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A New Urban Transportation System for the TXL Masterplan in Berlin

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Biography

Celine Krstulovic is a product owner in the field of mobility technology development. She is currently working on an Integrated Mobility Platform at AtoB in Berlin. Before that she worked on developing smart mobility solutions at the Siemens Mobility Digital Lab in the Netherlands and holds a Master's Degree from Delft University of Technology. She is an enthusiast for developing technology to make mobility and cities smarter.

Abstract

The rapid growth of cities raises the challenge of organizing mobility in a smarter and more sustainable manner. City governments face a trade-off between the investment in incremental improvements to the existing infrastructure or developing new technologies towards a smart city. This paper investigates the new urban transportation system for the Tegel area in Berlin. After closure of the TXL airport, the area will be redeveloped into a residential area, innovation hotspot and smart city within Berlin. Also, the current main public transportation line from Tegel airport will be cancelled. This presents the challenge of connecting the area to the rest of Berlin by a new mode of transportation, and organizing mobility within the area. This paper focuses on the different modes of transportation that have been researched. It discusses whether the proposed modes of transportation concern an incremental innovation on the existing transportation network and follows the improvement pathway, or if it creates a shift from transportation to the use of new mobility services and fits onto the so-called shift pathway.

Keywords: urban infrastructure, smart mobility, public transport, mobility hubs, smart city

Introduction

The need for integrating smart mobility planning in the future of developing urban cities is becoming increasingly important. “According to the United Nations, 55% of the global population currently lives in cities. By 2050, that number is expected to reach 68% (Frem et al., 2018).” This poses a challenge for urban mobility. As cities will become more congested, less space will be available for the mobility network to expand and it will require smart solutions to meet the increasing demand for urban mobility. Berlin, shown in Figure 1, can be considered a city ‘ahead of the curve’ in terms of shifting away from traditional patterns of urban mobility; it is a dynamic city with thriving tech industries to foster innovation in mobility, and it has a forward-thinking city government that has implemented progressive land-use and transport planning policies (Rode et al., 2015). An area under transformation is the former Tegel Airport which lies embedded in the city of Berlin. The plan is to transform the former Airport into a new smart city for ‘future urban technologies’.

Figure 1*: Impression of Berlin Skyline at Alexanderplatz*

The closure of the Tegel Airport, which is planned in October 2020, will be giving rise to a new residential area and technology park in the “TXL Masterplan” (or: masterplan area). Part of the transformation is to connect the area to the rest of the city Berlin and to organize mobility within the area. The redevelopment is expected to lead to an increase in the urban traffic load and requires the development of a new urban infrastructure system. Ambitions have been formulated for a CO2-free mobility concept and deploying smart mobility solutions. Figure 2 shows the current Tegel Airport.

Figure 2*: Tegel Airport. Image by Mario Hagen from Pixabay*

In the transition towards smart mobility, we can distinguish two pathways; the improvement and the shift pathway. “The *improvement pathway* represents the refinement of user experience, safety and efficiency through incremental innovations such as; using ICTs (information- and communication technologies) for monitoring and the introduction of self-driving or automated vehicles (IGLUS and EPFL, 2017)”. The shift pathway represents the shift from transportation to mobility, where the user perspective shifts from car ownership to using mobility. Technological innovation and the digitalization of consumption have enabled new access-based services to emerge over traditional ownership models; smartphone applications support people’s travel decisions on-the-go as they move through a smart city, which enables smart mobility services to respond flexibly to their needs (Rode et al., 2015). The *shift pathway* introduces services such as car sharing schemes, or carpooling and e-hailing services.

This paper describes the modes of transportation that have been researched for developing the new urban infrastructure system. Besides that, this paper

discusses whether the *improvement* or *shift* pathway would be followed in the transition to a smart urban infrastructure system.

Introduction to the area

Tegel Airport is one of the main airports of Berlin and is located in the north-east of the city. It will be closed after the opening of the new Berlin Brandenburg Airport. After closing, the Federal Government and State of Berlin will redevelop the area of approximately 490 hectares into a residential area and innovation hotspot where research and business will develop the Urban Technologies of the Future (Arup, 2020). The development, of which construction is planned to start in spring 2021, is carried out by the Tegel Projekt GmbH commissioned by the State of Berlin (Steinmann, 2020). The project is phased into several construction phases and is expected to be completed between 2030 and 2040. The area is divided into 4 districts, shown in Figure 3 on the left, which are:

- The "Kernbereich der Urban Tech Republic": The new research and industrial park called the "Urban Tech Republic" will be developed around the terminal building of the airport. Also referred to as the "technology park";
- The "Landschaftsraum" which is a large green space;
- The "Tegel Nord", the northern district area as a mixed area with approximately 4,000 apartements, and the "Kurt-Schumacher-Quartier" will be a mixed area with more than 5,000 apartments. Figure 3 on the right shows an impression of developments around the former Airport.

