

MODELLING AND MAPPING PEOPLE MOVEMENT IN HOSPITALS

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OUR TEAM | KEY TEAM MEMBERS



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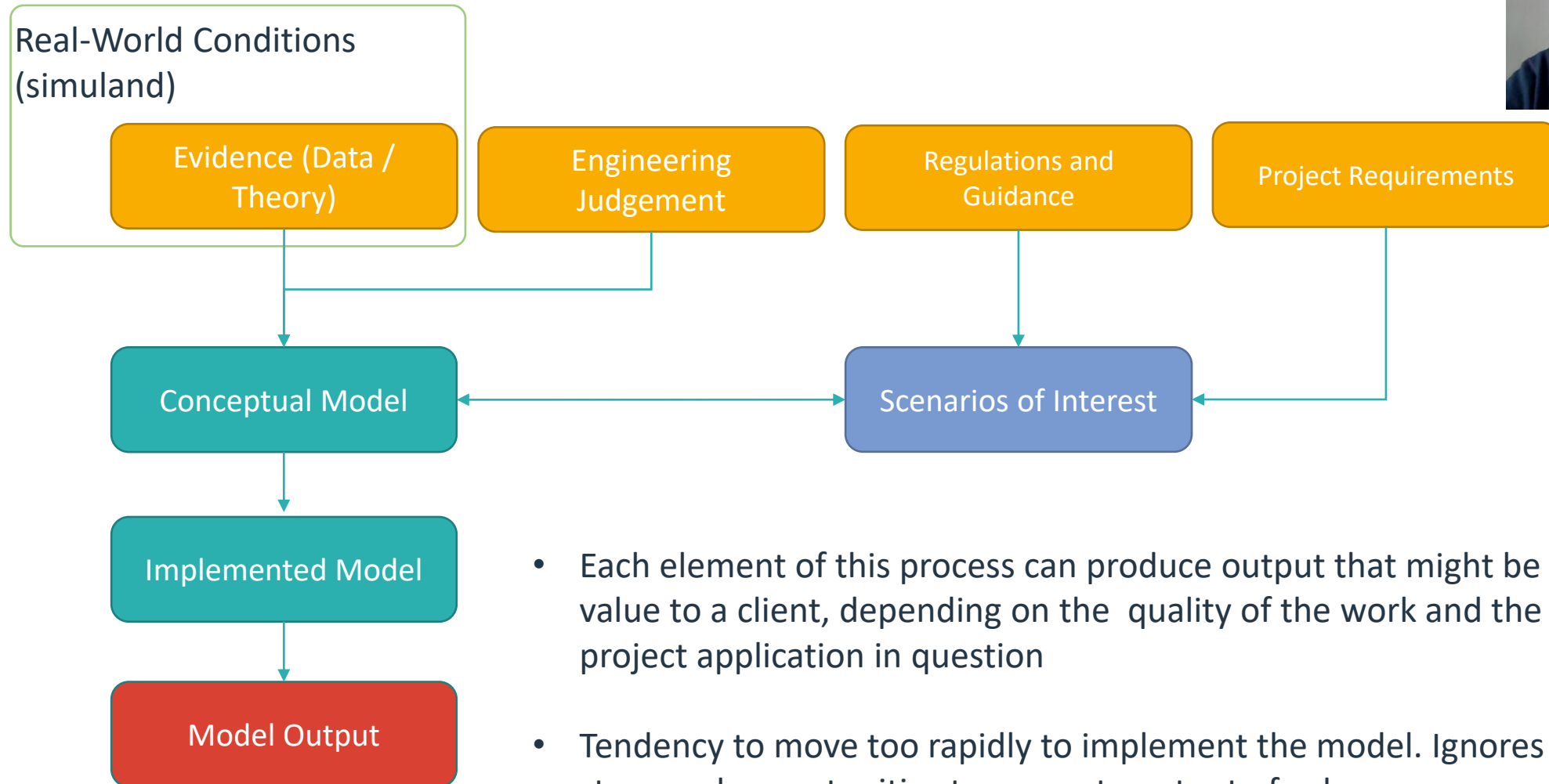
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Overview

- Modelling Process – Complexity of Healthcare
- Key modelling activities
- Example modelling applications
- Conclusions

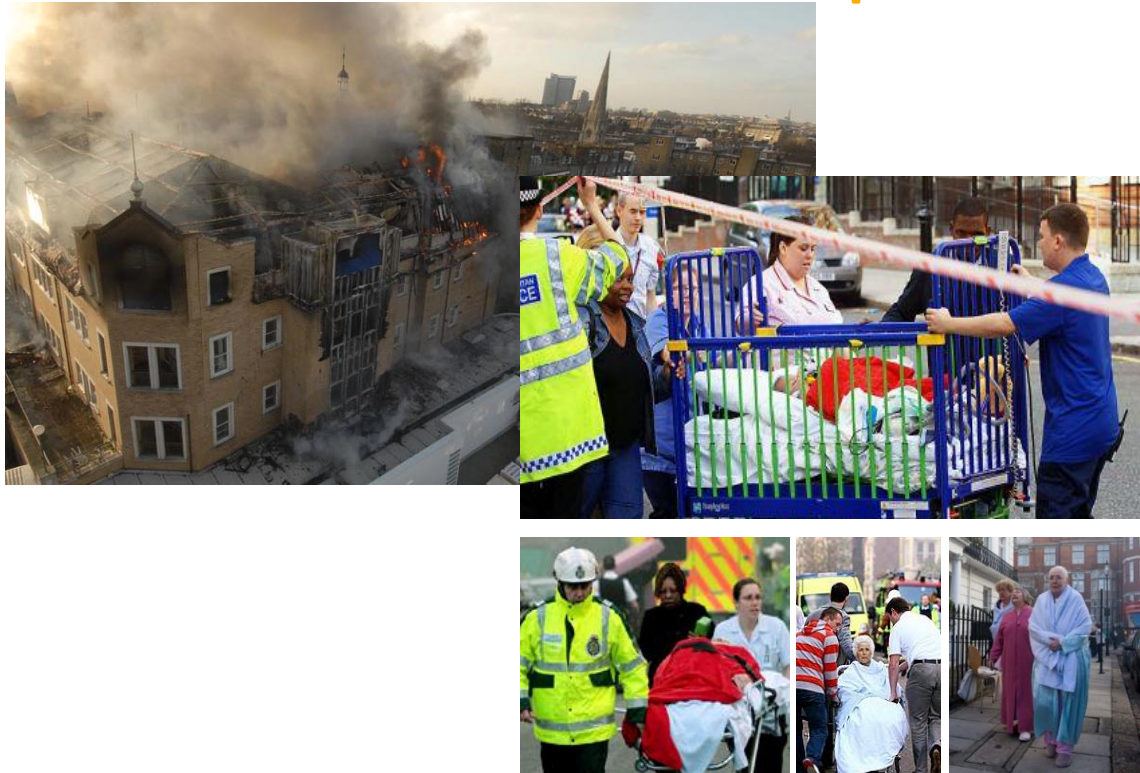


MODELLING PROCESS



- Each element of this process can produce output that might be of value to a client, depending on the quality of the work and the project application in question
- Tendency to move too rapidly to implement the model. Ignores key steps and opportunities to generate output of value.

