li>Chair Prof. Timothy JUNG Manchester Metropolitan University, UK</li> <li>Chair Prof. KAO Wen- Chung National Taiwan Normal University, Taiwan</li> <li>Prof. Anthony STEED University College London, UK</li> <li>Ar Prof. Stephen LAU Shenzhen University, China</li> <li>Prof. Tara BRABAZON Flinders University, Australia</li> <li>Prof. TAN Kim-Hua University of Nottingham, UK</li> <li>Prof. D. Daniel SHEU National Tsing Hua University, Taiwan</li> <li>Dr. Thomas BOHNÉ</li> </ol>	Day 1: 163 Day 2: 132 Day 3: 107

		University of Cambridge,	
		UK	
		9. Dr. YM TANG	
		The Hong Kong Polytechnic	
		University, HK	
		10. Dr. Alex TSE	
		Institution of Occupational	
		Safety and Health (Hong	
		Kong Branch), HK	
		11. Mr. Simon NG	
		China State Construction	
		Science and Technology	
		Limited, HK	
		12 Mr Ken HO	
		HUAWEI Cloud BU HK	
		13 Mr Terence TSENG	
		Motive Force Technology	
		Limited HK	
		14 Mr. Stephen AU	
		MTFCH Engineering Co	
		I td HK	
		1 Ar Ms Sunnie I AII	
International Webinar on		MIT Hong Kong Innovation	
Virtual/ Augmented		Node MIT US	
V in tual/ Augmented <b>D</b> eality (V/AP) Inspection		2 Ar Prof Stephen I AII	
Training and Education in	7 Jun 2022	2. Al FIOL Stephen LAU	70
Modular Integrated		2 Mr. Toronoo TSENG	
Construction (MiC)		5. WII. TETERICE I SEINO Motivo Eoroo Toolwoloov	
Construction (MIC)		Monve Force Technology	
		Limited, HK	

The events received positive feedback from the participants, which was reflected in the results of the evaluation survey. An evaluation questionnaire consisting of 11 questions was distributed to the participants for them to provide feedback on the events. All of the participants stated that they were satisfied or very satisfied with the activities and the performance of the speakers, as well as the overall evaluation. The participants also found the events well organized with suitable duration while meeting their expectations. The average score of likeliness to meet the expectations was 4.18 out of 5. Besides, the participants considered the events useful or extremely useful as they agreed the activities helped learning new information. They also reckoned that they would recommend the events to their friends or colleagues as reflected in the average score of 4.27 out of 5 for the likeliness to recommend the events. Overall, all of the participants would like to attend more related events with improvements on longer presentation time and more demonstration clips of VR/AR technology. Some photos from the events and the summary of the responses to the questionnaire are shown below.

Event 1 – The International Seminar on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC) was held on 25 Jun 2021 at the Hong Kong Metropolitan University. There were 301 participants joining this event through online meeting platform.



Group photo of the invited speakers and guests.

Group photo of the invited speakers and guests.



Prof. Philips Wang presented souvenirs to the invited speakers and guests.

The seminar adopted hybrid mode to provide both in-person and virtual interactions.



Mr. Stephen Au shared his views on digital twin and showed examples in his presentation.



Panel discussion among all the invited guests and speakers.

Event 2 – The International Symposium on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC) was held from 24 - 26 Nov 2021. Each of the 3 collaborating institutions hosted one day of the symposium. There were 163, 132 and 107 participants on Day 1, 2 and 3 respectively, bringing the total number of attendees (via online meeting platform) to 402 over the 3-day event.



Group photo of the invited speakers and guests on Day 1 of the symposium.



Panel discussion between all the invited guests and speakers on Day 2 of the symposium.



Mr. Simon Ng shared his experiences of utilizing BIM and MiC in construction projects.



Prof. Stephen Lau presented the trends of MiC and shared cases in Singapore and Hong Kong.



Group photo of the invited speakers and guests on Day 3 of the symposium.



Dr. Alex Tse shared his views on the safety inspection in MiC projects.

Event 3 – The International Webinar on Virtual/ Augmented Reality (V/AR) Inspection Training and Education in Modular Integrated Construction (MiC) was held virtually on 7 Jun 2022. There were 70 participants joining the webinar through online meeting platform.



The invited speakers of the webinar.



Ar Ms. Sunnie Lau highlighted the Virtual Experience Design Lab of MIT Innovation Node in her presentation.



Prof. Stephen Lau shared the cases of prefabricated building technology.



The prefabricated timber structure shared by Prof. Stephen Lau.



An example of V/AR application in building services shared by Mr. Terence Tseng.



