CONSTRUCTION SAFETY WEEK 2019

AI and IT Tools to Prevent Falls From Height

Dr. Goh, Yang Miang
Associate Professor

Deputy Head (Research),
Department of Building, NUS

1

Agenda

1. Introduction to SaRRU
2. Problems & Developments in Construction Safety
3. Current Work: Computer vision, FPSWizard & SafeSim
4. Conclusions and Future Work

2

2

Safety and Resilience Research Unit

National University of Singapore

RESEARCH AREAS

- Analytics, Machine Learning and Computer Vision
- Education and Training
- Safety Culture and Design for Safety
- Fall Protection

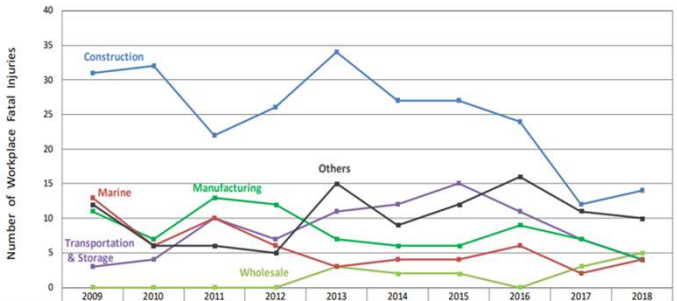
3

3

Challenges

IN CONSTRUCTION

Construction industry remains as the **TOP CONTRIBUTOR** of workplace fatal injuries



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Construction	31	32	22	26	34	27	27	24	12	14
Wholesale Trade	0	0	0	0	3	2	2	0	3	5
Transportation & Storage	3	4	10	7	11	12	15	11	7	4
Manufacturing	11	7	13	12	7	6	6	9	7	4
Marine	13	6	10	6	3	4	4	6	2	4
Others	12	6	6	5	15	9	12	16	11	10

4

4

PUSH FACTORS TO EMBRACE THE USAGE OF TECHNOLOGIES TO IMPROVE PRODUCTIVITY IN THE BUILT ENVIRONMENT

2ND CONSTRUCTION PRODUCTIVITY ROADMAP

FOCUS AREAS

- Design for Manufacturing and Assembly (DfMA)
- Automated equipment and robotics
- Info-comm technology
- Building Information Modelling (BIM)
- Virtual Design and Construction (VDC)
- 3D printing and Advanced construction materials
- Productive solutions for civil engineering works

WSH Tech Challenge

https://www.bca.gov.sg/IntegratedDigitalDelivery/Integrated_Digital_Delivery.html

Built Environment (BE) Robotics Research and Development (R&D) programme

Cities of Tomorrow (CoT) R&D Programme

5

5

Construction Industry Transformation Map

3 Key Areas

TO TRANSFORM THE SECTOR

Integrated Digital Delivery (IDD)

Enabled by Building Information Modelling (BIM), IDD fully integrates processes and stakeholders along the value chain through advanced info-communications technology (ICT) and smart technologies.

Design for Manufacturing and Assembly (DfMA)

- Design upfront for ease of manufacturing and assembly
- Highly automated offsite production facilities
- Efficient and clean on-site installation process

Green Buildings

- Design for Green Buildings
- Sustainable practices in operations and maintenance

6

6

Pushing for Higher-end DfMA Technologies

Components: Incremental Improvement

CONTINUUM OF PREFABRICATION & DFMA

Integrated assemblies: game-changing improvement

	Prefab Components	Advanced Prefab Systems	Integrated Sub-Assemblies	Fully integrated Assemblies
Structural				
	Precast	Structural Steel/ Advanced Precast/Hybrid	Mass Engineer Timber (MET)/Hybrid	PPVC MiC

Prefabricated Prefinished Volumetric Construction (PPVC) refers to a construction method whereby free-standing volumetric modules (complete with finishes for walls, floors and ceilings) are: constructed and assembled.

7

7

Impact of DfMA and MiC/PPVC on Workplace Safety and Health (WSH)

Hazard **reduced**

- On-site workers
- Formwork and scaffold
- Work-at-height
- Human factors issues due to rebar tying (MSD, heat stress, etc.)