NATURE OF THE PROBLEM | SCENARIOS OF INTEREST



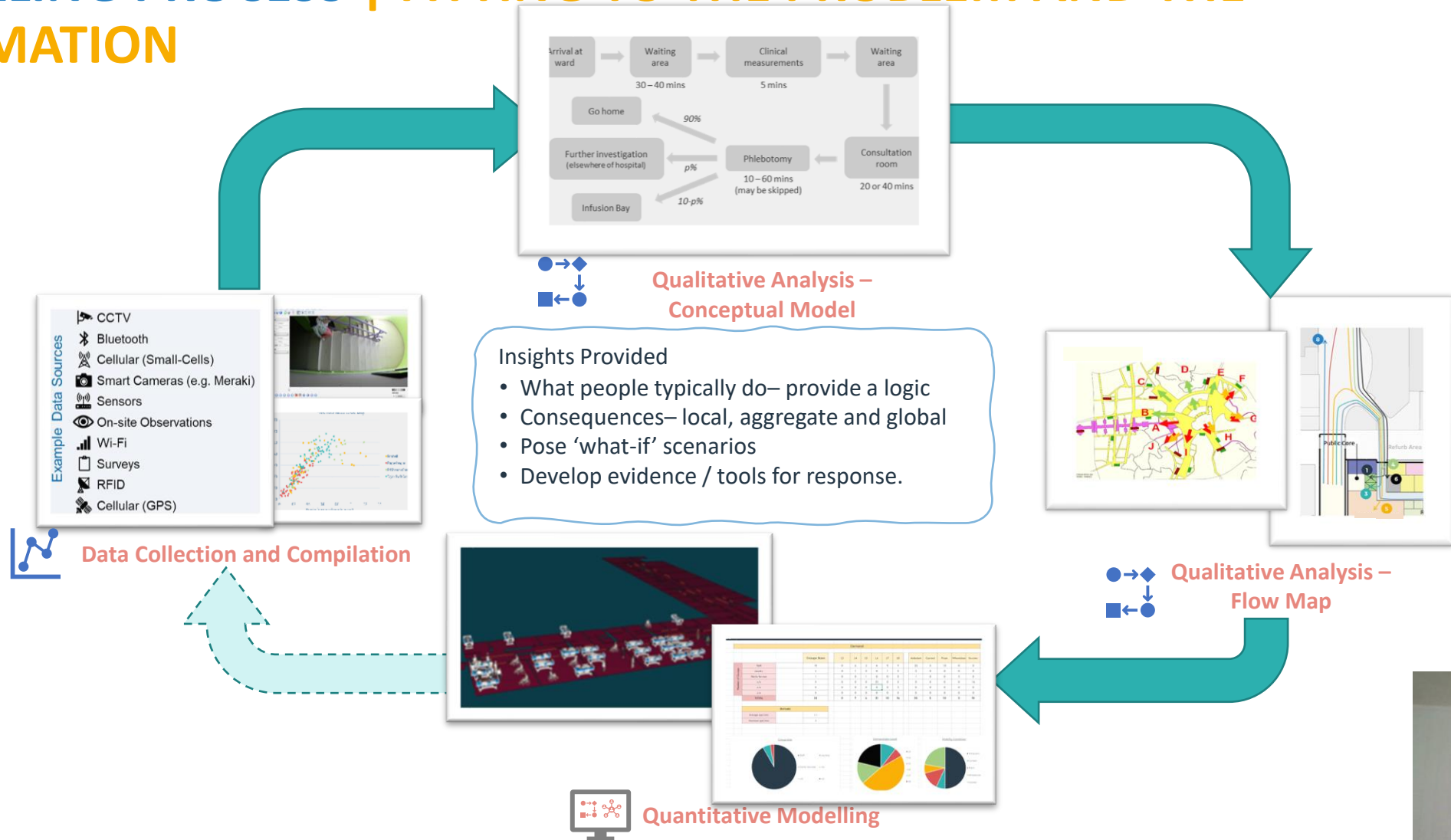
Fire Safety Risk Assessment: Healthcare Premises

- “Where lobbies are provided in buildings using progressive horizontal evacuation involving beds or trolleys, **it is likely that at some point vertical evacuation using mattresses will be necessary**. Therefore, the lobby should be capable of accommodating a mattress.”

- >1000 fires in UK hospitals / homes each year.
- **Complex scenarios.**
 - Convoluted / specialized spaces.
 - Dependency on staff procedures and expertise.
 - Demographic shift - more people of reduced mobility.
 - Movement assistance is vital.
- **Complexity amplifies importance of subject matter expertise and opportunities for valuable feedback.**