Stakeholders that are involved in developing plans for the new urban infrastructure system are the BVG (or "Berliner Verkehrsbetriebe") which is the main public transportation company of Berlin. Besides the BVG, the "SenStadtUm" (or: "Senatsverwaltung für Stadtentwicklung und Wohnen") is an important stakeholder as it concerns the governmental body responsible for urban development in Berlin.

The current urban infrastructure system

The Berlin road network in the vicinity of the current Berlin-Tegel Airport is well developed and shown in Figure 4. It connects the area for motorized vehicles in the east-west direction by the Saatwinkler Damm and in the north-south directions by the Highway A111 and the Kurt-Schumacher Damm. The area is located north of the Hohenzollern canal.

The public transport network currently consists of bus lines that take travelers from the airport into the city of Berlin. This is the only mode of public transportation connecting the area to the rest of Berlin. Figure 4 below shows the purple ring line into the masterplan area, which is the main bus line connection. There is currently no existing connection in the area to the tram network. Starting from the center of the area, there is no subway station in the proximity of walking distance. The closest U-Bahn stations are at approx-

Figure 3*: On the left: The four districts in the Berlin TXL Masterplan © SenStadtUm 2013. On the right: Berlin TXL – The Urban Tech Republic © Reicher Haase Associierte for Tegel Project GmbH. For further project information: www.berlintxl.de*

imately 2,5 kilometers walking distance and further from the future center of the Tegel area.

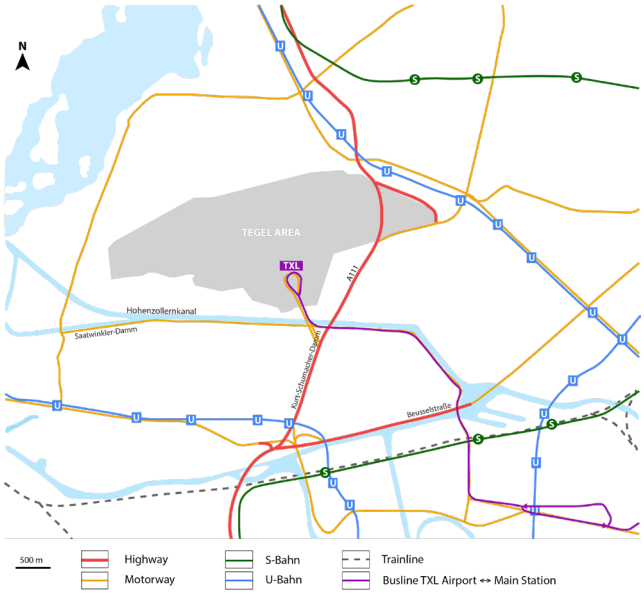

Figure 4*: Public Transportation System Berlin Tegel*

The current scheduled bus services to the area will be stopped with the closing of the airport. "This can lead to a large-scale shift in the number of passengers in the public transport network and a steadily increasing number of passengers illustrates the great importance of the subway (Drees & Sommer and Argus, 2013)". The current traffic volume that is estimated for the Berlin-Tegel airport is "approximately 39.500 vehicles per 24 hours (Drees & Sommer and Argus, 2013)". The future traffic volume prognosis, described in the research performed by Drees & Sommer and Argus (2013), focuses on the modal split between for motorized vehicles and public transportation. It anticipates a volume of 22.100 vehicles per 24 hours for motorized vehicles, and 20.300 vehicles per 24 hours for public transportation. This prognosis anticipates an increase of 7% in overall traffic volume and an increasing importance of public transportation to meet the increase in traffic demands. Besides meeting the increase in the traffic volume, the new urban transportation system will have to meet the objectives formulated within the TXL Masterplan.

