

Typologies of Therapy Cluster in Radiotherapy Departments Developed from Comparative Floorplan-Analysis

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INTRODUCTION & AIM

Cancer treatment is individually tailored to both the tumor type and patient, and consists of surgery, radiotherapy, and/or systemic treatment, e.g. chemotherapy or immunotherapy. Radiotherapy is an essential part of cancer treatment and is at the forefront of effective treatment therapies offered to cancer patients (Abshire & Lang, 2018). With doctor consultation, imaging for radiation treatment planning, treatment planning itself as well as high-energy photon and proton radiation treatment, radiotherapy is a multidisciplinary field including physicians, medical physicists, and radiation technologists besides the patient. Moreover, treatment is offered on an in- or out-patient basis. Owing to this, radiotherapy departments have complex building layouts.

With the high complexity of radiotherapy departments, the built environment and structure are eminent in providing the setting for optimized workflow and patient care. Some Design and Planning Guidelines have been developed by American, British, and international institutions. The guidelines are a product of experience and penal discussions. The lack of planning requirements derived from evidence based design, best practice analysis, connection to workflow optimization, and user group analysis becomes apparent. For developing design recommendations and planning requirements it is necessary to develop typologies, which can further be analyzed in combination with the workflow, patient journeys, adjacencies or spatial settings.

PROCESS & CLUSTERS IN RADIOTHERAPY

The floorplans of radiotherapy departments show a wide variety in size, structure, configuration, and position on the hospital premises. Due to the complexity of radiotherapy departments, their room variety, and multiple functions, it is not possible to directly compare all departments by their floorplans. To analyze the floorplans and derive typologies, various levels of abstraction and depth are necessary.

In the first step rooms corresponding to the same function in the treatment process are sorted into one cluster. Clusters were defined according to the five key functional areas in radiotherapy according to the International Atomic Energy Agency (IAEA, 2014) and refined by looking at the process (Müller-Polyzou et al., 2019) and user groups.

The defined clusters were used in prior comparative floorplan analysis, on the spatial relation of all clusters in radiotherapy departments, from which Hallway Typologies were developed.

In addition to these defined clusters **PERSONAL ROOMS** (e.g. offices, break room) and **SERVICE ROOMS** (e.g. storage, engineering, technical rooms) are defined. Due to their flexible and individual location, they were not considered in the floorplan analysis.

The following clusters were defined:

- R RECEPTION**
arrival and admission of the patient rooms: reception, archive, offices for administration
- O OUTPATIENT**
regular, additional and follow-up examinations and appointments with the radiation physician
- I IMAGING**
Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) scan for three-dimensional, highly conformal radiation treatment planning rooms: CT/MRI room, control room, anteroom, and changing cubicles
- P PLANNING**
based on the CT scan and the treatment prescription from the physicians, a treatment plan is developed by the medical physicists
- T THERAPY**
multiple therapy methods and with it different radiotherapy devices rooms: therapy room, control room, anteroom, and changing cubicles

COMPARATIVE FLOORPLAN ANALYSIS

The comparative floorplan analysis was conducted with 103 Therapy Cluster floorplans of 27 radiotherapy departments in Germany. To conduct the analysis of the Therapy Cluster the floorplans were compared in abstraction levels and summerized by three phases of typologies:

1) The Zoning Typology describes the structural configuration of the different room types starting with the hallway, which serves

as the access point to the Therapy Cluster. The control room and the changing cubicles are summarized in the category of "function". Followed by the anteroom, which connects all rooms of the Therapy Cluster. Last is the therapy room.

