



Digital Technology & AI in Construction H&S

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The Research Centre for the Built
Environment Asset Management

Sustainable Cities
and Communities

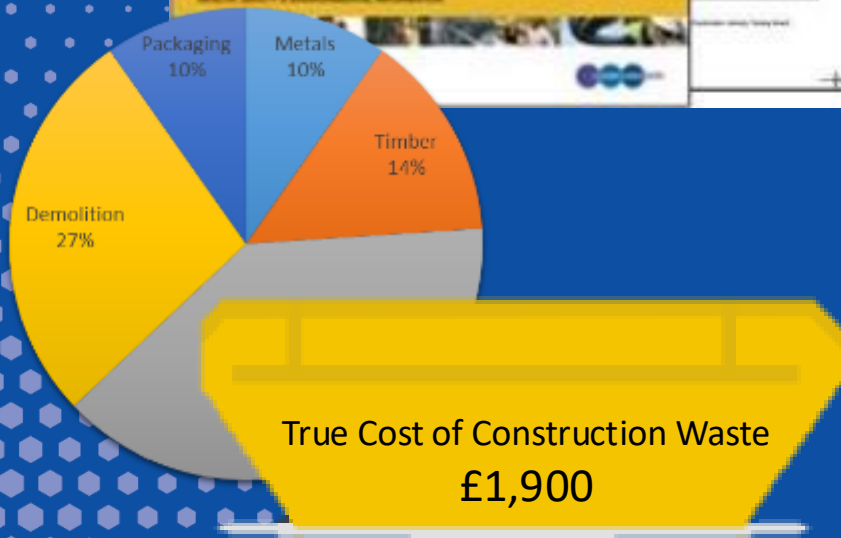
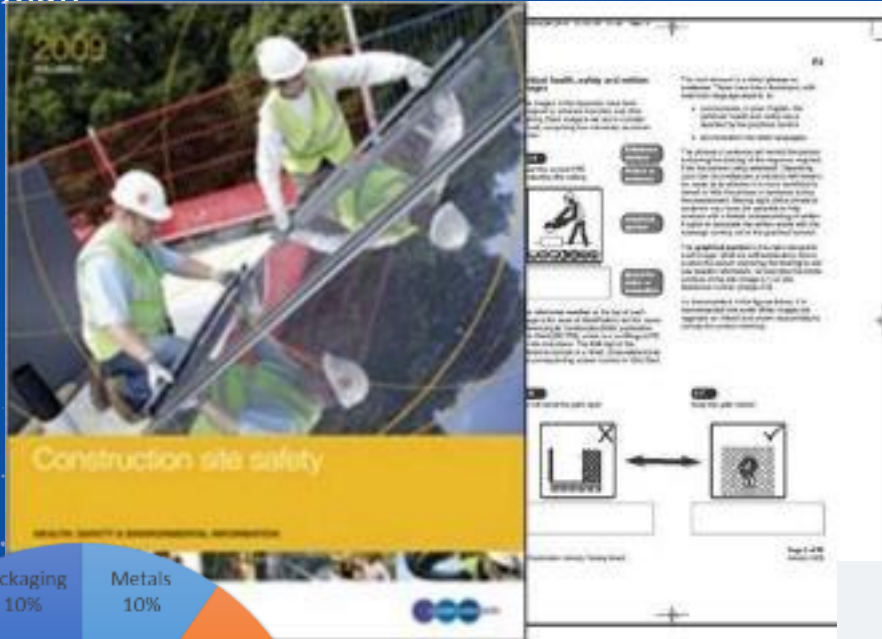
Construction Project Risk
and Value Management

Building Resilience and
Environmental Impact

Innovation | Technology | Sustainability

www.gcu.ac.uk/beam

Research Output



Worker Engagement

A tool for OSH practitioners to evaluate and benchmark worker maturity levels within their workplace towards improving OSH practices in construction

What is Digital Transformation?

- Means different things to different people
- Basic definition: Making any manual process digital
- E.g.: Excel, smartphone cloud, smart sensors, analysing 'big data'
- It is a spectrum and ongoing process
- Causes a lot of confusion within the sector
- Buzz words: BIM, CDE, Digital Twin etc.

Digital technologies for construction

- Building information modelling (BIM): Connects project data, teams, and workflows, creating visibility across the construction lifecycle
- 3D printing: Allows for the creation of complex shapes and structures using recycled materials
- Drones: Can monitor worksites and detect safety hazards
- IoT sensors: Can be used on equipment
- Cloud platforms: Can connect solutions and provide centralised access to project data analytics
- Data software: Can capture a wealth of data over the lifecycle of a project, including design model information, cost estimates, and process insights

SME's and Micro make up 99% of all construction businesses organisations not transforming to the same level