MODELLING PROCESS | FITTING TO THE PROBLEM AND THE INFORMATION

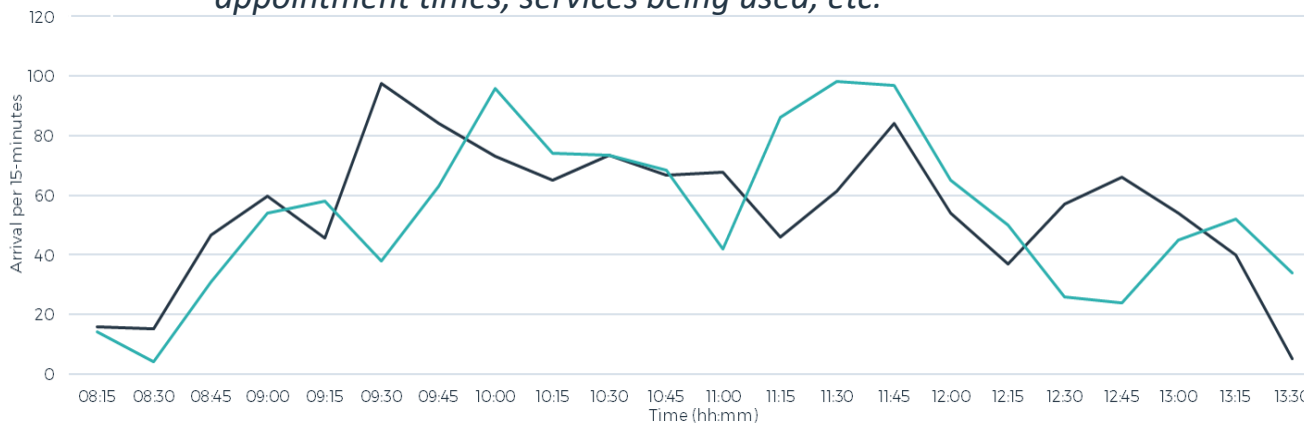


BASELINE UNDERSTANDING | DATA COLLECTION

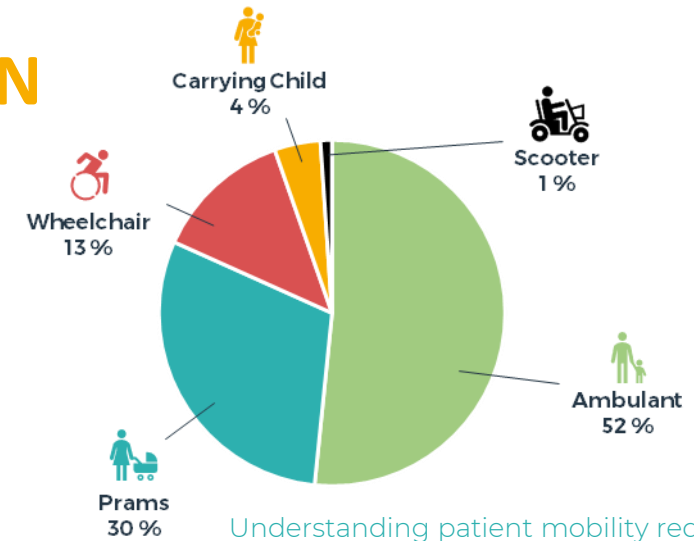
Capturing data on the flows of patients, visitors and staff throughout the hospital:

- Conducting Observations (e.g. patient/staff arrivals movement)
- Analysis of CCTV/ Camera Footage / Sensor data
- Conducting Surveys/Interviews of Staff and Patients

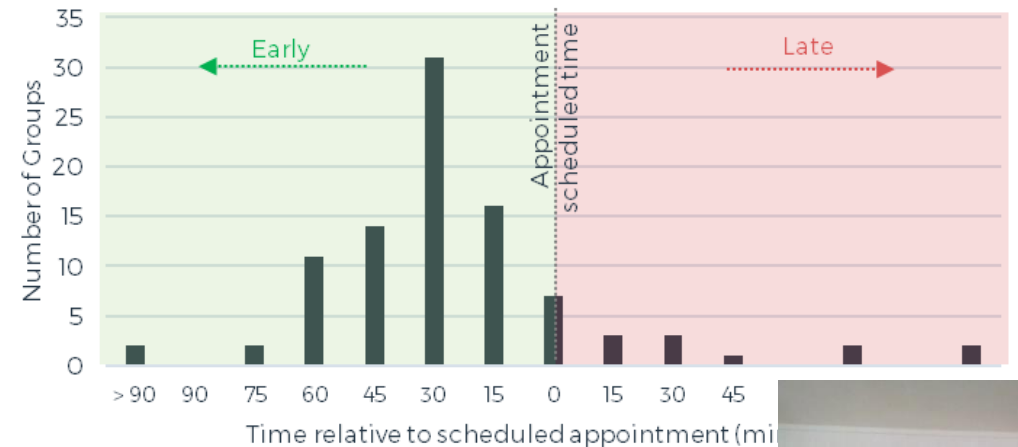
- For instance, demographics, purpose, experience, journey, appointment times, services being used, etc.



Understanding visitor arrivals over time

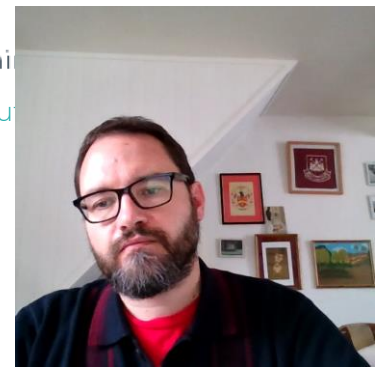


Understanding patient mobility requirements

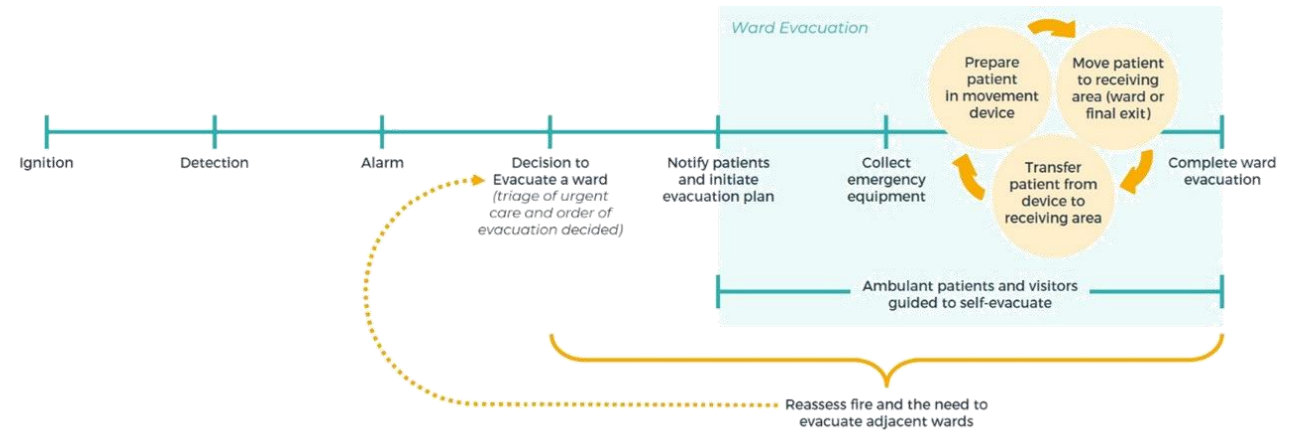
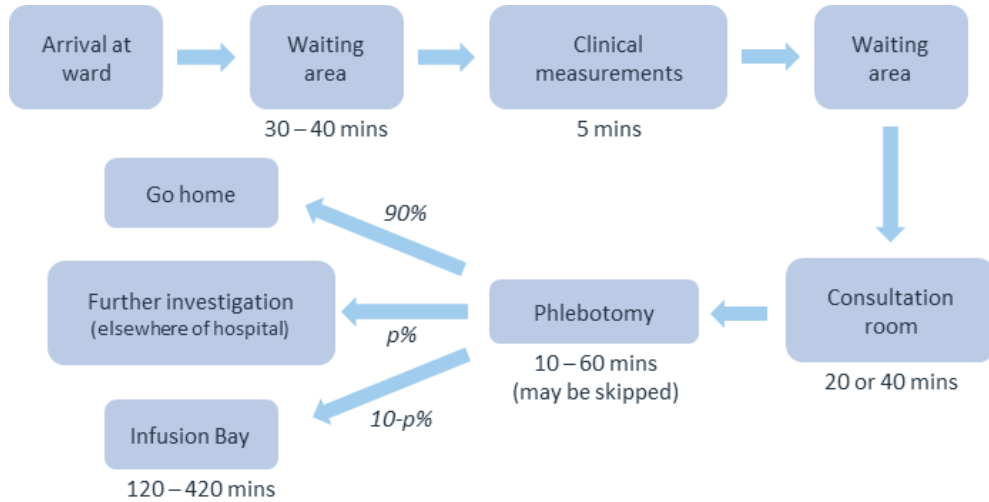


