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Content

Medical Neighbourhoods: Urban Planning and Design Considerations for Charité Virchow Klinikum in Berlin, Germany

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Abstract

In Berlin Germany, more than 60% of patients suffer more than one disease or condition (multi-morbid) requiring different specialists to attend their health needs in a coordinated manner. Unfavourably, more than 70% of care is delivered in solo-offices spread-out in a vast urban landscape whilst only 30% of care concentrates in large hospitals offering better chances of coordinated care.

A medical neighbourhood is a clinical partnership model seeking to coordinate health services at all levels of care with a patient-centred focus. It aims to overcome the most relevant issues towards reaching sustainable health systems such as: poor patient care coordination; unnecessary hospital admissions and readmissions; long waiting times; waste in healthcare spending; poor evaluation processes; and many others that lead to increasing costs.

Until now what remains overlooked in implementing this care model, and main purpose of the study, is improving the physical environment of neighbourhoods to first, protect the health of residents (health promotion) and second, support a patient-centred approach based on: (a) building medical teams around patients' needs for medical care and disease prevention, and (b) ensuring users' (staff, patients, other) journey quality experience from service to service.

Therefore, an evaluation study was conducted in two neighbourhoods in the vicinity of Virchow Klinikum Charité Medical University covering two main objectives:

- *Map neighbourhood environment functions and services which offer or facilitate healthier lifestyles, disease prevention, and clinical care; and*
- *Assess physical features and characteristics of the street network to determine levels of pedestrian friendliness (walkability)*

1.02 Km^2 of urban surface including 40 street blocks, 42 streets, 102 street segments, and 77 crossing situations, were systematically surveyed finding conclusive evidence that developing a medical neighbourhood physically in the area is necessary and feasible.

Keywords: Health System, Urban Health, Urban Development, Urban Design, Walkability

Introduction

A Medical Neighbourhood as defined by the PCPCC (Patient-Centered Primary Care Collaborative (PCPCC), 2015), is a clinical partnership seeking to coordinate primary and secondary care services, within a same building complex, or geographically spread-out, often the case of Berlin and for Germany in general (Hirsch et al., 2012). A patient-centred medical home (PCMH) is the main component of the partnership which acts as a central hub linked to other health services usually through sophisticated health information technologies (HIT).

The main objective of a medical neighbourhood is to overcome common issues for most health systems towards reaching sustainability such as: poor patient care coordination due to fragmented services; low health literacy hindering disease prevention and health promotion; waste in healthcare spending from unnecessary procedures and treatments; lack of transparency due to poor evaluation processes or organizational secrecy; and many others that lead to increasing costs as further explained in the background.

Following this particular definition, implementation efforts to strengthen relationships across different providers have produced guidelines and protocols mainly on: coordination mechanisms for information reliability; care delivery; communication flow; and shared accountability (Alidina, Rosenthal, Schneider, & Singer, 2016). An example of guidelines emphasizing the reciprocity of responsibilities and the importance of reliability among care providers, is found in the conceptual framework *Good Neighbours* developed in 2010 (Hoangmai, H., 2010).

In Germany, a similar integrative effort was introduced in 2004 called *medical care centers* (MVZs), where medical staff from different disciplines are contracted mainly aiming to reduce costs, service proximity, and waiting times. Since then, these centers have raised criticism especially from solo-office physicians which perceive them as a proliferation of small hospitals different to the decreasing numbers of family doctors (Woebkenberg & Schneider, 2015).

Differently, the thesis of this research understands the medical neighbourhood not as a health management company competing with solo-offices, nor as a health provider solely for primary and secondary care. It advocates for physically building a continuum of care in the neighbourhood by linking its numerous individual medical establishments, a PCMH, and the main hospital, through health promoting public spaces. In its ambition, it aims to create a voluntary doctor-patient-citizen network encouraged by cost reductions policies and improvement of health and health-related outcomes.

At early stage, this evaluation study assesses the actual state of two neighbourhoods in Berlin close by a main health care centre: the Charité Virchow Klinikum (a 2.000 bed, state owned university hospital). Through a systematic observation method called Walkability for Health, it questions – at three urban scales (macro, meso, micro) – the possibility of physically developing a medical neighbourhood on the site based on reviewing (a) the availability and proximity of health-related destinations conducive to healthier behaviours (lifestyle) and providing all levels of disease prevention and clinical care including a PCMH, and (b) the conditions of the neighbourhood environment for high quality biking and pedestrian experience, and public transportation usage over car dependency.

This study aims high at being a significant contributor to people-centred approaches for urban development and urban health such as the Healthy Cities concept developed by the World Health Organization (WHO). It follows its recommendations on designing environmental interventions to benefit and protect individual people's health and quality of life through creating walkable cities (WHO 2016).

Background

The need for transformational change

The point of departure for this study is to understand first, the actual state of health care delivery in Berlin which derives directly from eight main problems and organizational issues of the German health system, and secondly, two concepts crucial in physically developing a medical neighbourhood, the value-based agenda, and urban walkability.

Eight issues

To better understand the nature of the following 8 problems and a possible holistic solution, a theoretical framework has been prepared (see figure 1) under the following rationale: avoid overuse of the actual health care system focused on disease (with a pathogenic approach) by implementing a salutogenic ecosystem focused on attaining positive health of contributors through urban development. Therefrom, the importance of including in the evaluation process physical features of a medical neighbourhood model and a walkability perspective as further on explained in the approach.

