



THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

Improving construction safety in view of increasing volume of repair, maintenance, minor alteration and addition (RMAA) works

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Outline of the Presentation

- Introduction
- Background
- Research Methods
- Major Findings
- Conclusions





Introduction

Research Team Members

PolyU Team



Prof Francis Wong
Co-Investigator



Dr Michael Yam
Co-Investigator



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Co-Investigator

Awards

- OSH Best Project Award for the Academic Year 2011 organized by the Occupational Safety and Health Council of Hong Kong.
- Champion- Construction Industry Council (CIC) Award (Doctoral Group) of the “Student Project Competition (SPC) 2011” organized by the Hong Kong Institution of Engineers (HKIE) – Safety Specialist Committee.



HKIE THE HONG KONG
INSTITUTION OF ENGINEERS
香港工程師學會

Safety Specialist Committee
安全工程專責事務委員會

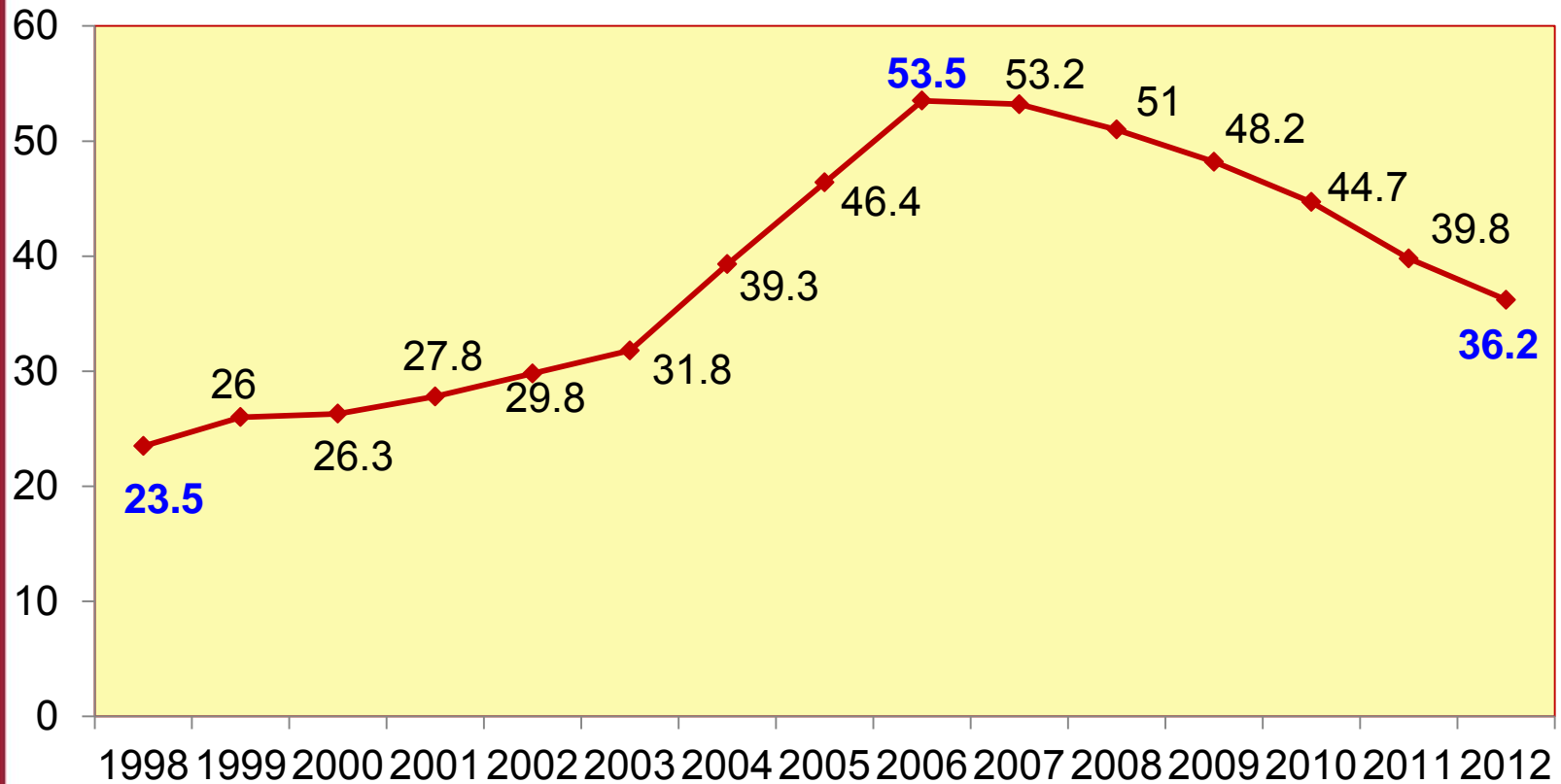


Background



Background : Growing Importance of RMAA Sector

% of RMAA Works to Total Construction Market

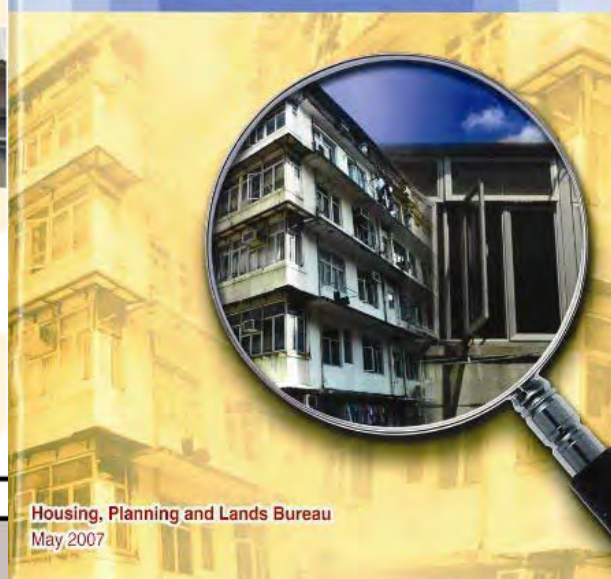


Background : Growing Importance of RMAA Sector

Minor Works Control System



Report on the Public Consultation on Mandatory Building Inspection



Housing, Planning and Lands Bureau
May 2007

樓宇安全貸款計劃 Building Safety Loan Scheme

樓宇安全貸款計劃
樓宇維修貸款人經已 經濟發展局政府撥款

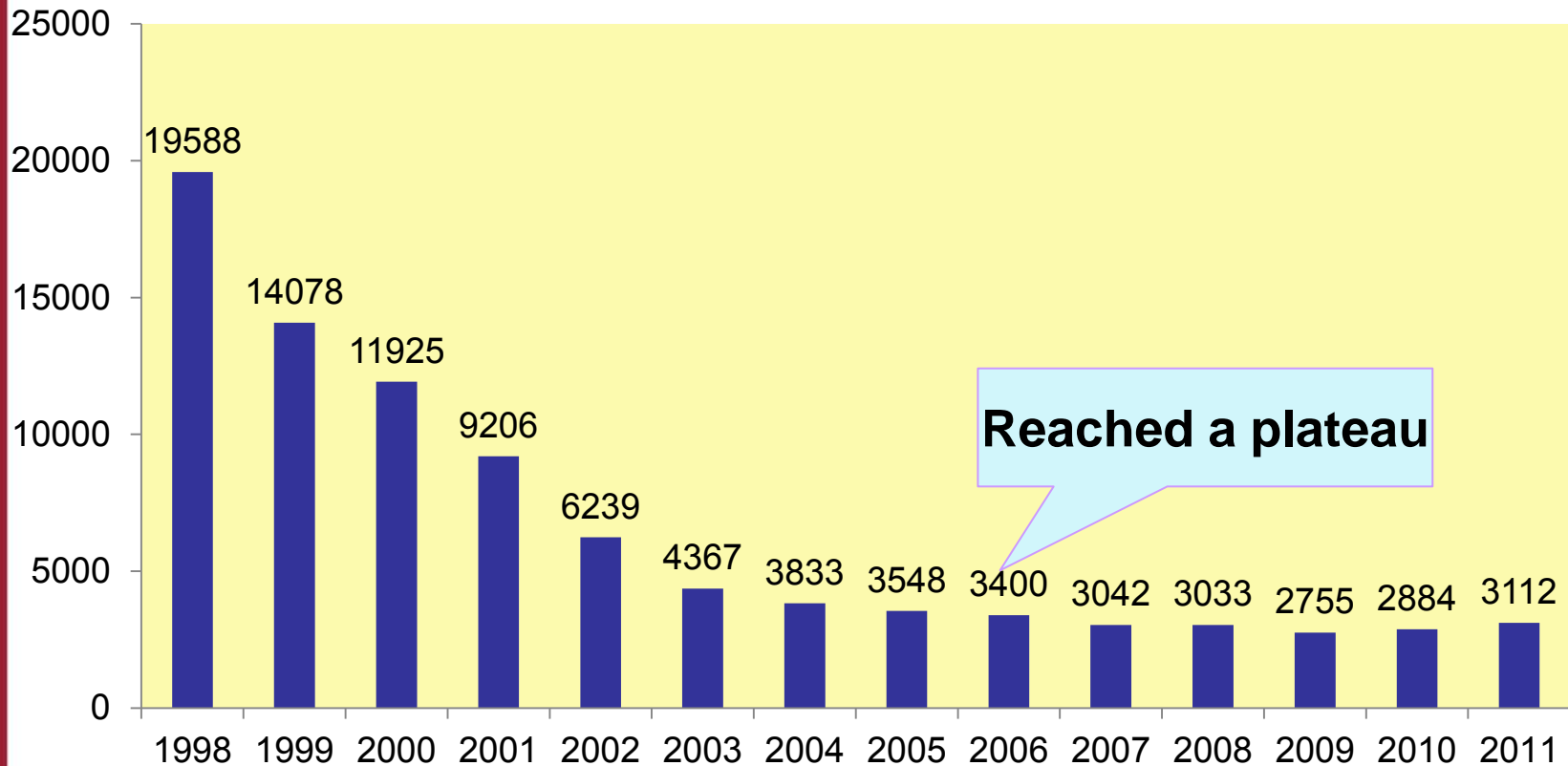