Understanding our

- Evidence critical to identify scenarios, set initial conditions, and support population performance.



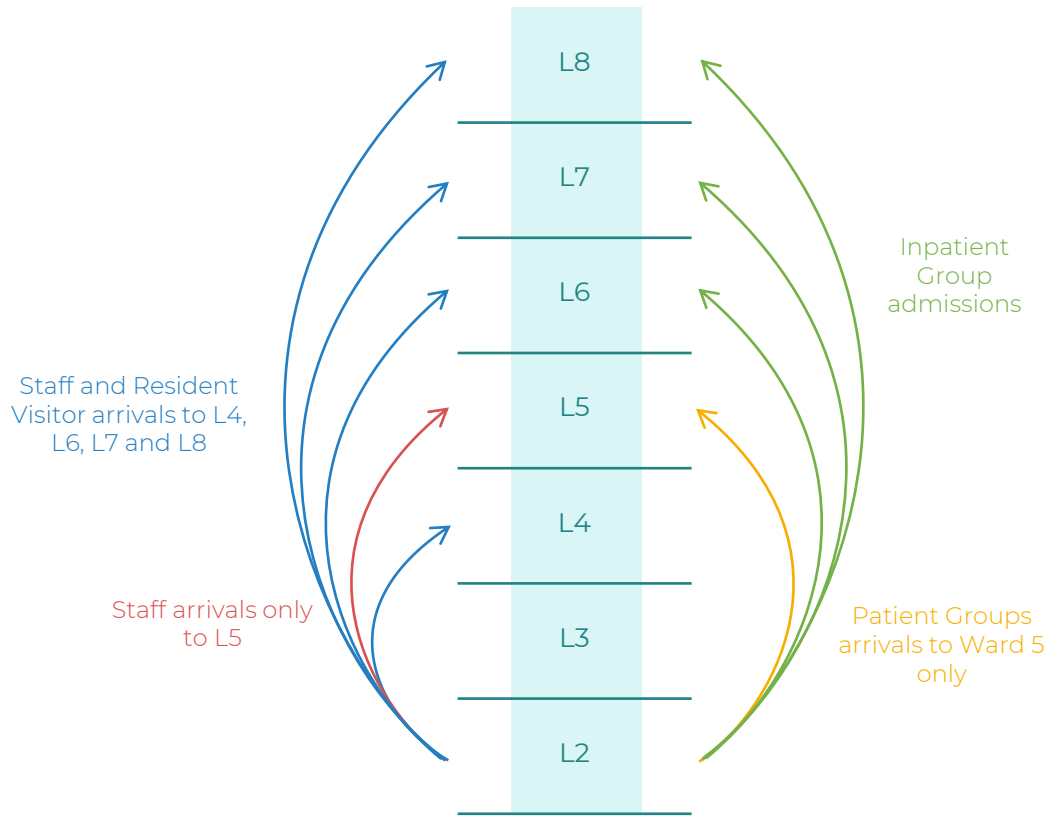
BASELINE UNDERSTANDING | INDIVIDUAL TIMELINE AND LOGIC



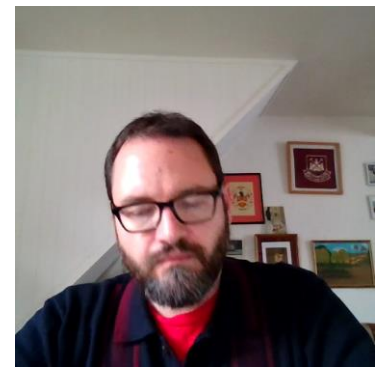
- What people might do, when and how it might affect the outcome.
- Timelines for individuals, processes or whole event (e.g. evacuation timeline)
- **Fundamental processes that need to be reflected in the model being used.**



BASELINE UNDERSTANDING | ROUTE USE AND LOADING



- How the decision-making logic, procedures and timelines interact with the space being examined.

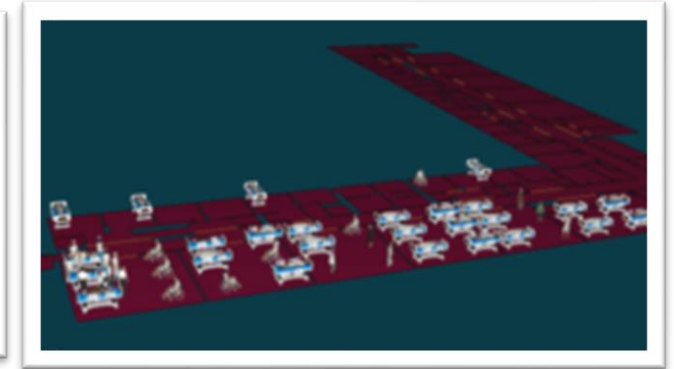
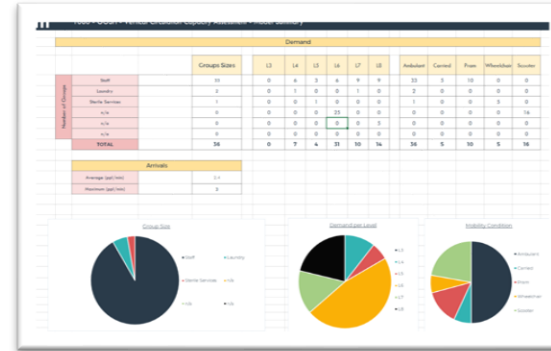