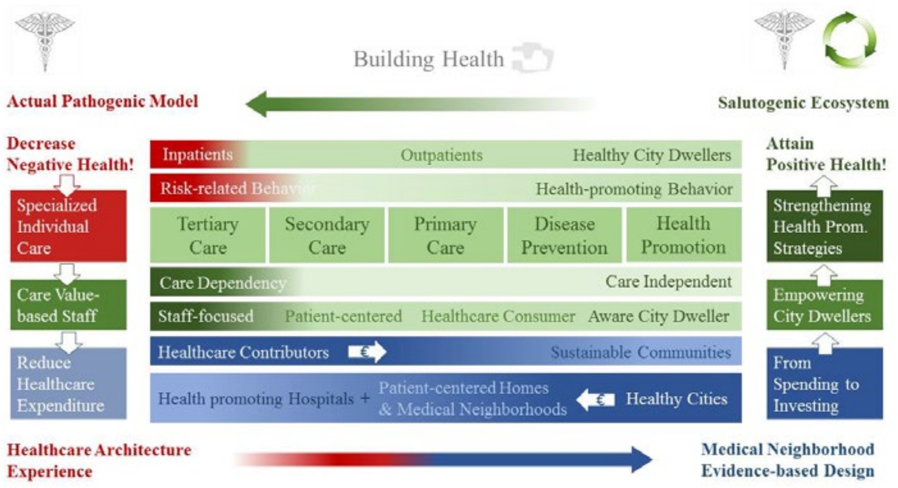

Figure 1. Salutogenic Ecosystem Model (Á. Valera Sosa, 2015)

(1) As the WHO (2014) reports, a relatively small group of non-communicable diseases (NCDs) are responsible for approximately 86% of the deaths and 77% of the disease burden; to which 80% of its risk factors are life-style related and avoidable (WHO, 2017).

(2) A large proportion of the population faces retirement whilst the working-age population consistently decreases. As consequence, home care and institutional care will increase (Schulz, 2010) with lesser security benefits to its recipients (Federal Statistical Office, 2015).

(3) In spite of high rates of lifestyle and age-related NCDs health cost reduction policies focus on reducing hospital inpatient care (OECD, 2014) without clear policy on improving outpatient care.

(4) Health policy has a clear pathogenic approach over a salutogenic one. The amount of avoidable disease in Germany accounts for 80% of all healthcare costs (EU Commission 2014). Anyhow, only 3,3% of the total

health expenditure is from disease prevention and health promotion strategies (OECD, 2014).

(5) Care staff capacity is overloaded and year by year suffers shortage. The number of patients per week is of 243 when in other OECD countries ranges between 102-154 and contact times between general practitioners (GPs) and patients are less than 8 min when in other OECD countries is between 11-19 min. The total workload of GPs is of 50,6 hours a week, again above the EU average.

(6) Conservative policy limits the introduction of new integrated health business models. The German Federal Ministry of Health (BMG) has a clear organizational structure that facilitates the supervision and regulation of hospital systems and clinics meanwhile local authorities (Länder) – with a better insight for local needs and bidding processes - are responsible for provision of care (The Economist, 2015).

(7) Healthcare services are highly fragmented; 70% of primary care physicians and 75% of secondary care physicians practice in solo offices (Hirsch et al., 2012). As a result, multi-morbid patients are mostly attended by single diseases with serial care instead of their health being managed employing parallel care (Schlette, Lisac, & Blum, 2009).

(8) In the system, health and economic outcomes are punishing to evaluate, for a similar health service or condition the system allows two processes (The Economist, 2015): a DRG (disease-related group) system for inpatient care, and out-of-pocket for service for outpatient care.

A medical neighbourhood's components

Aiming a needed transformational change, this study elaborates on how *medical neighbourhoods* can be a sustainable health system when built on the strongest pillars of any country's economy: the health care and urban development sectors.

The term is conceptualized from the six components of The Value-based Agenda as introduced by Michael Porter and Elizabeth Teisberg in their book Redefining Health Care from 2006. Since first published, many are the providers and organizations that have implemented its principles, especially for specific disease groups or conditions such as the Sun Yat-Sen Cancer Center in Taiwan for breast cancer, the Boston Children's Hospital in the USA for plastic, oral and orthopaedic surgery, and The West German Headache Center in Essen for integrated migraine care.

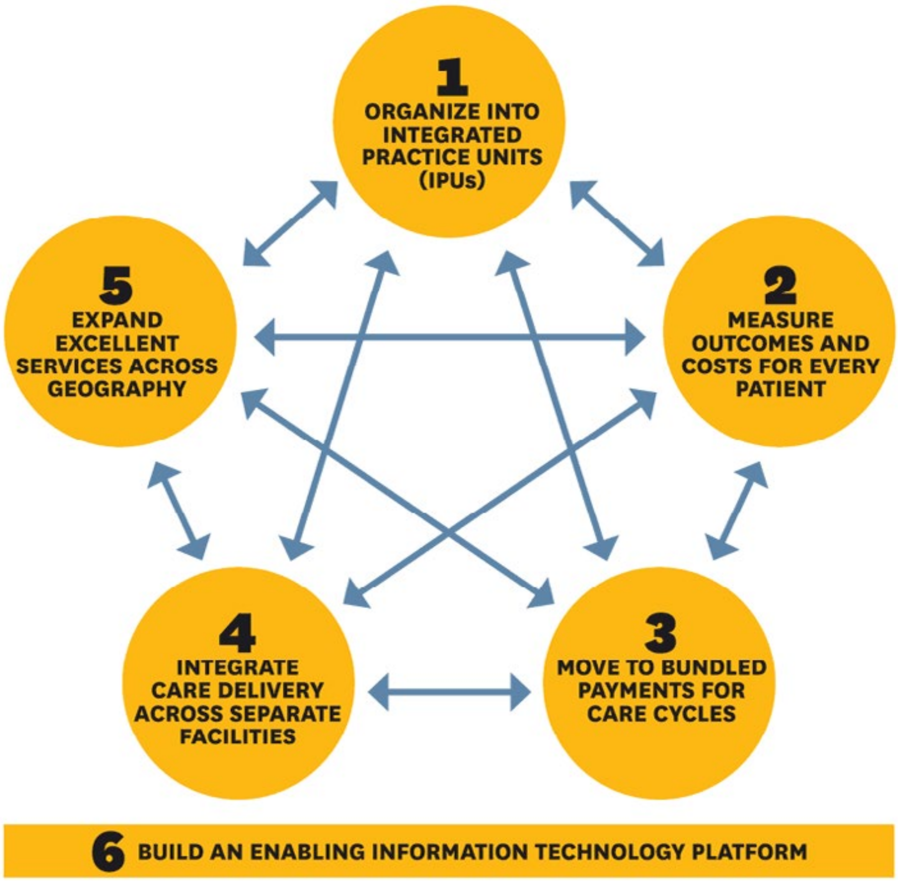

Figure 2. The Value-based Agenda (Porter & Lee, 2013)

Six are the components to a medical neighbourhood, according to Porter and Teisburg (see Figure 2) in the article “The Strategy that will fix Health Care” (Porter & Lee, 2013). Based on descriptions to all six components, this work includes in the evaluation process aspects from components 1, 4, and 5 which have a clear urban and architectural design importance.