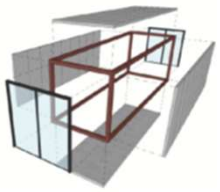
8

8

Impact on WSH

Hazard **introduced or increased**

- Heavy lifting
- Traffic-related
- Factor machinery hazards
- Learning curve for site workers, working in factory setting



Fall from height risk is **still significant**

- Riggers
- Installers

9

9

Impact on WSH

Synergises with Design for Safety (DfS)

ENACTED IN 2015

Makes engineering control and elimination/substitution more likely

10

10

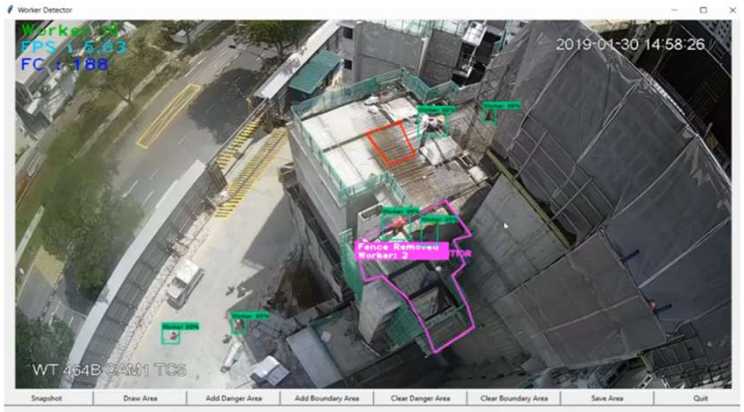
Technologies

NUS SaRRU is focusing on

- Computer Vision: CCTV Automatic Hazard Detection
- Mobile Solution: FPSWizard - Engineering Calculator
- EduTech: SafeSim Hazards

11

11



Computer Vision

Automated Hazard Identification
(Funded by AI Singapore and HDB)

12

12

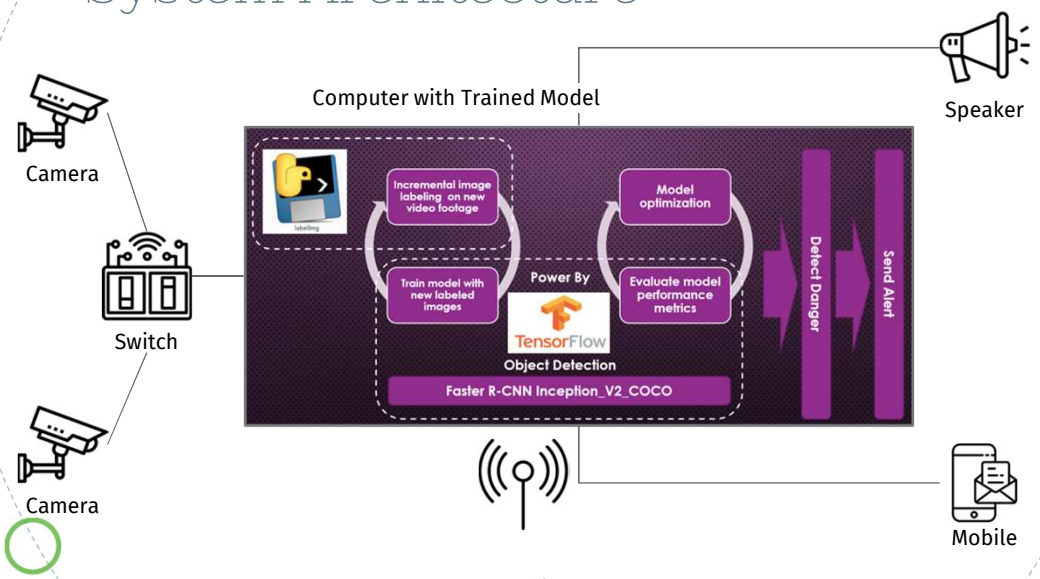
Scope

- Utilise computer vision techniques for
  - Detection and tracking of workers on site
  - Identification of danger zones
  - Detection of workers in proximity to danger zones
  - Detection and tracking of lifting crane operation
- Automatic alert for supervisors
- Dashboard for behaviour-based safety management

13

13

System Architecture

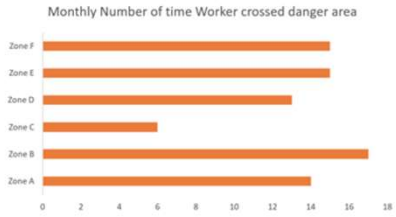


14

14

Dashboard

WORKER DETECTION



16

16

FPSWizard

FPSWizard is a mobile application with **3 basic functions**:
Calculations, **Case Retrieval** and **Supplier Directory.**

WHY THE NEED?