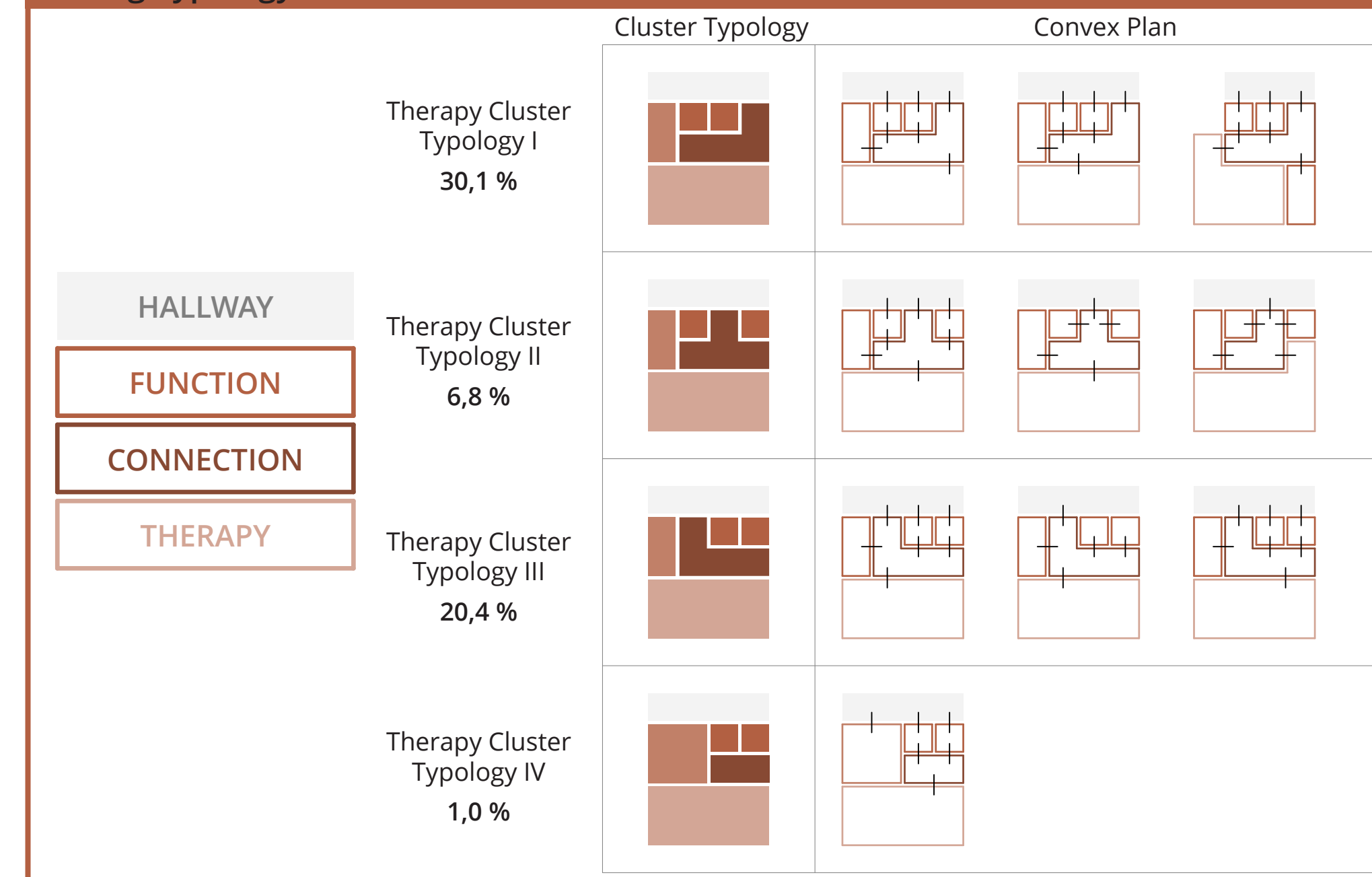
2) The second phase of typologies describes the room configurations in more detail and shows the relations towards each other.