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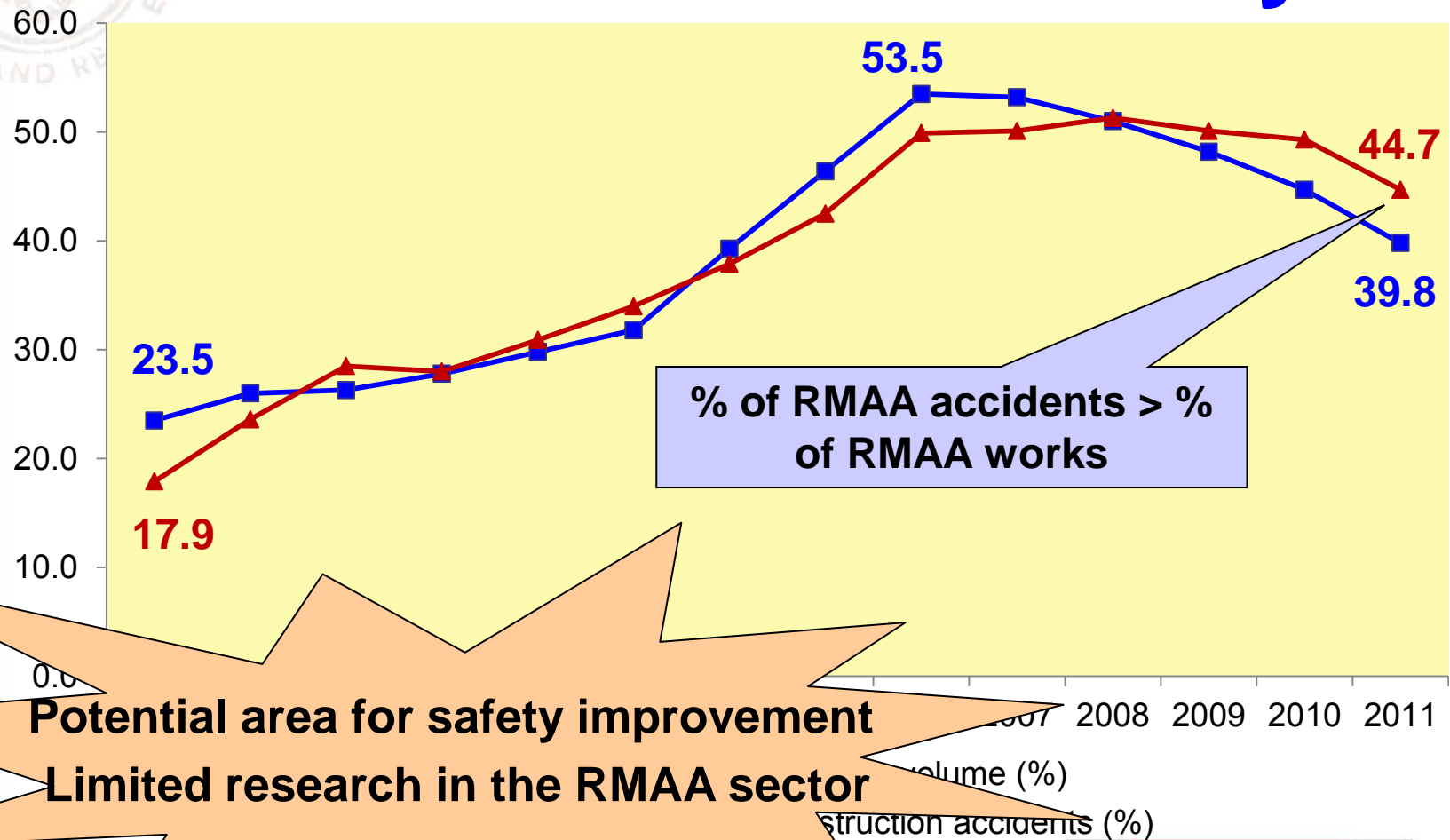


Accidents in the HK Construction Industry

Total construction accidents (No.)



% of RMAA accidents in the HK construction industry



Objectives

Objective 1: Safety problems and safety practices of RMAA works

Objective 2: Safety climate factors of RMAA works

Objective 3: Relationships between safety climate and safety performance of RMAA works

Objective 4: Demographic variables affecting safety climate

Objective 5: Strategies for improving safety of the RMAA sector



Research Methods

Interviews

**Eight face-to-face interview
RMAA contracting companies**



**One written reply
RMAA section of hotel**

Saturation
of data

**Coded in Nvivo 8
Constant comparative method**

Background

Hands-on experience of RMAA works
Large, medium and small companies

No. of Interviews	Position of interviewees	Project scale/ nature
A	Director	HKD\$ 10 million to more than HKD\$ 100 million
B	Project Safety Manager & Project Manager	HKD\$ 10 million to more than HKD\$ 100 million
C	Managing Director & Senior Manager	More than HKD\$ 100 million, term contract
D	Executive Director	Less than HKD\$ 20 million
E	Managing Director	Around HKD\$ 10 million
F	General Manager	Around HKD\$ 10 million
G	Senior Project Manager	Around HKD\$ 10,000- 2 million
H	Director	Several thousands to HKD\$ 10 million
I	Vice President (Project Development)	Hotel