MODEL APPLICATION | SELECTION, CONFIGURATION AND USE

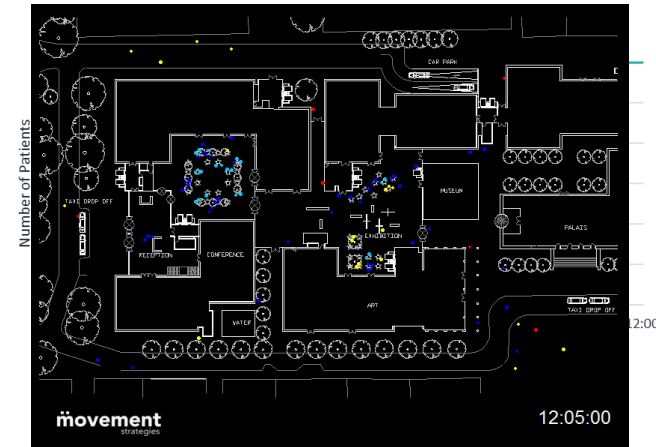


- Combining the factors into representative scenarios:
 - Client Questions
 - Project Questions
 - Situational Factors
 - Structural Factors
 - Population Factors
 - Procedural Factors
 - Environmental Factors
 - Behavioural Factors
 - Evidence Factors
 - Regulations / Guidance Constraints
 - Performance Questions
 - Output Requirements
- Depends on data available, the type of model use, etc.

- Selecting a model that fits the scenarios and data available



- Data that can be produced and that is needed





EVACUATION ANALYSIS | EXAMPLE 1

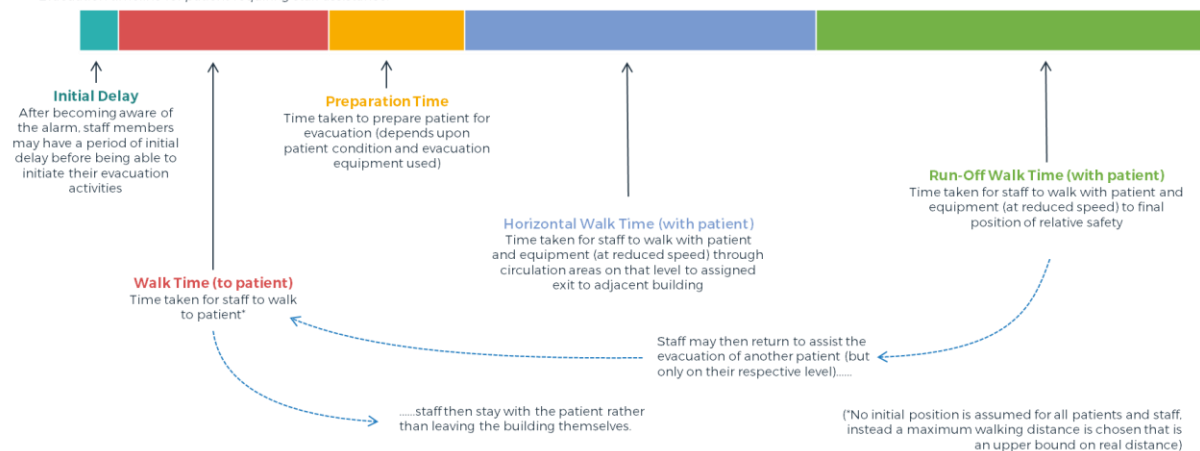
Project requirements:

- Building in place
- Limited understanding of precise procedures to be employed throughout
- Concern over viability of evacuation procedure.

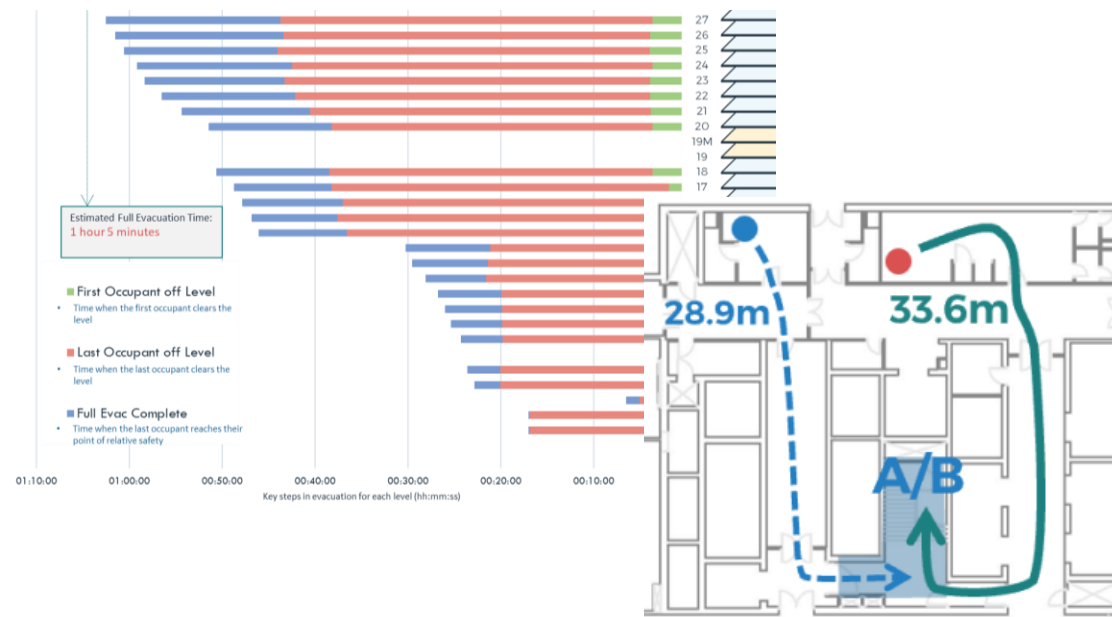
Engineering calculations to assess full building evacuation:

- ~3,500 patients, staff, visitors.
- Range of mobility conditions – requiring bed, wheelchair, staff assisted and self-evacuation
- **Objective – potential evacuation that might be achieved and the factors that might improve upon this.**

Evacuation timeline for patient requiring staff assistance:



Scenarios factors: staffing levels, maximum occupancy current egress route availability, horizontal and vertical evacuation to place of safety.



Engineering calculations applied across set of scenarios to assess robustness of current evacuation approach given variation in occupancy levels and procedure.