Objectives for the new urban infrastructure system

Several objectives have been formulated by the Tegel Projekt GmbH when creating the traffic concept with an innovative character. An important objective is the interconnection of transportation modes. The traffic concept focuses on enabling the integration of different modes of transportation, and connecting local with structural networks for optimal future-oriented traffic planning. Combining the established and an innovative transportation system is an important aim within the masterplan. In order to develop an infrastructure system that "can be integrated as well as possible into the existing infrastructure and surrounding city structure (Drees & Sommer and Argus, 2013)".

Transport planning also follows the goals of sustainable "green" development. Berlin is aiming to become climate-neutral by 2050 (Senate Department for Urban Development and the Environment, 2015). Plans have been formulated for implementing a CO2-free traffic concept in the area (Von Gerkan, 2013).

Transport planning should also provide a sustainable new urban infrastructure system through flexibility. It should be able to react to fluctuations in demand and enable flexible transport lines. It should close the existing gap in the public transport network between Jungfernheide and Kurt-Schumacher-Platz, which would take account for the increase in traffic demands. Also, the plan should allow for a phased implementation according to the masterplan.

From a cost perspective, developing the new urban infrastructure system according to the lowest cost possible is an important objective.

Identification of the main problem

Connecting the area to the rest of the city, and organizing mobility within the area, comes with its challenges. Economic challenges on the service layer and technological challenges on the infrastructure layer can be identified.

Firstly, an important challenge on the services layer is the decline in bus commuting. As stated earlier, the current scheduled bus services to the area will be stopped with the closing of the airport. The bus lines are currently the only form of public transportation services available to the area. Shutting down this service disconnects the area from the rest of Berlin with regards to public transportation. It introduces the immediate necessity of finding a new mode of public transportation as a service to the public.

Another challenge is presented by the sustainability objective that no motorized vehicles will be allowed within the area. It sets the solution space for mobility services to the use of renewable energy

sources, and may introduce technological challenges on the infrastructure layer. It requires the placement of charging stations, and raises the question of how to prohibit the access of motorized vehicles. However, it also introduces the economic opportunity of deploying new business models by providers of smart- and sustainable mobility services.

Technological challenges on the infrastructure layer are introduced by the fact that the Tegel area is enclosed by the Saatwinkler-Damm, the A111 highway and the Hohenzollernkanal. Connecting the area to the rest of Berlin poses a challenge of crossing these (multi-level) structures with a new mode of transportation. It may require the construction of bridge or tunnel structures. It can introduce large technological complexity, high construction costs and intervention to existing buildings. This presents the largest challenge in developing a new smart urban transportation system for the redevelopment of the Tegel area. It raises the question whether to focus on improving the current infrastructure, or shifting to a new mode of smart transportation that may not require changes to the current infrastructure.

Analysis of the measures

This chapter will describe the different modes of transportation that have been researched, in order to connect the area to the rest of Berlin. It will shortly elaborate on the considerations, and how it deals with the proposed challenges. Besides that, the solution for organizing mobility within the area is described. The options discussed are based on the research and recommendations by Drees & Sommer and Argus (2013) for developing a new urban transportation system.

Connecting the area to the city of Berlin

Firstly, a distinction can be made between central- and decentralized transport systems. Central systems include the U-Bahn and S-Bahn system, which stops have a large radius. From a central stop, external areas can be connected using supplementary transportation. Decentralized transportation systems include trams, regular buses and people movers. They “enable a closer-knit network of stops and, despite the usually lower passenger transport performance, offer a higher area coverage (Drees & Sommer and Argus, 2013)”.

Figure 5*: U-Bahn and S-Bahn stations in the vicinity of Tegel Area*

Centralized systems

The U-Bahn stations in the vicinity of the Tegel Area are shown in Figure 5. Two possible connections were researched for an U-Bahn extension. One of the variants would be a branch connection from the northern Line 6 with one central stop in the technology park. The second variant continues to close the existing gap between Jungfernheide station and Scharnweberstraße. The continuation to Jungfernheide station is only possible by a tunnel construction, and both variants require bridge structures to cross the A111.

For both U-Bahn variants a public transport connection would have to be organized until completion via regular buses. Since one central stop does not cover all areas, a supplementary bus route must be provided. Because adding another U-Bahn stop would increase the construction costs considerably. Furthermore, the system is considered not to be very flexible due to the necessary investment in rail infrastructure. It is expected that an U-Bahn connection will only cover 50% of the forecast of 20,300 public transportation trips. However, the U-Bahn is considered one of the best public transportation networks in the world. Connecting the area by U-Bahn would integrate the area seamlessly into the rest of the city. Unfortunately due to the high expected costs for a tunnel structure and the low expected passenger volume, the U-Bahn connection has been further disregarded.