Delphi Survey



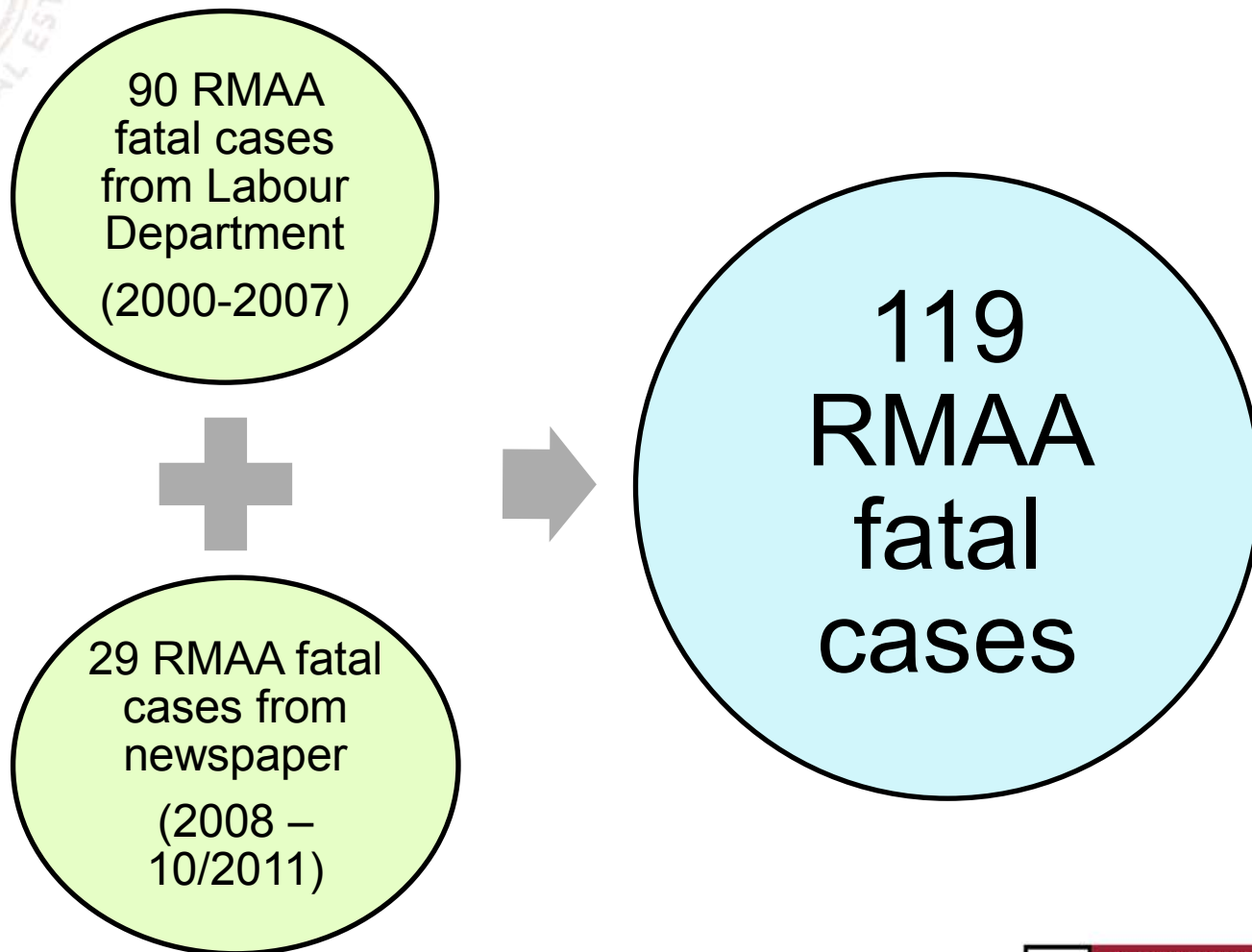
- 13 experts (Advisory group members)
- Verify interview findings
- Two rounds of interactive online survey
- Real time feedback & revision of rankings



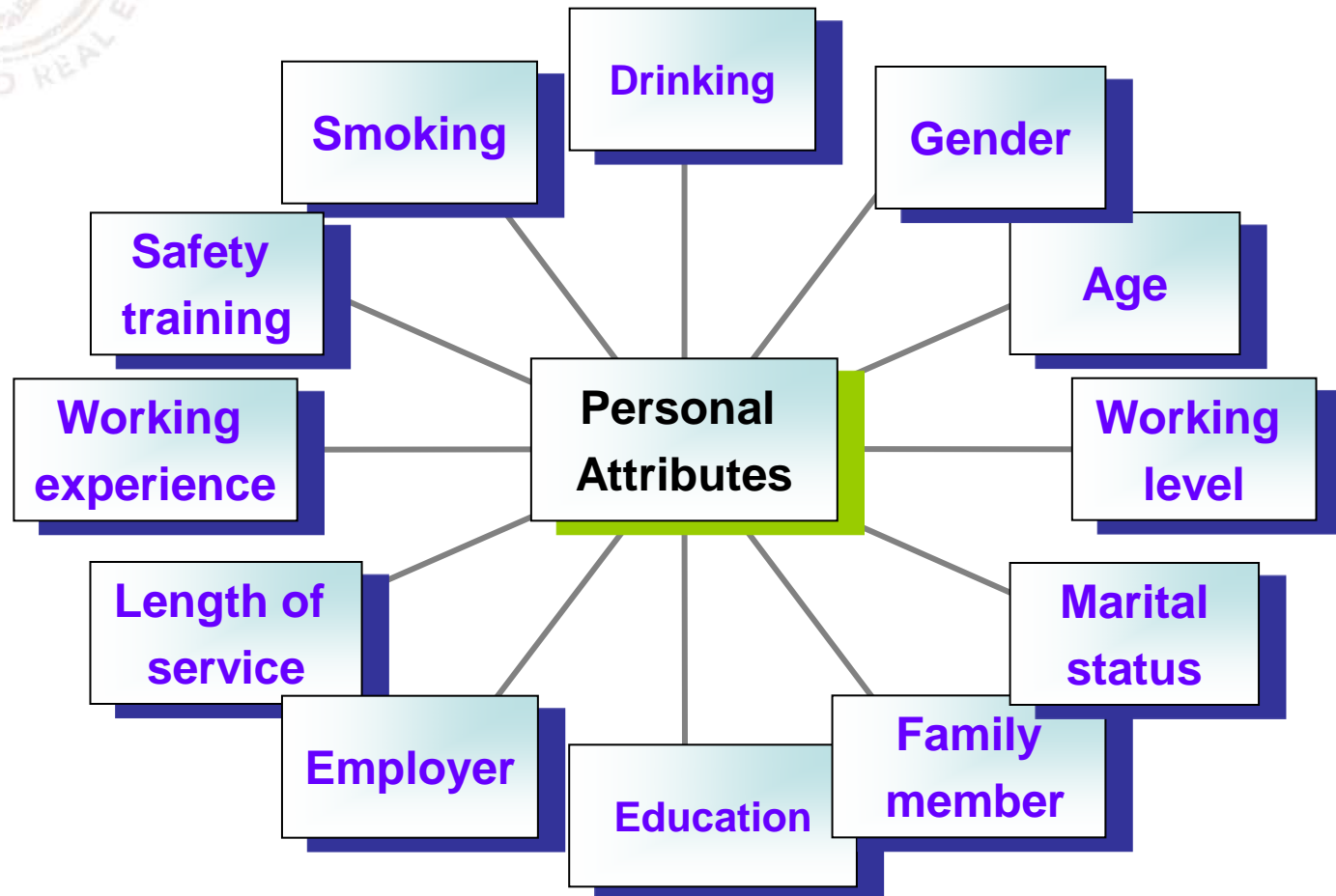
Background of the expert panel

Expert panel	Position	Organization1
1	Safety Manager	Contractor
2	Technical Manager	Property Management
3	Deputy Chief Occupational Safety	HKSAR Government
4	Senior Manager (Safety and Health)	HKSAR Government
5	Representative	Self-regulatory Body of Insurers
6	Manager	Contractor
7	General Manger	Quasi-government Body
8	Principle Consultant	Occupational Safety and Health Council
9	Chairman	Construction Industry Institute – HK
10	Manager	Private Developer
11	Senior Structural Engineer	HKSAR Government
12	Executive Director	E&M Contractor
13	Safety, Health, Environment and Quality Manager	Utility Service Company

Case Studies



Questionnaire Design: Personal Attributes

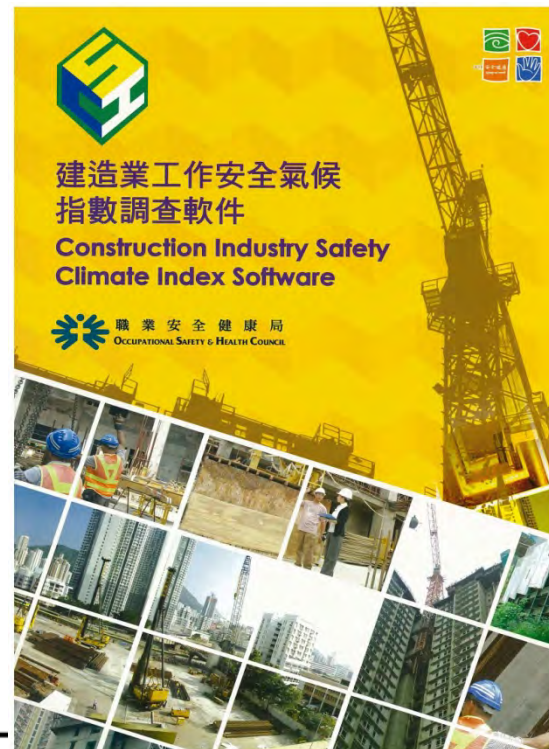


Reference:

Safety Climate Index (SCI) Survey of the Occupational Safety and Health Council

Questionnaire Design- Measurement of Safety Climate

- Safety climate index of OSHC
- 38 questions
- Prior validated
- Chinese version



RGC-funded project
Safety Climate and Its Impact on Safety Performance of Repair, Maintenance, Minor Alteration and Addition (RMMA) Works
Questionnaire

Instructions: Please answer this questionnaire with reference to a RMMA project you have been involved

Section A: Personal Particulars:
Please answer this section by ticking the most appropriate boxes.