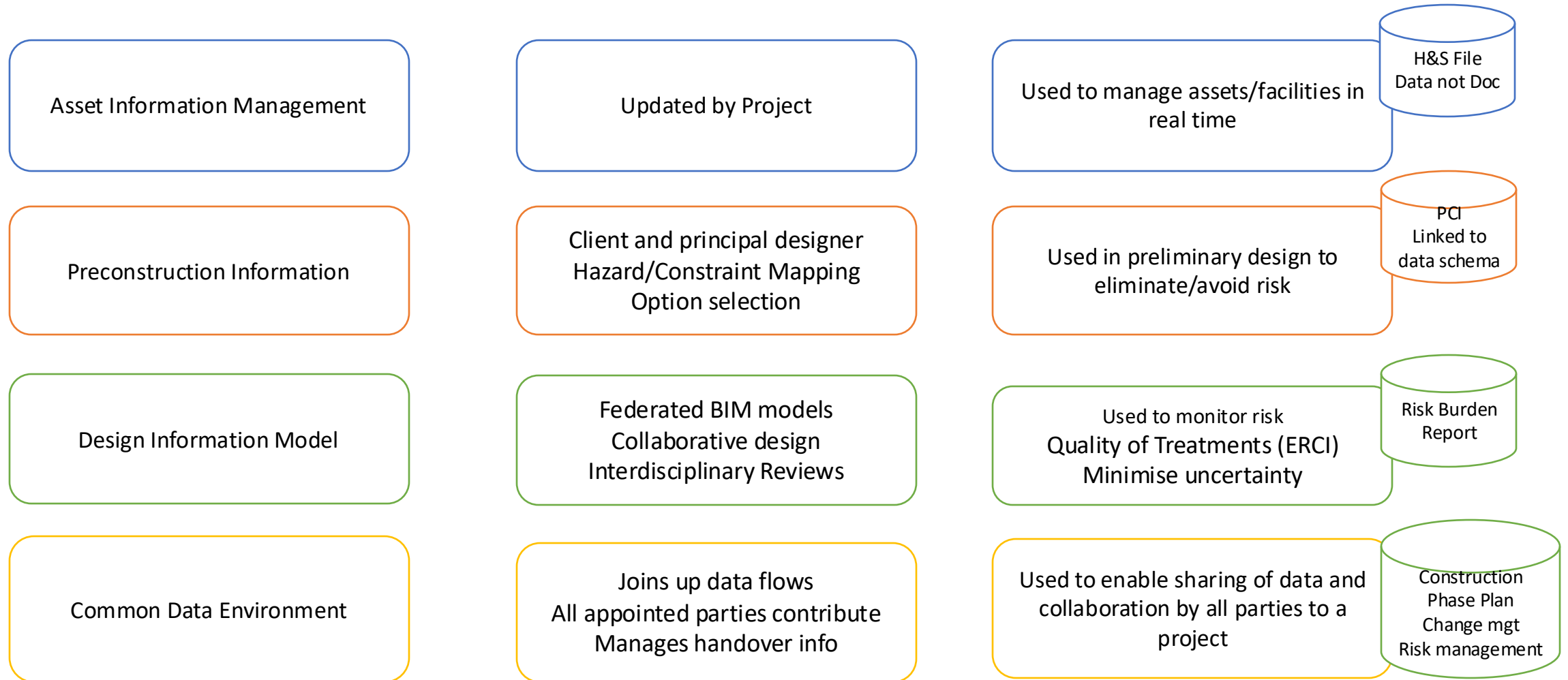
BIM4H&S

Recent work with UK BIM4H&S

Chaired by HSE



Main areas of work



Initiative 1 – Construction Risk Library (CRL)

<https://www.discoveringsafety.com/works/construction-risk-library-project/>

Risk Scenario Example



Treatment Matrix

	Eliminate	Reduce	Control by subsequent design	Inform
Preliminary Design	Design out the requirement for accessing the roof. For example, situate plant at ground level.	Position plant in centre of roof away from edges. Ensure plant is situated near access point to avoid walking across roof.	Design in staircase, for access to and between roof levels.	Maximum applied loads to be specified on the structural information.
	Design in suitable parapet or permanent edge protection to at least 1100mm height.	Design the plant controls to prevent the need of going to the roof.	Design in ships ladder, for access to and between roof levels.	Specify location and sizes of risers.
		Design out the requirement for multiple roof levels. Design in direct access to a plant enclosure forming suitable edge protection, to 1100mm min height.	Design in CAT ladder, for access to and between roof levels. Design in means to transport materials and remove waste.	Specify the location and sizes of lift overruns. Make sure accessways are suitably slip resistant. Consider loading requirements for tracking plant.
Detail Design	Provide edge protection permanently fixed for safe access to plant room	Prioritise long lasting plant with extended design life and minimum maintenance requirements. Provide guarded walkways to maintenance zones.	Coordinate pipework/ ductwork to one location to avoid clashes with walkways. Design in ballasted edge protection for the permanent state.	Specify requirements for maintenance of plant situated on the roof. Inform areas where hop ups are required and limit on manual handling routes.
		Design in access to each roof level independently, avoiding transition between roof levels. Provide proprietary access hatch with integral guardrail protection. Ensure access points are secure and lockable.	Fixed horizontal line system to be specified to access all required maintenance items. Observe safe working distances for walkways from edges. Provide suitable lighting in the permanent state.	
			Provide test and inspection of installed safety systems. Ensure selection competent Check SSoW.	Provide O&M's and H&S file for the building.
Pre construction				
Site work, Temp Works, Change control			Provide permit to work for access to roof level. Communication of emergency measures between contractor and building owner.	Update maintenance records and provide relevant information.

Falls from height risk due to While using working platform of the MEP plant while at Site wide during the Maintenance of the Mechanical services

Initiative 1 –CRL – In 3D or 4D modelling

SafetiBase

36. There is a potential fall in this edge

Carice 16 Apr 2021

RISK TREATMENT SEQUENCING SHAPES ATTACHMENTS

Description

(No Description)