Besides the U-Bahn, the S-Bahn is an integral part of the Berlin transportation network. For the S-Bahn two possible variants have been studied, but only one has been further researched. This variant would use the former Siemensbahn route from Jungfernheide station to find it's connection into the area. It would require reactivating this route. It would introduce the advantages of realizing a large part of the routing without negative impact on existing buildings and integrating Siemensstadt into the network. This variant is prognosed to take account of 70% of the forecast.

Decentralized systems

A promising option concerns the continuation of the tram into the Tegel area. The tram line would continue from the Beusselstraße S-Bahn station to the north via Saatwinkler Damm into the masterplan area. And eventually connect to the Kurt-Schumacher-Platz station. The routing can be realized at ground level, and can be well integrated into the existing infrastructure. Again, public transport connection would have to be organized via regular buses until completion. Once this connection would be realized, 70% of the forecasted public transportation traffic could be handled efficiently by the tram line.

Connecting the area by bus is considered to introduce high flexibility, high coverage, and the potential for innovative technology. Besides that, the area is already integrated into the Berlin transportation network by a bus connection. Several innovative technologies for buses have been considered, such as hydrogen or electrically driven. However, electric buses with a battery replacement system have been examined in depth as this system was preferred by the BVG. It was considered most economical and innovative, particularly with regard to initial investments and maintenance costs. The bus connection can be designed flexibly according to the phased development of the masterplan area and depending on the traffic demand.

The cable car presented a surprising alternative, and was considered to be an unique and attractive alternative for tourism and leisure activities. The cable car would run north from the Jungfernheide station to a central stop in the technology park. The cable car would be independent from traffic on street level, but would require an inflexible and fixed route. Large column spacings could reduce the intervention of existing buildings. Again, public transport would have to be temporarily organized via regular buses until completion. An opposition to the system is the risk of wind sensitivity leading to possible downtime. This is not desirable when it is the main form of public transportation into the area. Subjective feelings of safety would also have to be taken into account with regards to cabin design.

A mode of transportation that is considered to be quite innovative is the peoplemover. However, to date, there is no experience with peoplemover systems in Berlin. A peoplemover would run a pre-programmed route and can be fully automatic wheel or rail-based. The route could run from the Jungfernheide station in a northerly direction to the Jakob Kaiser Platz, and continue over the Kurt-Schumacher-Damm into the masterplan area. The main challenges are crossing two bridge constructions over the Westhafenkanal and the Hohenzollernkanal, and crossing the roundabout at Jakob-Kaiser-Platz. It is unclear how the peoplemover would integrate onto the roundabout and into the traffic feeding from the A111. If the current bridge design and cross-section do not allow for shared use by the people mover, then additional bridge structures would have to be built. With the suggested routing and multiple stops, the peoplemover can achieve a high area coverage. A supplementary bus route network would not be necessary. Taking into account the implementation phases of the master plan, it would be possible to implement the system in sections. At this moment in time, there are unclear regulations regarding insurance and liability issues in the events of damages or accidents, which withholds the technology from being used in public streets.

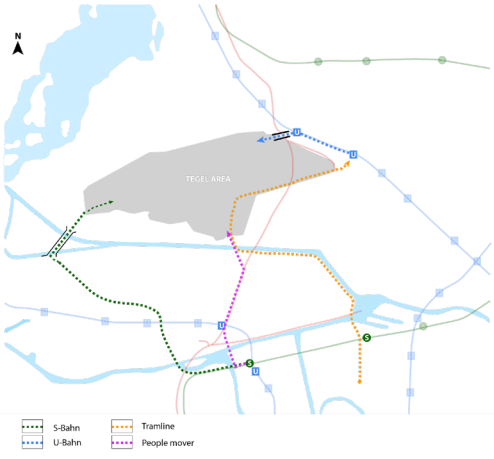

Figure 5*: Indication on how different options would connect the Tegel area. The Cable Car and Bus routes are not included in the image, due to lack of a sufficient description for providing an indication.*

An indication of the researched routes for the S- and U-Bahn connections, as well as the People Mover and Tramline, are shown in Figure 6.

