THREATS

Terrorist attacks on Hospitals:
Risk & Emergency Assessment, Tools & Systems

Hospital's Vulnerability Assessment

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Co-funded by the Prevention, Preparedness and Consequence Management of Terrorism and other Security-related Risks Programme of the European Union

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Outline

- **The THREATS project,**
- **The static model of OSR,**
- **The dynamic model of OSR,**
- **A vulnerability approach,**
- **Mitigation and response.**

THREATS Objective

To increase the resilience of EU hospitals as critical infrastructure by improving their protection capability and security awareness against terrorist attacks

THREATS Aims

- To develop a reliable method for assessing the risks and vulnerabilities of major EU health infrastructures to terrorist attacks
- To prepare specific security and threat assessment models and tools applicable to the Health sector using other EU projects
- To challenge these tools through application to the San Raffaele Hospital in Milan
- To disseminate guidelines designed to optimize the preparedness of hospitals' healthcare infrastructures against terrorist attacks

THREATS Partners

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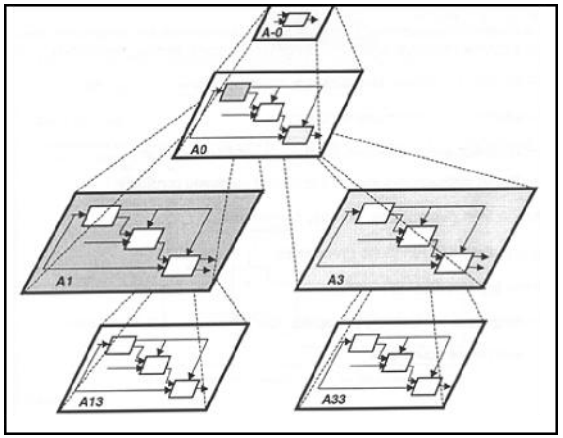
OSPEDALE SAN RAFFAELE

