RESEARCH REPORT
DESIGN BRIEF

A new multi-modal transfer station in Warschauer Straße Bahnhof, Berlin.

complex projects

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Berlin Studio

Berlin, Building and Bodies

Group theme: Culture

CONTENTS

INTRODUCTION

01

1.1 Thesis Topic

Train stations and the evolution of modern metropolitans have always gone hand in hand. Since the earliest emergence of horse-drawn stations, urban mobility has been a constant topic of development, a huge design issue that requires the collaborative participation of architects, planners, traffic engineers, etc. From an architectural point of view, as the physical space carrier of the most popular means of transportation in the last century, the train station, its form, function, scale, and technology have always reflected the latest trends in social transformation. Nearly forty years ago, Meeks' research listed four stages of railway station development from the 19th to the 20th century: classical, baroque, eclecticism, and modern.[1] The various stages are also clearly indicated as being characterized by a shift from closed, linear to transparent, and interpenetrating.[2] This transformation also reflects the social and technological changes that have occurred over the past 100 years, including innovations in building materials and transportation, the transformation of people's lifestyles through digital culture, etc.

Looking at the train station today, it is still constantly developing and evolving. Urbanization and the energy crisis urgently require architects to come up with a more complex and integrated project. The current urban transportation networks are made of different graded modes, from long-distance or regional trains to metros, trams, and buses, with collective or individual vehicles, with regulated or unregulated and free systems, and now with emerging micro-mobilities and possible new autonomous vehicles.[3] Nowadays train station has to deal with multiple modes and different scales of transportation, which is the definition of a multi-modal transfer station. At the same time, multi-modal transport terminals are being practiced among EU countries. In France, the goal of more multi-modal mobility is being written into law, alongside other goals (e.g., "a more secure, more connected, more sustainable mobility").[4] The Netherlands has also made major improvements to main train hubs such as Utrecht and Arnhem stations. However, as Kaminagi pointed out, efficient interchanges in inter-modal stations are still limited or difficult especially if they are large nodes or if they include bus stations.[5] The introduction of multi-modal stations requires passengers to proactively seek their way and then enter various modes of transportation. In this case, the way-finding system of the multi-modal terminal is particularly relevant.

Kevin Lynch pointed out early on that urban space is perceptible and that five elements of space (nodes, paths, districts, landmarks, and edges) have a significant impact on perception.[6] Similarly, architectural spaces are also legible, the legibility of a building is the degree to which a building facilitates the ability of users to find their way within it.[7] Therefore, the design of the different hierarchical spaces in the multi-modal stations is crucial to the user's perception and experience. Spatial legibility and recognition become the key to way-finding systems. At the theoretical level, Gestalt psychology research has also demonstrated that spatial similarity and legibility help people to accomplish way finding tasks.[8]

In summary, this research will use one of the

1. Meeks, C.L.V, *The Railroad Station, an Architectural History* (New Haven: Yale University Press, 1975), 5.
2. Ibid.
3. Yo Kaminagai, "Intermodal hubs as urban spaces," in Stations as Nodes: Exploring the Role of Stations in Future Metropolitan Areas from a French and Dutch Perspective, ed. Triggianese(editor) et al. (Delft: TU Delft Open, 2018), 33.
4. Ibid.
5. Ibid.
6. Lynch, Kevin, *The Image of the City* (Cambridge, Mass: MIT Press, 1997).
7. Jerry Weisman, "Evaluating Architectural Legibility: Way-Finding in the Built Environment," Environment and Behavior 13, no. 2 (1981): 189–204.
8. Niu Li, Xu Leiqing, and Tang Zhong, "Use of gestalt in wayfinding design and analysis of wayfinding process," Frontiers of Structural and Civil Engineering 2. No.4 (2008): 386-390.

multi-modal stations in Berlin as a design practice to explore how architectural space can guide or help people find the correct path and thus shape an efficient and convenient station.

1.2 Problem Statement

In Berlin, the public transportation system is large and varied. Train (S-Bahn), tram, metro (U-Bahn), and bus consist of the main skeleton of the system. Hundreds of stations are scattered within Berlin's central area and other satellite towns. However, if we take a closer look at Berlin's current public rail transport network again, we find that it has many unique features. Firstly, Berlin does not have an overwhelmingly dominant mode of rail transport. The route lengths of U-bahn, S-bahn and tram as a percentage of the total line length are 21.6%, 36.2% and 42.2%, respectively. These three modes of transport working together to serve the residents of Berlin. Second, the vast majority of U-bahn and tram lines are located only in the former West and East Berlin, respectively. This means that there are almost no stations where trams and U-bahn intersect, except for a few stations that are themselves close to the border. The reason for this current unique distribution of public transport network is supposed to be found in city's complicated history. During the division period last century, the struggle between the two different ideologies of East and West has had a profound impact on today. In 1953, the West Berlin government thought that trams were obsolete and wanted to replace electricity with diesel fuel, so they made a momentous decision - to convert all of West Berlin's tram fleet to buses. Later in 1961, wall was built and East Berlin blocked all the U-bahn routes in east area. After the reunification of Berlin, the municipality also proposed the Mushroom Concept to create a more integrated and joint transport system. During that period, Hauptbahnhof , Sudkreuz and Potsdamerplatza Bahnhof were renovated or newly built. A brand new, gorgeous hauptbahnhof built in 2006 has impressed everyone and successfully presented a new image of Berlin while the entire east Berlin was ignored in this upgrade plan. Thus, a special station in east Berlin where the u-bahn, tram and s-bahn intersect was chosen which is Warschauer Straße Bahnhof.