1. Your working level: ☐ Frontline worker ☐ Clerical staff ☐ Supervisor ☐ Manager

2. Your work trade: ☐ Labourer ☐ Plumber ☐ Database welder ☐ Planner ☐ Carpenter (joiner) ☐ Concrete ☐ Metal worker ☐ Joiner ☐ Site leader & site ☐ Plant & equipment operator ☐ Building services & E&M worker ☐ Domestic worker ☐ Painter & decorator ☐ Construction/ Mechanical plant mechanic or fitter ☐ Others _____

3. Your age: ☐ 20 or below ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61 or above

4. Your gender: ☐ Male ☐ Female

5. Your marital status: ☐ Single ☐ Married

6. Number of family members supported by you (not including yourself): ☐ None ☐ 1-2 ☐ 3-4 ☐ 5-6 ☐ 7 or more

7. Your education level: ☐ Below primary ☐ Primary ☐ Secondary ☐ Certificate/Diploma ☐ Degree or higher

8. Your direct employer: ☐ Client ☐ Main contractor ☐ Subcontractor ☐ Others _____

9. Length of service with the current company: ☐ < 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years ☐ > 15 years

10. Working experience in the construction industry: ☐ < 5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ > 20 years

11. Safety training you received: ☐ No Green Card ☐ Green Card ☐ Think specific safety training ☐ Silver Card (You may tick more than 1 box, if applicable)
☐ Others _____

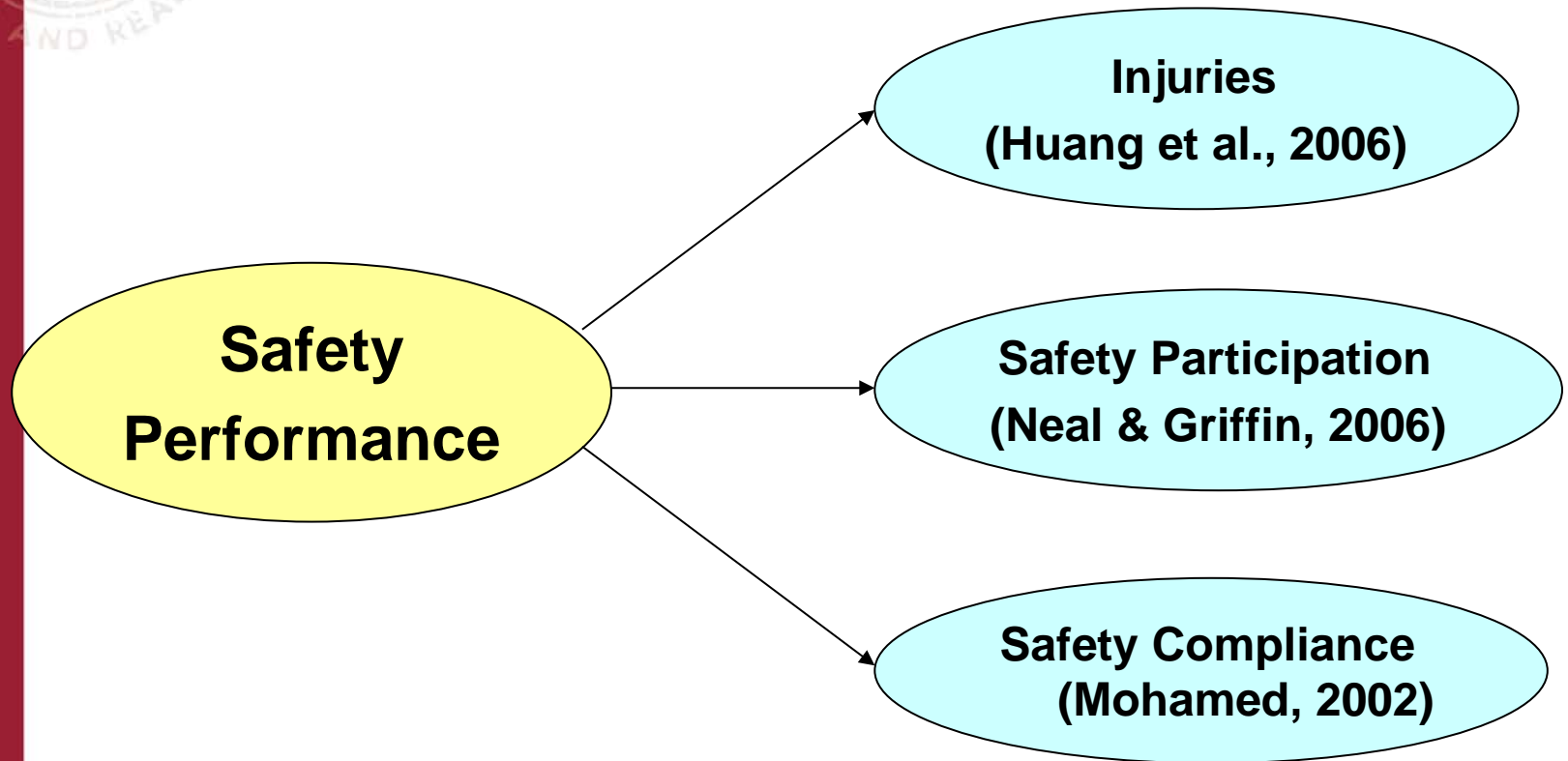
12. A habit of smoking (at least 1 cigarette per day in the last 12 months): ☐ I don't smoke ☐ I smoke, but not at work ☐ I smoke even at work (including lunch time & break)

13. A habit of alcohol consumption (drink at least 3 times per week): ☐ I don't drink ☐ I drink, but not at work ☐ I drink even at work (including lunch time & break)

Reference:

Safety Climate Index (SCI) Survey of the Occupational Safety and Health Council

Questionnaire Design - Measurement of Safety Performance



Questionnaire- Data



- Participants:
 - Property management companies,
 - RMAA section of general contractors,
 - small RMAA contractors,
 - building services contractors and trade unions.
- Data collected:
 - 814 number of questionnaires
 - Randomly split into calibration and validation samples

Major Findings





Safety Problems & Practices of RMAA Works

Ranked causes of RMAA accidents

Causes of RMAA accidents	Mean	Rank
Poor safety consciousness of RMAA workers.	4.54	1
RMAA workers underestimate potential risks when performing small tasks for a short period.	4.31	2
Personal protective equipment not used, incorrectly used, or not provided	4.31	2
Lowest bid tendering method without pricing for safety items.	4.23	4
Hurry to finish the work.	4.15	5
Insufficient safety training of RMAA workers for handling multiple tasks.	4.08	6
Inadequate site safety planning and hazard assessment.	4.00	7
Poor housekeeping and congested working environment.	3.77	8
Low safety awareness of small/medium-sized contractors on RMAA works.	3.77	8
Inadequate safety supervision.	3.69	10
Inadequate regulatory control and monitoring system.	3.46	11
Low safety awareness of flat owners/tenants on RMAA works.	3.23	12

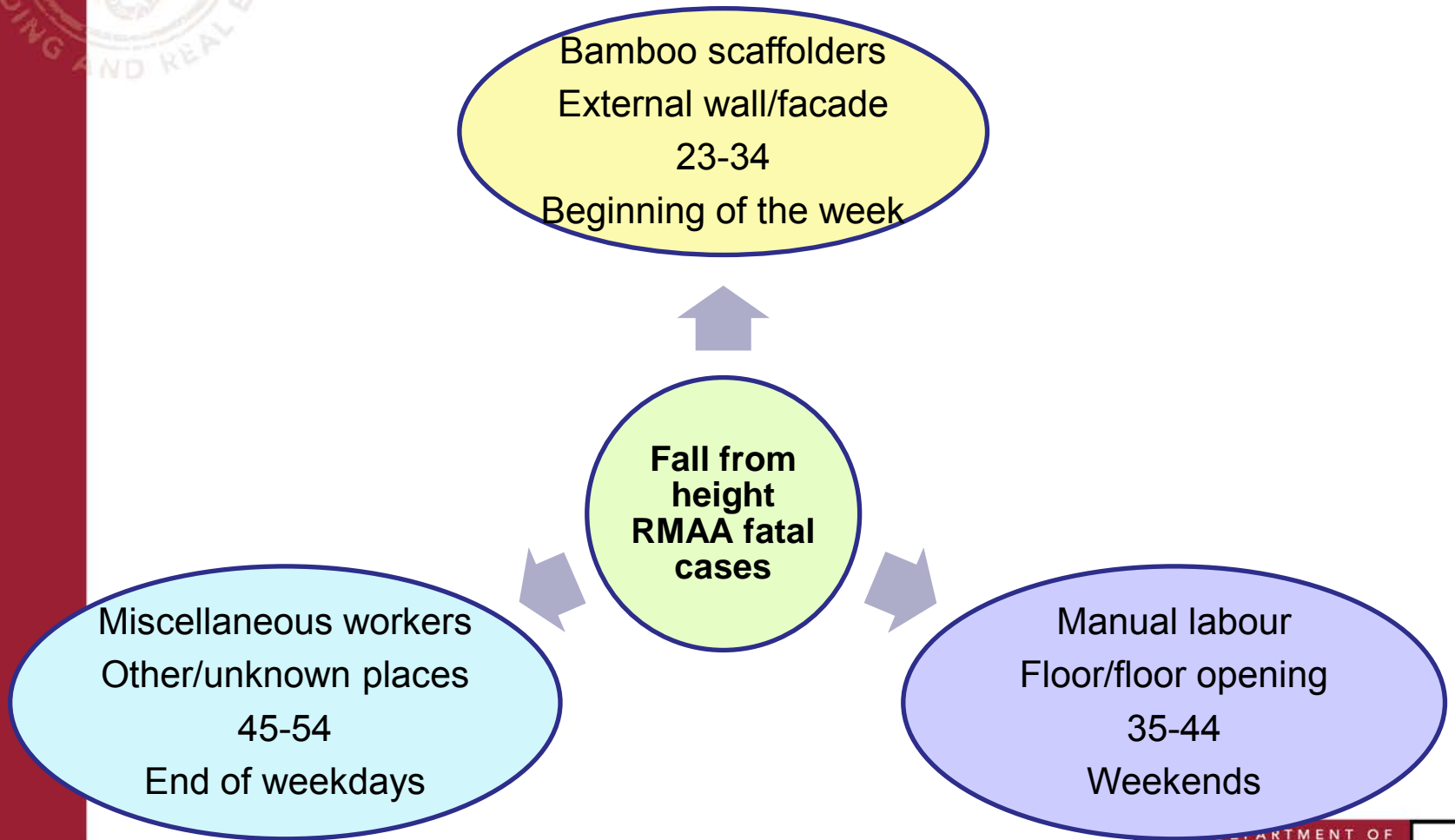
Ranked Difficulties of Implementing Safety Practices in the RMAA Sector