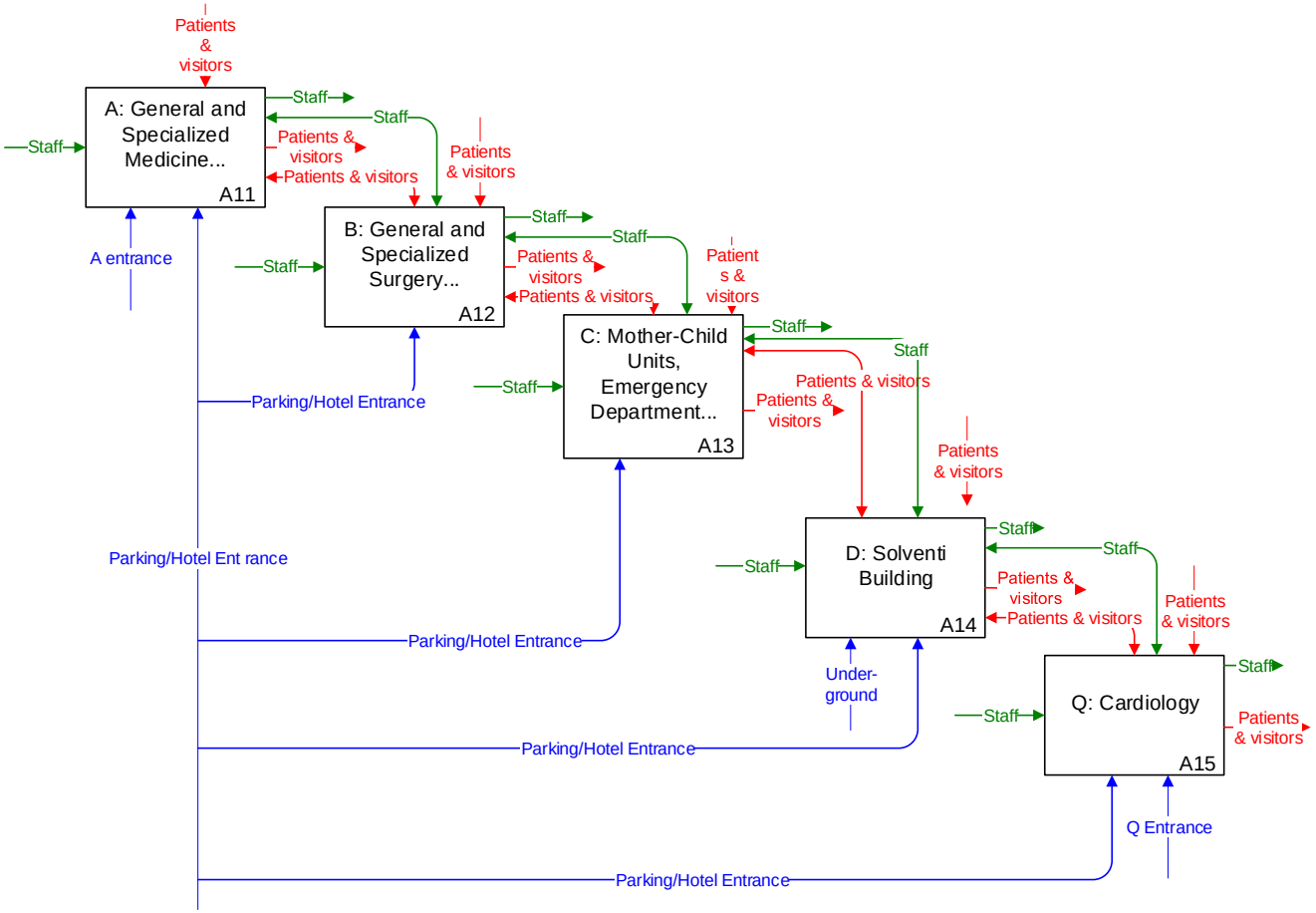
The static model

- To represent the “AS-IS” model of OSR.
- First, a physical decomposition to model the 11 buildings, the 49 speciality clinics, the 199 accesses between buildings/levels…
- Second, a functional decomposition to model the processes of some speciality clinics which define critical assets i.e. ED, OT, ICU…
- The selection of the IDEFØ method which allows both decomposition and defines a universal language…



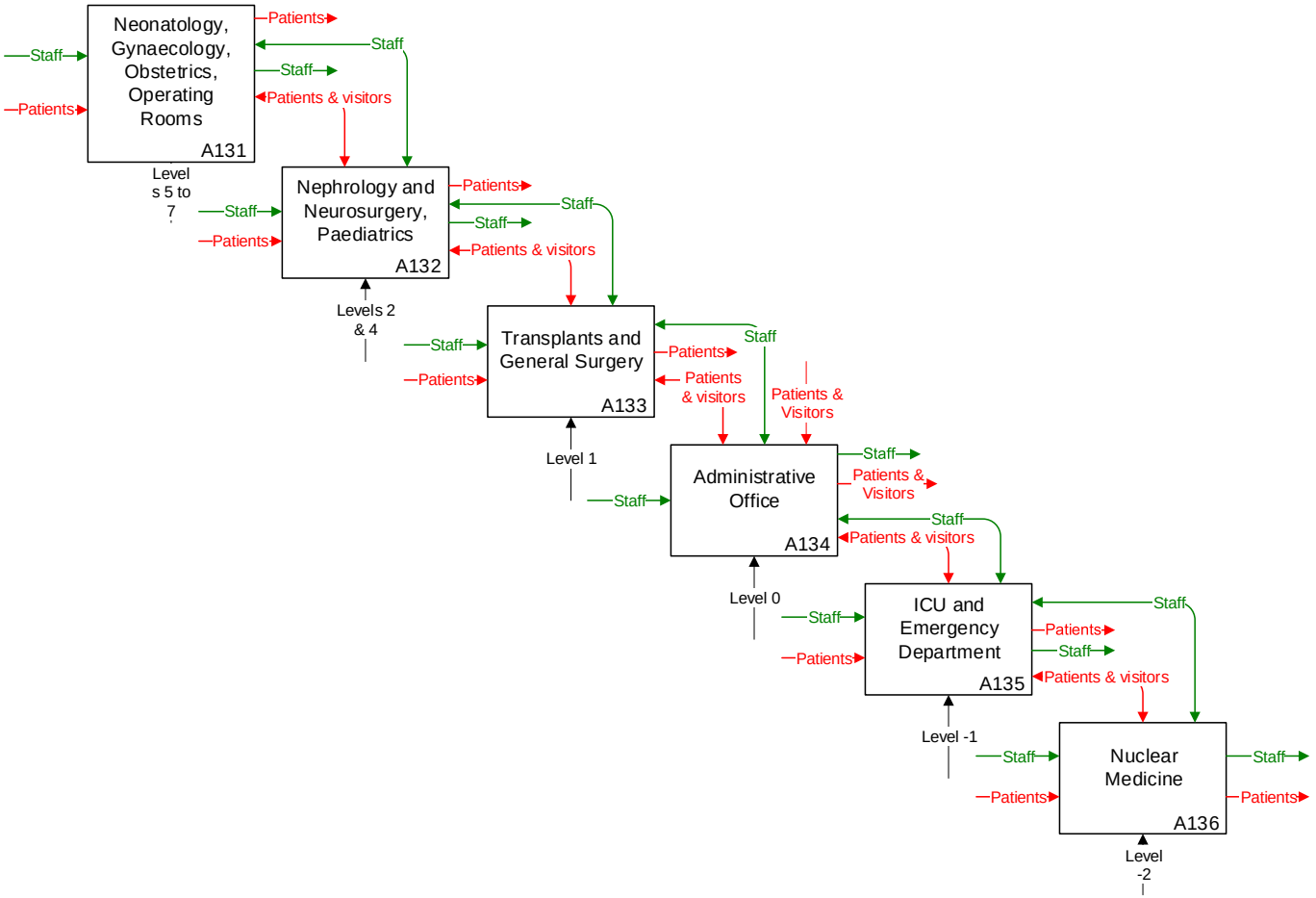
The static model: the physical decomposition

