‘Smart’ Facility Management in building fire emergency operations

An empirical research with the focus on multi-criteria analysis for supporting the selection of smart emergency applications in the facility management

Clifford Tjon

MSc. Management in the Built Environment,
Delft University of Technology,
P5, 26th of June, 2019

Research supervisors

Prof.dr.ir. A.C. den Heijer
Prof.dr.ir. P.H.A.J.M. van Gelder
Ir. B. Valks

Delegate of the Board of Examiner

Ir. Y. J. Cuperus

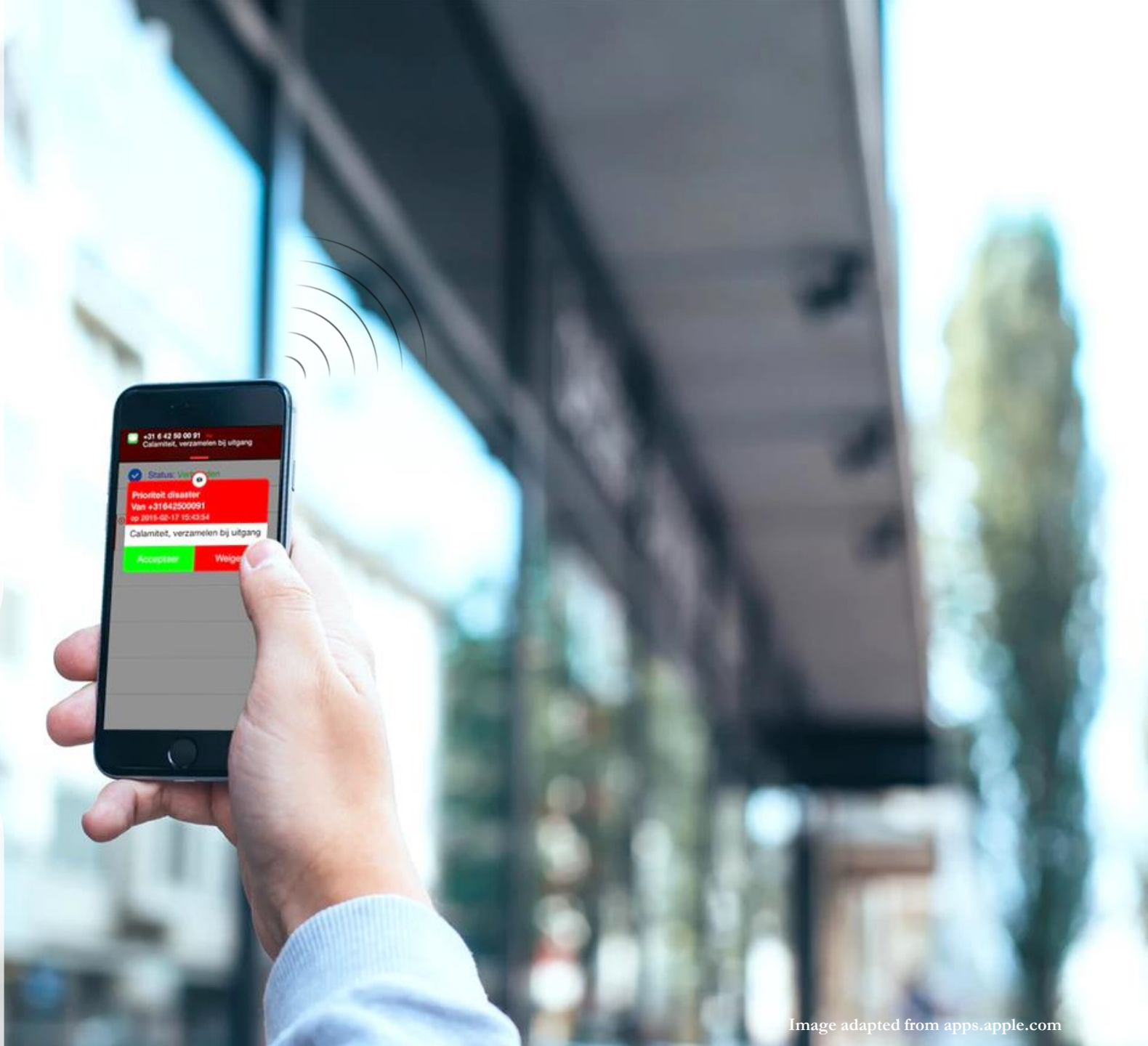


Image adapted from apps.apple.com

Introduction

- Background information
- Problem definition
- Research gap
- Main research question

Background information

Problem definition

Research gap

Main research question

The characteristics of university campuses

Functions	Who manages/own/uses?			Similar city functions
	University	Municipality	3rd party	Alternative available in city? Examples
ACADEMIC • EDUCATION AND RESEARCH				
Classrooms and studio spaces (small groups)	X			
Lecture halls (large groups)	X			Movies, theaters
Office space academic staff	X			
Office space support staff	X			
Laboratories	X		X	R&D facilities of large companies
Study places for individual use/small groups	X			Inner city coffee bars
Library	X			Community library
Special places for ceremonies (graduation)	X	X		City halls, churches
Special conference facilities	X		X	Conference center
Special educational facilities (dance, media, arts)	X	X		Theaters, studios, museums
Academic hospital			X	Other hospital
Medical school			X	

Table retrieved from Den Heijer (2011, p.184)

Background information

Problem definition

Research gap

Main research question

The characteristics of university campuses

The Netherlands

Delft University of Technology. Image retrieved from mecanoo.nl

Students

239.755

Building condition

Aging / improving

Academic staff

22.618

Data based on Den Heijer and Tzovlas (2014)

Background information

Problem definition

Research gap

Main research question

The characteristics of university campuses

United Kingdom

University of Oxford. Image retrieved from unsplash.com

Students

2.041.715

Building condition

Aging

Academic staff

145.837

Data based on Den Heijer and Tzovlas (2014)

Background information

Problem definition

Research gap

Main research question

The characteristics of university campuses

United States of America

Harvard University. Image retrieved from diarystore.com

Students

19.900.000 (2018)

Building condition

Aging

Academic staff

unknown

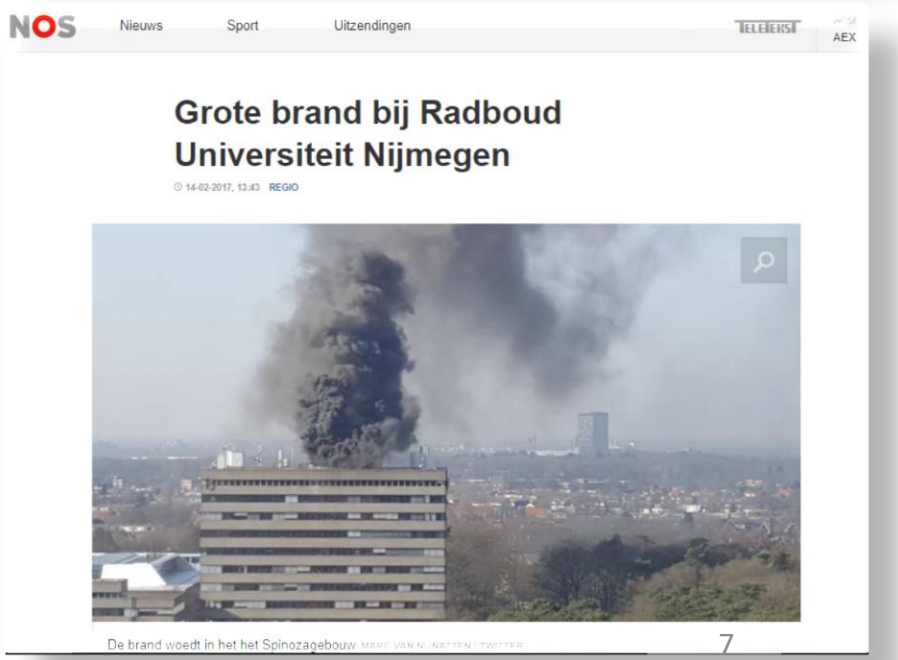
Data based on nces.ed.gov.

Background information

Problem definition

Research gap

Main research question



Background information

Problem definition

Research gap

Main research question

Fire at Georgetown University data center brings campus to a standstill

Takes a day out of students' calendar

April 06, 2018 By: Max Smolaks

Georgetown University's Laurel Data Center in Maryland was brought down by an electrical fi
week, resulting in campus-wide service outages.

According to student newspaper The Hoya, the fire caused the main and backup power syste
fail, leading to a complete shutdown of the facility.

The exact cause of the fire is still unknown, but most services have been restored.

School's out

Laurel Data Center is the university's primary

32 killed in Moscow university fire

▲ Firefighters battle to extinguish a blaze, in which 32 students died, at halls of residence belonging to Mos
Patrice Lumumba People's Friendship university. Photograph: AP

Huge fire breaks out in Bristol University new maths building

Georgia Diebelius Saturday 6 Jan 2018 6:14 pm

Cairo university set on fire amid Egypt protests

Cairo's al-Azhar University was set on fire and one person killed as supporters of the Muslim Brotherhood clashed with security forces.

Some 60 people were arrested in the latest incident of unrest by supporters of the banned group.

The BBC's Bethany Bell reports from Cairo.