Many professional engineers' designs for horizontal lifelines do not conform with Singapore Standard 607 Specification for design of active fall-protection systems

WHO DOES IT BENEFIT?

- Fall Protection Engineers / Professional Engineers
- Inspectors / WSHOs
- Students

Funded by Ministry of Manpower, Ministry of Education, NUS TAP Micro

18

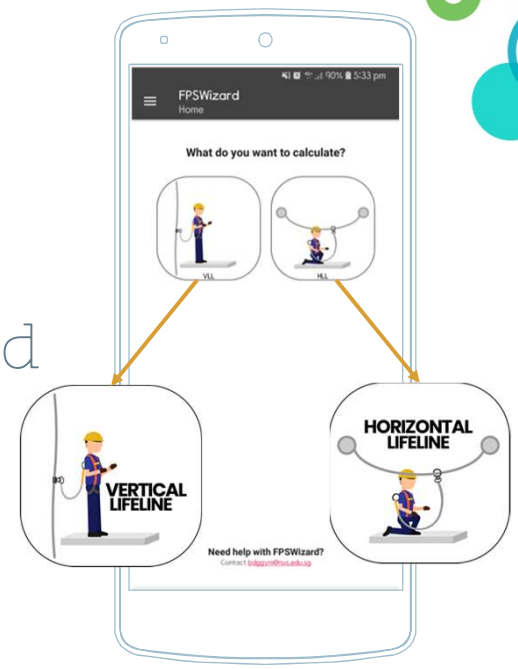
18

FPSWizard

STUDENT VERSION

FEATURES

- Calculation only
- Single span
- One worker



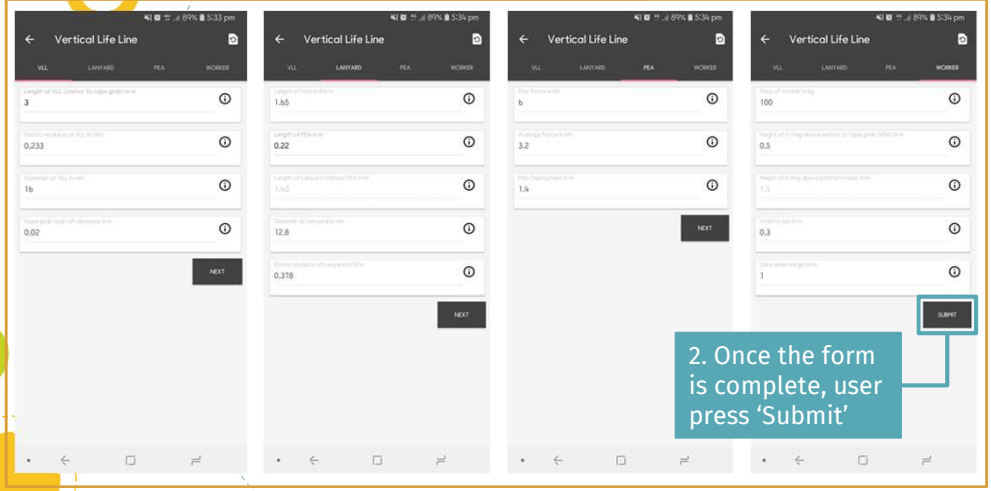
20

20

How does it work?