- The OSR buildings



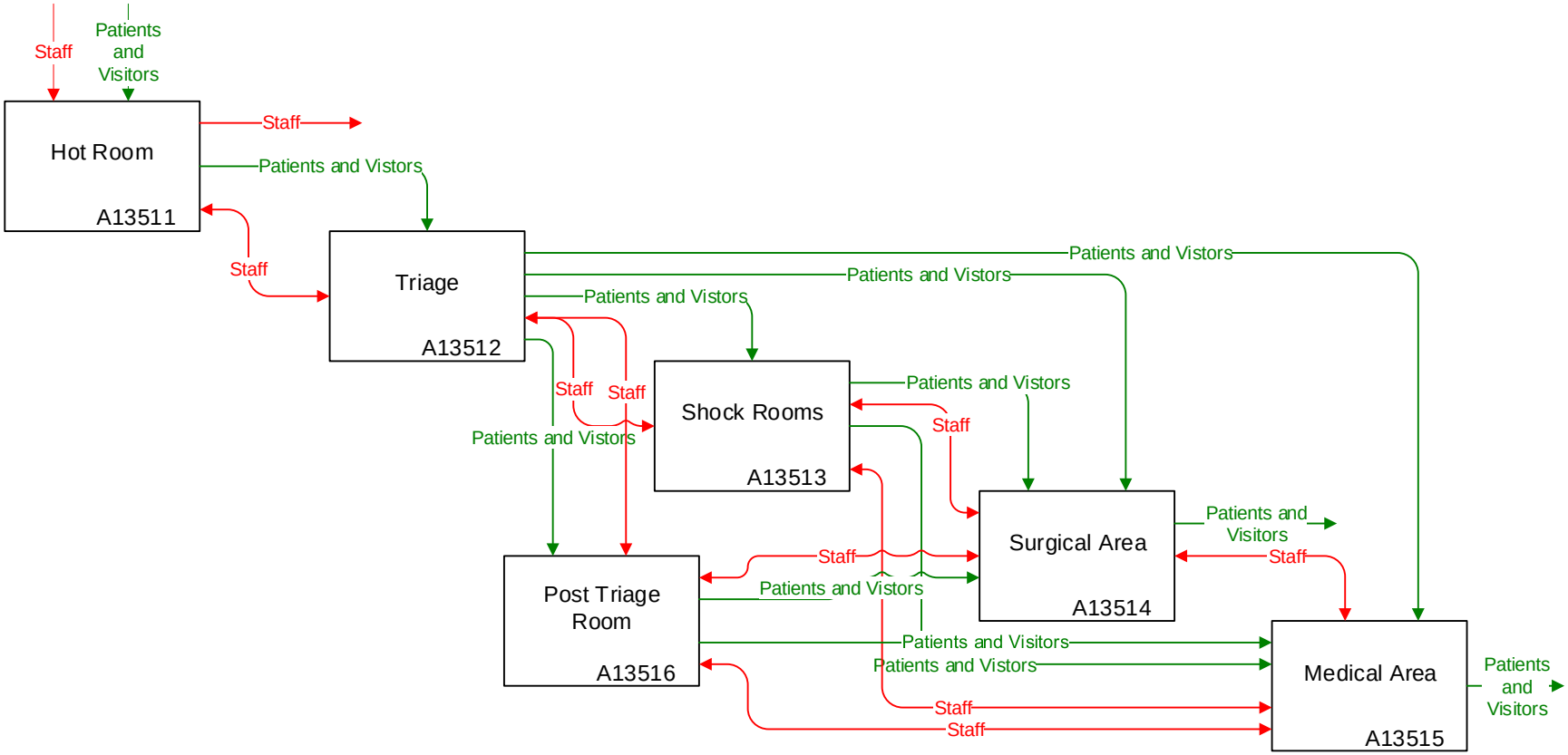
The static model: the physical decomposition