CIRCULATION ASSESSMENTS | EXAMPLE 2 - DATA COLLECTION

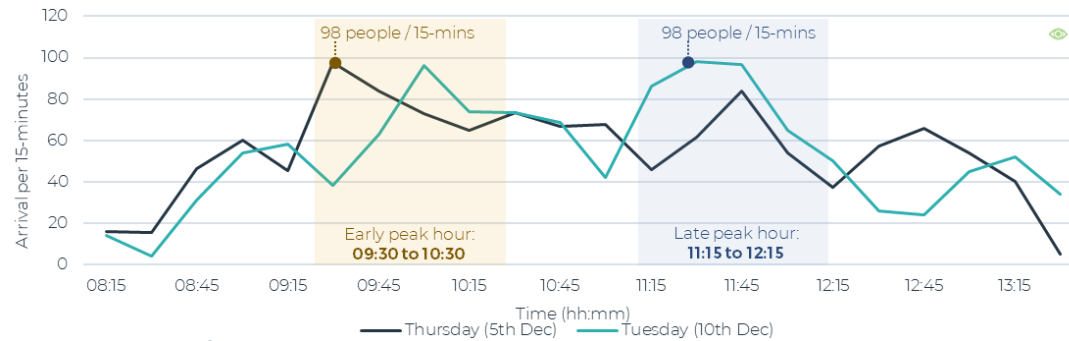


Early in design phase – design still in flux

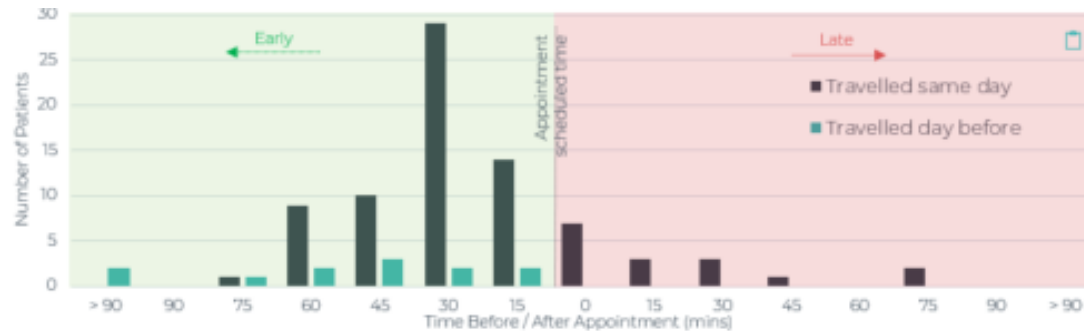
Client needed feedback on

- Circulation / evacuation of proposed design
- Interaction with existing parts of the structure

Combination of engineering calculations and simulation used.



- The arrival profile at a hospital main entrance



- The distribution of arrival time relative to appointment time

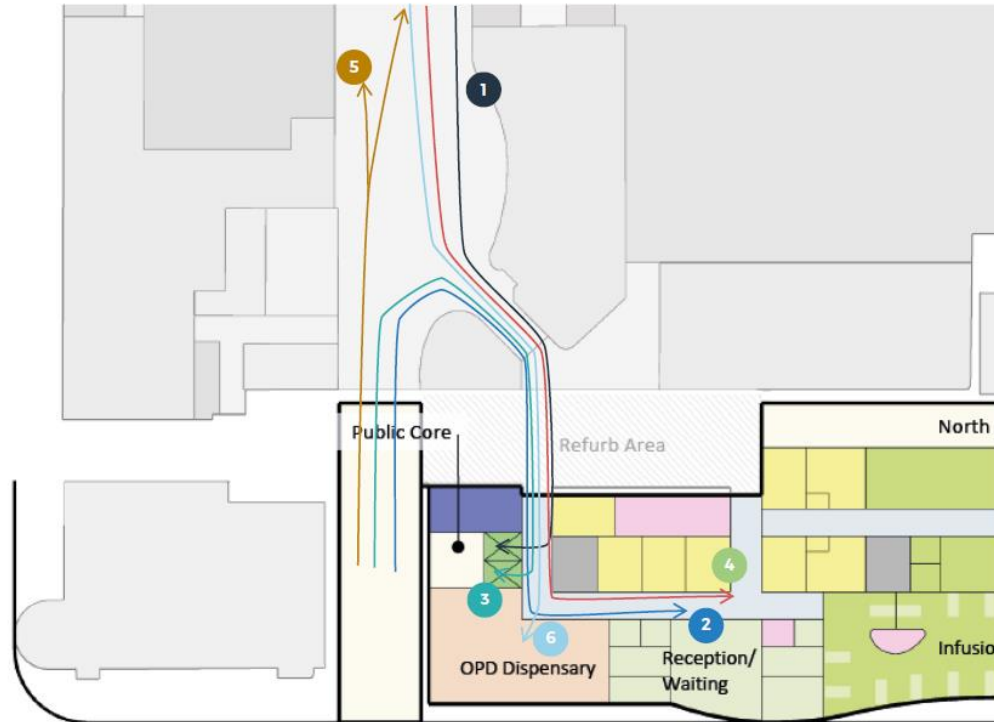
Data Collection Activities



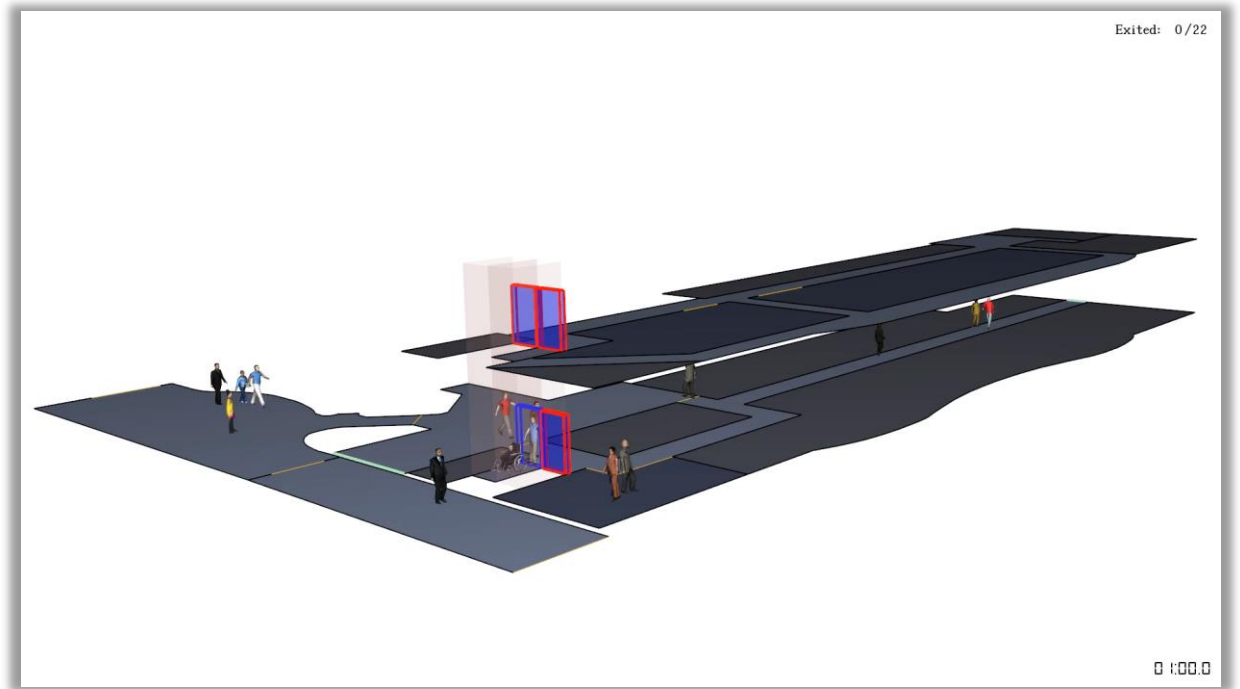
- Informed client of current patient population, arrival profiles and precise patterns of movement – even before and modelling had been conducted.

