ISSN 2052-0018 (print), ISSN 2053-3667 (online)
Geographical Locality Studies 2014 Volume 2, Number 1. pp. 356–385

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The Development of Fixed-rail Public Transport in Frankfurt

Abstract

Despite the economic crisis in the 2000s, the number of newly built homes has duplicated in comparison with the period between 1980 and 2001. One can find both green zone and brown zone investments among the recently developed residential areas; the traffic infrastructure is designed to catch up with the development of those new ones. In some cases, the latter one even gets ahead. Several districts of Frankfurt provide good examples for other European cities to show the way in which the mentioned two closely related fields can be jointly investigated. 90% of the development of traffic infrastructure concentrates on zero emissions having the establishment of tram and subway systems (Light Rail System and Stadtbahn), in scope along with purchasing transport vehicles. As the continuity of the period until 2021, the emphasis is put on the renovation of tram lines as well as building cross-town traffic network resulting in the increase of the number of passengers and less transfers on different lines. This article looks into the historical development of the Frankfurt transport system and summaries its infrastructural improvement.

Key words

Traffic & urban development; Zero emissions; Passenger traffic; Frankfurt am Main; Go green

1. Introduction

The system of the *Frankfurt* fixed-rail public transport is top ranked at European level in terms of its organisation, technical standards and pricing policies. By connecting the public transport of the suburban areas with the city centre, the tram has been gaining great popularity with the help of integrating various networks of fixed-rail traffic. The large-scale preparation plans of subway system establishment (*Light Rail Sytem* and *Stadtbahn*) were highly influenced by the newest express lines (*Commuter Train System* or *S-Bahn*) and the change of the economic environment. After the year 2000, experts have faced new challenges by building new residential areas and the process of re-urbanisation. The present study attempts to introduce both the historical background and the correlation between the most important projects of urban development and newly built in-town fixed-rail traffic systems. Nevertheless, the study also highlights the author's personal proposals to build such an effective public transport system similarly to that of *Frankfurt* for which *Geographical Locality Studies* provides an excellent platform for the author to present this German city's efficient and pioneering system as a good example of sustainable urban transport.

2. Research methods

The history of *Frankfurt's* public transportation goes back a long time. Although, there has been a continuous development and expansion, there is a very little information that has been documenting the changes. The majority of these are kept and preserved by the *Frankfurt Tramway Society (Historische Straßenbahn der Stadt Frankfurt am Main e.V.).* The author of this article in this research has identified the most significant changes after the year 2000 and has collected all the data from first hand resources. Putting these changes into focus and analysing them are a crucial part of the modern city planning of *Frankfurt*, because they strongly affect the future layout of transport routes. The amalgamation, organising and setting up a chronological order of all

the collected information and data in this article are published for the first time.

3. Historical background and development of lines

The development of *Frankfurt* public transport can be classified in different chronological stages. The investigation of great changes in the system can help figure out those important turning points which are linked with historical events, political terms and changes triggered by the growth of the city. Nowadays, the latter two phenomena are still defining factors. The length of the present study does not allow an in-depth research; however, it is essential to review the history in order to have a better understanding of current improvements and the process of urban development.

The first horse tramway was brought into use in 1872 ensuring the east–west connection between the downtown (*Hauptwache*, later *Konstablerwache*) and *Bockenheim* (independent city until 1st April 1985). The expansion of the network was improving; by 1980 the total length was 30 kilometres. The appearance of electricity in public transport initiated important changes in terms of both technical standards and system structure. The one-meter-gauge *Frankfurt–Offenbach* tram-way *(Frankfurt–Offenbach Trambahn Gesellschaft – FOTG) (Figure 1)* was opened in two steps in 1884. This line was the first one of its kind in *Germany*. Nowadays, the line is still a prominent part of the system, but the length has been shortened and terminates at the border of the suburban area of *Offenbach* (HANNA-DAOUD, T. 2000).

According to HANNA-DAOUD, T. (2000), the first local steam-traction train line in *Frankfurt* was opened in 1888 (with locomotive and passenger and goods wagons) between the northern area of the downtown *(Eschenheimer Tor)* and *Eschenheim*. The company *Frankfurter Lokalbahn AG (FLAG)* established an isolated *Oberursel* unit in 1899. The *Eschenheim* line had been electrified by 1908 where a part of it operates underground since 4th October 1968 becoming the core of the A line (A-Strecke) handling the most traffic including the *Oberursel* isolated area.