28 Dec 2013

Share

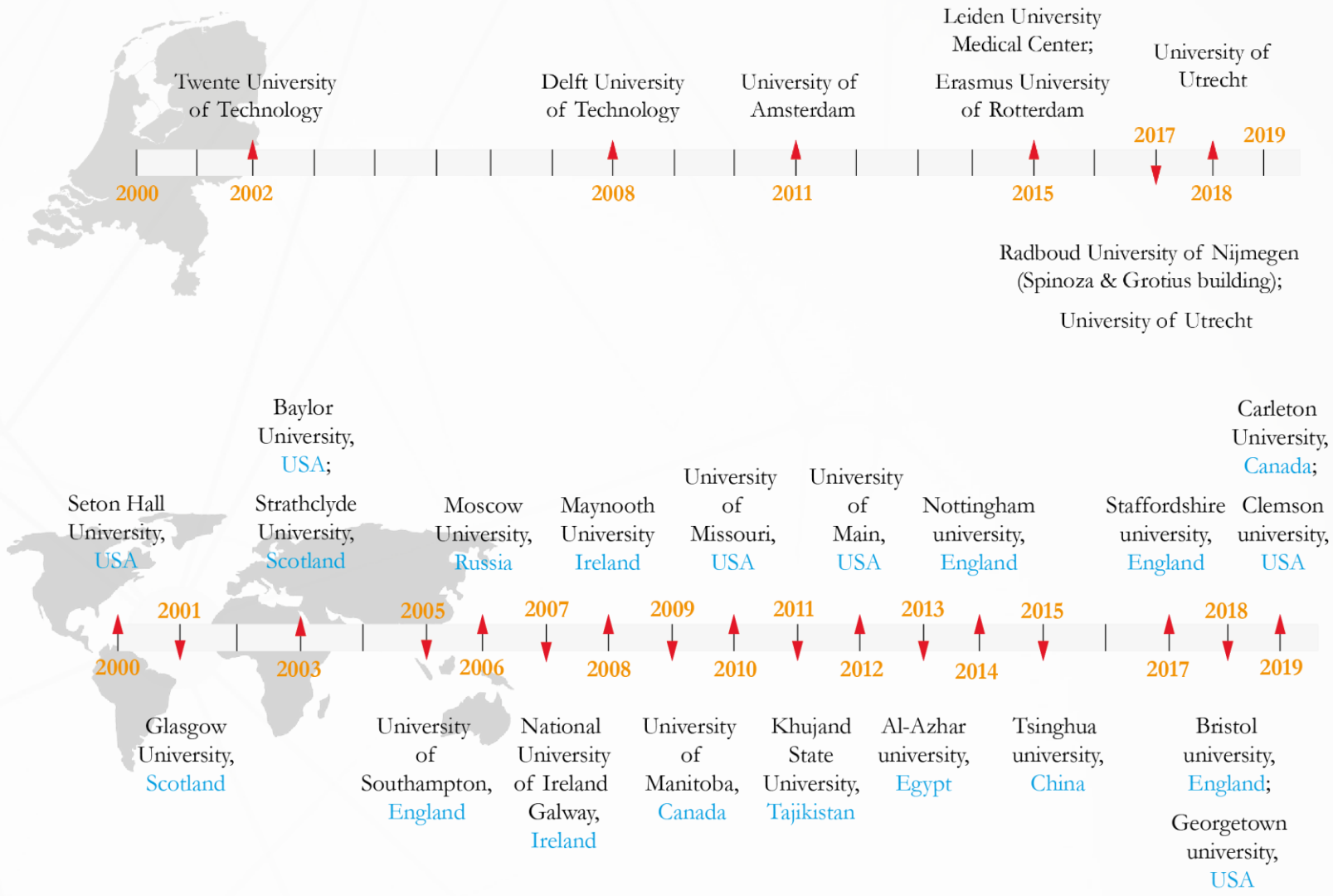
Background information

Problem definition

Research gap

Main research question

Fire incidents at international and national level in the past 19 years



Fire incidents at different universities. (author's illustration, 2019)

Background information

Problem definition

Research gap

Main research question

The responsible, relevant and competent person in the case of a fire outbreak at a university

Facility Manager

- ✓ Environment, health and Safety
- ✓ Emergency preparedness
- ✓ Fire safety system maintenance
- ✓ Recover supporting services

Background information

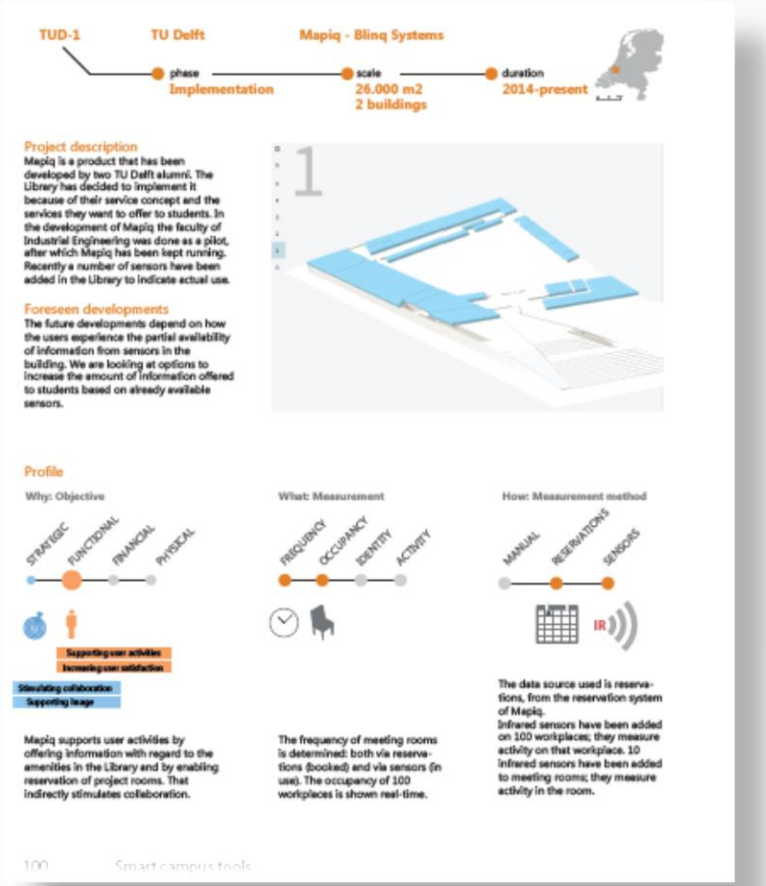
Problem definition

Research gap

Main research question

‘Smart’ (campus) tools

‘A **smart tool** is a service or product which collects (real-time) information on space use to improve the space use on the current campus on the one hand, whilst supporting decision making on the future space use on the other hand.’ (Valks et al., 2018, p.8)



Images retrieved from Valks et al. (2016) and Valks et al. (2018)