- The levels of building C



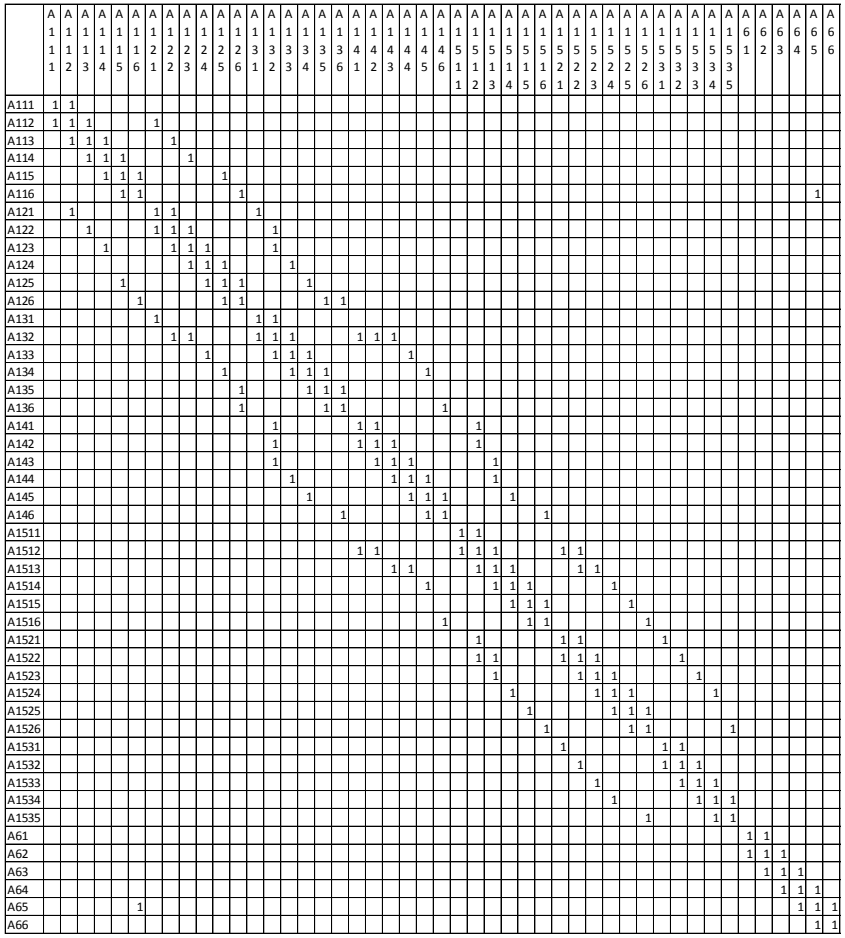
The static model: the functional decomposition