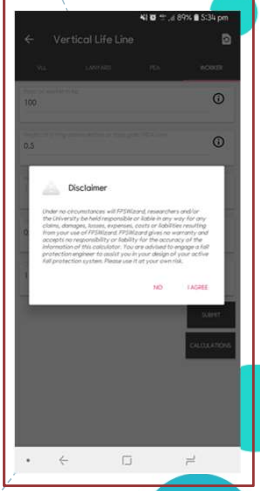
E.g. VLL

1. Users enter the inputs required by the application



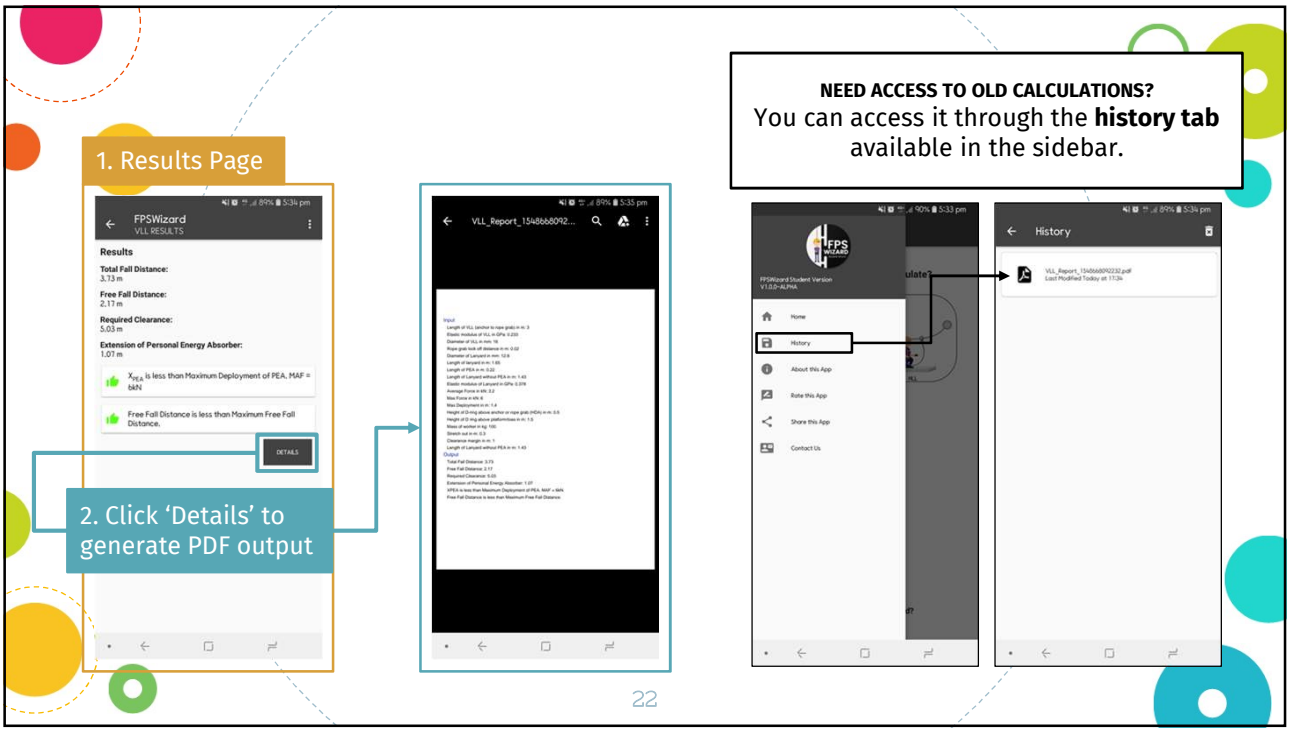
2. Once the form is complete, user press 'Submit'

3. Disclaimer pop-up will appear for users



21

21

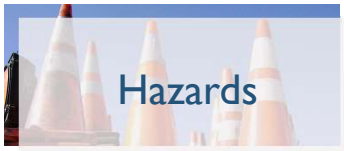

1. Results Page
FPSWizard
VLL RESULTS
Results
Total Fall Distance:
3.73 m
Free Fall Distance:
2.17 m
Required Clearance:
5.03 m
Extension of Personal Energy Absorber:
1.07 m
Free Fall Distance is less than Maximum Free Fall Distance.
DETAILS
2. Click 'Details' to generate PDF output
NEED ACCESS TO OLD CALCULATIONS?
You can access it through the history tab available in the sidebar.
History
22

22


00:57:57
SafeSim Hazard
Hazard Identification 3D Simulation Game
Funded by Ministry of Education, NUS TAP Micro
23

23

WSH training is Important, but…



24

24

Principles of Authentic Learning

(Herrington, 2000)

25

25

SafeSim Hazards

A 3D simulation game in which players enter a construction site to conduct safety inspections by identifying hazards and good practices.