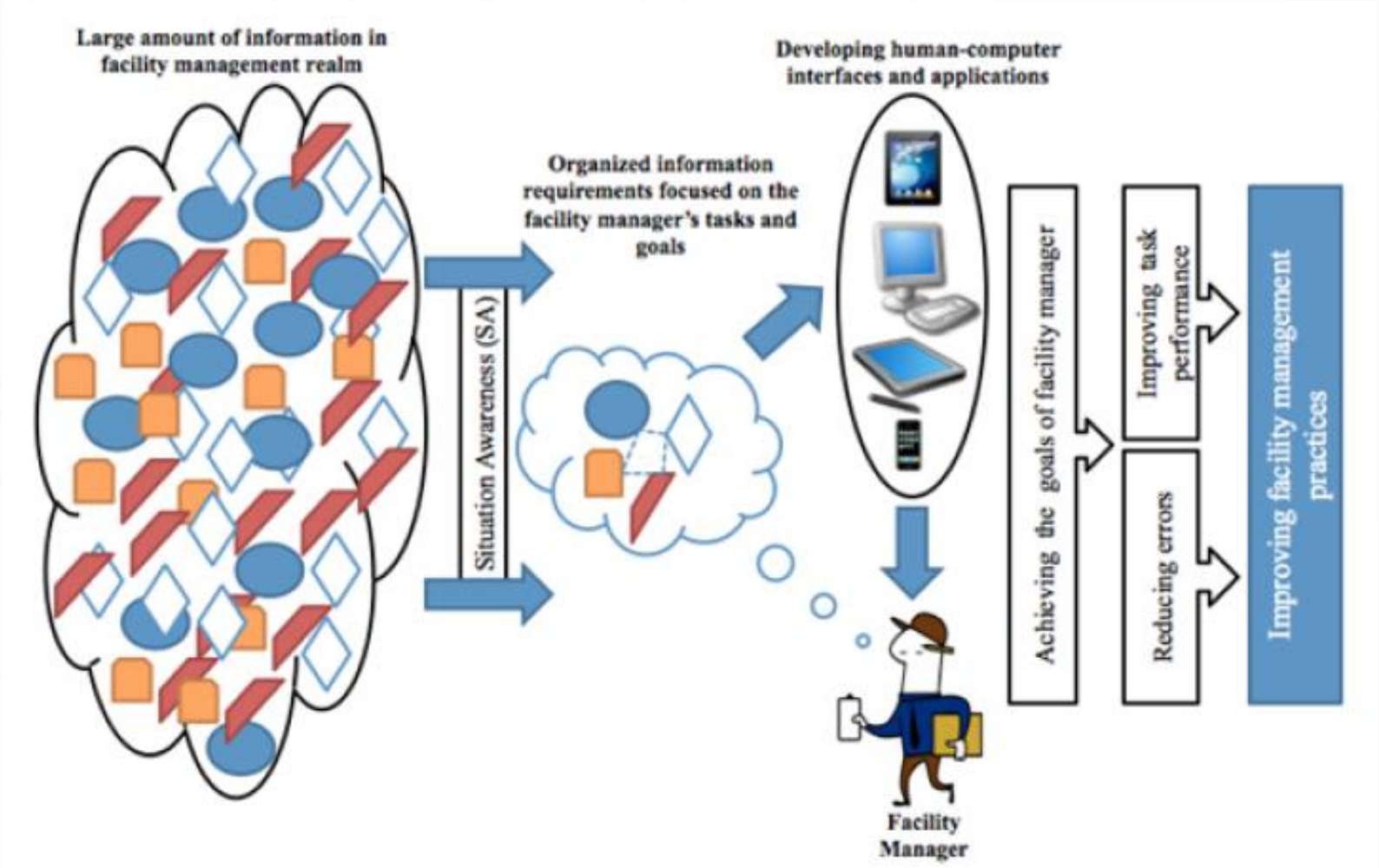
Background information

Problem definition

Research gap

Main research question

The conceptual model regarding facility manager's situational awareness



The relation between facility manager, situational awareness, and computer technologies. Image retrieved from Gheisari et al. (2011)

Background information

Problem definition

Research gap

Main research question

Problems with understanding, filtering and gathering information lead to lack of situational awareness during a fire emergency;

Incomplete, overload and incorrect information during an emergency situation;

In general, Facility managers have difficulties in managing and filtering a large amount of information.

Background information

Problem definition

Research gap

Main research question

Most studies…

- Focus on the benefits and technical aspects of the smart emergency app;
- Do **not** focus on the facility manager as a potential user of emergency apps and the corresponding information needs.

Lack of understanding of ….

- Information needs during a fire incident, through the lens of the facility manager.
- Contribution of current smart emergency apps to the facility manager;

Background information

Problem definition

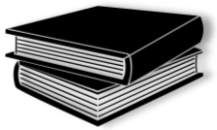
Research gap

Main research question

The **purpose** of this study is to add to the existing **body of knowledge** and increase the **understanding** of …

‘ How can current **smart emergency applications**, in terms of **information provision**, contribute to the **mitigative barrier** in order for the **facility managers** to improve their **situational awareness** in **building fire emergency response operations**? ’

Empirical research methodology



Research design

Sample selection

Multi-criteria analysis

Research design

Sample selection

Multi-criteria analysis

P1
September 2018

Problem definition

(1) Lack of situational awareness in the emergency situation, (2) lost in situation awareness can cause slower detection of problems, (3) risks are not communicated properly to the management level, (4) incomplete, overload or incorrect information during an emergency, (5) in general, facility managers have difficulties in managing and separating a large amount of information.

Main research question

How can current smart emergency applications, in terms of information provision, contribute to the mitigative barrier in order for the facility managers to improve their situational awareness in response to a fire emergency event

P2
October 2018

Theoretical framework	Research variables / Data collection	Data analysis
Literature review	• FM and CREM; • Bowtie model & ALARP; • Information items • Smart emergency applications.	• The role of FM and CREM in crisis situation • Risk scenario and acceptable level of risk • Information needs in crisis situation; • Information provision of smart emergency apps

P3
February 2019

Research instrument	Research variables / Data collection	Data analysis
Semi-structured interviews	Facilities managers (FM) from Dutch universities	• Role of the facility manager in crisis situation; • Acceptable level of risk • Required information needs in emergency scene • Viewpoint regarding to smart emergency apps

Multi-criteria analysis: a variety of information items evaluated according to different current smart applications

P4
April 2019

Conclusion to the main research question and discussion

Author's illustration (2019)

Research design

Sample selection

Multi-criteria analysis

University	Function title
LUMC, Leiden	Manager Crisis Management Team leader Safety & Crisis Management
TU Delft, Delft	Facility Manager Facility Manager Fire Safety Coordinator Building Management Coordinator
RU, Nijmegen	Head of emergency response team Emergency Coordinator
UU, Utrecht	Project leader Facility Service Center Director Facility Service Center
UVA, Amsterdam	Head of emergency response team
UT, Enschede	Safety officer
EUR, Rotterdam	Head of emergency response team Head of emergency response team

Author's illustration (2019)

Research design

Sample selection

Multi-criteria analysis

Evaluation of different smart emergency apps according to a variety of information items

Criteria	Importance based on Li et al. (2014) (ranking)	Agreement Respondents (#)	Options								
			Emergency app 1	Emergency app 2	Emergency app 3	Emergency app 4	Emergency app 5	Emergency app 6	Emergency app 7	Emergency app 8	Emergency app 9
Information item 1	2nd	xx/xx				✓	✓				✓
Information item 2	1st	xx/xx	✓				✓		✓		

Author's illustration (2019)

Theoretical framework

CREM and FM

Information items

BowTie

Smart emergency apps

CREM and FM

BowTie

Information items

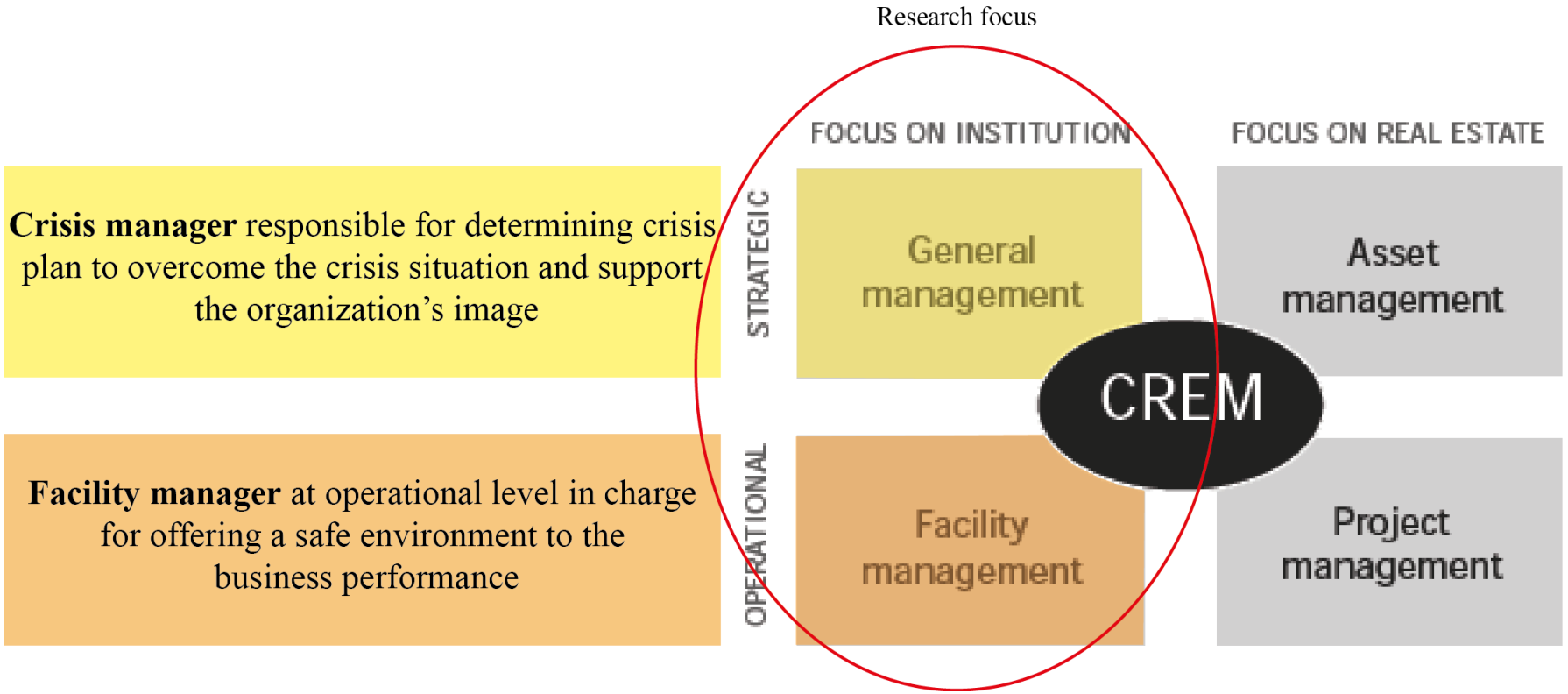
Smart emergency app

Picasse

SmartRescue

iRescue

The role of the Facility management and General Management amid building fire emergency operations