The first refers to integrated practice or parallel care instead of serial care. This means shifting from today’s fragmented health system of solo offices to a patient-centred care centre organized around the patient’s medical condition. This structure is called an integrated practice unit (IPU) or a patient-centred medical homes (PCMH) according to the U.S. Department of Health & Human Services.

The second and third are about measuring outcomes and costs for every patient, and bundled payments for care cycles, respectively.

The fourth is the integration of care across physically separate facilities and organizations by (a) defining the scope of services, (b) concentrating volume in fewer locations, (c) choosing the right location for each service line, and (d) integrating care for patients across locations.

The fifth claims an expansion of health services across a neighbourhood’s geography in two models. The first called a hub-and-spoke model, where satellite facilities to a main PCMH are established and staffed at least partly by clinicians and other personnel employed by the parent organization; the second called a clinical affiliation, in which the PCMH partners use facilities from other organization rather than adding capacity.

The sixth, is common to many of the implementations realized so far: a health information technology (HIT) platform across all previous components that support integrated multidisciplinary care.

To physically implement this agenda, urban planning and design considerations must be formulated in terms of developing a PCMH linked to the spread-out health-related services and functions of Berlin's healthcare landscape with special considerations on the needs and requirements of vulnerable user groups such as children, elder, and impaired (physically and/or cognitively). Here lies the critical importance of urban walkability.

Urban walkability

The vision of a well-connected pedestrian-friendly medical neighbourhood is all but a simple task. It is about creating built environments conducive for people to walk and live a healthier life style. Anyhow, as researcher and author Jeff Speck assures, the pedestrian is an extremely fragile species that under the right conditions thrives and multiplies (Speck, 2012).

Walkability is both as concept and a measuring tool which comprehensively explains how friendly the physical environment is for walking and/or biking (including variations such as canes, walkers and wheelchairs). The Transport for London Agency (2005) states that walkability is beyond measuring features which ensure pedestrian-path-safety and more about knowing to what extent walking is readily available as a connected, accessible, and pleasant mode of transport.

Anyhow, walkability is not only a term employed in transportation planning but also a strategy adopted by many health agencies, such as WHO and the Center for Disease Control and Prevention (CDC), which advocate for increasing neighbourhood walkability primarily to promote fitness, combat obesity, and enhance sustainability (Rattan, Campese, & Eden, 2012).

In a glance, the socio-economic determinants of health as defined by WHO, have great similarities to the long list of environmental, economic, social, and health impacts of walkability. Thereby, the urban layout of a medical neighbourhood or a healthy city should be of a walkable neighbourhood. But then, what makes a neighbourhood more walkable and less car dependent than others?

Since the mid-90s walkability research has incessantly tried to determine what built environment factors stimulate pedestrian activity and trigger path preference. Since then, many rating and auditing instruments characterizing the built environment have proliferated, describing urban and sub-urban situations at three city scales: the macro, meso, and micro scales.

The observation method used in this study (Walkability for Health) includes in its evaluation criteria the most common physical environmental indicators found in walkability literature over the past two decades which consistently explain walking and biking rates in urban areas.

Approach

The main purpose of the study was to deliver recommendations on how to improve the physical environment of a particular neighbourhood to first, protect the health of residents (health promotion) and second, support a patient-centred plan based on: (a) building medical teams around patients' needs for medical care and disease prevention, and (b) ensure users' (staff, patients, other) journey quality experience from service to service.

The purpose demanded two clear main research objectives:

1. estimate the availability and proximity of neighbourhood health-related destinations within a *(a) food environment* supporting good nutrition, *(b) social environment* improving community cohesion, *(c) active environment* conducive to more physical activity levels and a healthier lifestyle, and a (d) *health care environment* providing disease preventive and clinical services
2. assess the conditions of the neighbourhood environment that ensure high quality biking and pedestrian experience, and public transportation usage especially for vulnerable user groups (children, elder, and physically and/or cognitively impaired)

To approach both the purpose and its main objectives, a systematic observation method called Walkability for Health was designed to gather and graph primary and secondary data at three urban scales.

At the macro scale, finding urban form factors such as, street density, transportation diversity, and urban grid designs (Cervero, 2003) which significantly impact the proximity and directness of travel between destinations (Frank, Kavage, Devlin, & Marmot, 2012). At the meso scale, where street elements at road segments and intersections, determine the degree of path continuity and block-to-block connectivity for active travellers (Moudon & Lee, 2003). Finally, the micro scale, describing design features at neighbourhood destinations and points of interest along routes which ensure universal access and safety; environmental comfort; and a pleasant visual structure of the physical environment (Ewing, Handy, Brownson, Clemente, & Winston, 2006).

The method helped to effectively:

- Map physician solo-offices
- Map functions and/or services conducive to protective health behaviours and healthier lifestyles such as, diet, positive social interactions, and physical activity
- Determine the pedestrian friendliness of the street network in terms of its path continuity and block connectivity, safeness, comfort, and visual structure of its elements
- Select a site to develop a medical centre for integrated care (a PCMH for primary and secondary care)

The complete evaluation research required a total of 21 Assessment sheets be prepared to collect data (see table 1): 8 assessment sheets for the macro scale; 7 for the meso scale; and 6 for the micro scale.

For the macro and meso levels, 15 types of assessment sheets were used to collect secondary data from public databases. For the micro level two surveyors were instructed to collect primary data in 6 types of sheets using photography and annotations.

The data collected from the assessment sheets were organized in 11 tables (see tables 2 to 12) which generated a conclusion map at each scale respectively. Each map graphed important physical environmental factors for active travelling (mainly walking, biking, and commuting), and for health-protective behaviours (such as services for self-management) and health-promoting behaviours (mainly healthy eating, positive social interactions, and physical activity). The maps were analysed to progressively narrow down the study area into specific street segments and points of intervention (POI).