FEATURES

- Camera
- Measuring Tool
- Phone
- Map

Ver 1: Students

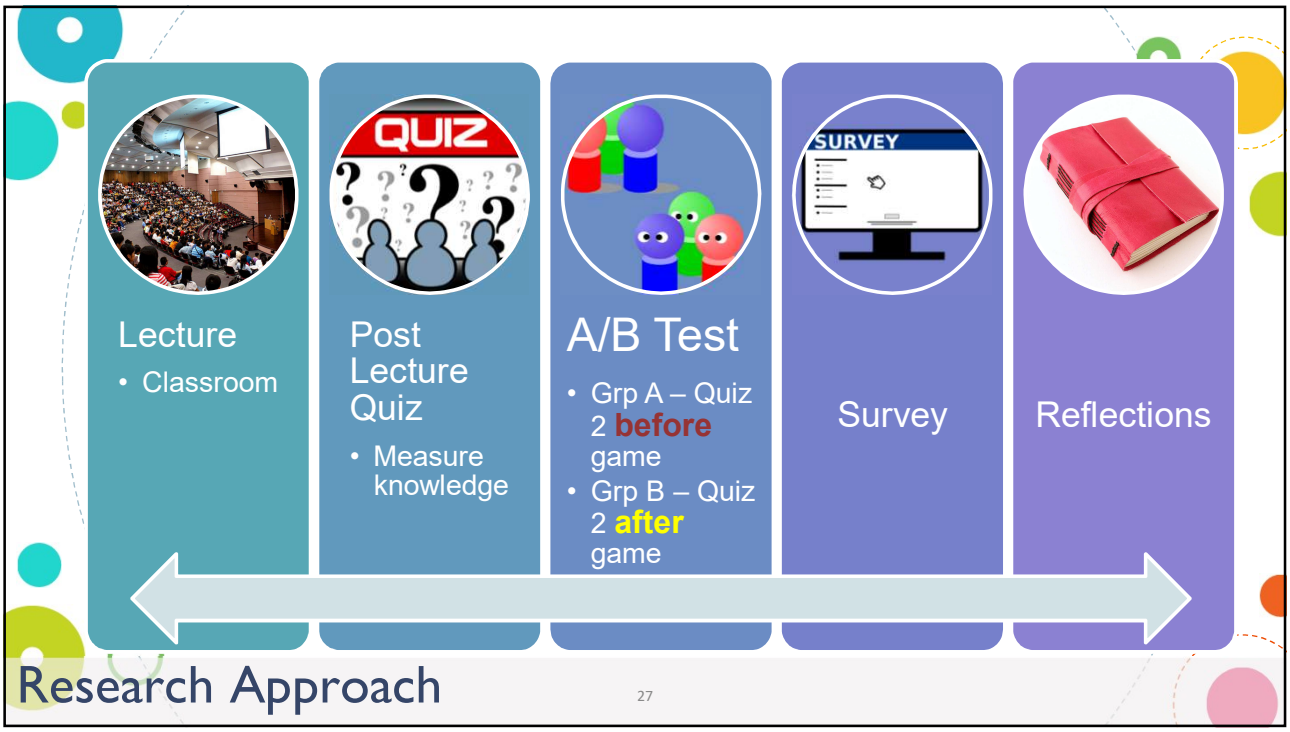
- Multiplayer
- Allows for collaboration

Ver 2: Practitioners

- Single Player
- Immediate Feedback
- Ability to choose language (i.e. English, Mandarin)