3D REPO

Project FED - 18/12/2020 08:38

Risk and Treatments Library

Input

Risk Scenario

Risk Likelihood: High

Risk Consequence: Very High

Risk owner: Unassigned

Associated Activity: Install construction

Risk factor: Physical-Opening

Location: High Level-Near Opening

Level of Risk: Very High

Category: Fall-From open edge

Element type: Slab

Construction Scope: Construction Scope

In situ concrete

Output

Suggested Treatments

Stage: Preliminary Design Type: Reduce

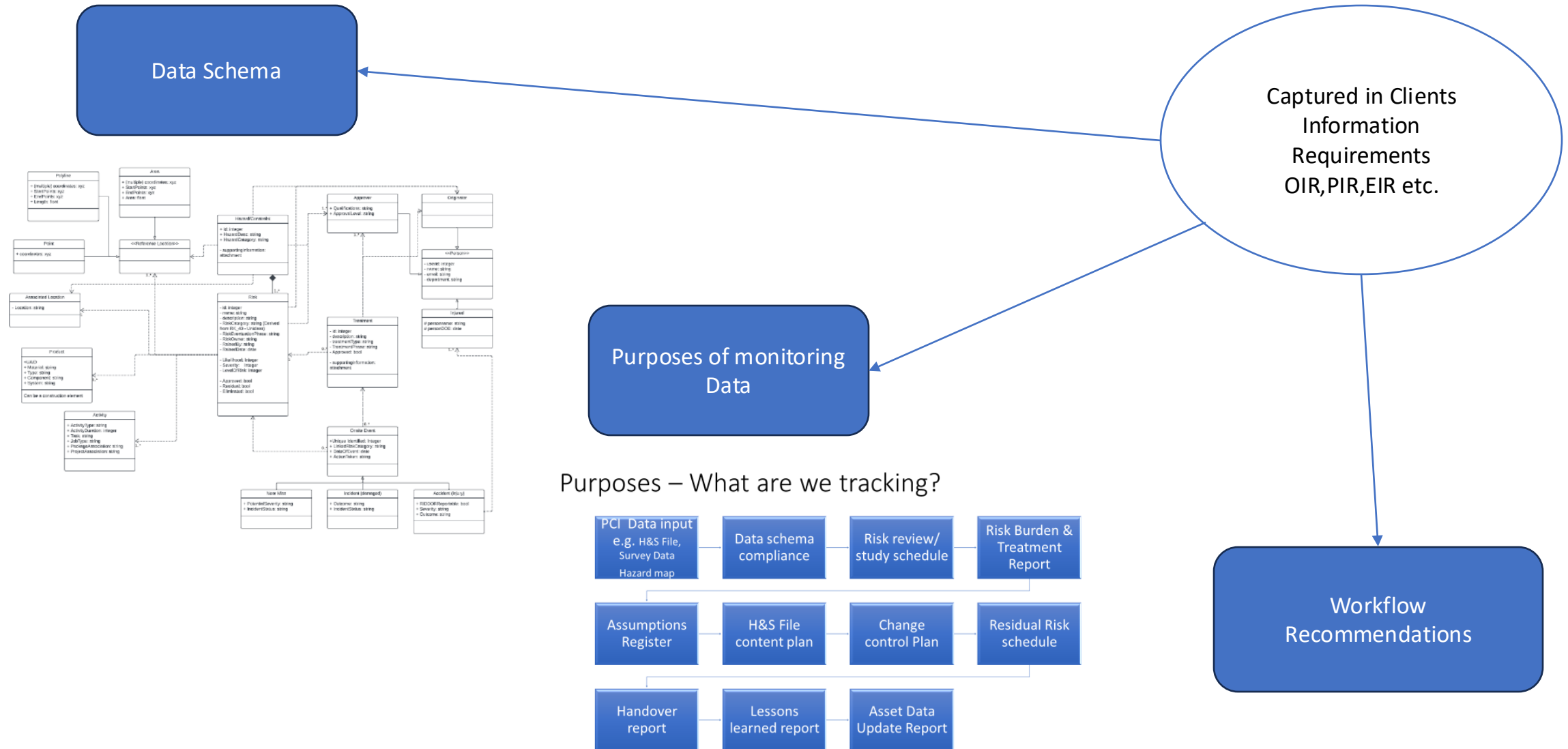
Cast in mesh in openings to reduce risk of person falling through. Stage: Preliminary Design Type: Reduce

Reduce hole sizes. Stage: Preliminary Design Type: Reduce

Consider forming full slab and cutting out openings when needed Stage: Preliminary Design Type: Reduce

Consider Location of penetration Stage: Preliminary Design Type: Reduce

Initiative 2 –Clients Monitoring Role – LTC Project

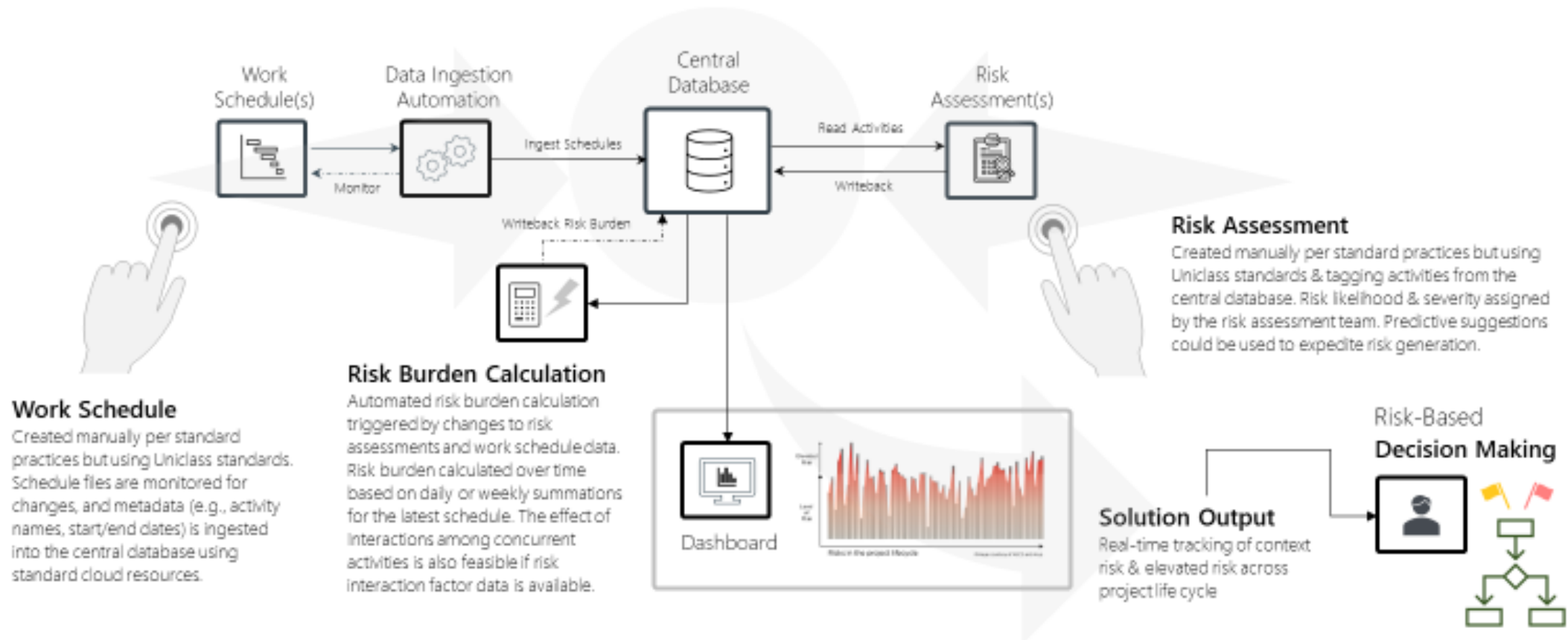


Initiative 3 – Monitor and Predict

RISK BURDEN MONITORING



Solution Block Diagram: Enabling real-time tracking of risk burden at scale using cloud resources