Besides the ambition of reconnection. Reducing traffic congestion and reactivating the cultural vitality of the spree river are also positive effects that the station can bring to Berlin. According to tom-tom's survey data, Berlin is still the third most congested city in Germany in terms of vehicle roads.[9] By mapping congestion indexes, We identified that these congestion areas are located in places that lack inter-modal transfer hubs and mostly located in eastern Berlin's tram network area. Multi-modal station are indeed an effective solution to combat motor vehicle use especially more micro mobilities are introduced and integrated.[10] The last mile in a public transportation trip is known to bring a large disutility to passengers while bikes and scooters are important solution to help travel from station to ultimate destination.[11] Furthermore, Warschauer Straße Bahnhof is also located in a high density urban area where it is possible to developed into a significant cultural hot-spot. Linking with water is also a promising potential by upgrading multi-modal such as ferry connection.

9. "Ranking of congestion index in German cities," Tom-tom, accessed November 3, 2022, https://www.tomtom.com/traffic-index/berlin-traffic#statistics.
10. Adamos, Giannis, and Eftihia Nathanail, "How Attractive are Public Transport Interchanges? A Cross Comparison of Two European Terminals," Transactions on Transport Sciences 13, no. 1 (2022): 74-83.
11. Arthur Scheltes and Gonçalo Homem de Almeida Correia, "Exploring the use of automated vehicles as last mile connection of train trips through an agent-based simulation model: An application to Delft, Netherlands," International Journal of Transportation Science and Technology 6, no.1 (2017): 28-41.
12. Fatemeh Torabi Kachousangi, Niels van Oort and Serge Hoogendoorn, "The Future of Intermodal Hubs," in *Stations as Nodes: Exploring the Role of Stations in Future Metropolitan Areas from a French and Dutch Perspective*, ed. Triggianese(editor) et al. (Delft: TU Delft Open, 2018), 57-58.

1.3 Research Question

The core and inevitable topic in the design of inter-modal stations is how to achieve a seamless transfer experience. The objective of the transfer hub design is to optimize transit times for different modes of transportation while ensuring that passengers are able to spend their travel time in a pleasant or useful manner.[12] Thus, the organization of both different functional spaces and the flow of people should be focused on. The spatial experience can be influenced by architectural elements such as skylights, atrium, materials, and so on while experience and perception directly decide the judgment of users when finding routes. In the digital life of the future, signage is likely to become increasingly complicated and carry large amounts of data and information. Yet the architectural space probably serves to simplify and provide a natural way-finding guide for passengers. In this case, exploring the relationship between space and natural way-finding becomes more essential in the design of a multi-modal transfer hub. Thus, the primary research question is how can architectural spaces guide people to find routes at multi-modal transfer hubs in Berlin?

In addition, the project aims to represent an inspiring example that can contribute to a more sustainable future transportation mode.