V/AR technology used in measuring building elements shared by Mr. Terence Tseng.



## 7. Research-Related Outcome

7.1 Potential for development into research proposal and the proposed course of action (*Maximum half a page*)

Based on the research insights from the international scholars, the research team applied both Virtual Reality and Augmented Reality for enhancing the training platform in the construction related industries, and successfully granted the Research Matching Grant Scheme (RMGS) funding and research topic is called "*Empirical Study on a Mixed Reality Training Platform for Property and Building Service Management*" (*Reference no*, 2020/3003).

## 7.2 Research collaboration achieved

(Please give details on the achievement and its relevant impact)

The events attracted participants of different background including the experts from academia and the professional practitioners in the industry. The events have also drawn attention and encouragement from the supporting organizations including:

- American Society of Heating, Refrigerating and Air-Conditioning Engineers Hong Kong Chapter
- Energy Institute Hong Kong (Branch) Limited
- Hong Kong Association for the Advancement of Science and Technology
- Hong Kong Society for Quality
- Institute of Industrial and Systems Engineers (IISE) (Hong Kong)
- Institution of Occupational Safety and Health (IOSH) (Hong Kong Branch)
- Product Safety Engineering Society (Hong Kong Chapter), The Institute of Electrical and Electronics Engineers (IEEE)
- The Chartered Institution of Building Services Engineers
- The Hong Kong Green Building Council Limited
- The Hong Kong Institution of Engineers (HKIE) Building Services Division
- The Hong Kong Institution of Engineers (HKIE) Control, Automation & Instrumentation Division
- The Hong Kong Institution of Engineers Manufacturing, Industrial & Systems (MIS) Division (HKIE-MIS)
- The Institution of Engineering and Technology (IET) Hong Kong
- The Institute of Measurement and Control (InstMC) (Hong Kong Branch)
- 7.3 Any new development and/or challenging research topic(s) has / have been identified and any new initiative(s) for future research has / have been inspired.

The research team has identify the inspection and operation procedures of using the Augmented Reality and Virtual Reality training platform in the construction related research project for future research development.

## 8. The Layman's Summary

(*Describe* <u>in layman's language</u> the nature, significance and value of the research activities, in no more than 200 words)

The project aimed to initiate and strengthen the inter-institutional collaboration on the quality inspection, training and construction technology management to enhance the competitiveness in the Modular Integrated Construction (MiC) method in Hong Kong. Through the partnership of the collaborating institutions (i.e., Hong Kong Metropolitan University, The Hang Seng University of Hong Kong and the HKCT Institute of Higher Education), 22 speakers specialized in the VR/AR and construction fields were invited to share their experiences, innovative techniques and views on the potentials of VR/AR technology for MiC.

A series of 3 international events (including seminar, symposium and webinar) were organized and used as a platform for the experts to provide an insight of the field. With the expanded connections of 14 collaborating organizations, the speakers in the events had a wide range of backgrounds including both local and overseas speakers from China, Australia and the United Kingdom. Apart from the experts from the academia, the professional practitioners in the industry were also invited to share the current practices of VR/AR technology in the built environment. The events provided innovative ideas with case studies and attracted more than 770 participants, who found useful information and inspiration for their future work.

## Part C: Research Output

# 9. Recognized Conference(s) Paper(s) Related To This Project Was / Were Delivered (As Applicable)

(*Please attach a copy of each conference abstract*)

Month / Year / Place	Title	Conference Name	Submitted to RGC (indicate the year ending of the relevant progress report)	Attached to this Report (Yes or No)	Acknowledged the Support of RGC (Yes or No)
	Virtual /Augmented	2021 IEEE			
11/2021/	Reality (V/AR)	International			
Virtual	Inspection Training	Symposium on	No	Vac	Vas
Symposi	and Education in	Product Compliance	NO	105	105
um	Modular Integrated	Engineering - Asia			
	Construction (MiC)	(ISPCE-ASIA)			

## **10.** Research Personnel Trained (As Applicable)

Name	Capacity
Nil	

### 11. Other Impact (As Applicable)

(e.g. prizes, collaboration with other research institutions, technology transfer, etc.)

Nil

## 12. Statistics on Research Outputs

	Peer-reviewed Journal Publications	Conference Papers	Scholarly Books, Monographs and Chapters	Patents Awarded	Other Rese Output (please spe	arch s cify)
No. of outputs arising directly from this project	-	1	-	-	Type -	No. -

### 13. Public Access Of Completion Report

(*Please specify the information, if any, that cannot be provided for public access and give the reasons.*)

Information that Cannot Be Provided for Public Access	Reasons	
N/A	N/A	