The macro conclusion map (see figure 3) showed: first, proximity between the hospital's main entrance and the vacant plots for the future PCMH considering a 600 m pedestrian catchment area; and second, proximity of the plots to public transportation hubs, and to areas dense with health-related destinations (services or settings for care, disease prevention, and health promotion). On top of public transportation proximity, three levels of access to the hub or transport unit were taken into account: easy street-level access (e.g. trams); moderate difficulty of street-level access (e.g. buses); and difficult access (e.g. underground and trains). The proximity, density, and access analyses, formed the criteria to select plots for exclusion or inclusion and to visualize where health-related destinations were provided or not.

The meso conclusion map (see figure 4) represented the plots pre-selected, the street classification of the site, and its pedestrian crossings at street intersections. 40 blocks, 42 streets, 102 street segments and 77 crossing situations were analysed. Streets were classified in nine groups following the presence or absence of its main elements (such as, pedestrian strips, bike lanes, furniture strips, building strips, buffers, etc). Pedestrian crossings (including bike lane crossings) were described by its visibility degree, if these were pedestrianized (levelled-up), fully marked (coloured), simple marked (striped), or if it had no markings at all. The information helped understand how and where the street network was supporting active transportation or not. Together with the macro information, some routes were selected for further study at the micro scale and the plot for future development was selected.

The micro conclusion map (see figure 5) prioritized those routes (by street segments), crossings, and other POI relevant to improve walkability levels towards the medical neighbourhood's settings. The routes were traced by connecting the selected PCMH plot to the hospital's main entrance, major transportation hubs, public open spaces, and areas with health-related destinations. The POI were spaces or places of stay where active travel would pause, generally induced by entrances to destinations or crossings. At these points, environmental conditions for pedestrians (such as safety, comfort, and visual structure) were assessed using Likert scale and photographic surveys.

Table 1: Assessment sheets

Macro Form Factors	
Study Area	A_Site Map
Density	A1a_Population Density (Results Table 1)
	A1b_Density of Uses and Services (health-related destinations; Results Table 1)
	• Active Environment
	• Food Environment
	• Social Environment
	• Healthcare Settings
	A1c_Street Density (Results Table 1)
Diversity	A2a_Public Transportation Provision (Results Table 2)
	A2b_Public Transportation Coverage (Results Table 3)
Design	A3a_Street Layout (Results Table 4)
	A3b_Building Layout (Results Table 4)
Macro Conclusion Map	A4_ Medical Neighbourhood Context Map
Meso-level Street Patterns	
Street Network	B1a_Street Hierarchy & Classification (Results Table 5)
	B1b_Blocks & Street Segments (Results Table 6)
Block Connectivity	B2a_Pedestrian Crossings Analysis (Results Table 7)
	B2b_Street Intersections Summary Map
Path Continuity	B3a_Street Main Element Analysis (Results Table 8)
	B3b_Street Space Allocation (Results Table 8)
	B3c_Street Pattern Summary Map
Meso Conclusion Map	B4_ Continuity & Connectivity Analysis Map
Micro Design Variables	
Safeness	C1a_Universal Access (Results Table 9)
	C1b_Signage and Signalization (Results Table 9)
	C1c_Sightline (Results Table 9)
Comfort	C2a_Spatial (complement of B3b, Table 10)
	C2b_Respite Areas, Noise Levels & Light Quality (Results Table 10)
Visual Structure	C3a_Enclosure, Transparency, Complexity & Human Scale (Results Table 11)
Micro Conclusion Map	C4_ Pedestrian Environment Summary Map

Table 2. Macro Form Factors – Density

Density	Population (A1a)	1,750,922 / ha. (Population Density 2015, Fis-Broker)		
	Uses and Services (Health-related destinations; A1b)	4 uses (Actual Use of Built-up Area 2010, Fis-Broker)		Amount
			Active Environment	12 (maps.me)
			Food Environment	46 (maps.me)
			Social Environment	56 (maps.me)
			Healthcare Settings	17 (maps.me & Gelbe Seiten)
	Street (A1c)	T-junctions: 26 (Google Maps)		
		Crossroads: 23 (Google Maps)		

Data: Assessment sheets A1a, A1b, and A1c

Population density of the site is higher than the Berlin average level of 394,760 per hectare. With four uses being recognized (residential, public facilities, mixed uses, green and open space), residential use is the most prevalent of this site. The street density is high, as most closed-edge block neighbourhoods in Berlin, favouring pedestrian path options and flow. For both streets there are 26 T-junctions and 23 crossroads, evenly distributed.

Table 3. Macro Form Factors – Diversity – Transportation Provision (Stations and Stops)

Transportation Availability	Active	Walking	Yes
		Biking	Yes
	Public	Regional Trains	No
		S-bahn	Yes
		U-bahn	Yes
		Trams	Yes
		Buses	Yes
	Private	Car-sharing	Yes
		Taxis	Yes
		Privately-owned vehicles	Yes

Data: Assessment sheet A2a

The site supports active, public, and private transportation. All modes of public transportation, except regional trains, are available on this site. With 6 day lines and 3 night lines (altogether 11 stops), bus services are the most prevalent public transportation on this site.

Table 4. Macro Form Factors – Diversity – Transportation Coverage

		Percentage (%)
Public Transportation Coverage (Pedestrian Catchment)	Regional Trains	0
	S-bahn	20
	U-bahn	40
	Trams	50
	Buses	100

Data: Assessment sheet A2b

The site is fully covered by public transportation services. Bus services provide 100% coverage to the site, making it not only the most available but also the mode of public transportation with the most pedestrian catchment area.

Table 5. Macro Form Factors – Design

Street layout	Deviations	0 (Google Maps)
	Dead Ends	2 (Google Maps)
Building layout	Building area	726,177 m^2 (Fis-Broker)
	Void area	683,823 m^2 (Fis-Broker)
	Building/void ratio	1:0.9
	Green void area	24,318 m^2 (Fis-Broker)
	Grey void area	659,505 m^2 (Fis-Broker)
	Green/grey ratio	1:27

Data: Assessment sheets A3a and A3b

Only two dead ends are found; one of them leads to a children's playground which actually benefits pedestrians.

Building area and void area almost take up the same amount of land respectively in the site. Out of the total void area of 683,623 m^2, only 1 m^2 of green void area is found for every 27 m^2 of grey surface.