3) With a further level of abstraction the

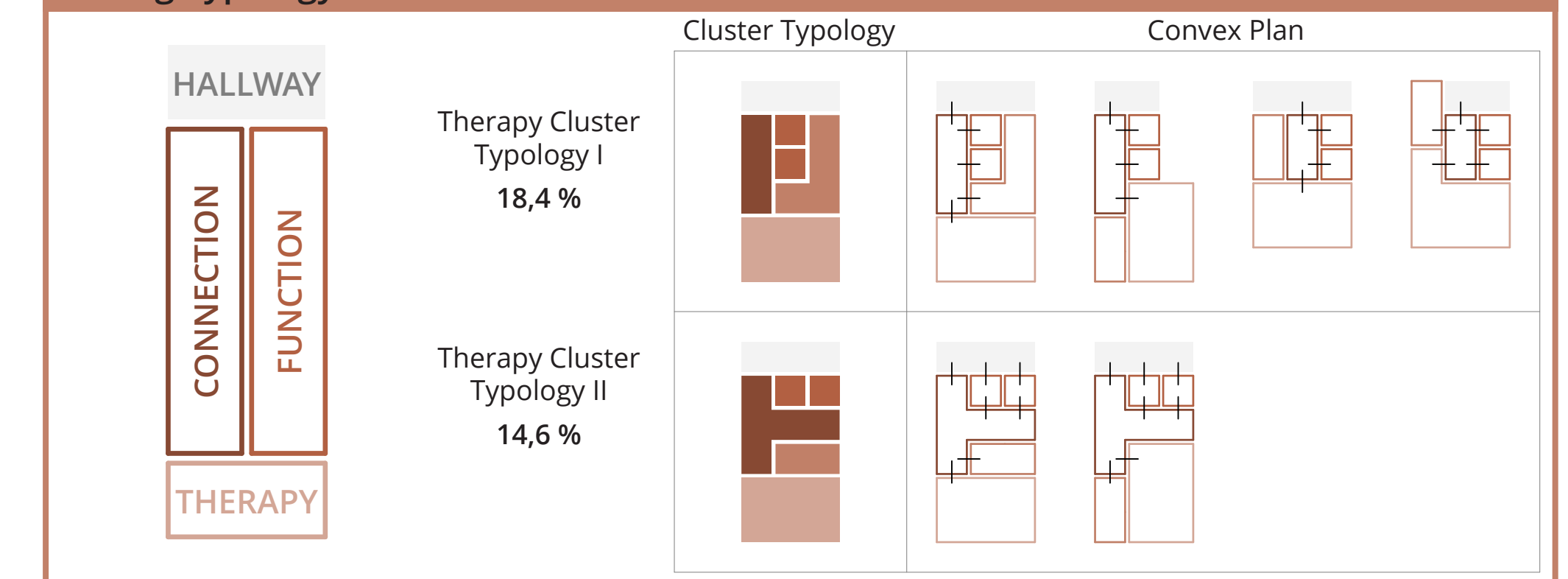
floorplans were analyzed with a quantitative tool of Space Syntax (Hag & Luo, 2012) by looking at convex plans. These translate the floorplans into a diagram that reflects the configuration of selected properties and as-

sists in the identification of spaces and connections from these architectural plans (Ostwald, 2011). The properties interesting for this analysis are the configuration and spatial relations between the rooms.