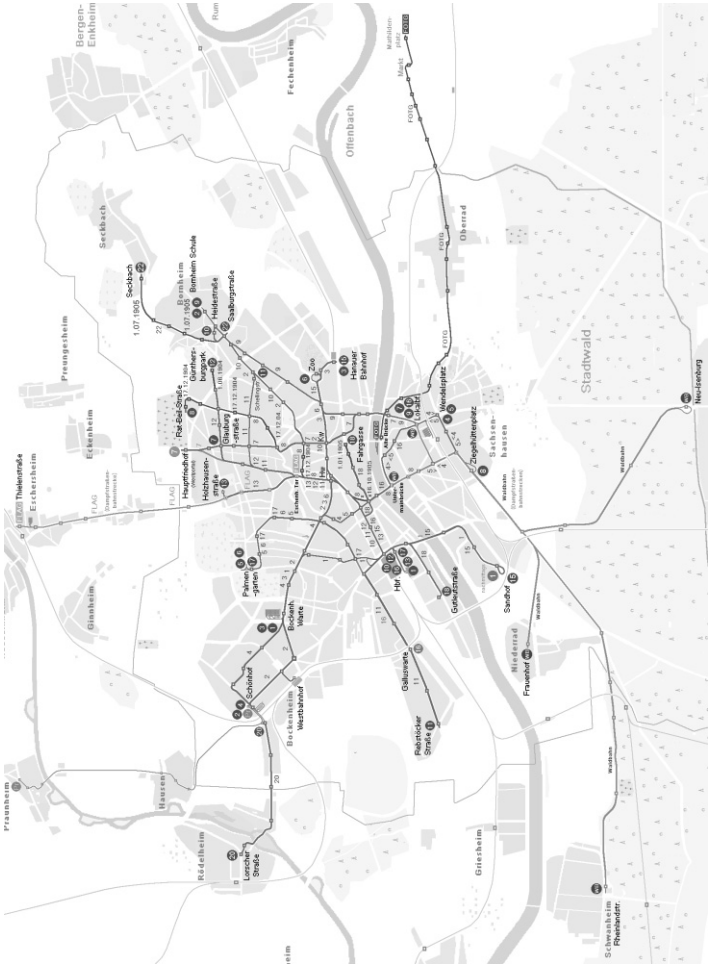

Figure 1 – Isolated traffic lines before integration. Map of the tram system from 1905. FLAG on the north, FOTG on the east, WLB on the west and south.

Source: RODMANN, B. (2013)

Between 6th February 1889 and 18th April 1889, the steam-traction forest line (WLB – Waldbahn) *(Figure 1)* was built in two steps in the southern area of the *River Main* which was quite similar to *FLAG* in operation. This line provided a connection among *Frankfurt Sachsenhausen*, *Niederrad*, *Schwanheim* and the city of *Neu-Isenburg*. At the

beginning, passenger traffic was not so prominent and the majority of the transport of goods included the one from the mines of *Niederrad* and *Schwanheim* which was used in city constructions. By the exhaustion of these mines, the amount of transport of goods had decreased. In contrast, passenger traffic developed a lot as even six-carriage passenger trains were needed at weekends and on bank holidays (HANNA-DAOUD, T. 2000).

WLB became part of the tram system through multiple steps until 1929. Various modifications were implemented in its route adjusting it to the city's expansion (western part of *Goldstein*, *Niederrad*). The tramline heading to *Neu-Isenburg* has maintained its popularity even after 100 years, and the forest is still an attractive tourist destination (*Frankfurter Stadtwald*—5785 hectares of area).

Much ahead of its age, a new three kilometre line was opened on the 1st January 1897 operating with battery-supplied engines, connecting the railway station (which is now the central station) and the *Gallus district*. The line can be regarded as an experiment as it was extended on the 1st September 1910 as far as the western border of district *Gallus* (practically the border of *Frankfurt*). The overhead electricity supply was also introduced on this line. In harmony with other parts of the tramway network, the one-meter gauge *Frankfurt–Offenbach* line was reorganised in 1906. The tramline in *Offenbach* was also built by that time; however, the connection between the two systems was established on the 28th December 1910. By 1914, towns in the northern part of *Frankfurt* had been integrated into the transport system. The branch-railways from *Bonames*, *Niedereschbach*, *Bad Homburg (Taunus)* were integrated in 1910, and other branch-railways from *Niederursel*, *Bommersheim* became part of the system in 1913. The already mentioned isolated system of *Oberusel* was also integrated in 1913. The tramway system was fully built in the northern area of *Main* connecting *Riederhöfe* (port) and *Bergen-Enkheim* (HORST, M. – CLAUDE, J. 1972).

During the *World War I*, public transport development came to a sudden stop. In 1923, the *Offenbach* leadership denounced the separa-

tion from the *Frankfurt* system in lack of proper treatment on expenses; however, the line was reconnected to the system due to public pressure. In the eastern part of the *Osthafen* port, three thousand people were employed in the *Casella chemical industry* thanks to its improved traffic infrastructure. To meet passenger demands, a separate line (Linie F) was opened in July 1926 and then it was integrated on 31st October into the city tramway system in 1928 (HANNA-DAOUD, T. 2000).

At the turn of the 20th century, *Berkersheim* (a little town with a population of 399) was also integrated in the tramway system in 1925. *Berkersheim* had been a part of *Frankfurt* from 1910. It is an interesting fact that *Berkersheim* was inhabited only by 3,643 people even in 2012. In 1978, the tram traffic was limited and then terminated due to its unused capacity in the village-like city, and was replaced by buses heading to the newly built (1977) *Preungesheim* subway line U5. This fact would not be much of an interest, although the planning of the *Riedberg* subway line U9 could have been a warning sign for engineers designing city traffic (HÖLTGE, D. – KÖHLER, G. H. 1992).