Table 6. Meso-level – Street Network – Street Hierarchy and Street Classification

		Amount
Street hierarchy	Arterial	0
	Collector	5
	Local street	16
	Supplementary road	6
Street classification	Transit corridor	1
	Downtown corridor	4
	Downtown two-way street	1
	Neighborhood main street	3
	Neighborhood street	13
	Boulevard	2
	Downtown one-way street	0
	Commercial alley	0
	Yield street	3
	Residential shared street	0
	Commercial shared street	0
	Green alley	0

Data: Assessment sheet B1a

There are 5 collectors in total. Seestraße and Müllerstraße at at the perimeter of the study area; Föhrerstraße, Amrumerstraße, along with Seestraße framing the hospital; and Luxemburgerstraße separating both Kiez.

Amrumer Straße, Föhrer Straße and Luxemburger Straße, which all are downtown corridors, lay between Virchow-Klinikum, Brüsseler Kiez, and Sprengelkiez. Tram services are provided along the only transit corridor (a collector) of this site, Seestraße. On the other hand, Müllerstraße (also collector) is recognized as a downtown two-way street. Besides, there are two residential boulevards in Brüsseler Kiez: Lütticher Straße and Antwerpener Straße where strips of public open spaces are found in the middle of both of them respectively.

Table 7. Meso-level – Street Network – Blocks and Street Segment

No. of blocks	40 (Fis-Broker)
No. of street segments	102 (Google Maps)

Data: Assessment sheet B1b

There are 40 blocks and 102 street segments on the site. The blocks in Brüsseler Kiez resemble a grid of squares while those in in Sprengelkiez are larger and relatively irregular in shape.

Table 8. Meso-level – Block Connectivity – Pedestrian Crossings Analysis

	Amount
Pedestrianized	15
Fully marked	3
Marked pavement	77
No markings	142
Dead end	29

Data: Assessment sheet B2a

The majority of the pedestrian crossings are unmarked, nearly doubled the amount of marked pavements whereas only 15 crossings are pedestrianized.

Table 9. Meso-level – Path Continuity – Street Main Elements Analysis

	Amount
1A_ Pedestrian zone + bike lane with buffers	0
1B_ Pedestrian zone with buffer + bike lane	0
1C_ Pedestrian zone with buffer	16
2A_ Pedestrian zone + bike lane with buffer	1
2B_ Pedestrian zone + bike lane	0
2C_ Pedestrian zone	0
3A_ Pedestrian strip + bike lane with buffer	29
3B_ Pedestrian strip + bike lane	0
3C_ Sidewalk or pedestrian strip	67

Data: Assessment sheet B3a

Most of the streets of the site are sidewalks or pedestrian strips (3C) where bike lanes are not provided. While streets within Brüsseler Kiez are all pedestrian strips, there is a mix of pedestrian zones plus bike lanes with buffer (2A) and pedestrian strips within Sprengelkiez. All collectors except Amrumer Straße and Müllerstraße are without bike lanes. Besides, a discontinuous bike lane is also observed on Nordufer and Sylterstraße.

Table 10. Micro Design Variables – Safeness

		Safeness		
Point of Interest (POI)		Universal access	Signage and signalization	Sightline
1	(R1)	yes	yes	clear
2	(R1)	yes	yes	clear
3	(R1)	yes	yes	clear
4	(R1, R3)	yes	yes	clear
5	(R1, R4)	yes	yes	very clear
6	(R1)	yes	yes	very clear
7	(R1)	yes	yes	very clear
8	(R1)	yes	no	very clear
9	(R2)	no	no	clear
10	(R2)	yes	no	clear
11	(R3)	no	no	clear
12	(R2, R3)	yes	no	clear
13	(R3, R5)	no	yes	not clear
14	(R4)	yes	yes	clear
15	(R4, R5)	yes	yes	very clear
16	(R2, R4)	yes	yes	clear
17	(R4)	yes	yes	clear
18	(R5)	yes	no	clear
19	(R5)	yes	no	clear
20	(R4)	yes	yes	clear
21	(R4)	yes	no	very clear
22		yes	no	clear
23		yes	yes	clear

POI = Point of interest

Data: Assessment sheets C1a, C1b, and C1c

Only two of all POI do not provide universal access. Almost half of the POI do not have signage and signalization. Sightlines are either clear or very clear at all points.

Table 11. Micro Design Variables – Comfort

Point of Interest (POI)		Comfort					
		Spatial comfort	Respite areas	Noise levels		Light Quality	
				D	N	D	N
1	(R1)	✓	××	×	•	✓✓	•
2	(R1)	✓	××	•	✓	✓	•
3	(R1)	✓	××	•	✓	✓	•
4	(R1, 3)	✓	××	•	•	✓✓	•
5	(R1, 4)	✓✓	•	•	•	✓✓	•
6	(R1)	✓	×	×	•	✓✓	•
7	(R1)	✓✓	××	×	✓	✓	•
8	(R1)	✓	•	•	✓	✓✓	×
9	(R2)	✓	✓	•	✓	•	×
10	(R2)	✓	•	•	✓	•	×
11	(R3)	✓	✓	•	✓	•	×
12	(R2, R3)	✓	•	•	✓	•	×
13	(R3, R5)	✓	•	•	✓	•	×
14	(R4)	✓	×	×	•	✓✓	•
15	(R4, R5)	×	××	×	•	•	•
16	(R2, R4)	×	××	×	•	•	•
17	(R4)	××	××	×	•	✓	•
18	(R5)	•	✓✓	✓	✓	•	•
19	(R5)	✓✓	××	•	✓	✓	•
20	(R4)	•	××	×	✓	•	•
21	(R4)	×	××	××	×	✓✓	•
22		•	××	•	✓	•	•
23		✓	×	×	✓	•	•

POI = Point of interest; D = Daytime; N = Night time
✓✓ Very Suitable ✓ Suitable • Moderate × Unfit ×× Very Unfit
Data: Assessment sheets C2a and C2b

Although spatial comfort at POI are suitable in general, respite areas are unfit or very unfit at most points. Noise levels are higher during daytime while lower during night time. Higher noise levels are found at POI which are located on collectors. Light quality during day time on wider streets and open spaces is brighter than those within the two neighbourhoods whereas it is moderate in general at night.