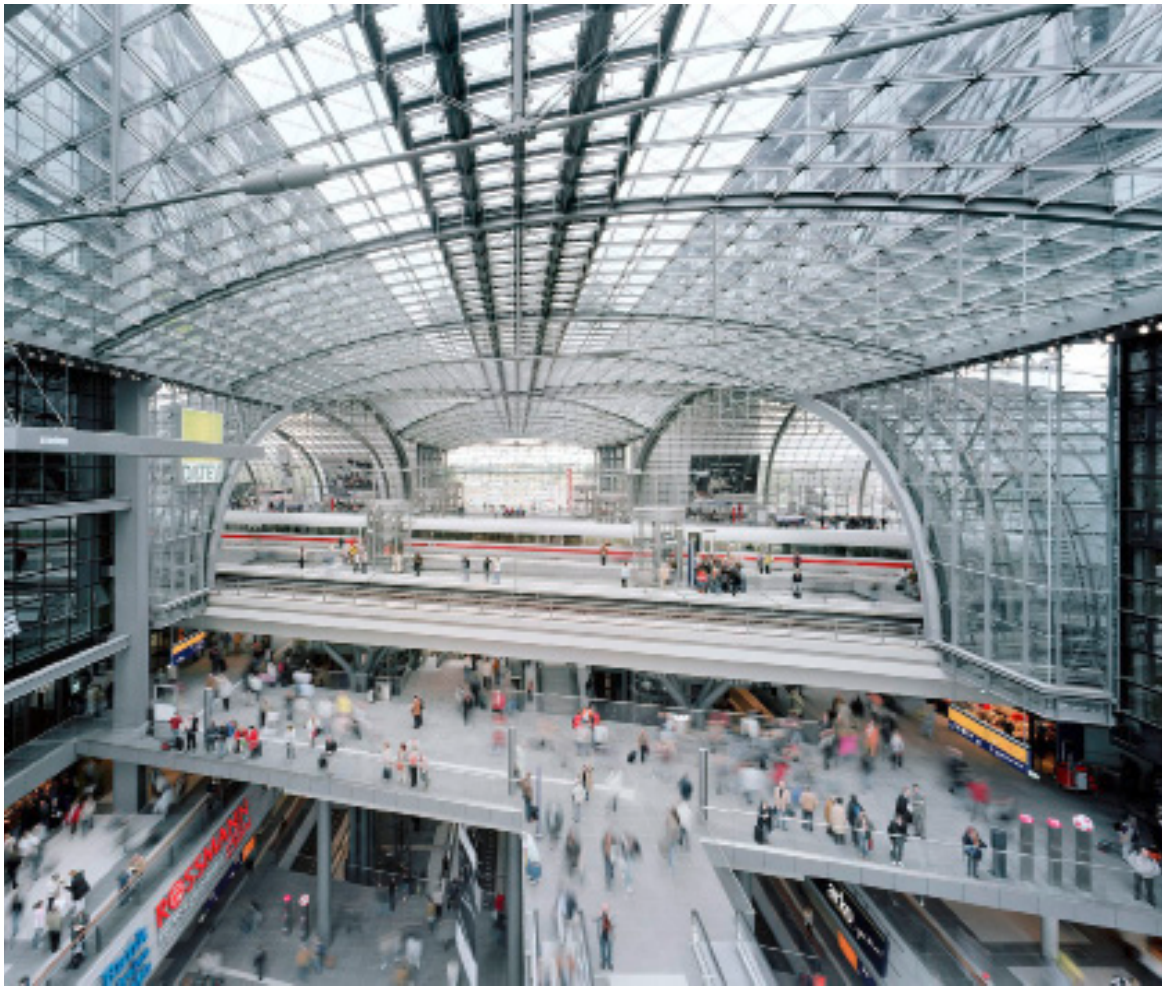

Figure 1. Interior of Berlin Hauptbahnhof. Retrieved from https://wsdg.com/projects-items/berlin-hauptbahnhof-central-station

THEORETICAL FRAMEWORK

02

2.1 Theoretical Framework

The theoretical framework will be based on the theories of architecture and its intersecting disciplines, including Gestalt psychology, theories of perception and legibility of space, theories of spatial orientation and way-finding, etc. In addition, it includes a historical development and a modern typological study on multi-modal railway stations.

Jerry Weisman evaluated the correlation between architectural legibility and way-finding systems through questionnaires and analysis of two-dimensional plan diagrams and argues that spatial readability facilitates the way-finding process and results in a variety of different behaviours.[13] On the basis of Jerry's readability study, some scholars brought forward a new definition named "Gestalt space".[14] Spatial classification, grouping, and interruptions are also significant basic strategies to accomplish way-finding design. Besides the study of way-finding and legibility, the sensory experience of space is another theoretical research direction. Paul and Romedi explained the importance of graphics, auditory and tactile to the way-finding design and how signage and architectural components work together to facilitate way-finding systems.[15] In a subsequent study, Jason illustrates more concretely how graphic indicators and spatial structures work together to define spatial characteristics and establish way-finding order through a specific architectural renovation case in Amsterdam.[16]

For the building type of multi-modal transfer station, the integration and interconnection of multiple traffic modes are bound to a more complex flow inside the building than in a conventional train station. Therefore, before investigating the way-finding system inside the multi-modal transfer station, it is essential to analyse both the spatial hierarchical organization and critical spaces. Edwards summarized six main elements of designing which respectively are railway tracks, platforms, circulation areas, ticketing, parcel areas, and concourse.[17] These key spaces of the building are interconnected and influence each other. Based on these, in the subsequent case study, the spatial relationship between railroad track and concourse, parcel area, and concourse will be used as the main theme to be compared by means of a relationship diagram. The summarized relation diagram is graphically shown below(Fig.2).

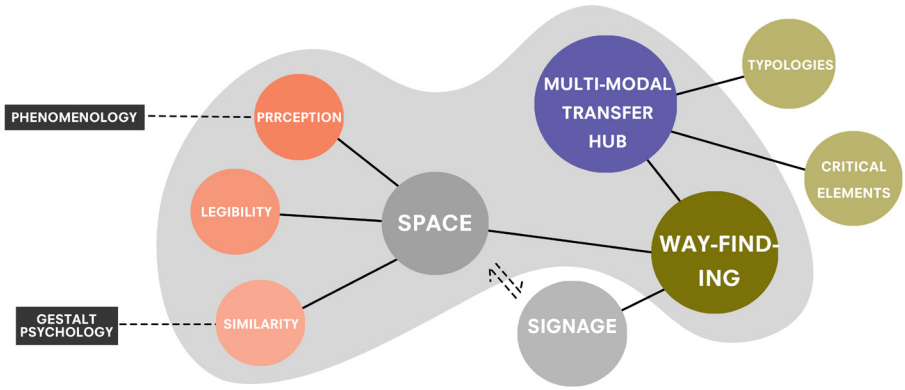

Figure 2. Relation diagram of theories connection. Illustration by author.