CREM and FM

BowTie

Information items

Smart emergency app

- Picasse
- SmartRescue
- iRescue

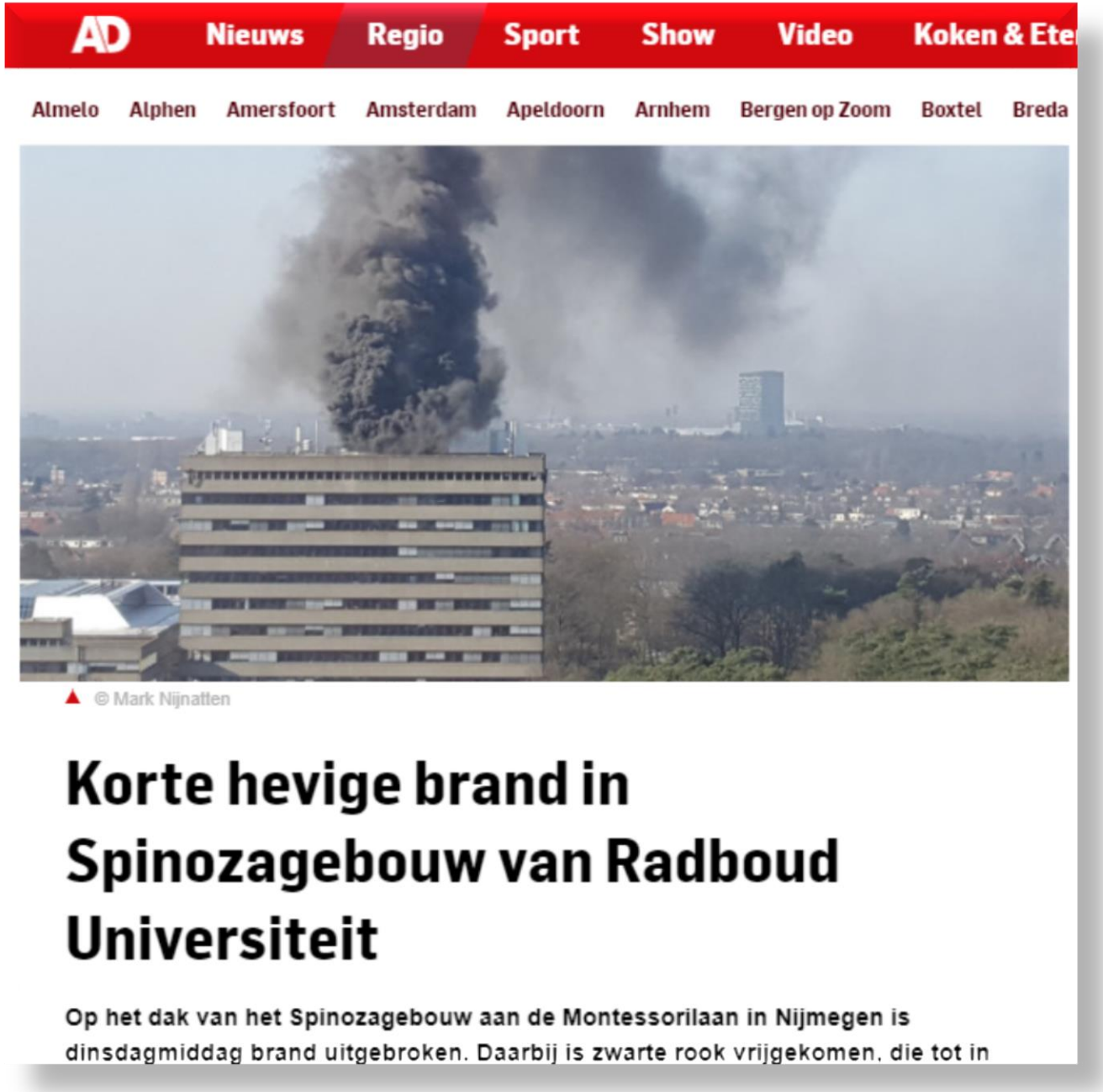


Image and news article retrieved from AD.nl

CREM and FM

BowTie

Information items

Smart emergency app

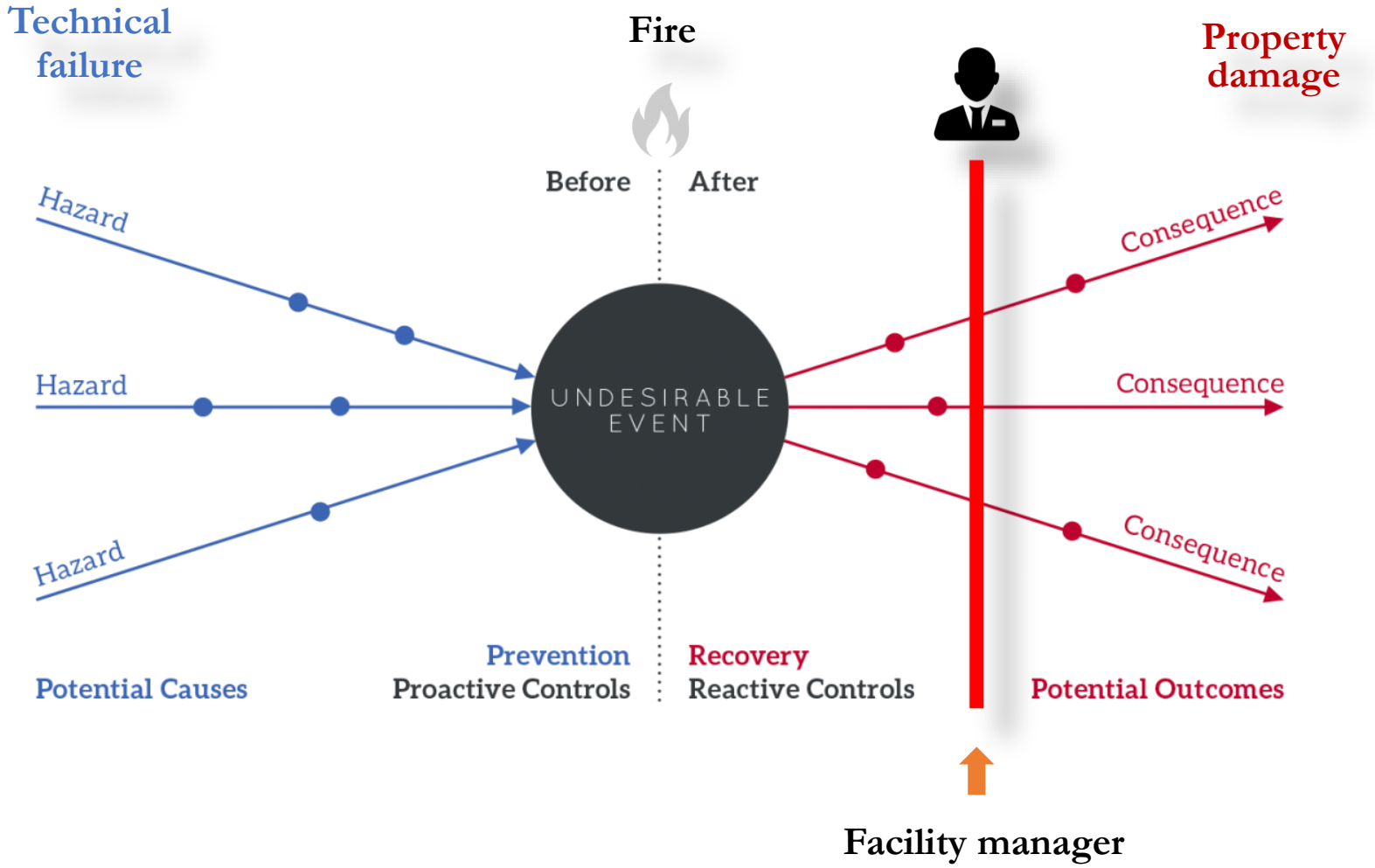
Picasse

SmartRescue

iRescue

The position of the facility manager in relation to the Bow-Tie model

(e.g. case: fire outbreak at Radboud University Nijmegen in 2017)



The Bow-Tie model in relation to the facility manager. Image adapted from asqs.net

CREM and FM

BowTie

Information items

Smart emergency app

Picasse

SmartRescue

iRescue

Information used in building fire emergency operation

Category	Number	Description
Before arrival to scene	A1	Building occupancy (number and identities of occupants, based on time of day)
	A2	Building layout and site plan (building size, construction type, floor plans)
	A3	Location of water sources nearby (fire hydrants, fire department hookups for sprinkler system, standpipes)
	A4	Routing information to the building and area map of the neighborhood of the building
	A5	Contact information of building owners, managers and utility contacts
	A6	Hazards, location and identification of unusual hazards (above ground propane tanks, gas lines, chemicals, explosives, etc.)
	A7	Location of important objects (facilities, documents, equipment) to be saved
At emergency scene	B1	Location of fire in the building, fire size, and duration
	B2	Sprinklers' status (number of location of sprinklers that have gone off)
	B3	Presence and location of occupants in the building
	B4	Location and condition of smoke
	B5	Warnings of structural collapse based on material type, fire location, fire size and duration
	B6	Confidence in the fire being real
Attack and mitigation	C1	Required water flow (gallon/minute) or foam based on fire condition
	C2	Location of available areas of refuge, staging areas
	C3	Location and condition of deployed and standing-by responding units
	C4	Local weather conditions and predictions, wind direction and velocity
	C5	Locations of building entrance/exit signs
	C6	Contact information of other emergency agencies

Li et al. (2014)