Organizing mobility within the area with Mobility Hubs

Previous modes of transportation have been discussed to connect the masterplan area to the rest of the city. The Mobility Hubs are meant to organize mobility within the area. The concept of Mobility Hubs is the bundling of mobility modes by different micro-mobility providers, to enable a smooth changeover in one location. At these locations a high level of movement is to be expected. It makes Mobility Hubs an interesting place for urban life and from a commercial perspective as shown in the impression in Figure 7. The Mobility Hubs are planned in the outer areas of the district (Steinmann, 2020). The different modes of micro-mobility that can be integrated in Mobility Hubs are among; carsharing, free floating carsharing, bike-sharing, public transportation stops, e-bike charging stations, taxi-stands, and carpooling stands. The Mobility Hubs are expected to largely contribute to the reduction of motorized vehicle travel volume, because the Hubs will only be accessible with electric cars or offer the opportunity to switch to electric vehicles and other CO2-free modes of transportation (Von Gerkan et al., 2010). The Mobility Hubs provide a perfect place for MaaS ("Mobility-as-a-Service"). MaaS combines public and semi-private modes of transportation into packaged mobility services on a mobile MaaS-platform. The strength of MaaS is that planning and booking all modes of transportation are available through one single interface. Users on the platform have access to the services depending on their subscription.

Figure 7*: Allowing for seamless multimodality: the mobility hubs in Schumacher Quartier © rendertaxi for Tegel Project GmbH. For more information: https://www.tegelprojekt.de/en.html*

The financial perspective

As a final part of the research, the financial perspective has been considered. Table 1 shows a rough estimation of the initial investment costs analysed by Drees & Sommer and Argus (2013) for the different options in order to connect the area to the rest of the city.

	Investment costs				Operational & Maintenance costs	Total Costs
	Vehicle Technology	Infrastructure, stops, third party measures	Bridge and Ramp structures	Total	*Total 30 Years*	*Price base 2013*
U-Bahn	€ 7.000.000	€ 42.000.000	€ 52.000.000	€ 101.000.000	€ 38.000.000	**€ 139.000.000**
S-Bahn	€ 6.000.000	€ 139.000.000	€ 7.000.000	€ 152.000.000	€ 110.000.000	**€ 262.000.000**
Tram	€ 5.000.000	€ 171.000.000	€ 2.000.000	€ 178.000.000	€ 71.000.000	**€ 249.000.000**
Bus (Diesel)	€ 2.000.000	€ 23.000.000	-	€ 25.000.000	€ 46.000.000	**€ 74.000.000**
Bus (Battery)	€ 3.000.000	€ 31.000.000	-	€ 34.000.000	€ 46.000.000	**€ 74.000.000**
Cable car	€ 5.000.000	€ 72.000.000	-	€ 77.000.000	€ 46.000.000	**€ 123.000.000**
Peoplemover (Battery)	€ 6.000.000	€ 31.000.000	€ 6.000.000	€ 43.000.000	€ 38.000.000	**€ 75.000.000**

Table 1*: Rough estimation of investment costs (Reproduced from a previous study of Drees & Sommer and Argus, 2013)*

The investment costs combined with the economic efficiency leads to a trade-off between continuing an environmentally friendly bus connection versus the higher investment costs for an U-Bahn, S-Bahn or Tram connection. Eventually, an electric bus connection which can be developed into a fully automatic people mover system in the future was recommended by Drees & Sommer. An electric bus connection can already be implemented today, which addresses the first challenge discussed in paragraph 3. Both options do not present large complex technological challenges for crossing the A111, and represent the "urban technologies of the future" (Drees & Sommer and Argus, 2013)". The bus line can be organized and easily integrated using the current existing infrastructure and introduces high level flexibility. The people mover can be implemented in the future, after further

development of a fully automatic ground-level people mover system together with manufacturers. Both modes of transportation are expected to deal with 100% of the prognosed passenger volume. Another important challenge concerns zero-emission vehicles in the area. The combination of an electric bus, a future peoplemover, and mobility hubs that enable for CO2-free modes of transportation, manages this challenge. Surprisingly, in February 2019 the city announced its transit masterplan for 2019 to 2023 and committed an investment of €28.1 billion into transportation projects (O'Sullivan, 2019). The plan targets new lines for the U-Bahn and S-Bahn, but feasibility studies are to be performed in order to determine which routes can actually be realized (Loy, 2019). A new line under study is from Kurt-Schumacher-Platz to the Urban Tech Republic (Loy, 2019). This leaves hope for a future S-Bahn or U-Bahn connection from the new Tegel area to the rest of Berlin.