13. Jerry Weisman, "Evaluating Architectural Legibility: Way-Finding in the Built Environment," Environment and Behavior 13, no. 2 (1981): 189–204.
14. Niu Li, Xu Leiqing, and Tang Zhong, "Use of gestalt in wayfinding design and analysis of wayfinding process," Frontiers of Structural and Civil Engineering 2. no.4 (2008): 386-390.
15. Arthur Paul and Romedi Passini, *Wayfinding: People Signs and Architecture* (New York, McGraw-Hill Book, 1992).
16. Abrams, Jason Brandon, "Wayfinding in Architecture," (2010) *Graduation Theses and Dissertations*.
17. Edwards Brian, *The Modern Station: New Approaches to Railway Architecture 1st ed* (London, E&FN Spon, 1997).

RESEARCH METHODS

03

3.1 Site

The site studies will be approached in two phases. Station mapping as well as traffic data collecting will be processed in the first phase. This helps the author to gain a general understanding of Berlin's traffic conditions and eventually define an approximate area. Then the fieldwork will be conducted including drawing sketches, taking photos and doing interviews, etc. Field experience in taking various modes of transportation in person is also a good way. Strolling maps and sketches of critical spaces and nodes in sites will be drawn as well during the experience. Then the conclusion and outcome should be drawn in which specific site area and boundaries, buildable area and boundaries, site potentials and constraints etc. are included.

3.2 Program

In order to reach the conclusion and establish a comprehensive design brief for further design, the architectural program has to be the most significant part to set a clear list of various functions and uses. This list should include the area proportion of rooms for each function, the estimated number of users in each functional area, and the ratio of gross floor area and net floor area. In particular, in a multi-modal transfer station, due to the different distribution characteristics of transportation modes, the proportions of the area of each traffic mode to the total footprint also need to be defined and compared. In addition to the program bar, the relations or intersections between the functional areas should be explained in a clear graphical way.

Nevertheless, all the analyses and conclusions of the architectural program are still aiming to design a multi-modal transfer station in Berlin with an effective natural way-finding system by spatial design. Thus, case studies and benchmarking will be used to figure out the size and program bar of the project. The average ratio figure will be calculated and then fine-tuned to the specifics of the project. During the process, archives, books, and online materials will be accessed. For those statistics which cannot be reached from existing information, floor plan and section drawings will be collected and areas of each functional room will be traced by the author through the software adobe photoshop, or illustrator. Afterward, excel will be used as the data processing and calculation tool. For relation diagrams, the specific analysis themes should be first defined for the multi-modal transfer station. In this case, relations between the concourse and tracks, the building and tracks, and the concourse and entrances were chosen as three main topics. Through the comparative analysis of these topics, the flows of different groups of users or logistics will be clearly defined. They are graphically visualized as flow chart diagrams while vertical and horizontal intersections will be marked as important nodes.

3.3 Client

According to the investigation data from Allianz pro schiene, only one-fifth of station buildings still belong to the federal government and Deutsche Bahn.[18] Most of them were sold to private associations or companies after the German rail reform. However, as the Pro-Rail Alliance managing director criticized, "*Too many of the reception buildings sold are in an unsatisfactory condition today, many can no longer be used for travellers.*"[19] The segregated ownership of reception buildings and traffic platforms results in a chaotic and inefficient management model which hinders the long-term development of multi-modal transport stations.

Based on this preliminary conclusion, the following studies on clients need to focus on the ownership of reception buildings and traffic platform buildings. Besides, the benefits of other stakeholders like the micro-mobility, sharing, and electrical transportation

18. "Only every fifth station building still belongs to DB," Allianz pro schiene, accessed November 11,2022, https://www.allianz-pro-schiene.de/presse/pressemitteilungen/nur-jedes-fuenfte-bahnhofsgebaeude-gehoert-noch-der-db/.
19. Ibid.

providers, micro-mobility associations, and Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action should be taken into account as well. Regarding the specific methodology of the investigation, first of all, it is necessary to continue to collect online information from both railroad companies and professional survey agencies. The main ambitions or strategies they are achieving are main basis for design. Secondly, the most critical needs and concerns of clients can be obtained through direct interviews or email contact if possible. At last, functional ambitions should be summarized and translated into more specific architectural ambitions. Collages is a good graphical way to show the preliminary possible architectural expressions.

DESIGN BRIEF

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This design brief has been prepared in such a way that it can be referred to by anyone to design a new multi-modal transfer station in the context of Warschauer Straße Bahnhof in Berlin.

It is broken down into three main parts, namely: site, program, and client. For each category, functional ambitions and requirements will be firstly proposed. On top of that, more specific architectural ambitions will be presented as the potential references for design. Furthermore, these ambitions and requirements will be supported and clarified by means of diagrams or illustrations.

4.1 Site

On a city scale, the main and crucial issue for Warschauer Straße Bahnhof is lacking of effective connections between U-Bahn, S-Bahn, bus, and Tram. Furthermore, due to its high density context and proximity to cultural hot-spots, it can also contribute to reduce traffic congestion and reactivate waterfront public corridor. Thus, the new Warschauer Straße multi-modal transfer station aspires to fill the gap of public traffic hub in the east Berlin (Fig.3). More specifically, it has potential to achieve this ambition by an overarching traffic building, upgrading the inter-modality, and facilitating the connection to ferry station.