Stages during a fire incident

All required and relevant information in each stage

CREM and FM

BowTie

Information items

Smart emergency app

Picasse

SmartRescue

iRescue

The most important information

according to the 29 first responders, 13 paramedics and firefighters

	Order	Frequency	Importance
Before arrival to scene			
1st	A4: Routing information to the building and area map of the neighborhood of the building	A6: Hazards, location and identification of unusual hazards (above ground propane tanks, gas lines, chemicals, explosives, etc.)	A4: Routing information to the building and area map of the neighborhood of the building
2nd	A1: Building occupancy (number and identities of occupants, based on time of day)	A3: Location of water sources nearby (fire hydrants, fire department hookups for sprinkler system, standpipes)	A1: Building occupancy (number and identities of occupants, based on time of day)
3rd	A3: Location of water sources nearby (fire hydrants, fire department hookups for sprinkler system, standpipes)	A7: Location of important objects (facilities, documents, equipment) to be saved	A3: Location of water sources nearby (fire hydrants, fire department hookups for sprinkler system, standpipes)
At emergency scene			
1st	B1: Location, size, and duration of fire in the building	B3: Presence and location of occupants in the building	B1: Location of fire in the building, fire size, and duration
2nd	B3: Presence and location of occupants in the building	B1: Location of fire in the building, fire size, and duration	B3: Presence and location of occupants in the building
3rd	B4: Location and condition of smoke	B4: Location and condition of smoke	B4: Location and condition of smoke
Attack and mitigation			
1st	C3: Location and condition of deployed and standing-by responding units	C3: Location and condition of deployed and standing-by responding units	C3: Location and condition of deployed and standing-by responding units
2nd	C2: Location of available areas of refuge and staging areas	C2: Location of available areas of refuge, staging areas	C1: Required water flow (gallon/minute) or foam based on fire condition
3rd	C1: Required water flow (gallon/minute) or foam based on fire condition	C1: Required water flow (gallon/minute) or foam based on fire condition	C2: Location of available areas of refuge, staging areas

Li et al. (2014)

CREM and FM

BowTie

Information items

Smart emergency app

Picasse

SmartRescue

iRescue

May 13, 2008

Fire outbreak at the Faculty of Architecture (TU Delft)

Image retrieved from rizoomes.nl

CREM and FM

BowTie

Information items

Smart emergency app

Picasse

SmartRescue

iRescue

What: measurement

- Location emergency source
- Emergency type
- Fire activity
- Location first responders
- Presence first responders
- Location victim
- Physical status victim

How: measurement method

- Wi-Fi
- Mobile network
- Beacons
- Smartphone sensors
- RFID
- GPS
- Sound

CREM and FM

BowTie

Information items

Smart emergency app

- Picasse
- SmartRescue
- iRescue

October 22, 2012
Small fire outbreak at the lecture hall of National University of Singapore

Image retrieved from sg.news.yahoo.com

CREM and FM

BowTie

Information items

Smart emergency app

Picasse

SmartRescue

iRescue

What: measurement

- Location emergency source
- Emergency type
- Fire activity
- Location first responders
- Presence first responders
- Location victim
- Physical status victim

How: measurement method

- Wi-Fi
- Mobile network
- Beacons
- Smartphone sensors
- RFID
- GPS
- Sound

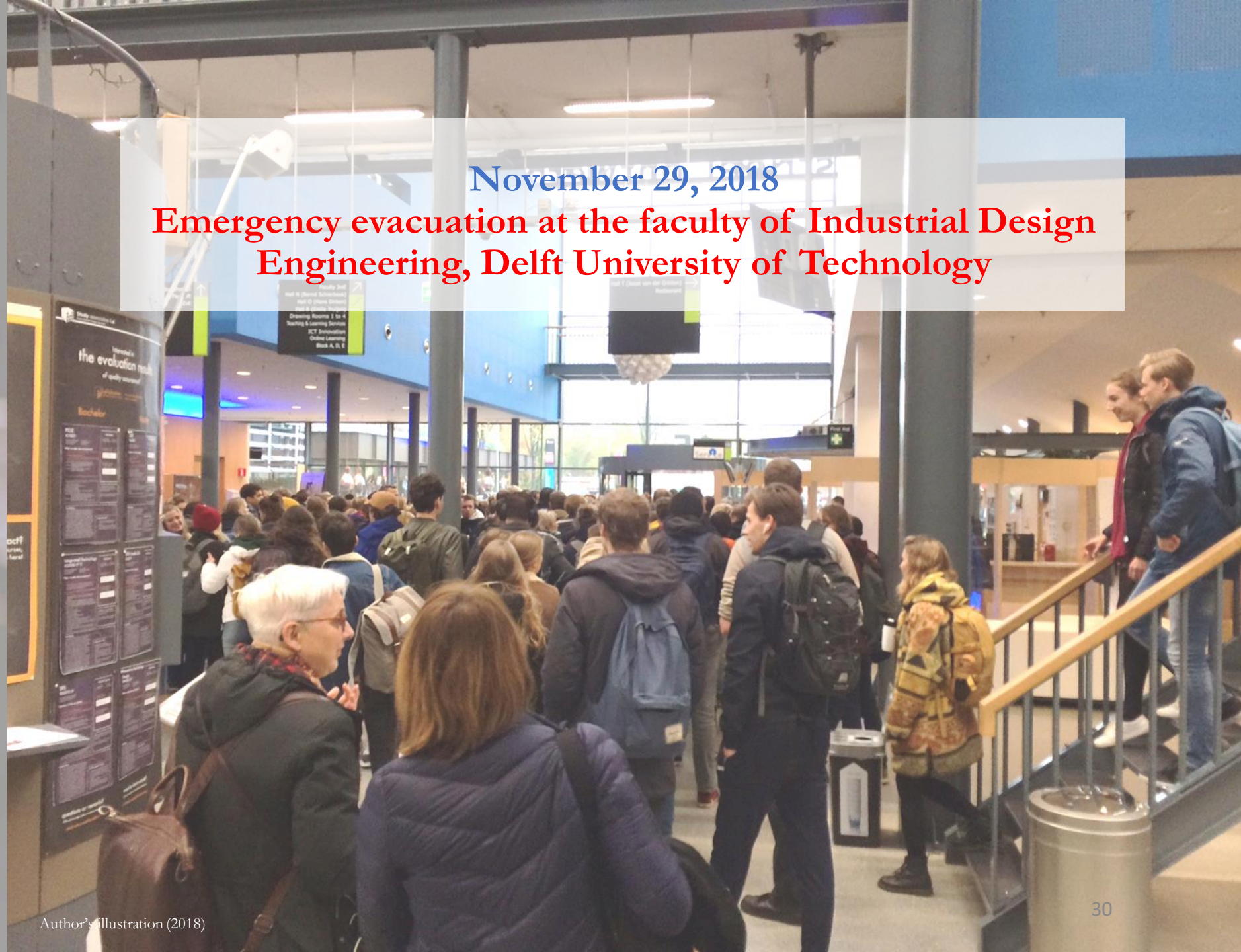
CREM and FM

BowTie

Information items

Smart emergency app

- Picasse
- SmartRescue
- iRescue



Author's illustration (2018)

CREM and FM

BowTie

Information items

Smart emergency app

- Picasse
- SmartRescue
- iRescue

What: measurement

- Location emergency source
- Emergency type
- Fire activity
- Location first responders
- Presence first responders
- Location victim
- Physical status victim

How: measurement method

- Wi-Fi
- Mobile network
- Beacons
- Smartphone sensors
- RFID
- GPS
- Sound

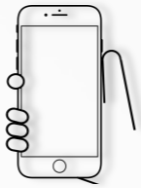
Main research question

‘ How can current **smart emergency applications**, in terms of **information provision**, contribute to the **mitigative barrier** in order for the **facility managers** to improve their **situational awareness** in building fire emergency response operations? ’

Results empirical research

Participant's role

Desired emergency app



Perception in the use of emergency apps

Information needs

Multi-criteria analysis

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

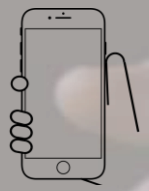
Desired emergency app

Case	Job title	Emergency duties
	Strategic level	
TUD (2008)	**Fire Safety Coordinator**	• Advisor of the emergency response team to set and meet long-term goals.
RU (2017)	**Emergency Coordinator**	• Establish building's emergency action plans; • Conduct risk assessments; • Bringing emergency plans up to date; • Aftercare of students and employees; • Communication to the media.
UU (2017) **UU** (2018)	**Director Facility Service Center**	• Link between the emergency response team and crisis team; • Responsible for the safety and security issues.
LUMC (2015)	**Manager Crisis Management**	• Establish long-term strategic plan with the crisis team; • keep an overview of the whole situation during a fire incident.
UT (2002)	**Safety officer**	• Organize and evaluate evacuation exercises; • Provide feedback of results to the crisis team.
	Operational level	
TUD (2008) **UVA** (2011) **RU** (2017)	**Head of emergency response team**	• Take preventive measures to prevent and limit accidents; • Managing the emergency response team; • Coordinate the alarms and evacuation of person present in the building.
TUD (2008)	**Building Management Coordinator**	• Responsible for the technical elements such as fire safety system and building operational system.
UU (2017) **UU** (2018)	**Project leader Facility Service Center**	• Coordinate inspection rounds; • Coordinate evacation of people present; • Provide suggestions about the emergency situation to the crisis team that operates at the strategic level.
LUMC (2015)	**Team leader Safety & Crisis Management**	• Delegate the teamleaders of the emergency response team and the security officers in emergency situations.