- The patient process of the Emergency Department



The access matrix Acc: the links between care-units

- How to construct a dynamic model from the static model



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The dynamic model: the physical part

- The basic flow model

$$Min\ Z = \overbrace{\sum_{p=1}^{T}\left(\sum_{i=1}^{N}\sum_{j=1}^{N}\left(XG(i,j,p)+XR(i,j,p)\right)\right)}^{Traffic} * \mathrm{p} \quad (1)$$

$$\overbrace{\sum_{j=1|j\neq i}^{N} XG(j,i,p) * Acc(j,i) - \sum_{j=1|j\neq i}^{N} XG(i,j,p) * Acc(i,j) + Input(i,p)}^{Input\ Flows}$$

$$\geq \quad Inp(i,p) + Outp(i,p) \quad \forall i = 1,\ldots,N \quad \forall p = 1,\ldots,T \quad (2)$$

$$\overbrace{\sum_{j=1|j\neq i}^{N} XR(i,j,p) * Acc(i,j) - \sum_{j=1|j\neq i}^{N} XR(j,i,p) * Acc(j,i) + Output(i,p)}^{Output\ Flows}$$

$$\geq \quad Inp(i,p-H) + Outp(i,p-L) \quad \forall i = 1,\ldots,N \quad \forall p = 1,\ldots,T \quad (3)$$

The dynamic model: the functional parts

- The inventory flow model for critical assets

$$\overbrace{Min\ Z = \sum_{k=1}^{M}\sum_{p=1}^{T}(WGU(k,p))}^{Waiting\ patients} * p \quad (4)$$

$$\overbrace{\sum_{j=0|j\neq k}^{M} XGU(j,k,p) * Accun(j,k) - \sum_{j=1|j\neq k}^{M+1} (XGU(k,j,p+d(k)) * Accun(k,j))}^{Patient\ Path}$$

$$+WGU(k,p) \quad = \quad WGU(k,p+1) \quad \forall k = 1,...,M \quad \forall p = 1,...,T-d(k) \quad (5)$$

$$\overbrace{\sum_{j=1|j\neq k}^{M} \left(\sum_{q=p-d(k)+1}^{p} XGU(k,j,q) * Accun(k,j) \right) \leq Capun(k,p)}^{Activity\ Capacity}$$

$$\forall k = 1,...,M \quad \forall p = d(k),...,T \quad (6)$$

The dynamic model: the very first results

- A linear problem has been defined. 265 081 variables, and 5 640 constraints, for 60 periods. 408 maximum patients per hour for the most crowded place. Computational time less than 10 seconds with CPLEX.

- The dynamic model can represent 47 care-units over an horizon of 120 periods.

- The basic flow model allows us to calculate the flow traffic in the hospital, and to define the most crowded place, i.e. the most vulnerable place, or the patients contaminations…

- The inventory flow models enables us to simulate the patient flows in critical assets during mass casualty admissions or patient evacuations…

A vulnerability approach

- Assessment of threat sources, reviewing historical data on terrorist attacks.
- Identification of critical assets, their mapping, and their added-value for the hospital, with the IDEFØ method.
- Attractiveness analysis based on pairing of each critical asset and of each threat source to identify potential vulnerabilities per adversary.
- Scenario definition and their simulation with the Flow model: Based on the attractiveness of the critical assets, the most likelihood scenarios with the worst consequences are constructed and studied.

Mitigation and Response

- Define the most likelihood scenarios of terrorist attacks.
- Calculate potential damages for the hospital with the dynamic model.
- Propose and simulate counter-measures for mitigation, studying a "to be" model with IDEFØ and CPLEX.
- Model and simulate Emergency Management Plans to respond to terrorist attacks, translating the plans with IDEFØ and CPLEX.

Acknowledgments

Thanks to:

- Julien Fondrevelle and Wanying Chen from DISP,
- Daniele Baranzini and Vincini Sauro from Ospedale San Raffaele,
- Carl Dakin and Carol Morey from Hanover, …

Discussion

For more information:

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- Visit the website www.threatsproject.eu
- See our newsletter