In the neighbourhood and building scale, Warschauer Straße Bahnhof is located in an area where functions are ever-changing while it is still under transformation currently. In order to adapt to both existing situation and future development, station should be easily approachable in all directions of site (Fig. 4). In addition, due to high people stream and vehicle volume, the two façades facing the spree river and Warschauer Straße should be the two most emphasized façades in terms of architectural expression (Fig 5). The building height should higher than 20m which is the average of the surrounding buildings to form the rhythm of the skyline(Fig. 6).

Besides, the project side boundary was defined (Fig 7) while the build-able area boundary (Fig. 8) also proposed according to surrounding context. For example, the inward offset of the southwest corner of the site boundary line is due to the noise requirements of the educational institution and to allow flexibility for future platform expansion.

Other general requirements are as follows:

- Building should no higher than 40m and within the building envelope (Fig 9).
- U-Bahn traffic building needs to be preserved as monumental building while S-Bahn traffic building is supposed to be demolished (Fig 10).
- Bus stop can be relocated in order to be integrated into new station's circulation system.
- Abandoned parking lot under underneath viaduct can be reused as a part of outdoor public space.
- Existing pedestrian bridge connecting S-bahn and U-Bahn need to be demolished while the concrete materials for recycle.
- Tram station cannot be moved.
- Due to the sun path, facade towards Spree river has potential to decorated by green plants.
- Transitional or in-between spaces are needed between building and outdoor stations.
- Planting on train station square should be taken into account.
- Entrances should be located at both street level and viaduct level.
- For reducing cost and facilitate future expansion, island platforms should be prioritized.

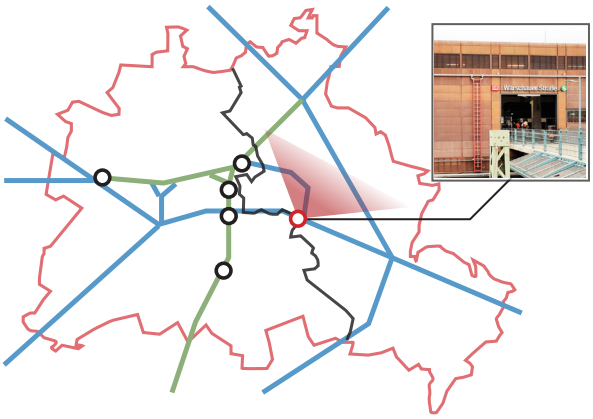

Figure 3. Station to fill the gap in east area. (Own diagram)

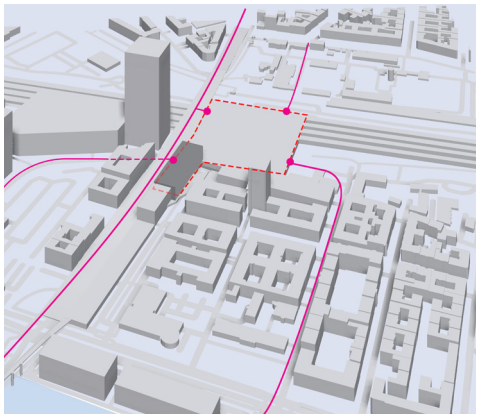

Figure 4. Potential accessible points (Own diagram)

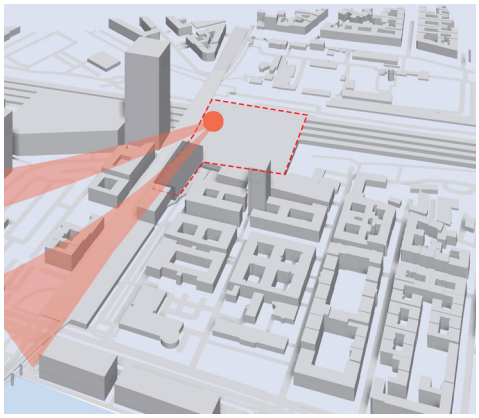

Figure 5. Directions of high people and vehicle flow (Own diagram)

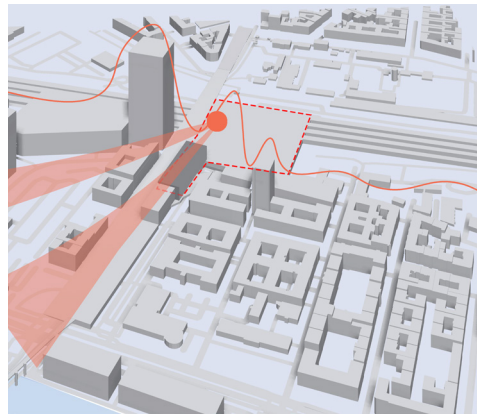

Figure 6. Rhythm of skyline (Own diagram)

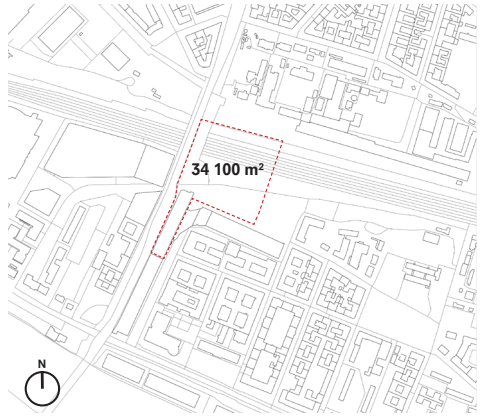

Figure 7. Project site of multi-modal transfer station (own diagram)