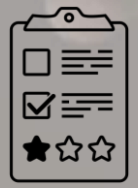
(author's illustration, 2019)

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

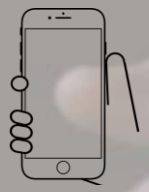
Desired emergency app

Conclusion:

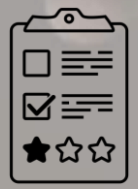
Participants from both strategic and operational level have different job titles but more or less similar emergency duties as the facility manager

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

Desired emergency app

Information needs according to the participants

Li et al. (2014)

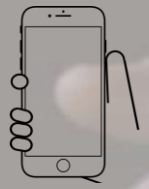
Interview results

	Before arrival to scene	Yes	No	Maybe	N/a
2nd	**A1.** Building occupancy (number and identities of occupants, basd on time of day)	8	2	1	
	A2. Building layout and site plan (building size, construction tye, floor plans)	7	4		
3rd	**A3.** Location of water sources nearby (fire hydrants, fire department hookups for sprinkler system, standpipes	5	6		
1st	**A4.** Routing information to the building and area map of the neighborhood of the building	7	3	1	
	A5. Contact information of building owners, managers and utility contacts	8	3		
	A6. Hazards, location and identification of unusual hazards	11			
	A7. Location of important objects (facilities, documents, equipment to be saved)	8	3		

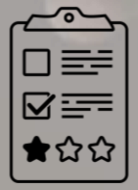
(author's illustration, 2019)

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

Desired emergency app

Information needs according to the participants

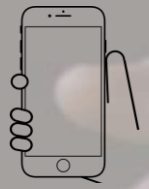
Li et al. (2014) — Interview results

	At emergency scene	Yes	No	Maybe	N/a
1st	**B1.** Location of fire in the building, fire size, and duration	11			
	B2. Sprinklers' status (number of location of sprinklers that have gone off)	9	2		
2nd	**B3.** Presence and location of occupants in the building	10	1		
3rd	**B4.** Location and condition of smoke	10	1		
	B5. Warnings of structural collapse based on material type, fire location, fire size, and duration	10	1		
	B6. Confidence in the fire being real	9	2		

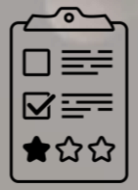
(author's illustration, 2019)

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

Desired emergency app

Information needs according to the participants

Li et al. (2014)

Interview results

	Attack and mitigation	Yes	No	Maybe	N/a
2nd	**C1.** Required water flow or foam basd on fire condition	5	6		
3rd	**C2.** Location of available areas of refuge, staging areas	8	3		
1st	**C3.** Location and condition of deployed and standing-by responding units	8	3		
	C4. Local weather conditions and predictions, wind direction and velocity	5	5	1	
	C5. Locations of building entrance/exit signs	7	4		
	C6. Contact information of other emergency agencies	10	1		

(author's illustration, 2019)

Participant's role

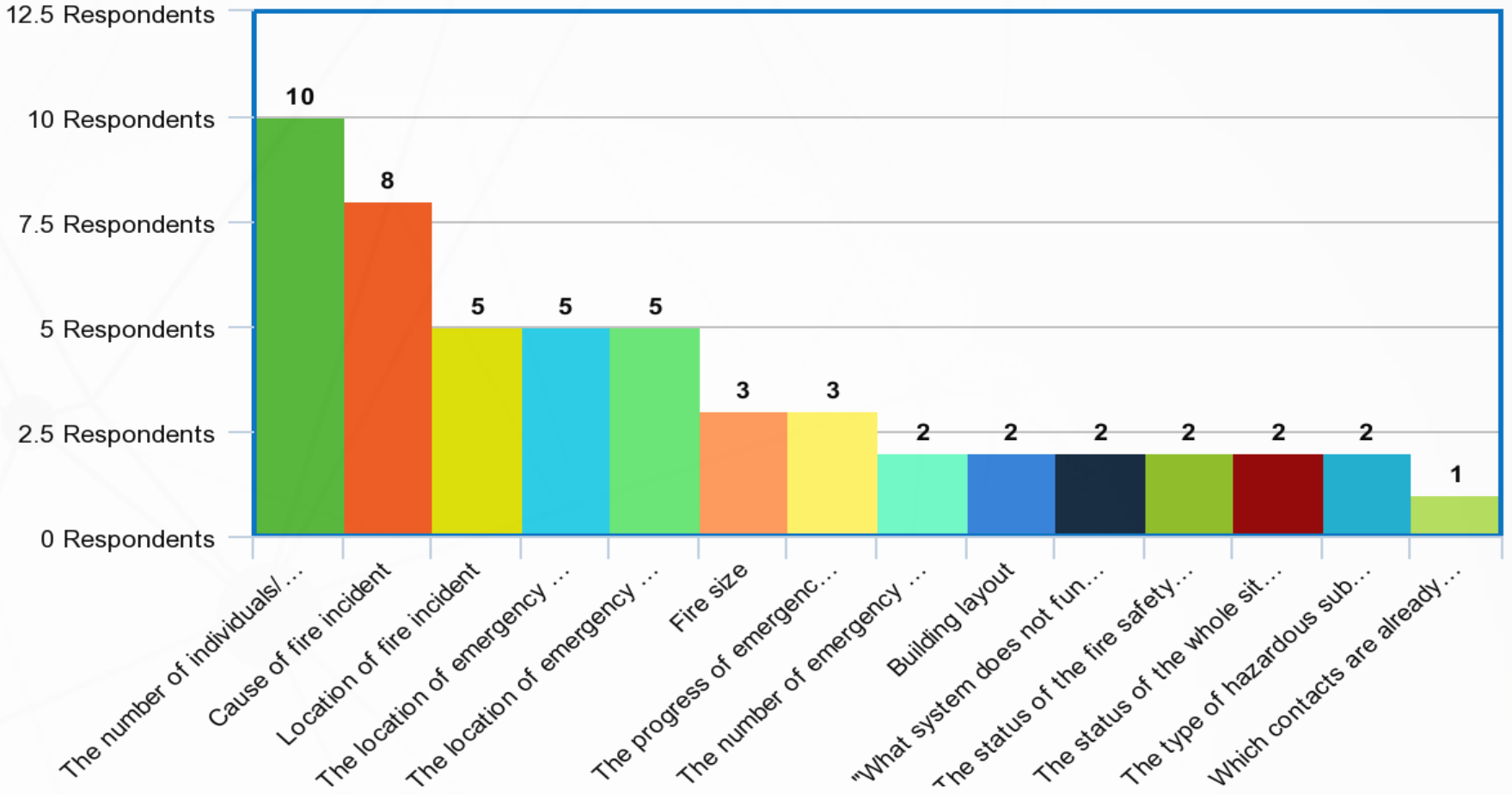
Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

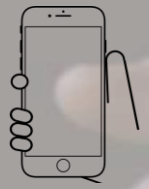
The most important information in general according to the participants



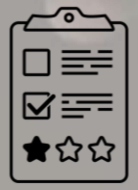
(author's illustration, 2019)

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

Desired emergency app

Conclusion:

- Many information items examined by Li et al. (2014) seems to **correspond** to the information needs of the participants

- The most important information in general according to the participants:

1. The number of victims in the building
2. Cause of fire incident
3. Location of fire incident
4. Location of first responders
5. Location of emergency service (e.g. firefighters)

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

Positive

Building Management Coordinator (TUD)

'Receiving relevant information contribute the situational awareness.'

Team leader Safety & Crisis Management (LUMC)

'Emergency apps contribute to the situational awareness.'

Safety officer (UT)

'Emergency apps are helpful for first responders.'

Facility Manager (TUD)

'Emergency apps contribute to the situational awareness due to receiving facts.'

Doubtful

Facility Manager (TUD)

'A combination of traditional communication tools and emergency apps can be useful, but real-life contact is preferable.'

Head of emergency response team (RU)

'It is an added value if the emergency app is reliable.'

Project leader Facility Service Center (UU)

'Emergency apps are useful to alarm first responders, but people are more reliable than technologies.'

Unconvinced

Head of emergency response team (UVA)

'Emergency apps do not improve situational awareness.'

Manager Crisis Management (LUMC)

'ICT network is not reliable and WI-FI network does not work one-hundred percent correctly.'

Emergency Coordinator (RU)

'Cannot rely on the techniques of emergency apps. Skilled and trained fpeople do the job.'

Fire Safety Coordinator (TUD)

'Reliability of the emergency app is the biggest threat.'

Director Facility Service Center (UU)

'Manpower are more reliable than technologies.'