- Artificial intelligence (AI): enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy
- Machine learning: systems that learn from historical data
- Deep learning: machine learning that mimic human brain function
- Generative AI (gen AI): can (supposedly) create original text, images, video and other content

- AI Analytics: 'Big data':- near miss reports; incident investigations

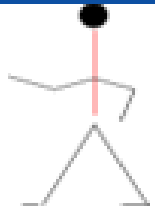
Machine learning techniques to forecast fatal accidents on construction sites in Brazil

Features
Gender
Age
Occupation
Construction sub-sector
Region of accident
Day of the accident
Month of the accident
Year of the accident
Day of the week
Accident mechanism
International Classification of Diseases – ICD
Indicates Death
Injury Type
Affected Body Part
Lost-time injuries

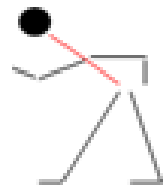


<https://www.discoveringsafety.com>

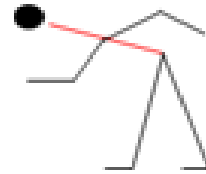
- Vision AI: Using image recognition technology, AI can assess ergonomics and monitor potential hazards in the workplace, helping to prevent injuries



J1 - Almost Neutral



J2 - Moderately flexed,
twisted or side bent



J3 - Excessively flexed,
twisted or side bent



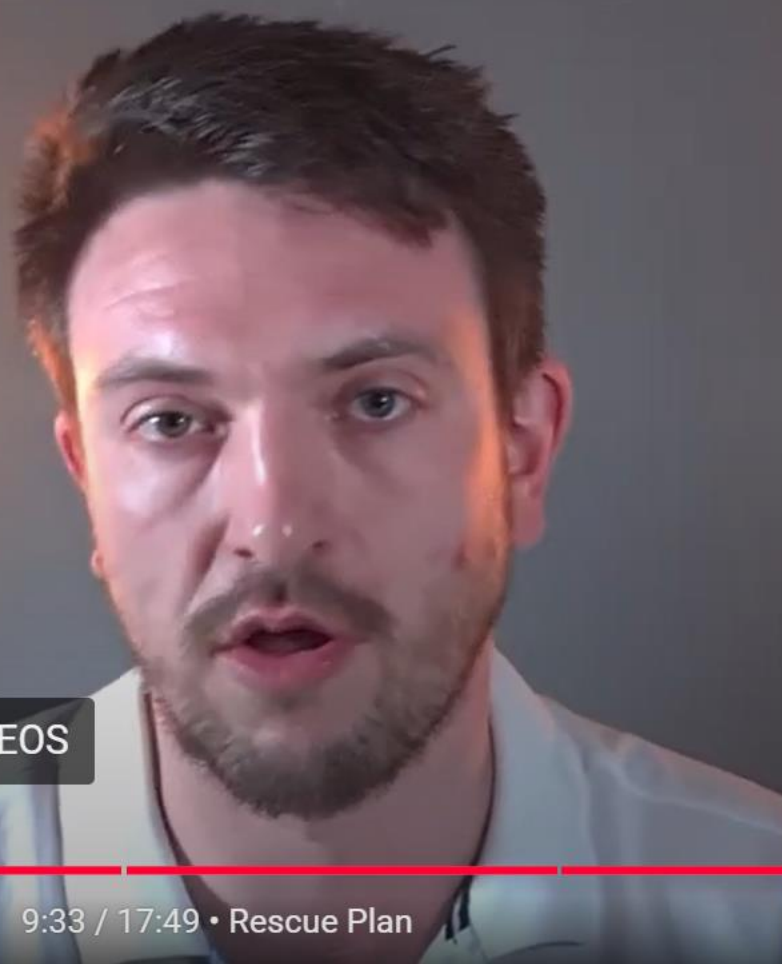
- Conversational AI: chat with an OSH advisor!

WILL CHATGPT REPLACE SAFETY CONSULTANTS?





Will ChatGPT Replace Safety Consultants?



MORE VIDEOS

Play (k)



9:33 / 17:49 • Rescue Plan

A reliable communication system must be in place, and all personnel must be trained in its use. The communication system must be used to summon rescue team and provide them with the necessary information about the emergency.

Watch Later

Share

Info

4. Procedures

In the event of an emergency, the following procedures must be followed:

- The operator of the cherry picker should immediately stop the machine, stabilize it, and lower the basket to the ground, if possible.
- The operator should contact the rescue team using the communication system and provide them with the necessary information, including the location of the cherry picker, the type of emergency, and the number of personnel involved.
- The rescue team should arrive on the scene as quickly as possible and assess the situation.
- The rescue team should secure the cherry picker and the personnel in the basket using a full-body harness and lanyard and carefully lower them to the ground.
- If the rescue team determines that it is unsafe to lower the basket, they should use appropriate rescue equipment to remove the personnel from the basket and transport them to safety.

5. Training and Drills

All personnel using the cherry picker must be trained in the rescue plan and must participate in regular drills to ensure that they understand the procedures and can follow them in an emergency.

Digital Construction OSH: GCU

- Masters Students: RA Exercise with AI
- Digital Construction Module: H&S x 6 Weeks

AI for OSH: Student Exercise

Conduct a risk assessment for the following works by rating the risk before control measures were applied, identifying persons at risk, and rating the risk after control measures were applied.