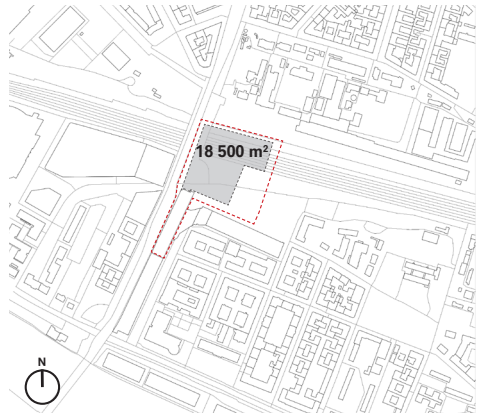

Figure 8. Build-able area boundary (own diagram)

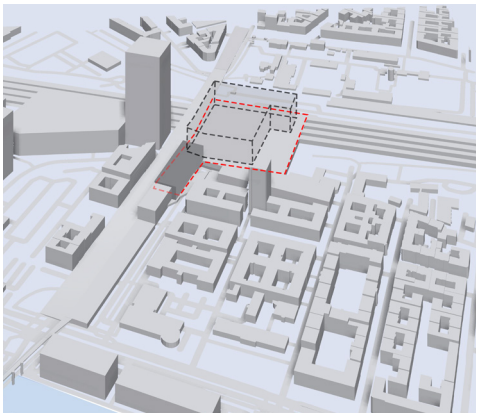

Figure 9. Envelope of buildings (own diagram)

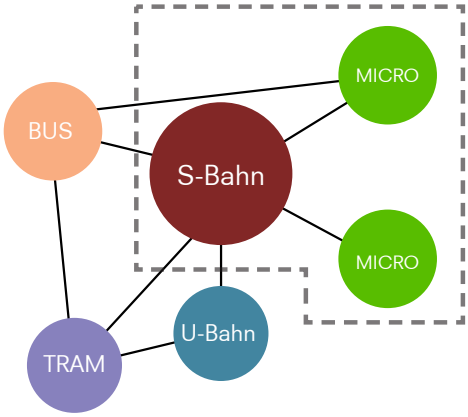

Figure 11. Relations of different transport modes (own diagram)

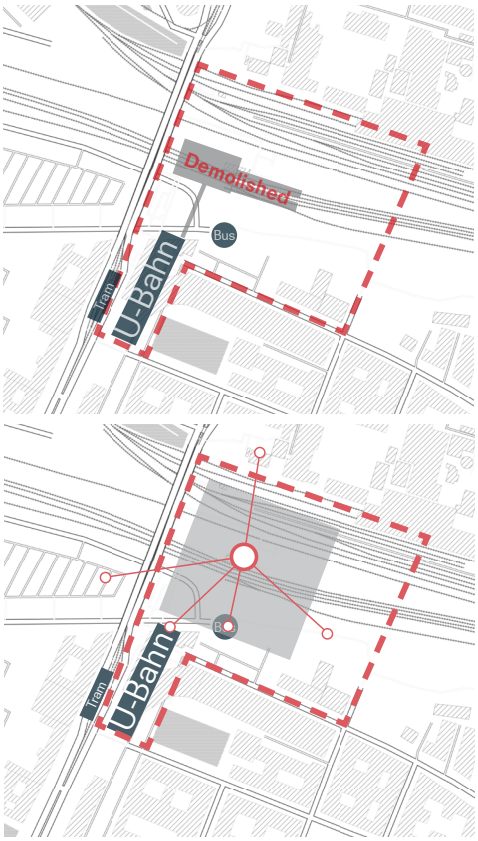

Figure 10. Demolition and new construction (own diagram)

Figure 12. Area proportions of each transport mode (own diagram)

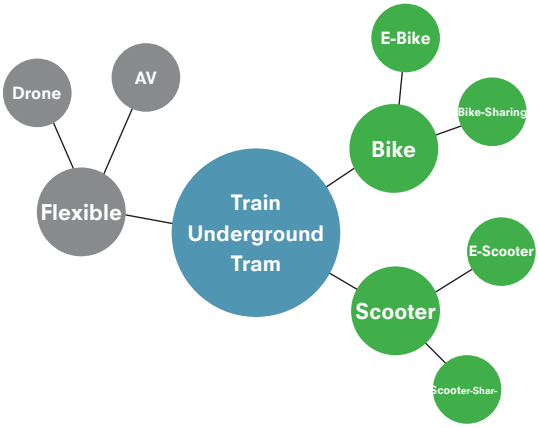

Figure 13. Selection of micro-mobility modes (own diagram)

4.2 Program

The multi-modal train station aims to improve the mobility within a complicated public transport network and provide a seamless transfer experience in one overarching building.

The ambition is to find the suitable architectural way-finding tools that can be applied for the project, proper area of each functional zone, and relations between them. Furthermore, the form and size of space needed for new forms of transportation also was defined.