26

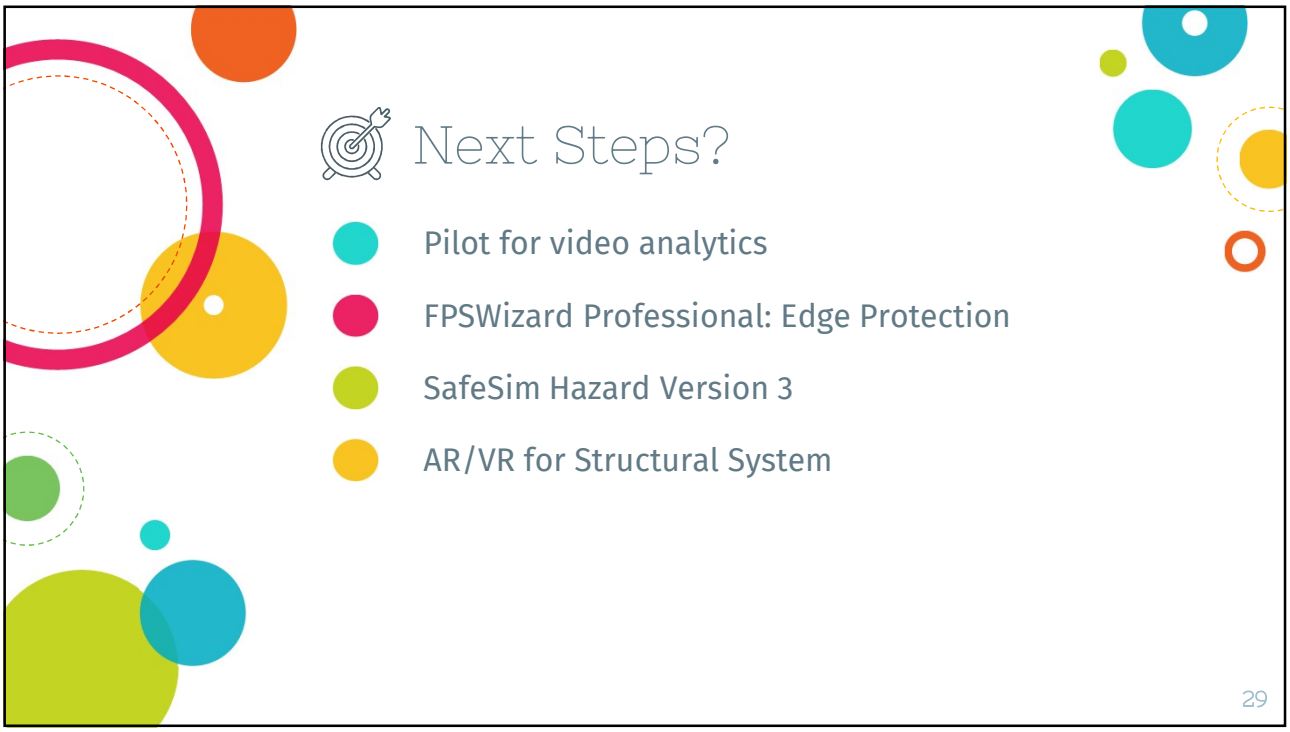
26



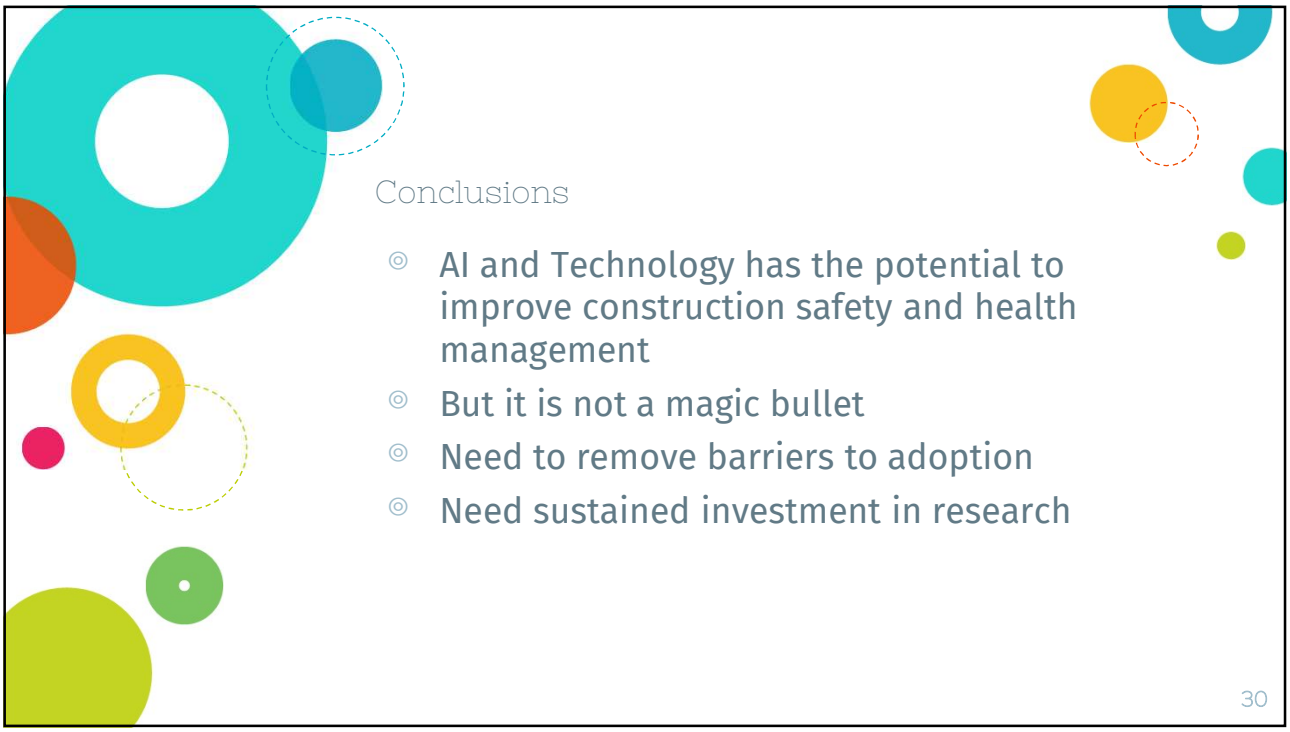
Research Approach

27

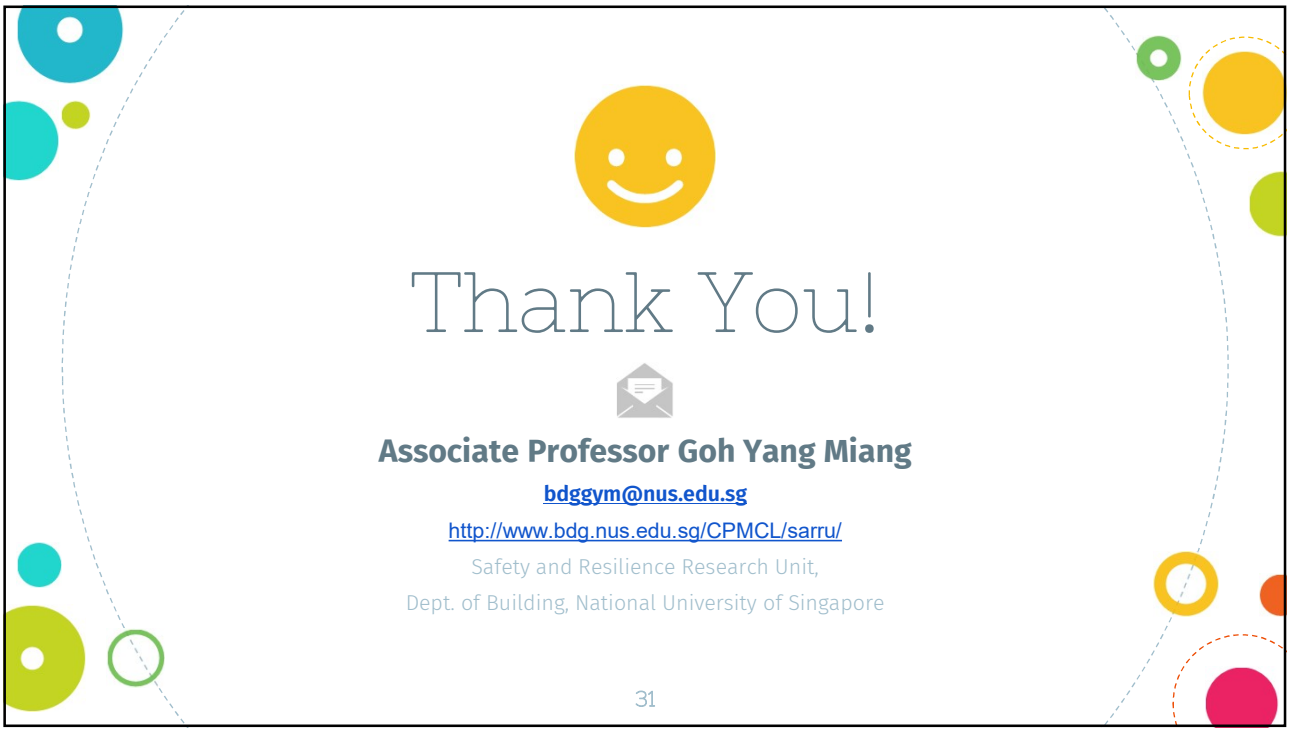
27


Next Steps?
Pilot for video analytics
FPSWizard Professional: Edge Protection
SafeSim Hazard Version 3
AR/VR for Structural System
29

29


Conclusions
AI and Technology has the potential to improve construction safety and health management
But it is not a magic bullet
Need to remove barriers to adoption
Need sustained investment in research
30

30


Thank You!
Associate Professor Goh Yang Miang
bdggym@nus.edu.sg
http://www.bdg.nus.edu.sg/CPMCL/sarru/
Safety and Resilience Research Unit,
Dept. of Building, National University of Singapore
31

31