AI Prompt (ChatGPT):

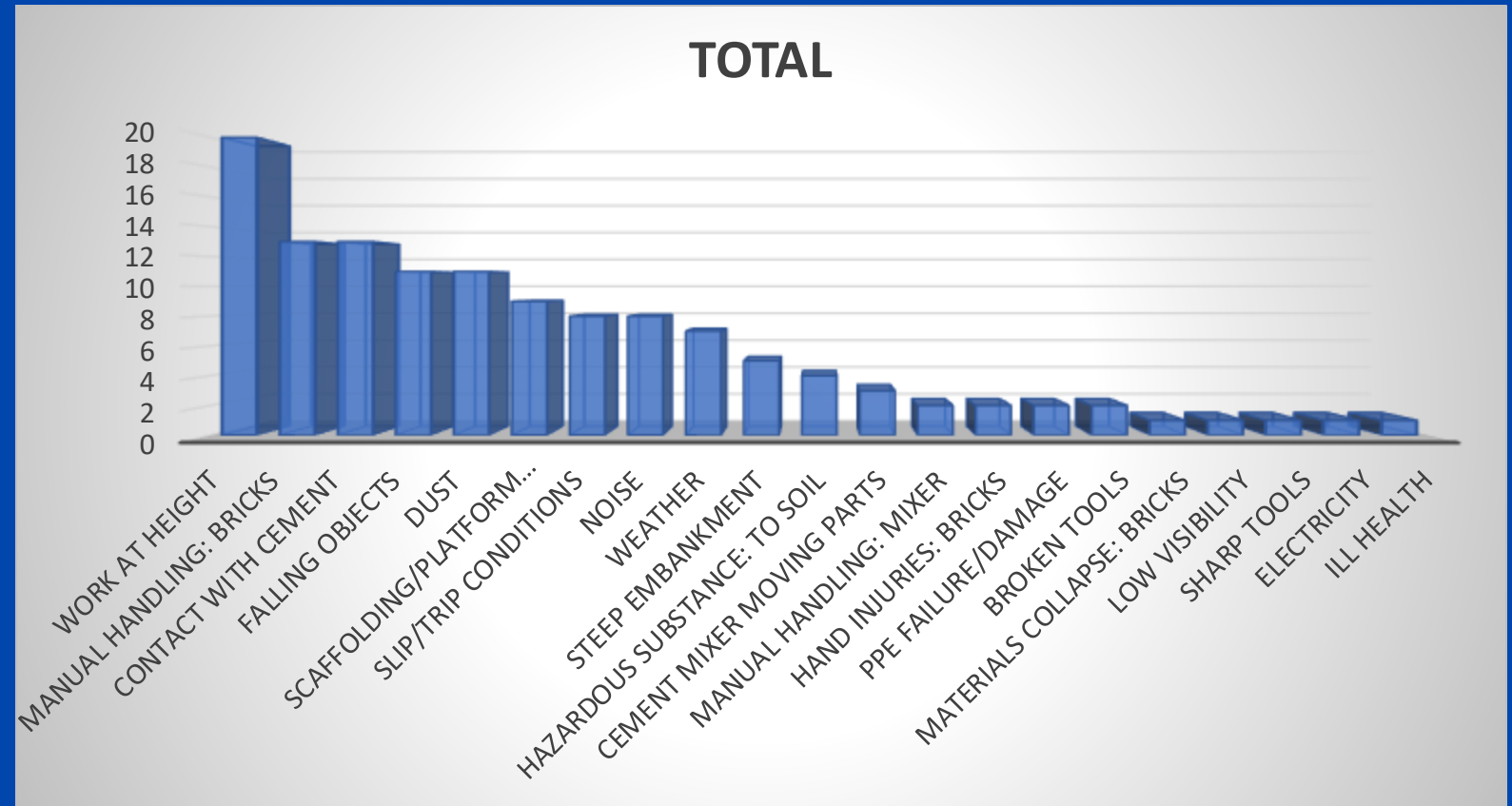
Create a construction risk assessment for the following conditions:

- 1. Project Description:** Build a brick wall, 10m wide, 2.4m high
- 2. Tools and Equipment:** hawk and trowel, cement mixer, 1.2m high working platform
- 3. Processes and Activities:** mixing cement, laying bricks, working at height
- 4. Participants:** brick layers, labourers
- 5. Environment:** garden with steep embankments