Firstly, in order to get a total size of building, precedents of different scales and which are located in different urban contexts were compared. The passenger volume is considered as a main factor that affects building size. 0.001 square meters per passenger per year as a relatively average number was chosen. Then it is multiplied with the estimated total number of passengers to get the final gross floor area(GFA) which is 39 990 square meters. The functional traffic area of each transport modes is related to site design. In Warschauer Straße Bahnhof, based on its current situation, an overarching building provides an integrated circulation space for S-Bahn, micro-mobilities, U-Bahn and transitional spaces for tram and bus (Fig. 11).

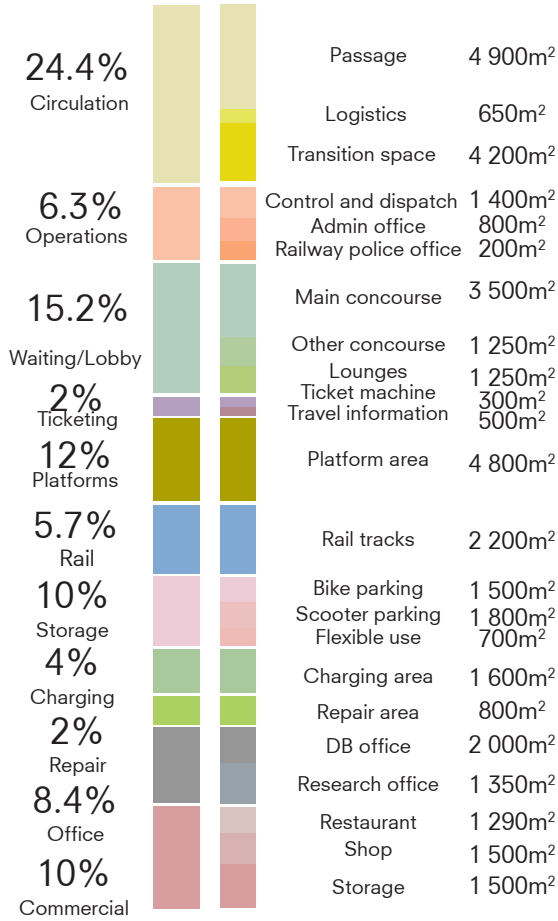

Figure 14. Program bar breakdown (own diagram)

Other general requirements are as follows:

- Options of micro mobilities and short-term future mobilities as shown in figure 13.
- Square meters and program percentage as shown in figure 14.
- A central concourse as an intersection of all traffic flows.
- Functional relations based on the basic order which is from concourse to circulation, ticketing and then platforms. (Fig. 15)
- Natural way-finding elements which can be applied to site as shown in figure 16.

Specifics (Fig 17):

- S-Bahn passenger platform height is 960mm while it is 760mm for ICE.
- Side platform minimum width: 2.5m
- Middle platform minimum width: 6m
- Island (access at end) platform minimum width: 9m
- Island (access in the middle) platform minimum width: 10.8m
- Standard gauge (1435mm) for both U-Bahn and S-Bahn in Berlin.
- Current S-Bahn rolling stock for Warschauer Straße Bahnhof is DBAG Class 481/482 (3000mm*3585mm) with a length of 36.8m.