Table 12. Micro Design Variables – Visual Structure

Point of Interest (POI)		Visual structure			
		Enclosure	Transparency	Complexity	Human scale
1	(R1)	open	30%	simple	no
2	(R1)	moderate	25%	moderate	no
3	(R1)	moderate	25%	moderate	no
4	(R1, R3)	moderate	35%	moderate	no
5	(R1, R4)	open	35%	simple	no
6	(R1)	open	40%	moderate	no
7	(R1)	moderate	55%	moderate	yes
8	(R1)	very open	10%	simple	yes
9	(R2)	enclosed	35%	moderate	yes
10	(R2)	enclosed	35%	moderate	no
11	(R3)	enclosed	35%	moderate	no
12	(R2, R3)	moderate	35%	moderate	no
13	(R3, R5)	moderate	35%	moderate	no
14	(R4)	open	65%	moderate	no
15	(R4, R5)	open	20%	very simple	no
16	(R2, R4)	open	20%	very simple	no
17	(R4)	very open	25%	simple	no
18	(R5)	moderate	35%	moderate	no
19	(R5)	enclosed	20%	simple	yes
20	(R4)	very open	15%	simple	no
21	(R4)	open	23%	simple	no
22		enclosed	20%	simple	no
23		enclosed	15%	simple	no

Data: Assessment sheets C3a

In general, the POI possess moderate to open level of enclosure; low to medium level of transparency; simple to moderate level of complexity; and low human scale.

Conclusions

The following are descriptions at three scales that summarize the main findings of the evaluation study which led to a selection process to define (1) a plot for a PCMH, (2) routes for active travel and, (3) points of interest to be developed at pedestrian level.

Macro scale conclusions

At this scale, the hospital and plots for the PCMH were mainly analysed in terms of proximity to health-related services and access to diverse public transportation hubs.

All plots measured had at least 5.000m^2, sufficient surface area to build a PCMH. The smallest plot (plot D) is approximately 14.000m^2 and the largest (plot E) around 26.000m^2 (see Figure 3).

Virchow-Klinikum is bordered by street collectors that limit easy access to pedestrians. It has one main pedestrian-only entrance and two secondary ones. One of the secondary entrances is accessible for pedestrians, cars, and deliveries including a car parking lot. The other secondary entrance is accessible for pedestrians, cars and the only one for bikers. This situation limits a proper pedestrian travel (safe, comfortable and pleasant) to any of the five plots.

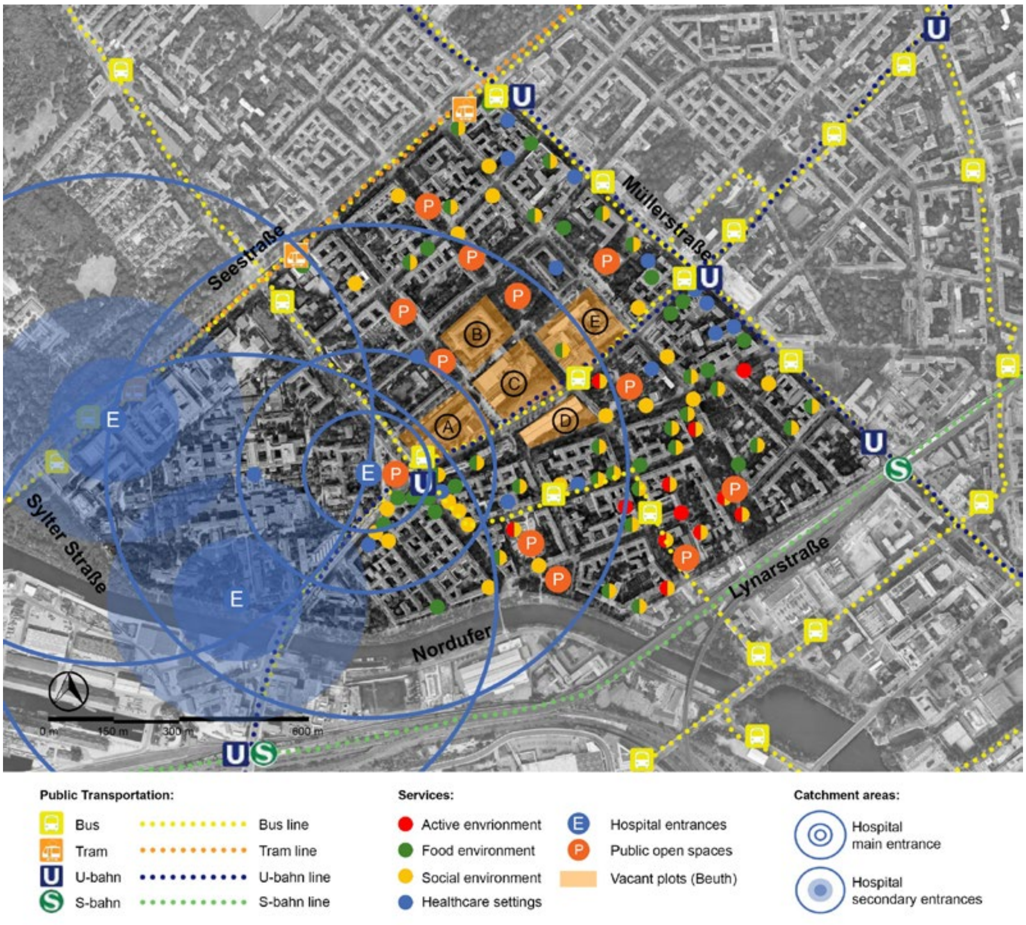

Figure 3. Macro Scale Conclusion Map

Public transportation in the area is served by 4 bus lines (including 1 night line), 2 tram lines, and 1 underground line having a complete coverage over the site. Although, the tram stop – having the friendliest accessibility for vulnerable groups - is the farthest to the hospital's main entrance and to the plots. Differently, the hospital and all plots except for B, have a privileged location towards the underground, although its entrances are not convenient for vulnerable groups.

Among the services found, around three fourths of the 56 stores and shops of the social environment are found in Sprengel Kiez, a similar proportion for the food environment, and almost 90% of all destinations of the active environment. The majority of solo offices or services for primary and secondary care are mostly distributed along Müllerstraße, a main collector which limits both Kiez in the East. Only three services in Brüsseler Kiez and five in Sprengelkiez are found on its local streets. In general, more than 65% of all stores, shops and services from all environments of both Kiez are beyond the 600m pedestrian catchment area from the hospital's main entrance and from plots A and B. In this case the most favoured is plot E.