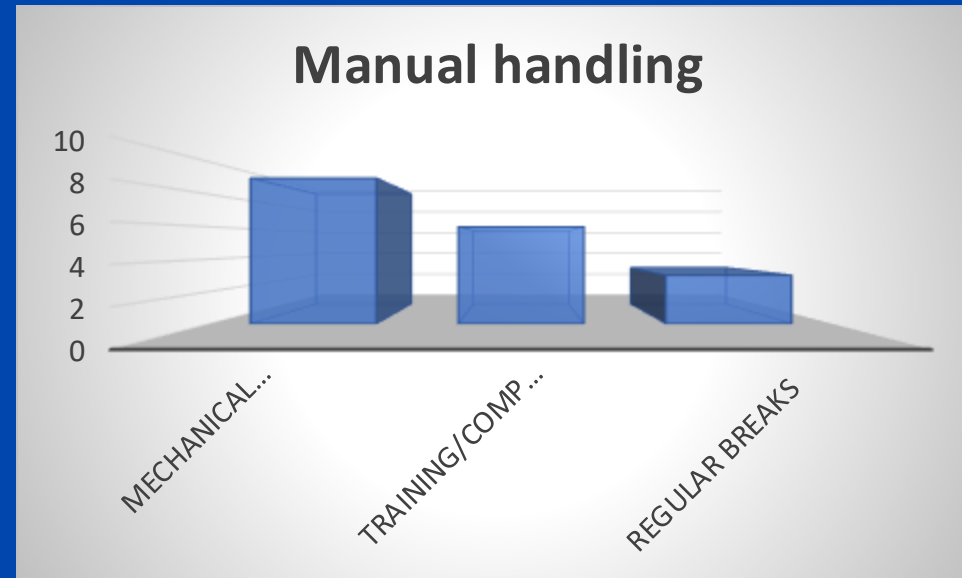
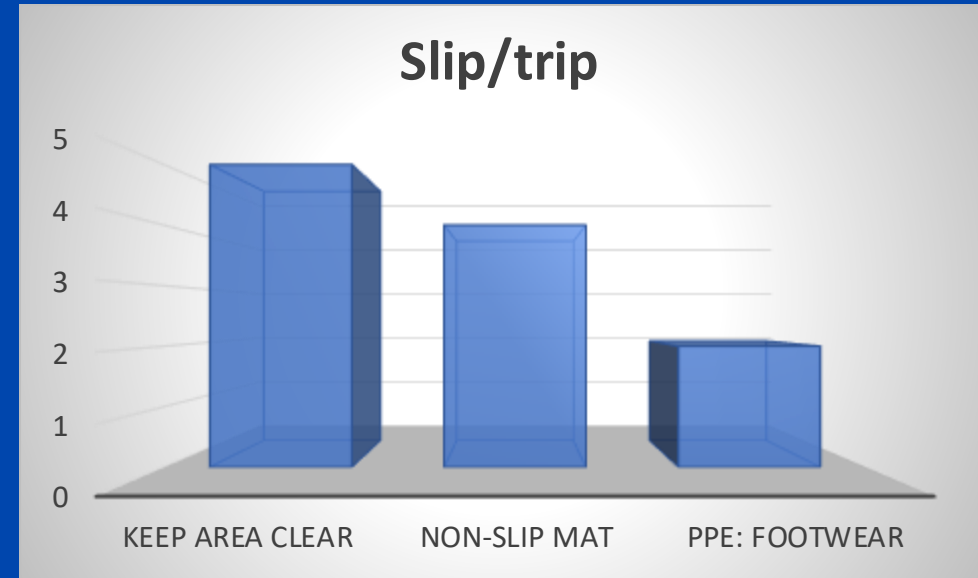
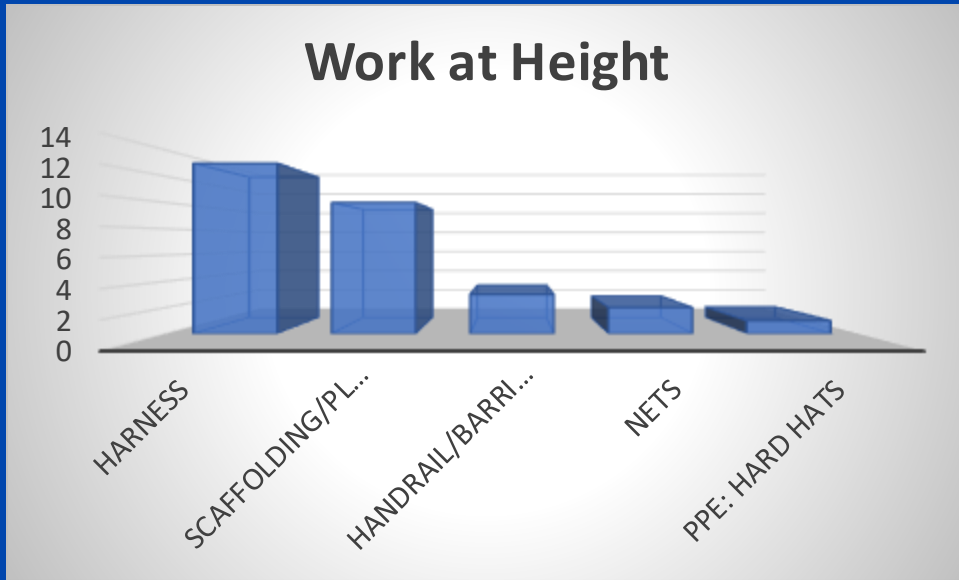


Student Results (n: 25) Hazards

Hazard	TOTAL
Work at height	20
Manual handling: bricks	13
Contact with cement	13
Falling objects	11
Dust	11
Scaffolding/platform collapse	9
Slip/trip conditions	8
Noise	8
Weather	7
Steep embankment	5
Hazardous substance: to soil	4
Cement mixer moving parts	3
Manual handling: Mixer	2
Hand injuries: bricks	2
PPE failure/damage	2
Broken tools	2
Materials collapse: bricks	1
Low visibility	1
Sharp tools	1
Electricity	1
Ill health	1



Student Results: Controls



Student Results: All Controls

Hazard	Controls	Total
Work at height	Harness	13
Work at height	Scaffolding/platform	10
Work at height	Handrail/barrier	3
Work at height	Nets	2
Work at height	PPE: hard hats	1
Weather	Stop work	4
Weather	Secure materials	3
Steep embankment	Walkway	3
Steep embankment	Plan to avoid	1
Steep embankment	Support scaffolding	1
Slip/trip conditions	Keep area clear	5
Slip/trip conditions	Non-slip mat	4
Slip/trip conditions	PPE: footwear	2
Sharp tools	Training/competence	1
Scaffolding/platform collapse	Follow plan/drawing	7
Scaffolding/platform collapse	Training/competence	2
PPE failure/damage	Regular checks	2
Noise	PPE: ear protection	4
Noise	Sound damping: mixer	3
Noise	Buffer zone	2
Materials collapse bricks	Training/competence	1

Hazard	Controls	Total
Manual handling: mixer	Mechanical lifting aids	2
Manual handling: bricks	Mechanical lifting aids	9
Manual handling: bricks	Training/competence	6
Manual handling: bricks	Regular breaks	3
Low visibility	Flood-lights	1
Ill health	Monitor/surveillance	1
Hazardous substance: to soil	Protective barrier	3
Hazardous substance: to soil	Training/competence	1
Hand injuries: bricks	PPE: gloves	2
Falling objects	PPE: hard hats	5
Falling objects	Secure storage	5
Falling objects	Nets	2
Falling objects	Crash deck	2
Falling objects	Guards	1
Electricity	Training/competence	1
Dust	PPE: mask	9
Dust	Water suppression	3
Contact with cement	PPE: gloves	11
Contact with cement	Training/competence	2
Contact with cement	PPE: eye protection	1
Cement mixer moving parts	Training/competence	3
Broken tools	Check before use	2