CIRCULATION ASSESSMENTS | EXAMPLE 2 - INTERIOR FLOWS

Qualitative Modelling



Dynamic Modelling

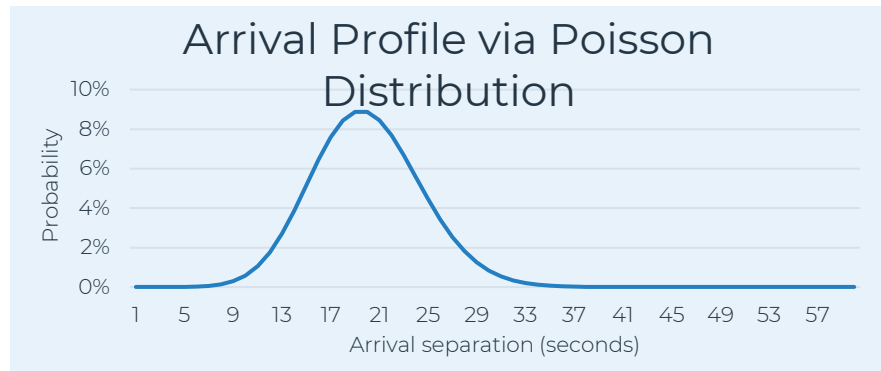
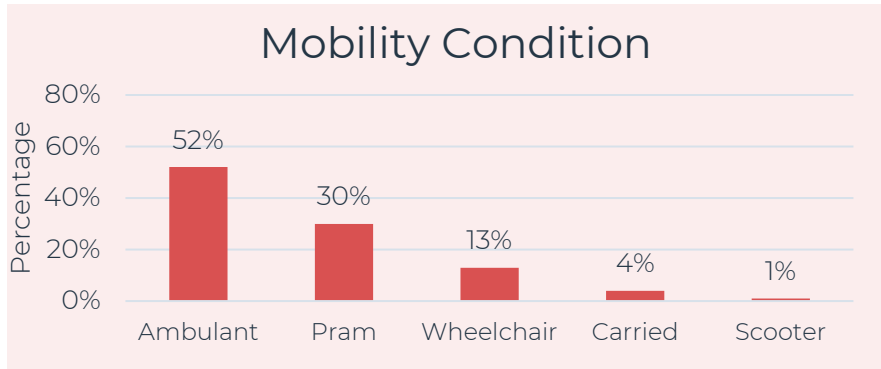


Pathfinder

- Implications:
 - Outpatient groups arrivals
 - Visitor arrivals
 - Staff/Impatient internal movements
 - School flow
- **Identified challenges to the new design**



BESPOKE OUTPUT DESIGN | EXAMPLE 2



RESULTS | PHASE 1

Scenario C (6 Lifts)

UPPEAK POISSON 6 LIFTS

CIBSE Performance Criteria

Quantity of Service	Demand Spread:	Av. Handling Capacity (H):	07:51	PASS - 100%	FAIL - 0%
Quality of Service	Av. Waiting Time (WtI):	Av. Interval (INT):	00:30	00:30	CIBSE Category: Average (> 25s)

User Experience

Average Journey Time: (lobby waiting time + transit time)

Min:	02:15
Average:	02:34
Max:	02:53

Min: 00:18, Average: 00:23, Max: 00:32

Lift Bank

Lift Utilisation:	Lift	1	2	3	4	5	6	7	8	Average:
Use		97%	96%	95%	95%	94%	93%	-	-	95%

Bank footprint size: Minimum single lift: 2.24m² | Minimum lift bank footprint area: 13.44m²

Peak Queue

Predicted Peak Queue Size (people): Min: 7, Average: 11, Max: 16

Predicted Peak Queue Area (at target LoS: B): Min: 1.9m², Average: 5.3m², Max: 7.8m²

Indicative Peak Queue Area In Lobby (at target LoS: B): Queue (5.3m²), Dispensary, R€

Summary

- 6 lifts provides enough handling capacity (100% PASS) and 'Average' interval time (Quality of Service)
- Expected peak queuing area is 5.3m² at Level of Service B
- Average lobby waiting time (23 seconds) is less than the highest recommended value

All times given in units of *mm:ss*

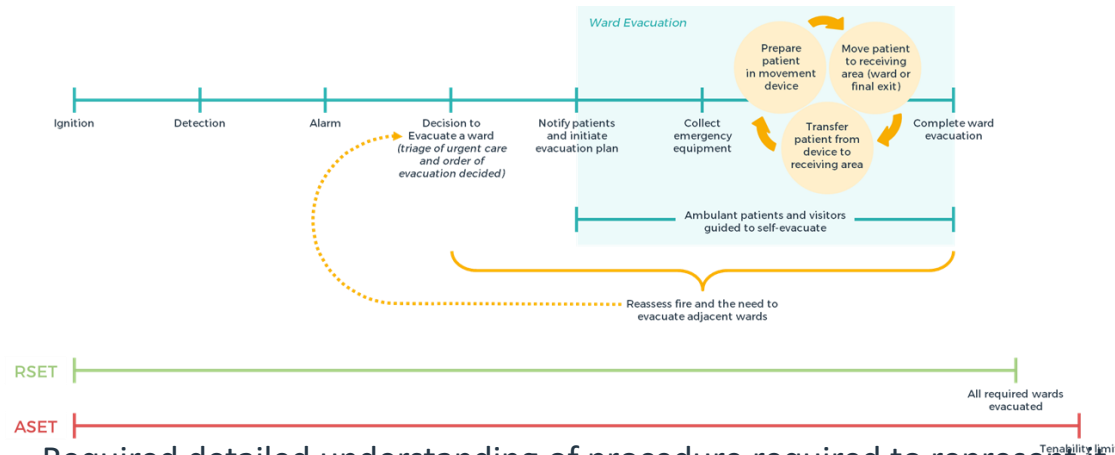
Combined core data collection, scenario assumptions and modelled output – qualitative and quantitative insights of design influence

EVACUATION ANALYSIS | EXAMPLE 3

- Analyse simultaneous horizontal evacuation
- Existing structure. Existing understanding of spatial design, staffing and procedure.