Difficulties	Mean	Rank
Limited safety resources for RMAA projects undertaken by small/medium-sized contractors.	4.08	1
Difficult to change the mindset of RMAA workers.	3.92	2
Difficult to conduct safety supervision due to scattered locations.	3.77	3
Small scale and short duration of RMAA projects.	3.62	4
High turnover rate of RMAA workers.	3.54	5
Difficult to control self-employed workers.	3.54	5
Shortage of time to deal with safety issues.	3.23	7
Difficult to standardize the operational procedures of RMAA works due to ad hoc site problems.	3.08	8
Influx of illegal workers.	2.85	9

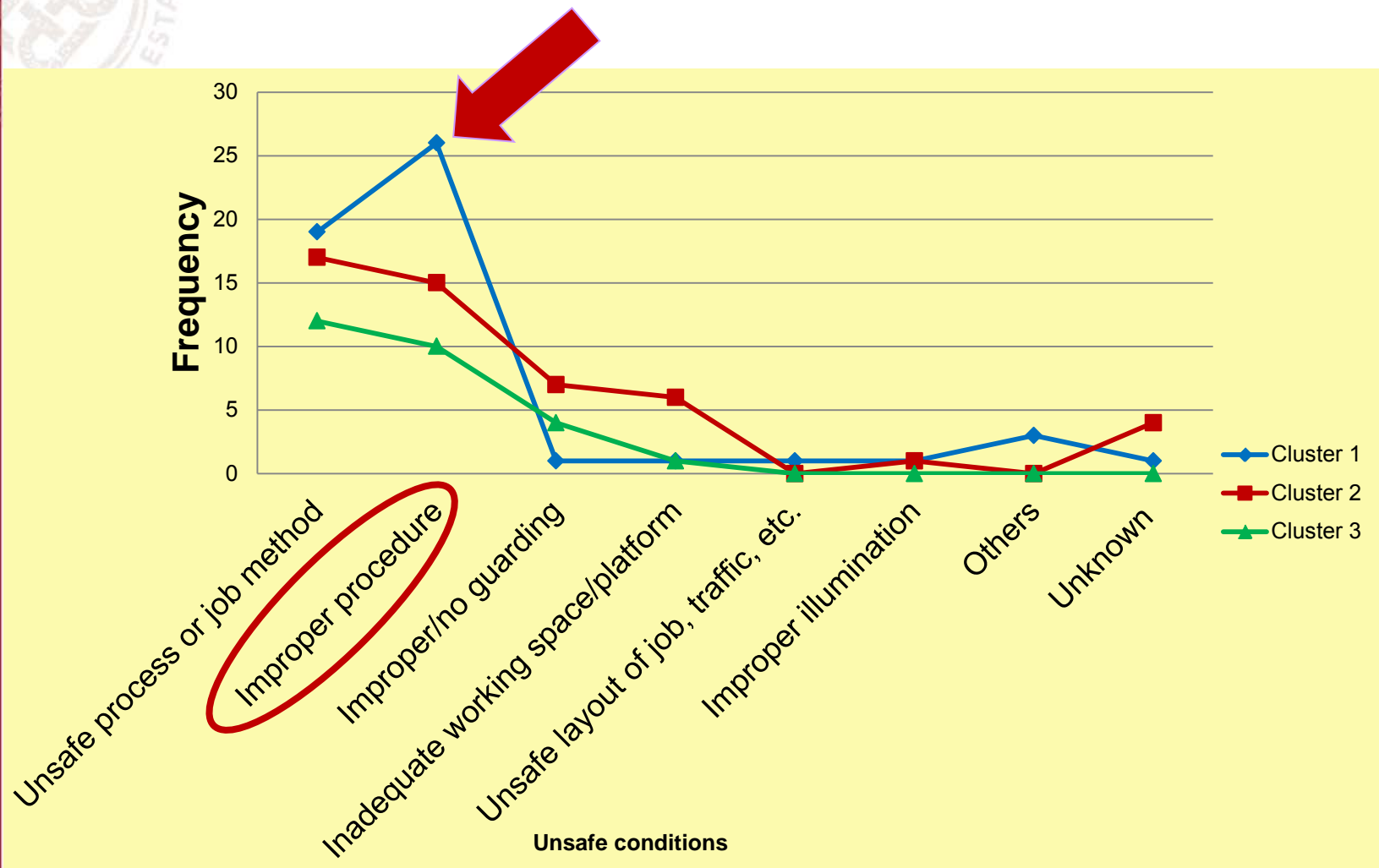
Analysis of RMAA Fatal Cases

Types of RMAA accidents	Frequency	Percentage
Fall of person from height	74	62%
Contact with electricity or electric discharge	20	17%
Contact with moving machinery or object being machined	3	3%
Trapped by collapsing or overturning object	5	4%
Asphyxiation	4	3%
Slip, trip or fall on same level	1	1%
Trapped in or between objects	4	3%
Striking against or struck by moving object	1	1%
Exposure to or contact with harmful substance	1	1%
Struck by falling object	5	4%
Others	1	1%
Total	119	100%