AI Results: Hazards

Hazards	St'dt	Hazards	St'dt
Working at Height:			
Falls from the 1.2m high working platform.	Yes	Being struck by moving equipment.	No
Falls from the wall itself during construction.	No	Being struck by falling tools.	Yes
Falls from the steep embankments surrounding the garden.	Yes	Electrical Hazards:	
Manual Handling:		Electric shock from faulty equipment or power tools.	Yes
Lifting and carrying heavy bags of cement.	No	Contact with overhead power lines.	No
Lifting and handling bricks.	Yes	Chemical Hazards:	
Handling and moving the cement mixer.	Yes	Exposure to cement dust and other construction chemicals.	Yes
Slips, Trips, and Falls:		Skin irritation or eye contact.	Yes
Slippery surfaces due to mud, rain, or spilled materials.	Yes	Fire Hazards:	
Uneven or obstructed walkways.	No	Risk of fire from sparks or welding equipment.	No
Loose cables or equipment.	No	Flammable materials stored near heat sources.	No
Striking Hazards:		Traffic Hazards:	
Being struck by falling bricks or mortar.	Yes	Risk of being struck by vehicles if work is near a road.	No
		Weather Hazards:	
		Extreme weather conditions (e.g., high winds, heavy rain, extreme temperatures).	Yes

Student Hazards Missed by AI

- Scaffolding/platform collapse
- Noise
- Hazardous substance: to soil
- Cement mixer moving parts
- Hand injuries: bricks
- PPE failure/damage
- Broken tools
- Materials collapse: bricks
- Low visibility
- Sharp tools

AI Control Measures

Working at Height:

- Provide and ensure the use of appropriate fall protection systems (e.g., guardrails, safety nets, harnesses).
- Secure the working platform properly to prevent tipping.
- Ensure adequate access and egress to the platform.
- Implement a "lookdown" procedure before each lift.

Yes
Yes
No
No

Manual Handling:

- Use mechanical aids (e.g., trolleys, hoists) where possible.
- Plan lifts to avoid awkward postures.
- Ensure adequate breaks and rotation of tasks.
- Provide training on safe manual handling techniques.

Yes
No
Yes
Yes

Slips, Trips, and Falls:

- Keep the work area clean and tidy.
- Address any uneven ground or obstructions immediately.
- Use appropriate footwear (e.g., steel-toe boots).
- Provide adequate lighting.

Yes
No
Yes
Yes

Striking Hazards:

- Implement a safe system of work for handling bricks and mortar.
- Use appropriate barriers and signage to segregate work areas.
- Secure tools properly when not in use.

No
No
Yes

Electrical Hazards:

- Use only properly maintained and tested electrical equipment.
- Ensure all electrical equipment is properly grounded.
- Isolate power sources when not in use.
- Avoid working near overhead power lines.

Yes
No
No
No

Chemical Hazards:

- Provide and ensure the use of appropriate personal protective equipment (PPE), such as gloves, goggles, and dust masks.
- Ensure adequate ventilation.
- Provide access to handwashing facilities.

Yes
No
No

Fire Hazards:

- No smoking policy within the work area.
- Store flammable materials safely away from heat sources.
- Have appropriate fire extinguishers readily available.

No
No
No

Traffic Hazards:

- Implement traffic management measures if necessary (e.g., signage, barriers, traffic marshals).

No

Weather Hazards:

- Monitor weather forecasts and adjust work schedules accordingly.
- Stop work if conditions become unsafe.

Yes
Yes

Student Controls Missed by AI

Hazard	Control
Steep embankment	Walkway
	Plan to avoid
	Support scaffolding
Sharp tools	Training/competence
Scaffolding/platform collapse	Follow plan/drawing
	Training/competence
PPE failure/damage	Regular checks
Noise	PPE: ear protection
	Sound damping: mixer
	Buffer zone
Materials collapse: bricks	Training/competence
Hazardous substance: to soil	Protective barrier
	Training/competence
Dust	Water suppression
Cement mixer moving parts	Training/competence
Broken tools	Check before use

Summary of results

	AI	+ Student	= Total
Hazards	20	10	30
Controls	28	16	44

Plus how many? Identified by a competent OSH advisor?

Common AI limitations

- It lacks context. AI can summarise, but it doesn't fully understand what's important.
- It ignores new developments. It has missed major legal rulings and scientific updates.
- It makes things up and can confidently generate false information.
- It can't tell fact from fiction. It doesn't distinguish authoritative sources from unreliable ones.

How do you write better AI prompts?

- Give examples
- Specify the audience
- Explain who you are
- Tell it the format you want
- Define the tone:
- Use natural language
- Ask the AI tool to show its working out
- Refine as you go

Digital Construction Module: H&S x 6 Weeks

No. (H&S No.)	Lecture	Computer Lab	Assessment
6 (1)	Intro Digital 4H&S	Hazard Spotting	
7 (2)	Intro H&S Regulation	R.A. & A.I. Exercise	
8 (3)	PAS 1192-6	Hazards on Dwg	
9 (4)	ISO 19650-6	Hazards on BIM	
10 (5)	CDM Regulations	Practice Test	
11 (6)	BIM 4 H&S	Test	In computer lab
12 (7)	Test Feedback	None	

Overview

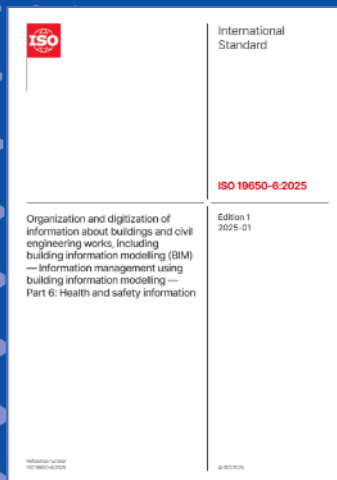
Six Week Schedule

BIM H&S Information Standards



PAS 1192-6

- Specification for collaborative sharing and use of structured health and safety information using BIM