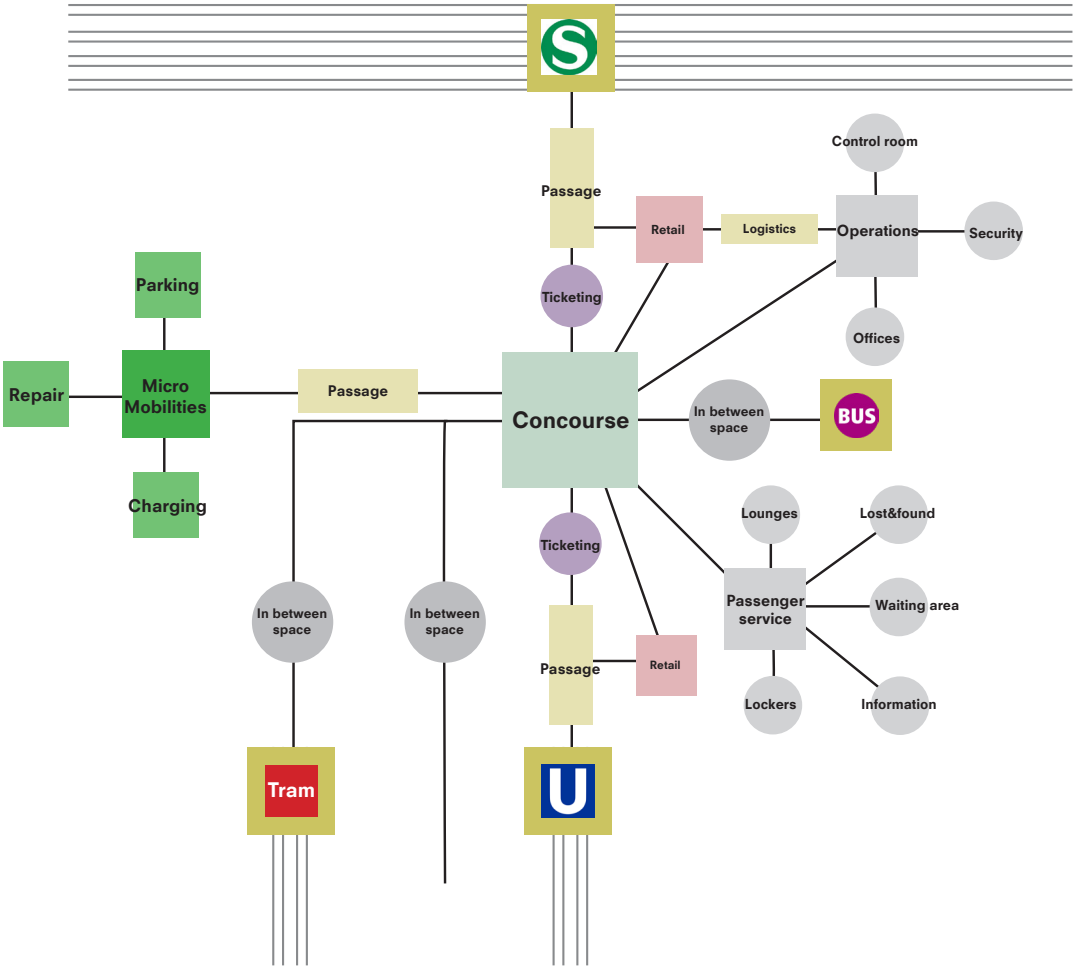

Figure 15. Relation scheme (own diagram)

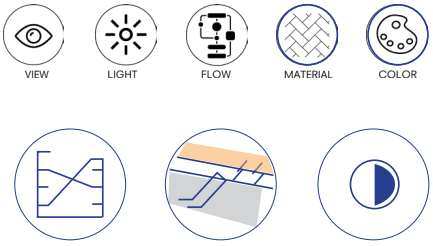

Figure 16. Natural way-finding tools (own diagram)

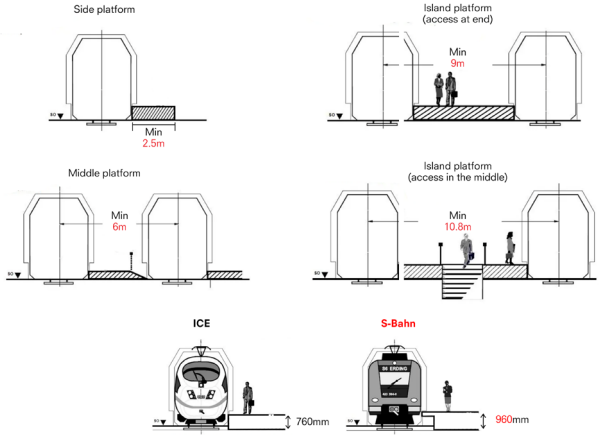

Figure 17. Platform dimensions (own diagram)

4.3 Client

The clients are initially divided into three groups: initiators, operators, and policymakers. Deutsche Bahn AG the most important railroad-operating company in Germany was defined as the main client whose ambition was "a strong rail" which means a more climate-friendly, and more mobile German rail network.[20] Another conventional transportation operator in Berlin is Berliner Verkehrsbetriebe (BVG) which is responsible for managing the city's U-Bahn underground railway, tram, bus, replacement services, and ferry networks. BVG is also an explorer who is seeking an electric future for Berlin by promoting more electrical public transportation.[21] Most of the other relevant clients are emerging and innovative traffic operators who are providing sharing, on-demand, or electrical mobilities like Lime and Tier. In addition, Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action regarded Warschauer Straße a mixed and vibrant community. Based on these functional ambitions mentioned above, architectural ambitions were translated into collages as initial expressions.

- In order to achieve the ambitions of further expansion, flexible spaces should be provided for future platforms and tracks with a minimum cost. Adaptive and flexible building components that can be replaced with low cost might be a good solution (Fig 19).
- An eye-catching green facade aims to contribute to promote concept of sustainability to global passengers for Deutsche Bahn company (Fig 20).
- A good link between building and outdoor public space such as square and park contribute to a more diverse and mixed community (Fig 21).

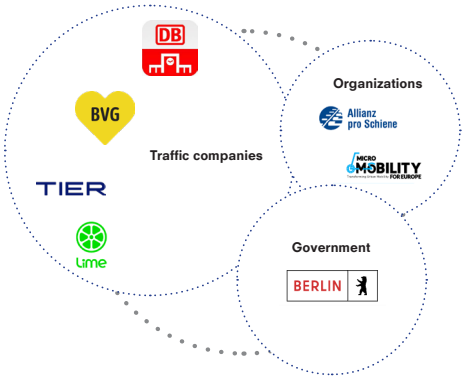

Figure 18. Stakeholders network (own diagram)

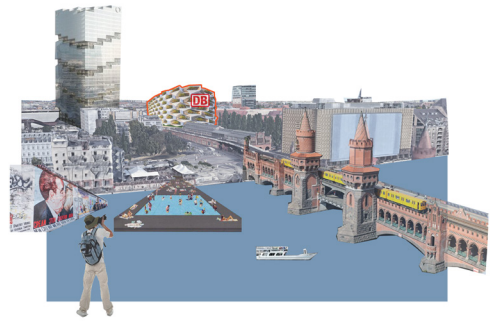

Figure 20. Eye-catching green facade (own diagram)

Figure 19. Adaptive and flexible components (own diagram)

Figure 21. Courtyard building (own diagram)

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