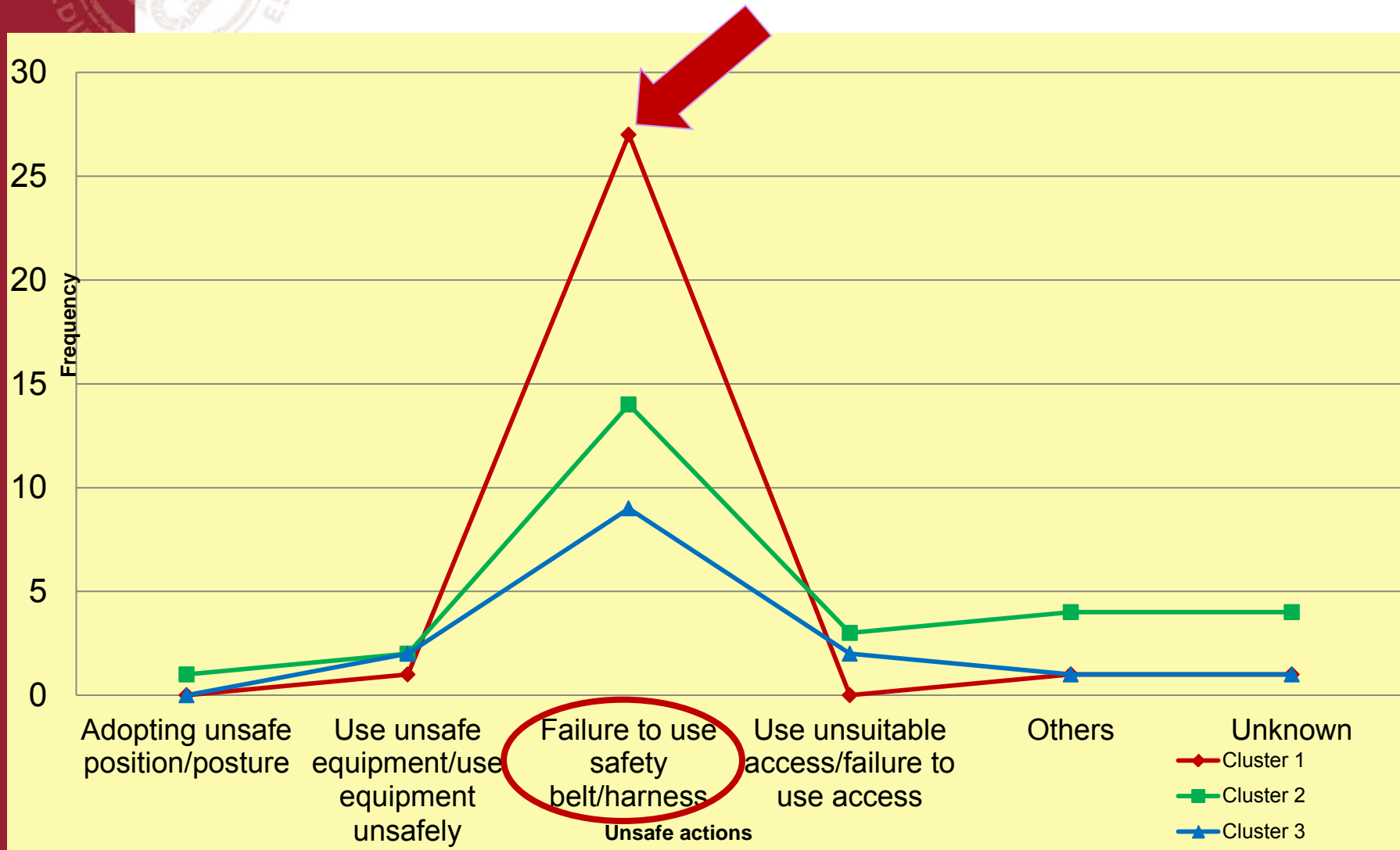
Clusters of Fall from Height RMAA Fatal Cases



Unsafe Conditions



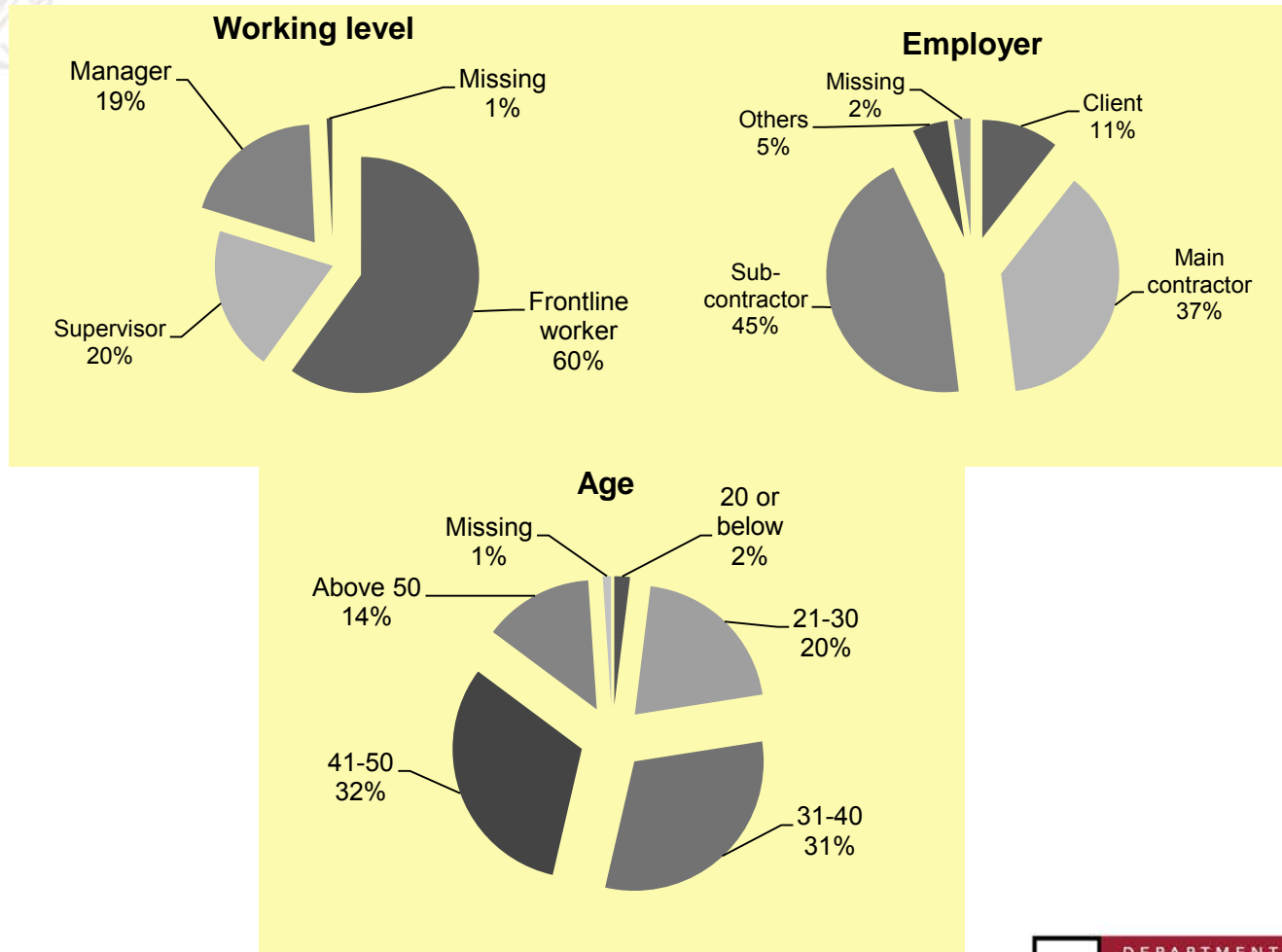
Unsafe Actions





Safety Climate & Safety Performance of RMAA Works

Profile of Survey Respondents



Exploratory Factor Analysis (EFA)

Factor 1 Management commitment to OHS and employee involvement (Eigenvalue = 6.992; % of variance =31.782; cumulative % =31.782)

		Loading
B8	The company really cares about the health and safety of the people who work here	0.756
B21	There are good communications here between management and workers about health and safety issues	0.73
B15	The company encourages suggestions on how to improve health and safety	0.708
B19	I am clear about what my responsibilities are for health and safety	0.688
B38	I think management here does enough to follow up recommendations from safety inspection and accident investigation reports	0.686
B13	All the people who work in my team are fully committed to health and safety	0.685
B16	There is good preparedness for emergency here	0.657
B30	Accidents which happened here are always reported	0.642
B9	Most of the job-specific safety trainings I received are effective	0.633
B3	I fully understand the health and safety risks associated	0.586
B28	Safety inspection here is helpful to improve the health and safety of workers	0.569
B34	Staff are praised for working safely	0.525

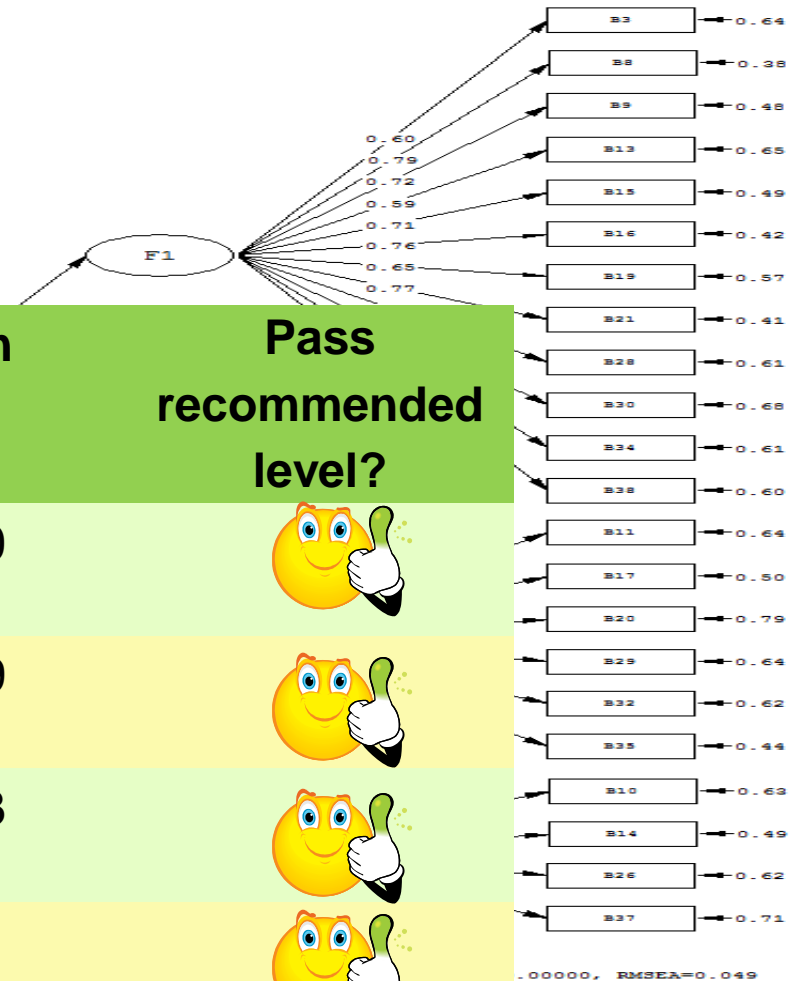
Factor 2 Applicability of safety rules and work practices (Eigenvalue = 1.928; % of variance =8.763; cumulative % =40.545)