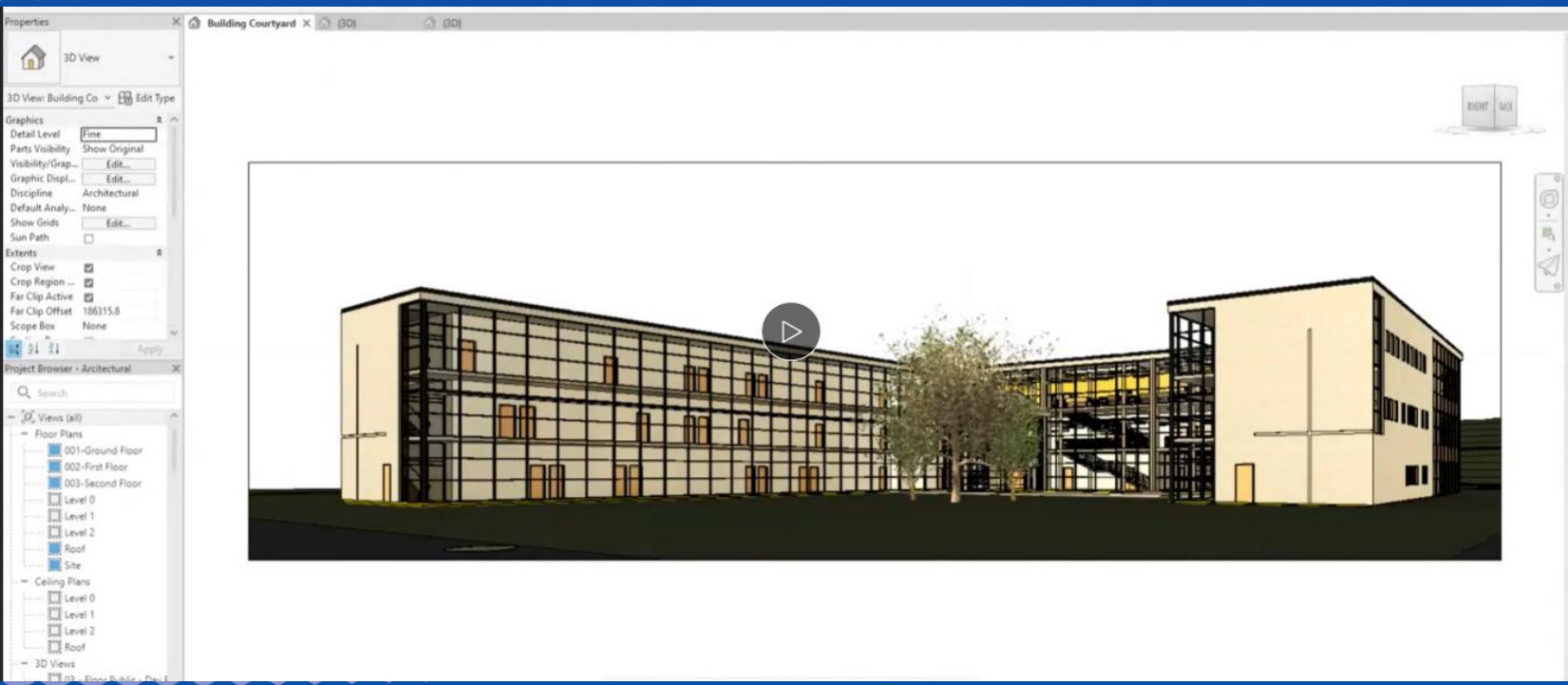
ISO 19650-6

- Organization and digitization of information about buildings and civil engineering works, including BIM — Information management using building information modelling

Part 6: Health and safety information

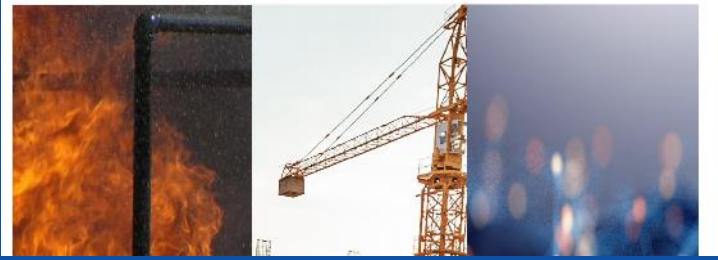
BIM Assessment Exercise

BIM Model



Digital library

Discovering Safety
Construction Risk Library User Guide



Risk Classification	Application Criteria
RK_40_05 Collapse risk	This class is based on the stored energy inherent within different scenarios and the potential for this to be released in a sudden and uncontrolled way when a supporting element falls, fails or caves in.
RK_40_05_54 Modular or prefabricated components	Includes modern methods of construction before they can be classified as an existing structure
RK_40_05_60 Permanent structures	Structures that already exist but are being worked upon

Associated Product	Associated Location	Associated Activity
Asbestos	Adjacent to railway	Access / egress
Beam	Adjacent to road	Atrium
Bracing	Below ground	Bridge
Capping beam	Excavation	Builder's work in connection
Ceiling finishes	High level	Cleaning of buildings
Cladding	Public domain	Cofferdam
Column	Roof level	Deep basements and shafts
Contaminated ground	Site assembly / storage / loading area	Drainage and pipework

AI for OSH

Overreliance on technology?



Once upon a time...



Stanislav Petrov



Post Office accused of cover-up over secret Horizon documents

By Andy Verity
BBC economics correspondent

26 January 2024

BBC NEWS



Unqualified engineer's unsafe computer aided design of a retaining wall

"A chartered engineer's check found retaining walls, designed by a person not qualified as a civil or structural engineer and who relied solely on a computer program, to be inadequate. It is likely the walls will need to be demolished and rebuilt."



CROSS UK:

<https://www.cross-safety.org/uk/safety-information/cross-safety-report/unqualified-engineers-unsafe-computer-aided-design-1210>

Critical considerations (Dr Fred Sherratt):

Consider whether and how the technology can see the **people** in the process.

Consider how things can be fixed if the technology does get it wrong – where are the **checks and balances** and fail safes?

Consider the **digital exhaust** of any technology – what data is being generated, captured and monitored, and what could or should it be used for?

Don't ever forget the **people** in the process!

Academics seem to be increasingly **dehumanizing construction work** as we lean more into tech - and that's really not OK!

In conclusion

- Digital technology is advancing at a tremendous pace
- Construction industry feels like it needs to catch up
- Technology is already advancing Construction OSH
- But AI has a long way to go
- AI is a useful tool for OSH advisors
- But not a replacement (yet)
- Ethical use of digital tools including AI is paramount