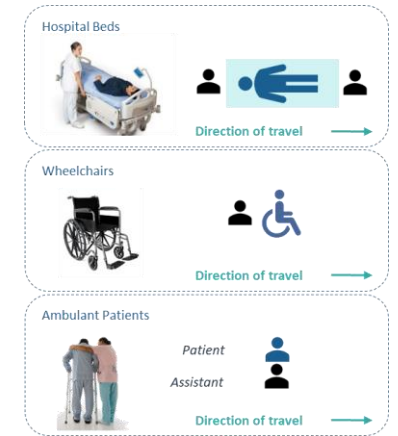


- Establish sensitivity of ASET to staff numbers and actions.



- Required detailed understanding of procedure required to represent it at individual-level in simulation tool.

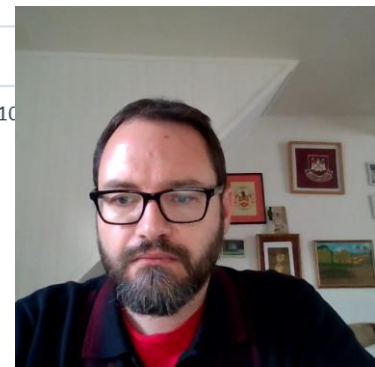
- Pathfinder simulation tool used in each scenario.
- Allowed performance sensitivity to staff numbers / actions to be compared.



- Enabled recommendation on:
 - staff training requirements, equipment location, procedural management.

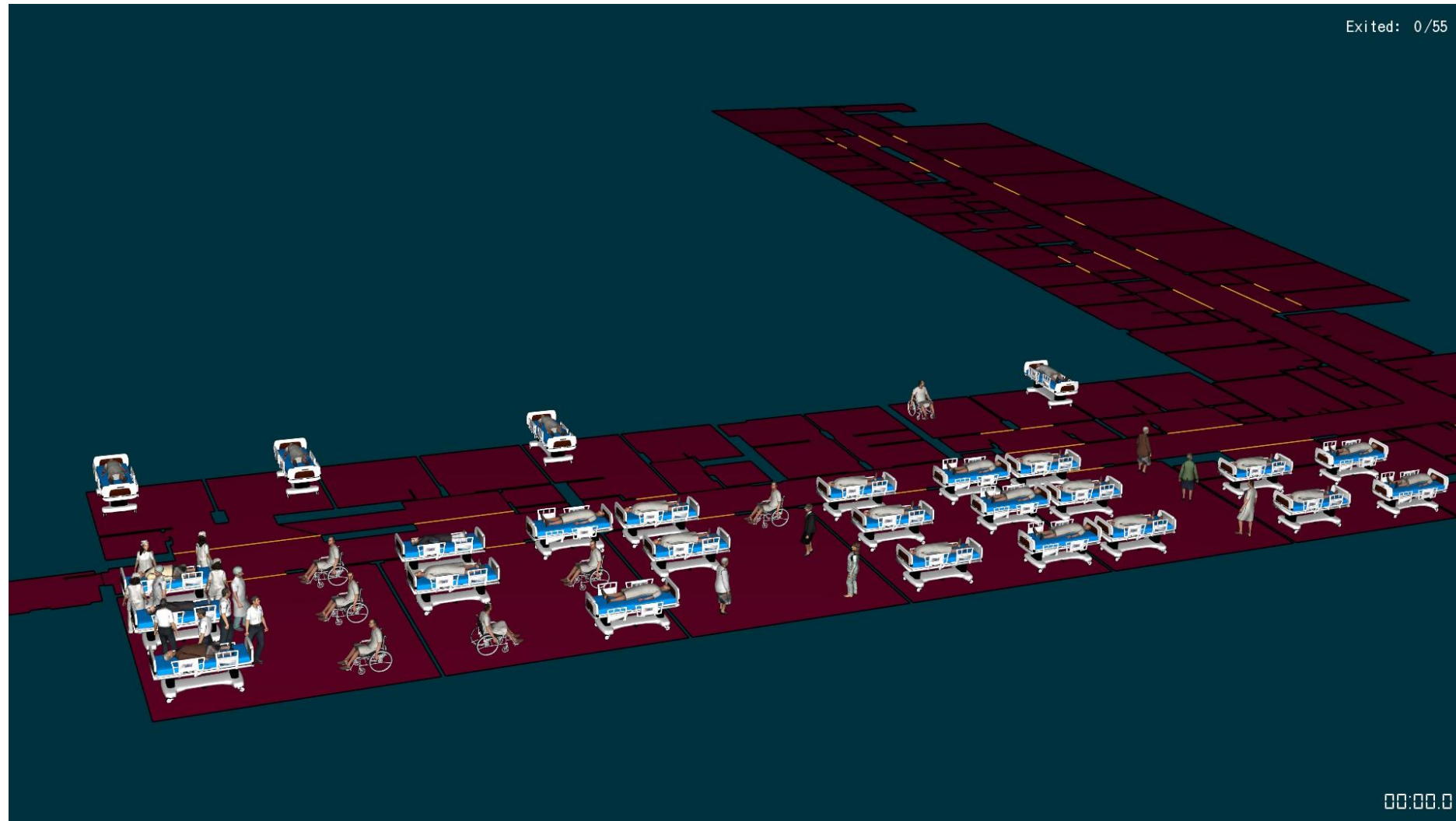


- Client more interested in refined assessment of limited number of indicators than deep dive across numerous scenarios.





EVACUATION ANALYSIS | EXAMPLE 3



Pathfinder



CONCLUSION



- Hospital movement is incredibly complex
- We need sufficient expertise/evidence to understand the problem and the requirements / limitations of our modelling approach
- Subject matter expertise is key
 - To set scenarios
 - To select models
 - To interpret the results and understand their value throughout the modelling process
- Valuable insights can be generated from multiple points in the process
 - Compiling/collecting data
 - Mapping existing processes and movement
 - Patient / staff narratives
 - Numerical model outputs
- Subject matter expertise is fundamental - to ensure credible modelling **and** to enable a wider variety of output to be produced.



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