The twelve open public spaces found, are half in Brüsseler Kiez being four predominately strips of unprogrammed green areas partly equipped with children playgrounds located along Lütticher Straße and Antwerpener Straße. The most relevant open public space at this Kiez is the Zeppelinplatz, which has been recently reequipped and renovated to serve as a multigenerational park. Virchow Klinikum and all plots are very close to this situation but, Virchow Klinikum and plot D are segregated by two prominent collector streets, Amrumer Straße and Luxemburger Straße, respectively.

In Sprengelkiez, Sprengelpark is the largest open public space, also recently renovated for different age groups. Another important park is Pekinger Platz, equipped for diverse formats of structured and unstructured play and age groups. The only plot nearby both parks is D.

From this macro analysis it was concluded that plots C and E were the strongest options for developing a PCMH mainly due to their proximity to a dense area of health-related services and parks, proximity to public transportation hubs, and large surface area ideal for a mixed used complex.

Meso scale conclusions

The aim at this scale was to define routes fit for an active travel from plots C and D towards the hospital's main entrance and other health-related destinations.

After assessing 40 street blocks, 42 streets, 102 street segments, and 77 crossing situations, Plot E was found to have best block to block connectivity and path continuity over Plot C.

Plot E borders northwest with Limburger Straße, a very important local street heading straight to the hospitals entrance without deviations. Improvements to this 580 m street are critical to the medical neighbourhood's master plan. At this street, a pedestrianized crossing with Zeppelinplatz facilitates flow through this park to Ostenderstraße. At this street pedestrianized crossings keep helping the flow towards Antwerpenerstraße, an important connector to other neighbourhoods. Ostenderstraße also connects very well to Müllerstraße where most healthcare settings are located. Northeast of the plot, Genterstraße has crossings over a car parking island towards an open green public space –used as a local market- have no markings. This situation can be easily improved by pedestrianizing a midblock crossing directly to the market. This action would connect plot E with a very important social and food asset of the neighbourhood. The plot borders southeast with Luxemburger Straße, an important street collector which 26 m width is a pedestrian barrier between both neighbourhoods due to first it's as broad crossings and second, its unbalanced space allocation favouring motorized vehicles. Southwest to the plot, a car free alley defines the boundary with Plot C.

Plot E holds a similar situation as Plot C although with few but very relevant differences. It does not have access to Genter Straße with its market situation and no direct contact to Zeppelinplatz.

The meso scale survey identified 5 main routes across the study site which conditions need to be improved for a well-connected and continuous active travel.