B29	Some jobs here are difficult to do safely	0.717
B32	Not all the health and safety rules or procedures are strictly followed here	0.714
B20	Some of the workforces pay little attention to health and safety	0.676
B11	Some health and safety rules or procedures are difficult to follow	0.624
B35	Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedures	0.615
B17	Sometimes it is necessary to take risks to get the job done	0.594

Factor 3 Responsibility for health and safety (Eigenvalue = 1.684; % of variance =7.653; cumulative % =48.198)

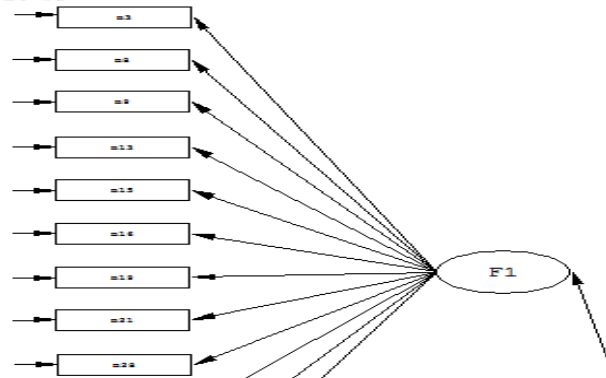
B10	People are just unlucky when they suffer from an accident	0.785
B37	Accident investigations are mainly used to identify who should be blamed	0.624
B26	Work health and safety is not my concern	0.61
B14	Little is done to prevent accidents until someone gets injured	0.589

Confirmatory Factor Analysis (CFA)



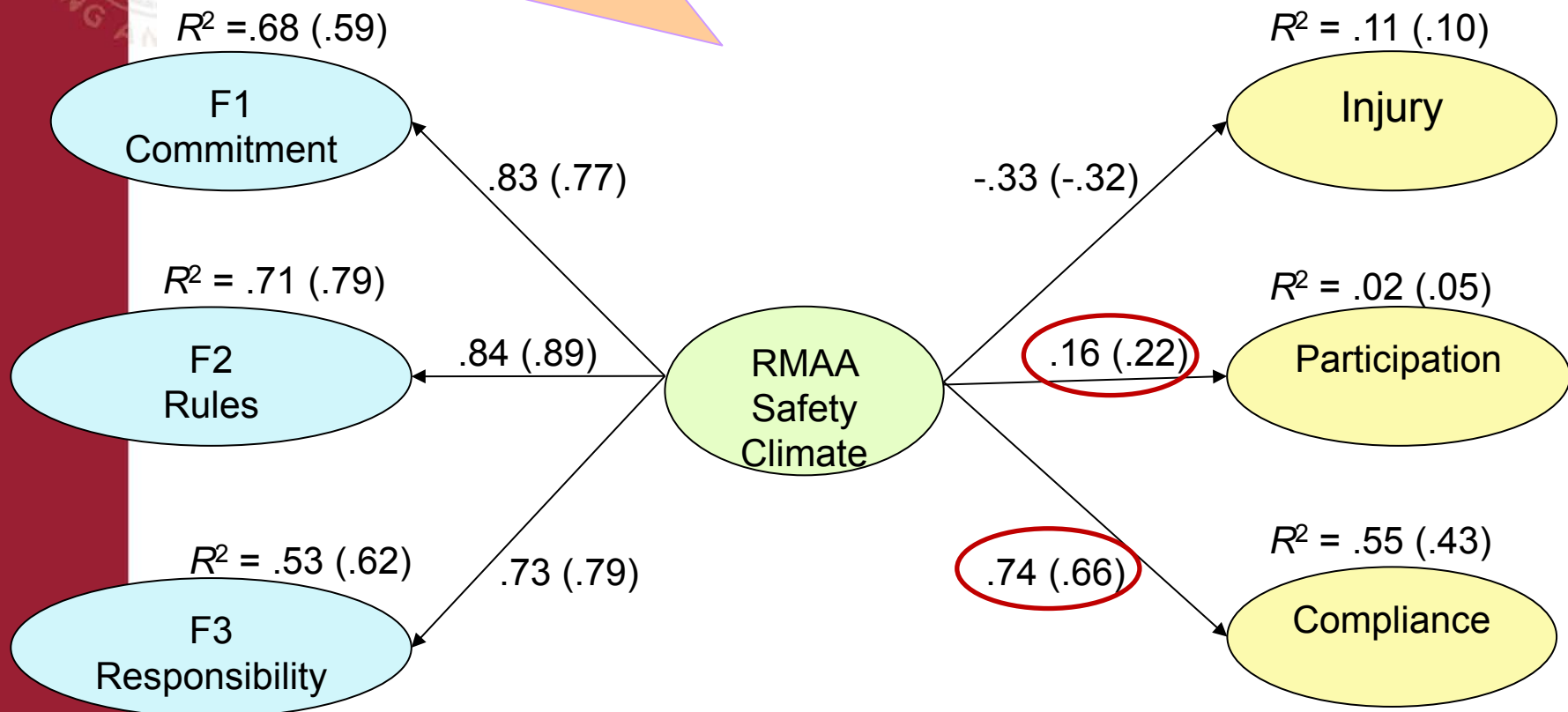
Goodness-of-fit measures	Validation sample	Pass recommended level?
Chi-square/ degrees of freedom (χ^2/df)	1.780	
Root mean square error of approximation (RMSEA)	0.049	
Comparative fit index (CFI)	0.983	
Normed fit index (NNFI)	0.981	

Structural Equation Model



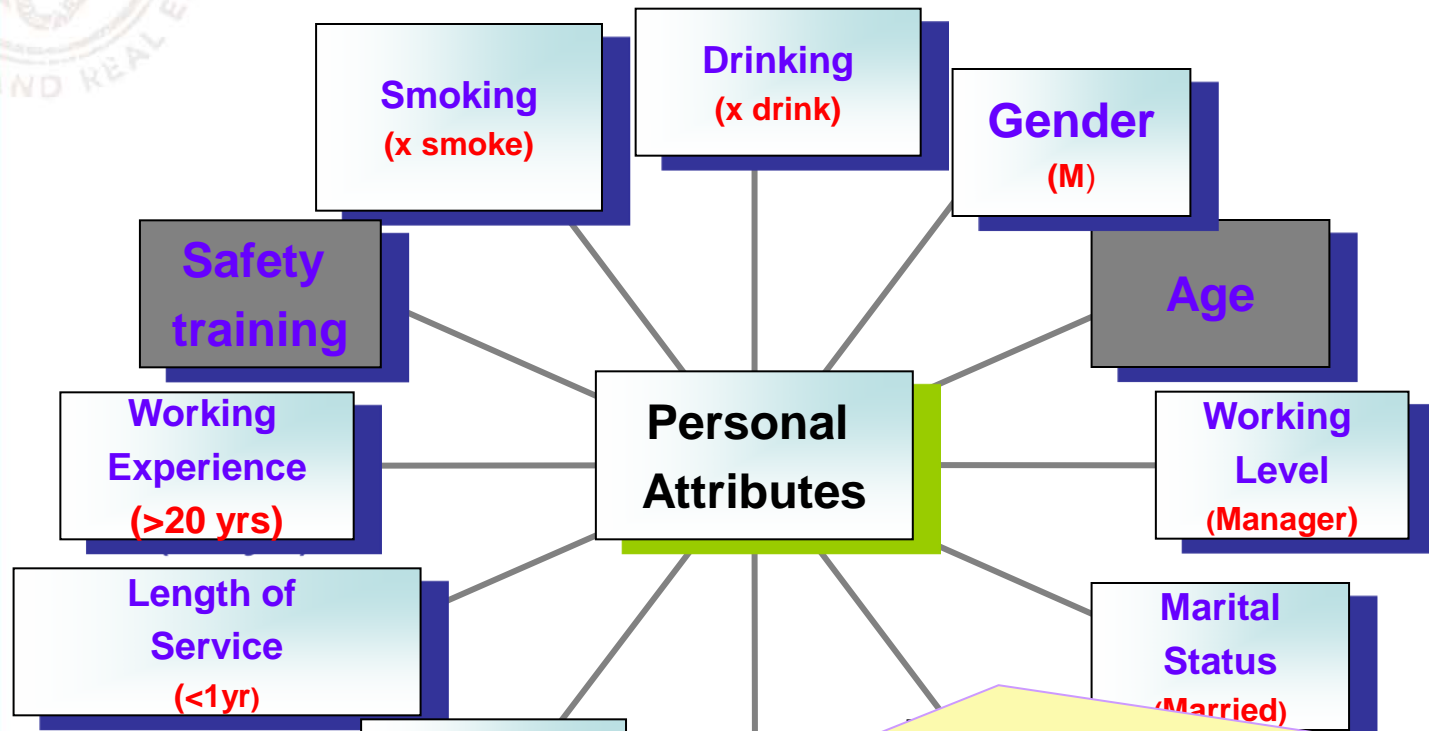
Goodness-of-fit measures	Calibration sample	Validation sample	Pass Recommended level?	
Chi-square/ degrees of freedom (χ^2/df)	1.707	1.780		
Root mean square error of approximation (RMSEA)	0.046	0.049		
Comparative fit index (CFI)	0.980	0.983		
Normed fit index (NNFI)	0.978	0.981		