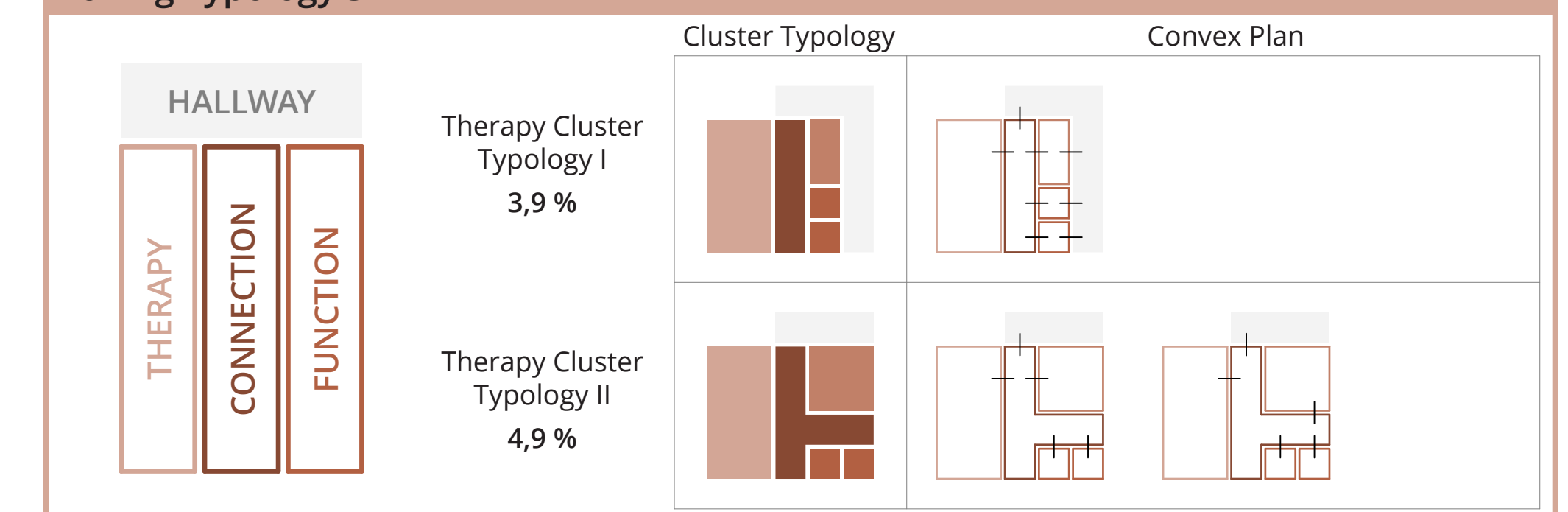
Zoning Typology 1



Zoning Typology 2



Zoning Typology 3



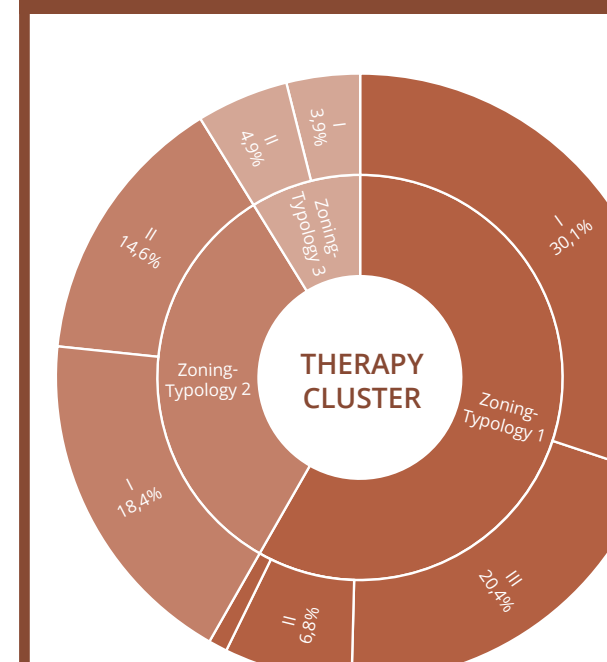
THERAPY CLUSTER & METHODOLOGY

The heart of the department, where all user groups come together and the patient receives the radiation treatment is the Therapy Cluster. For this study, only Therapy Clusters with linear accelerators were considered due to their comparability. This study establishes typologies and spatial criteria of room organization in the Therapy Cluster by analyzing floorplans of radiotherapy departments in German hospitals. By abstracting, comparing, and analyzing floorplan layouts in terms of their spatial patterns and adjacencies, typologies for Therapy Clusters of radiotherapy departments were developed.

The following rooms were defined:

- HALLWAY** access to Therapy Cluster and connection to the waiting area
- CONTROL ROOM**, where staff controls the radiation device and monitors the patient in the therapy room
- CHANGING CUBICLES** for patients usually two for each therapy room, in some cases only one or up to three
- ANTEROOM** connecting all rooms in Cluster
- THERAPY ROOM**, where cancer patients receive their radiation treatment

RESULTS & CONCLUSION



The Zoning Typology 1 and its Therapy Cluster Typology I are the most frequently found Therapy Cluster in built radiotherapy departments. The choice of typology in planning a radiotherapy department is assumed to have various factors, e.g. depending on the typology of the entire department, the avail-

able area, and the relation to adjacent Therapy Clusters. To evaluate and develop the derived typologies, further analysis will be conducted on the adjacency of Therapy Clusters and by putting the defined typologies into context with workflow and individual travel paths of the user groups.

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