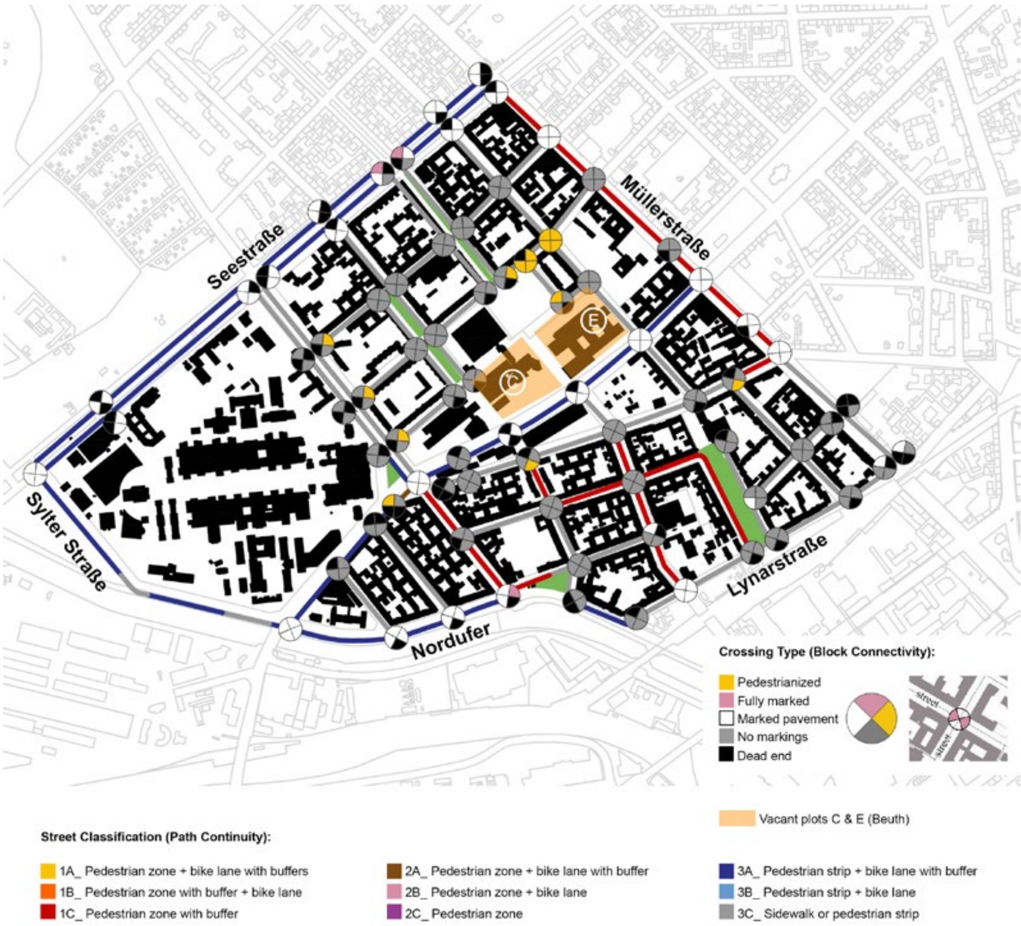

Figure 4. Meso Scale Conclusion Map

Micro scale conclusions

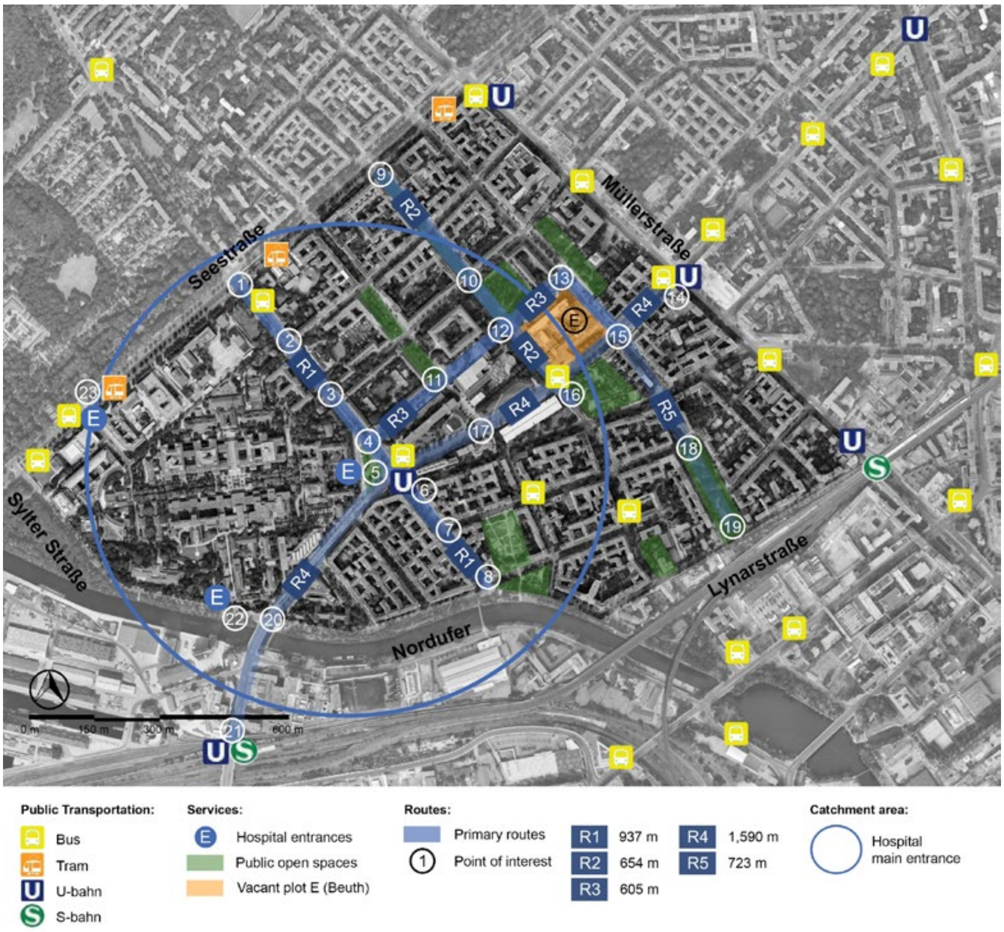

Figure 5. Micro Scale Conclusion Map

The micro scale surveys realized on the five routes (previously defined at meso level) identified 23 POI which environmental conditions require attention. The most relevant were those at public transportation hubs, street intersections, entrances to health-related destinations and most important the hospital entrance.

The hospital's main entrance has a very prominent space located at the border of both Kiez. At this point, the pedestrian flow is disconnected due to a broad intersection of three main collectors (Föhrer Straße, Amrumer Straße, and Luxemburger Straße) and car parking areas.

In general, all POIs provide universal access but not universal designs which could address children, for example. Half of these situations are not signalized but moreover they all need to improve pedestrian scale pathway finding. Sightline is not a problem across the whole study area only in a few situations close to green pockets (POI 16) where shrubbery does block views. Although spatial comfort at POIs are suitable in general, the evenly surfaced hard pavements can be combined with softer ones (more permeable) and more seating areas provided (respite areas), especially along Limburger Straße.

Noise levels during daytime and night time are moderate to low in all routes except for route 1 (see Figure 5) where at all times vehicular traffic is heavy on POIs 4, 5 and 6.

Natural light quality is not a problem, artificial lighting is. Along all street collectors, lighting at pedestrian scale is not provided, only for cars. In most local streets pedestrian lamps are present but need to be improved at some street intersections as for example POI 11 where tree canopies are obstructive.

It is strongly recommended to develop a streetscape design concept for all 5 routes to improve their visual structure.

General conclusion

This study found feasible to physically develop and implement a medical neighbourhood in the site studied. Medical teams can be built due to the proximity and diversity of medical solo-offices and patient journey quality experience can be easily ensured with moderate investments in streetscape designs. Although, despite a good provision of urban services and functions (compared to the berlin average), it is highly recommended for competent research institutions in nutrition, physical activity, and social behaviour to realize further studies on the quality of service of the neighbourhood's environment.

These measures once adopted can address most of the common issues hindering sustainability in the German health care system by:

- decreasing high rates of lifestyle-related diseases with health promotion
- improving conditions for the elder to age in place
- balancing costs for clinical care with community-level disease prevention measures
- enabling local staff for care and empower patients for self-care
- stimulating the creation of new health business partnerships among solo offices with the future PCMH
- creating a disease prevention and health promotion culture for other neighbourhood services to follow

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Research on health in architecture is a growing field that inherently is interdisciplinary, drawing on knowledge from medicine, nursing, gerontology, architecture and environmental psychology in order to understand the complex interaction between healthcare and architecture. How does architecture support the practices of healthcare? How does architecture impact the wellbeing of patients and staff? And can architecture enhance physical activity? These are some of the issues that are discussed at the ARCH17 conference on architecture, research, care and health held in April 2017 in Copenhagen. The academic papers presented at the conference are published in these proceedings.

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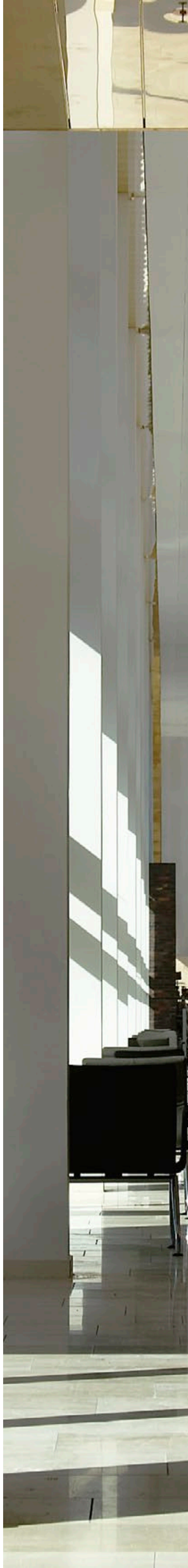

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