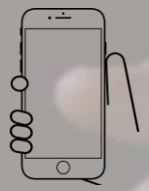
Participant from the ***strategic*** level

Participant from the ***operational*** level

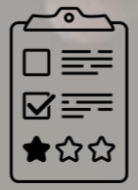
(author's illustration, 2019)

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

Desired emergency app

Conclusion:

- Most participants from the **strategic level** are **'unconvinced'** in regard to the contribution of smart emergency apps during a fire incident

- Most participants from the **operational level** are **'positive'** and **'doubtful'** in regard to the contribution of smart emergency apps during a fire incident

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

Criteria	Importance based on Li et al. (2014) (ranking)	Agreement Respondents (#)	Options								
			EMS app	iRescue	My disaster droid	NerveCentre	Picasse	Rescue mate	RescuePal	Rescuer app	SmartRescue
Before arrival to scene											
A1. Building occupancy (number and identities of occupants, based on time of day)	2nd	8/11							✓		✓
A2. Building layout and site plan (building size, construction tye, floor plans)		7/11							✓		✓
A3. Location of water sources nearby (fire hydrants, fire department hookups for sprinkler system, standpipes	3rd	5/11									
A4. Routing information to the building and area map of the neighborhood of the building	1st	7/11			✓					✓	
A5. Contact information of building owners, managers and utility contacts		8/11	✓			✓	✓				
A6. Hazards, location and identification of unusual hazards		11/11									
A7. Location of important objects (facilities, documents, equipment to be saved)		8/11				✓					

Recommended emergency app, in terms of information provision

(author's illustration, 2019)

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

Criteria	Importance based on Li et al. (2014) (ranking)	Agreement Respondents (#)	Options								
At emergency scene			EMS app	iRescue	My disaster droid	NerveCentre	Picasse	Rescue mate	RescuePal	Rescuer app	SmartRescue
B1. Location of fire in the building, fire size, and duration	1st	11/11	✓			✓	✓			✓	✓
B2. Sprinklers' status (number of location of sprinklers that have gone off)		9/11									
B3. Presence and location of occupants in the building	2nd	10/11		✓					✓	✓	✓
B4. Location and condition of smoke	3rd	10/11									
B5. Warnings of structural collapse based on material type, fire location, fire size, and duration		10/11									
B6. Confidence in the fire being real		9/11									

Recommended emergency app, in terms of information provision

(author's illustration, 2019)

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

Criteria			Options								
Attack and mitigation	Importance based on Li et al. (2014) (ranking)	Agreement Respondents (#)	EMS app	iRescue	My disaster droid	NerveCentre	Picasse	Rescue mate	RescuePal	Rescuer app	SmartRescue
C1. Required water flow or foam based on fire condition	2nd	5/11									
C2. Location of available areas of refuge, staging areas	3rd	8/11									
C3. Location and condition of deployed and standing-by responding units	1st	8/11	✓			✓		✓		✓	
C4. Local weather conditions and predictions, wind direction and velocity		5/11									
C5. Locations of building entrance/exit signs		7/11									
C6. Contact information of other emergency agencies		10/11	✓			✓	✓				

Recommended emergency app, in terms of information provision

(author's illustration, 2019)

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

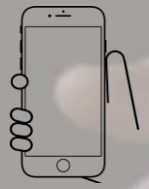
Criteria	Agreement Respondents (#)	Options								
5 *most important* **information according to interviewees**		EMS app	iRescue	My disaster droid	NerveCentre	Picasse	Rescue mate	RescuePal	Rescuer app	SmartRescue
The presence of individuals and victims in the building	10/11		✓					✓	✓	✓
Cause of fire incident	8/11									
Location of fire incident	5/11				✓	✓			✓	✓
Location of emergency response officers	5/11	✓			✓		✓		✓	
Position of emergency services (e.g. where are the fire fighters)	5/11									

Recommended emergency app, in terms of information provision

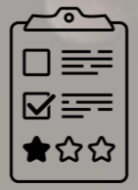
(author's illustration, 2019)

Participant's role

Information needs



Perception in the use of emergency apps



Multi-criteria analysis

Desired emergency app

Conclusion:

- Much information in 'before arrival to scene' are covered by emergency apps.
- A few information in 'at emergency scene' and 'attack and mitigation' are readily available in emergency apps
- Much essential information according to the participants are included in the current emergency apps

Participant's role

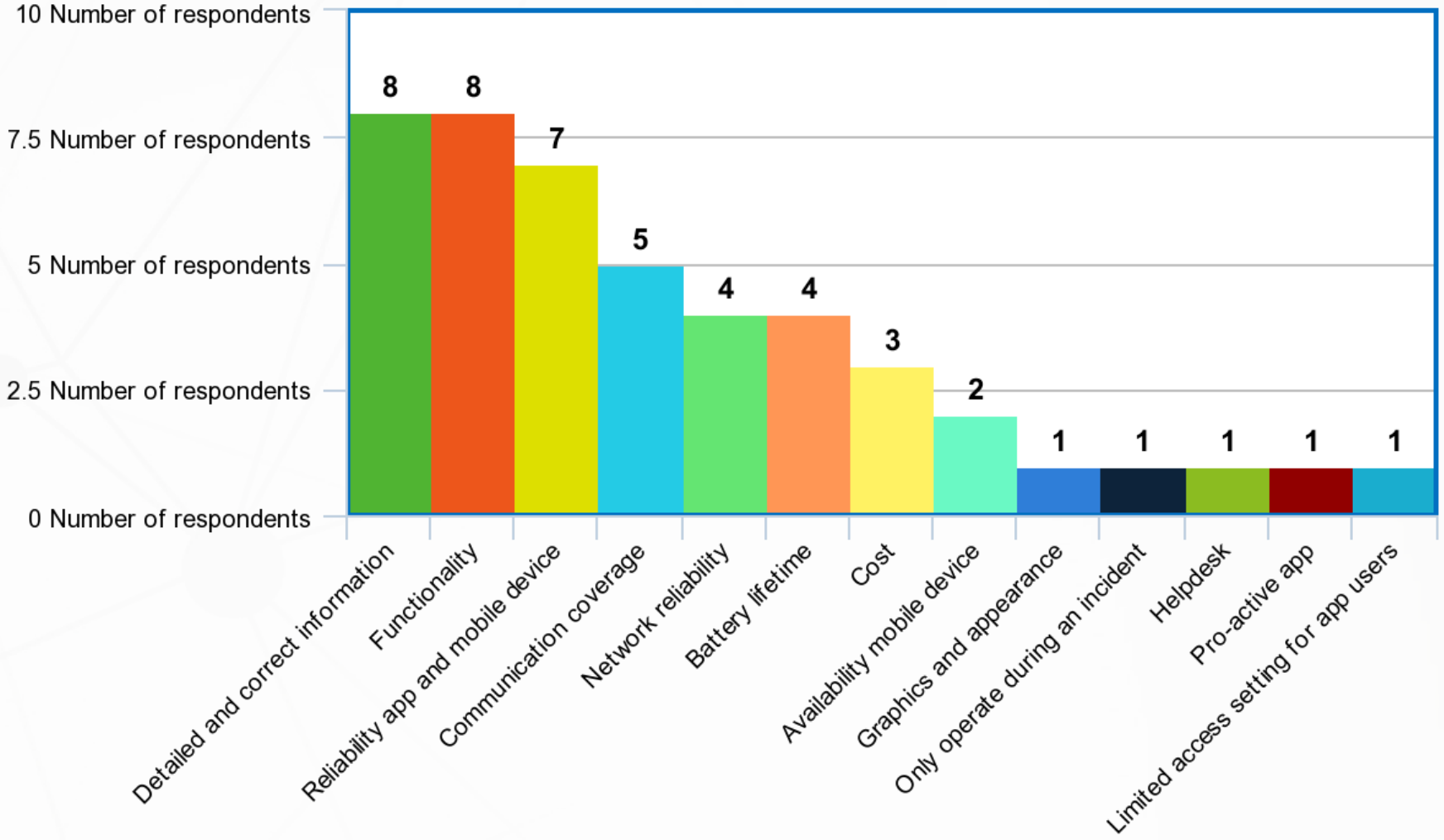
Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

Preferences regarding the use of emergency apps



(author's illustration, 2019)