- RMAA safety climate is negatively related to Injury.
- RMAA safety climate is positively related to Safety Participation & Safety Compliance.
- The relationship between RMAA safety climate & Safety Compliance is the strongest.
- The relationship between RMAA safety climate & Safety Participation is the weakest.



Note: Values not in blanket denote results of the calibration sample. Values in blankets denote results of the validation sample.

Demographic Variables Affecting Safety Climate

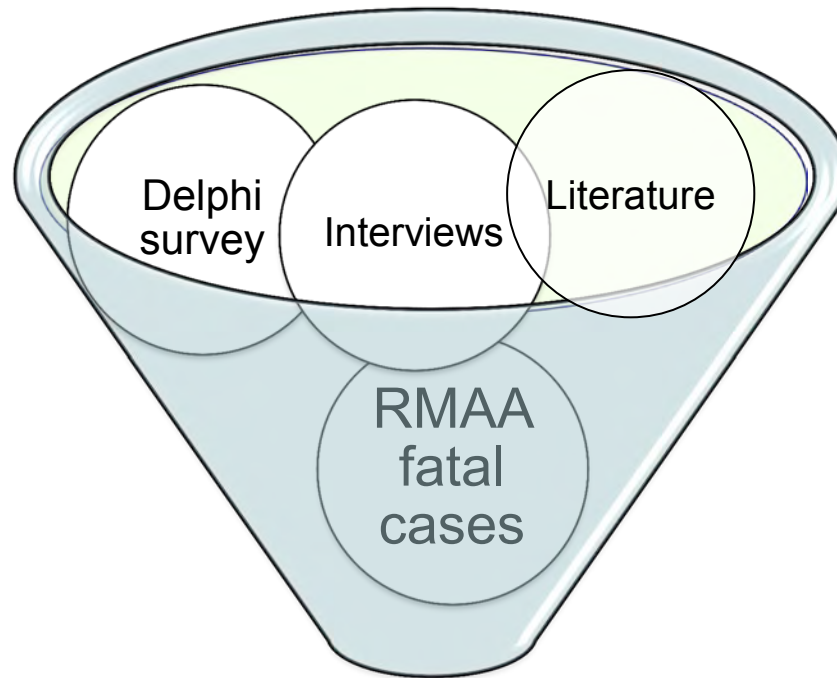


- 9 variables significantly affect safety climate of RMAA works.
- Respondents who had higher mean score of RMAA safety climate: male, manager, married, with degree/secondary level of education, work for client, length of service in current company for less than 1 year, working experience for more than 20 year, non-smokers, and no drinking habit.



Strategies for Improving Safety of the RMAA Sector

Formulating strategies for improving safety climate factors of RMAA works



Strategies for improving safety climate factors of RMAA works



Strategies for Improving Safety of the RMAA Sector

Strategies for improving RMAA safety	Mean	Rank
Select the RMAA subcontractors with good track records of safety performance. Raise safety awareness of the RMAA workers.		
Provide relevant safety training for the specific trades of RMAA works.	4.23	3
Nurture a good safety culture in the company.	4.23	3
Provide safety promotion and education towards the RMAA sector.	4.23	3
Strengthen site monitoring and safety supervision.	4.15	6
Create clear safe working procedures and guidance for the RMAA workers.	4.08	7
Provide sufficient safety equipment for the RMAA workers.	4.08	7
Design for safety of RMAA works.	4.08	7
Have a mandatory licensing system for the RMAA workers.	3.85	10
Implement award and penalty scheme.	3.77	11
Improve site tidiness and housekeeping.	3.77	11
Review legislative control.	3.77	11
Implement pay for safety scheme of RMAA works.	3.62	14
Implement technological innovations for better safety.	3.54	15



Conclusions

Conclusions

Causes of RMAA accidents

- Poor safety consciousness of RMAA workers.
- RMAA workers underestimate potential risks when performing small tasks for a short period.
- Personal protective equipment not used, incorrectly used, or not provided.

Difficulties of implementing safety rules and practices in RMAA works

- Limited safety resources for RMAA projects undertaken by small/medium-sized contractors.
- Difficult to change the mindset of RMAA workers.
- Difficult to conduct safety supervision due to scattered locations.

Conclusions

RMAA fatal cases

- Fall of person from height
- Improper procedures
- Not use safety harness

Safety climate factors of RMAA works

- Management commitment to OHS and employee involvement
- Applicability of safety rules and work practices
- Responsibility for health and safety

Conclusions

Relationships between safety climate and safety performance

- ↑ Safety climate -> ↓ Injury
- ↑ Safety climate -> ↑ Safety participation
- ↑ Safety climate -> ↑ Safety compliance

Demographic variables affecting safety climate

- 9 variables significantly affecting safety climate.
- Working level, gender, marital status, education, employer, length of service in the current company, working experience, smoking, drinking

Conclusions

Strategies for improving safety of the RMAA sector

- Select the RMAA subcontractors with good track records of safety performance.
- Raise safety awareness of the RMAA workers.
- Provide relevant safety training for the specific trades of RMAA works.
- Nurture a good safety culture in the company.
- Provide safety promotion and education towards the RMAA sector.
- Strengthen site monitoring and safety supervision.
- Create clear safe working procedures and guidance for the RMAA workers.

Research Outputs

Journal Papers (Published & Accepted)

Hon, C.K.H., Hinze, J. and Chan, A.P.C. (2014). Safety climate and injury occurrence of the repair, maintenance, minor alteration and addition works: A comparison of workers, supervisors and managers. *Facilities*, accepted.

Hon, C.K.H., Chan, A.P.C. and Yam, M.C.H. (2013). Determining safety climate factors in the repair, maintenance, minor alteration, and addition sector. *ASCE Journal of Construction Engineering and Management*, 139(5), 519-528.

Hon, C.K.H. and Chan, A.P.C. (2013). Fatalities of repair, maintenance, minor alteration, and addition works in Hong Kong. *Safety Science*, 51, 85-93.

Hon, C.K.H., Chan, A.P.C. and Yam, M.C.H. (2012). An empirical study to investigate the difficulties of implementing safety practices in the repair and maintenance sector: a case of Hong Kong. *ASCE Journal of Construction Engineering and Management*, 138(7), 871-884.

Hon, C.K.H., Chan, A.P.C. and Chan, D.W.M. (2011). Strategies for Improving Safety Performance of Repair, Maintenance, Minor Alteration and Addition (RMAA) Works. *Facilities - Special Issue on Infrastructure Management*, 29(13/14), 591-610.

Hon, C.K.H., Chan, A.P.C. and Wong, F.K.W. (2010). An analysis for the causes of accidents of repair, maintenance, alteration and addition works in Hong Kong. *Safety Science*, 48(7), 894-901.



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- The authors also wish to acknowledge the contributions of other team members including Prof. Francis Wong, Dr. Daniel Chan, Dr. Michael Yam, Dr. Don Dingsdag and Prof. Herbert Biggs.



Question & Answer





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