The "Improve" or "Shift" Pathway

The recommendation of an electric bus, people mover and mobility hubs shows a combination of the *improve* and *shift* pathway. Replacing the current bus connection by an environmental friendly electric bus can be considered an incremental innovation. It is a technological innovation to address an environmental oriented objective, but the user experience remains unchanged from the current situation. A future "people mover" can also be considered an incremental improvement by the introduction of a fully automated vehicle. But it also takes us onto the *shift* pathway, as a peoplemover might be a very good mode of transportation to enable demand-responsive mobility in the future. The current bus line will follow a fixed schedule, but an automated- and connected vehicle on a separate lane can optimize its efficiency by meeting the mobility demands through the use of data. Potentially connecting the area by an S- or U-Bahn can be considered an incremental improvement on the *improvement* pathway, but from the transportation network's reputation it might be regarded as the optimal way to connect the area seamlessly to the rest of the city. The Mobility Hubs are especially an example of the *shift* pathway, where modes of transportation are bundled in order to facilitate mobility throughout the area. Mobility Hubs provide a ground for many new services such as car-sharing, bike-sharing, carpooling and most promising: Mobility-as-a-Service. Users can get from a to b through a monthly subscription, that allows them to use any mode of transportation to facilitate their mobility.

Conclusion

The former Tegel Airport area will be redeveloped into a research- and technology hotspot and residential area, due to the opening of the new Berlin Brandenburg Airport. After redevelopment, the traffic load in the area is expected to increase and ambitions have been formulated for realizing low emission and innovative mobility. In the transition towards smart mobility, we distinguish two pathways: the *improvement* and *shift* pathway. This paper describes which modes of transportation have been researched, how it addresses objectives and challenges, and whether the *improvement* or *shift* pathway is followed in the transition to smart mobility.

The most important objectives for the new urban infrastructure system concern the interconnection of transportation modes, high integration into the current existing transportation network, zero-emission objective, a "lowest cost possible" financial objective, and the new urban transportation system should represent innovation in the urban technologies of the future. Also, several challenges had to be taken into account when developing the mobility plan. First of all, the current bus connection will be shut down as soon as the Tegel Airport closes and raises the immediate need for a new public transportation service. Developing a new infrastructure system would have to potentially cross the (multi-level) structures of the A111 highway, Saatwinkler Damm motorway and the Hohenzollern Canal. The last challenge, which can also present an opportunity for new business models, is the zero-emission objective formulated for the area.

Different modes of transportation have been researched to connect the area by means of public transportation. Among them are a connection by U-Bahn, S-Bahn, Tram, Bus, Cable Car and Peoplemover. Mobility within the area can be organized in so-called "Mobility Hubs" which bundle modes of transportation in one location and enable a smooth change-over. The combination of an electric bus connection, with the future prospect of a peoplemover, and mobility hubs to organize mobility in the area, could make up the new smart urban infrastructure system for the masterplan area. This shows a combination of the *improve* and *shift* pathway. The electric bus is an example of an incremental innovation on the *improve* pathway. The peoplemover can also be considered an incremental improvement by the in-

troduction of an automated vehicle. However, it also highlights a future for demand-responsive mobility which is an example of the *shift* pathway. Eventually, Mobility Hubs facilitate the *shift* pathway in the area. Mobility Hubs provide a ground for many new mobility services by different providers, and focus on enabling mobility by bundling modes of micro-mobility.

In February 2019 the city announced its transit masterplan for 2019 to 2023 and committed an investment of €28.1 billion into transportation projects. One of the new lines under study is from Kurt-Schumacher-Platz to the Urban Tech Republic. Therefore, potentially, the new Tegel area will eventually see an S-Bahn or U-Bahn connection to the rest of Berlin.

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IGLUS Quarterly is an analytical open access journal dedicated to the analysis of Governance, Innovation and Performance in Cities and is edited at EPFL ME, Ras Al Khaimah, U.A.E. IGLUS Quarterly aims to facilitate knowledge and experience sharing among scholars and practitioners who are interested in the improvement of urban system's performance in terms of the service efficiency, sustainability and resilience.

IGLUS Quarterly applies the highest academic standards to analyze real world initiatives that are dealing with today's urban challenges. It bridges the gap between practitioners and scholars. IGLUS Quarterly therefore adopts a multidisciplinary perspective, simultaneously considering political, economic, social and technological dimensions of urban systems, and with a special focus on how governance affects and is affected by the use of technologies in general, and especially the pervasive application of the ICTs.

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