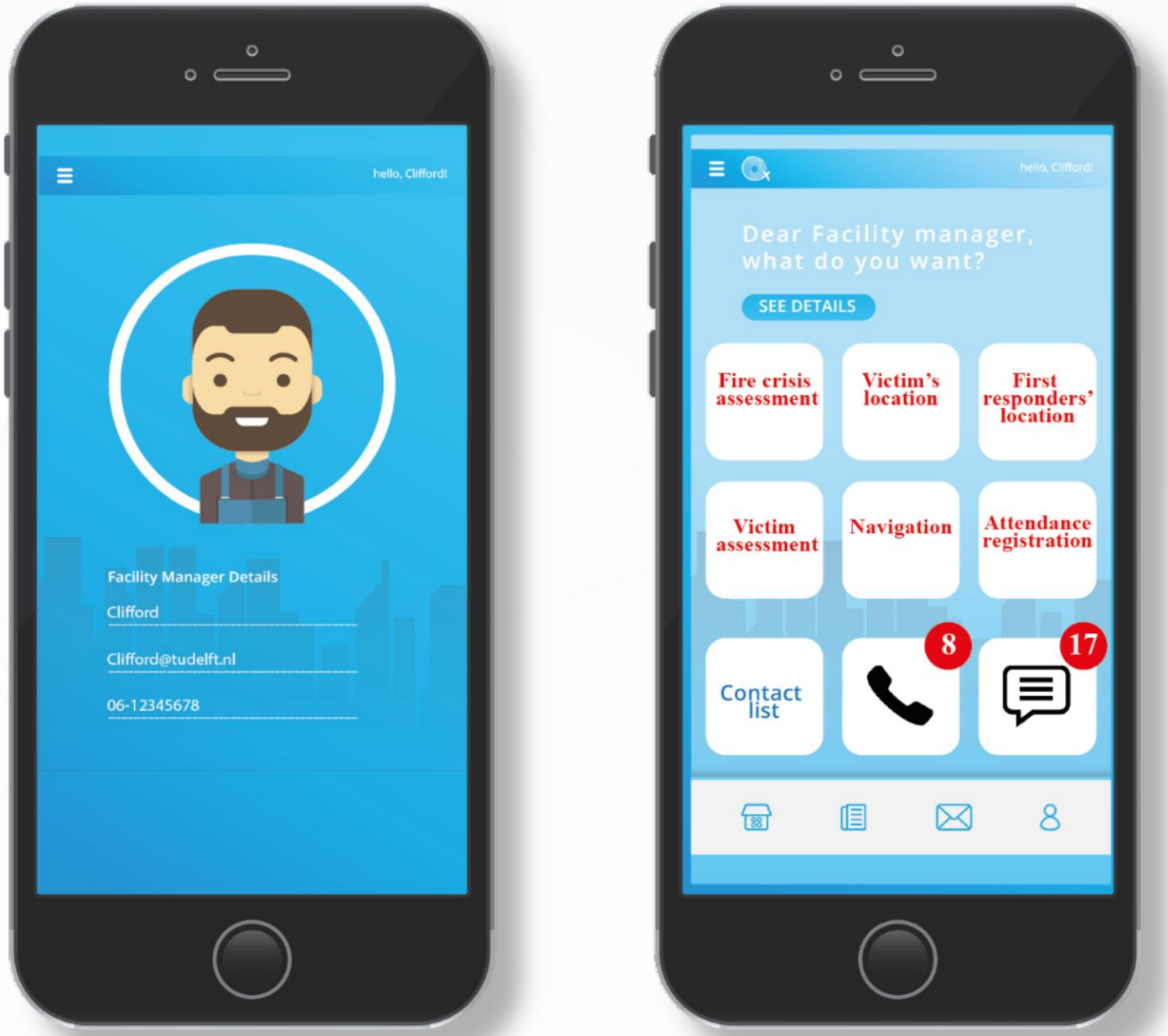
Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app



Desired emergency app (author's illustration, 2019)

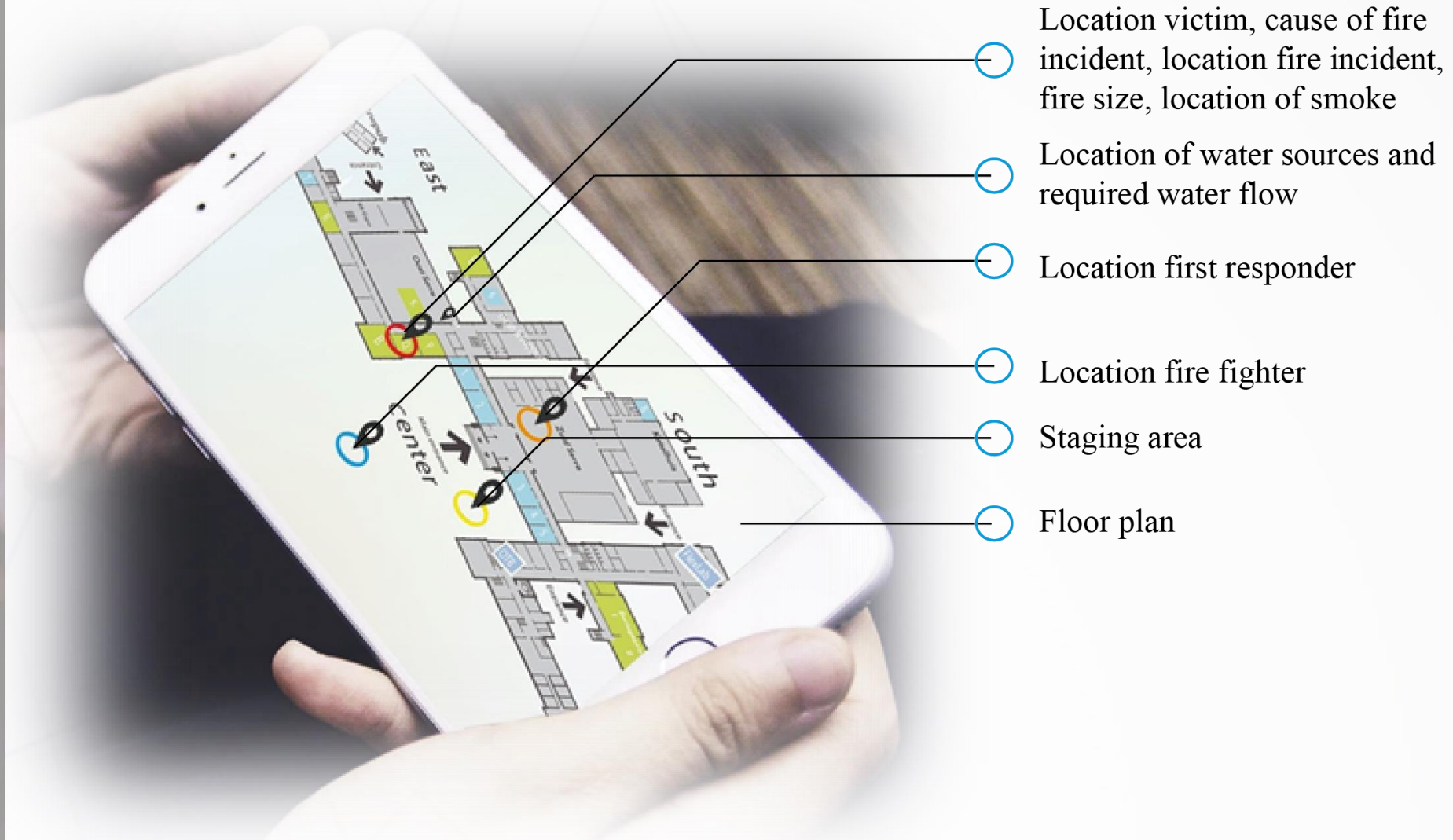
Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app



Desired emergency app (author's illustration, 2019)

Participant's role

Information needs

Perception in the use of emergency apps

Multi-criteria analysis

Desired emergency app

- Location fire incident;
- Navigator;
- Distance to fire incident.

Real-time walking direction

Desired emergency app (author's illustration, 2019)

Conclusion

Main research question

Concluding remarks

Further research

Main research question

Concluding remarks

Further research

‘ How can current **smart emergency applications**, in terms of **information provision**, contribute to the **mitigative barrier** in order for the **facility managers** to improve their **situational awareness** in building fire emergency response operations? ’

Main research question

Concluding remarks

Further research

The role of the facility manager in a fire incident

- Environment, health and safety;
- emergency preparedness;
- fire safety system maintenance;
- recover supporting services.

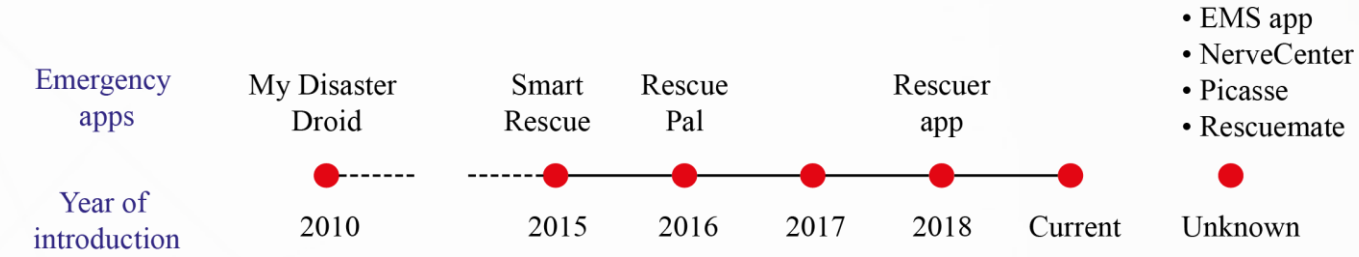
Facility manager in relation to the BowTie

Facility manager at the mitigative barrier during a fire incident

Information items

Relevant information needed during a fire incident according to Li et al. (2014) which is divided in three different phases.

Smart tools

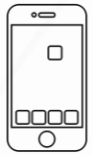


Main research question

Concluding remarks

Further research

‘Before arrival to scene’:
Much information are readily accessible in the current emergency apps when needed;



‘At emergency scene’ and **‘attack and mitigation’:**
Small number of information items are available in the current emergency apps;

Most important information suggested by the participants are obtainable in the current smart emergency apps.

‘Cause of fire incident’ and ‘position of emergency service’ is not covered by the current emergency apps

Main research question

Concluding remarks

Further research

Participants from operational level **agree** that the use of smart emergency apps will **improve** the situational awareness due to receiving facts and relevant information;

Most participants from the strategic level are not convinced yet in using smart emergency apps because they rely more on manpower than on the current technologies.

- Include the most important information and functionalities;
- Enable direct communication and real-time walking direction;
- Improve and maintain the reliability of the app and network, communication coverage and battery lifetime.

Main research question

Concluding remarks

Further research

Extension participants population

Invite participants from international universities

Invite participants with experience in the use of emergency apps

Extend smart emergency apps criteria

A special thank you goes to Prof.dr.ir. A.C. den Heijer, Prof.dr.ir. P.H.A.J.M. van Gelder, Ir. B. Valks and all interviewees for their valuable input during this research

Image adapted from braaksma-roos.nl