The system was expanded between World War I and World War II adding *Griesheim* and *Nied* to the system consecutively in 1930 and 1936. By the end of *World War II* on the 25th March 1945, aerial bombings had been causing tremendous damage in buildings and to the traffic infrastructure. Retreating German troops exploded all the bridges on the River Main, but that could not stop the marching in of the *American Army*. The tramway system was stopped for two months and the restoration procedures at first were initiated on the east-west axle of *Nied*, *Griesheim*, *Hauptwache*, *Konstablerwache*, *Bornheim*. By 1949, all bridges on the *Main* had been restored, and, then—until 1952—the tramway system was gradually rebuilt. Furthermore, in 1952, the system was expanded to the west as far as *Höchst* (SCHWANDL, R. 2008).

The expansion of the system had been practically finished by 1963. By this time, the terminus of the supplementary lines had been in *Offenbach*, but the one heading to the market place *(Marktplatz)* was still

existent until its final termination (1996). The most prominent transformations were triggered by building the subway system from 1968. At the first stage, the subway line was built as far as *Nordweststadt* as a central part outside of the city centre. Also, as the number of subway carriages increased from 1971, the system was further expanded primarily to the northern agglomeration area (in the direction of *Bod Homburg* and *Oberursel*) (KRAKIES, J. – NAGEL, F. 1989).

At the end of the 1970s, the existence of east–west subway line 'B' (*Preungesheim-Hauptbahnhof*, B-Strecke) served the main terminus of the tramway system in various city parts (*Nordend Ost*, *Seckbach*, *Preungesheim*, *Berkersheim* lines on the east and *Griesheim*, *Gallus*, *Rödelheim* lines on the west). The new public traffic conception *(FVV – Frankfurter Verkehrsverbund)* brought changes in public transport and opened new ways for further development. As the 'C' line (*Zoo-Hausen*, *Heerstrasse*, C-Strecke) was opened at the end of the 1980s (following the line of the first horse tramway), city centre tram lines had their terminus primarily there (*Westend*, *Bahnhofsvirtel*, *Bockenheim*, *Hausen*) (KRAKIES, J. – NAGEL, F. 1989). The tunnel for the express train (S-Bahn) was built in three stages (1978: between *Hauptbahnhof* and *Konstablerwache*; 1989: *Konstablerwache* and *Südbahnhof*; from 1994 to 1997: *Mühlberg* and *Offenbach*) (DIRMEIER, W. 2002).

By the end of the 1990s, the public transport system had become more distinct. The extension of the line 'C' to district *Enkheim* in 1992 can be regarded as the most important change of the decade. Engineers utilised the already used tramway infrastructure resulting in the separation of *Bergen* district from the system. By the integration of several pricing units in city public transport, the *Rhine–Main Transport Union* was founded making the transport easier for passengers between the agglomeration and *Frankfurt*. The complicated pricing control was replaced by a matrix-based pricing policy in each area. Underground express railway crossing *Offenbach* was built in 1996, so that the former *Frankfurt–Offenbach* tramway line was shortened only to the city border of *Frankfurt* due to city plans and the decreasing number of passengers (MUTH, F. 2007).

There are four distinguishable stages in the historical background:

1. Before *World War I*, certain lines had been expanded; therefore daily commuters could get to their jobs more easily within the city and in the suburban area. Isolated traffic systems were integrated resulting in a complex network.
2. Between the two world wars, those districts and important industrial units benefited the most that did not have tramway system. After *World War II*, a re-structuring process of transport of inner districts was implemented and the damaged infrastructure was quickly restored. As a result, a stable system was constructed by the middle of the 1960s which can be observed as the golden age of the *Frankfurt* tramway system.
3. From the beginning of the 1970s until the middle of the 1990s, the establishment of the subway and express train lines transformed the public transport to a great extent as a consequence of suburbanisation. This process triggered the termination of less popular downtown lines; however, the process also contributed to the popularity of bus lines.
4. After the year 2000, re-urbanisation processes brought new challenges to *Frankfurt*. City development and public transport became inseparable and operated together. It is important to investigate the relationship between designing public transport and urban planning which will be introduced through examples in the following sections.

3.1. 2001: the 'D' line

The underground line 'DI' was opened on the 10th February 2001, connecting the *Hauptbahnhof* (central station) and *Bockenheim*. The line connected three popular and busy places: the central station, market *(Fair and Exhibition Centre – Messe)* and the university *(Unicampus Bockenheim)*. The construction of the 'DI' line meant the birth of the new line 'D', but due to its shortness it currently functions as an extended part of the 'B' line. When the construction started between 1989 and 26th November 1993, the removal of the contaminated soil

and subsoil water was necessary as an ink factory *(Brönnersche Farbenfabrik)* had been situated there previously. The line is really busy where four-carriage trains pass in every five minutes in rush hours.

The tunnel was designed based on the 1964 plans establishing a junction at *Messe* station for the line up to *Rebstock* through *Theodor-Heuss Alle (Figure 2)*. This plan never came about and the idea was finally dropped as the *Rebstock* tramway line built in 2003 (FAZ, 2003).

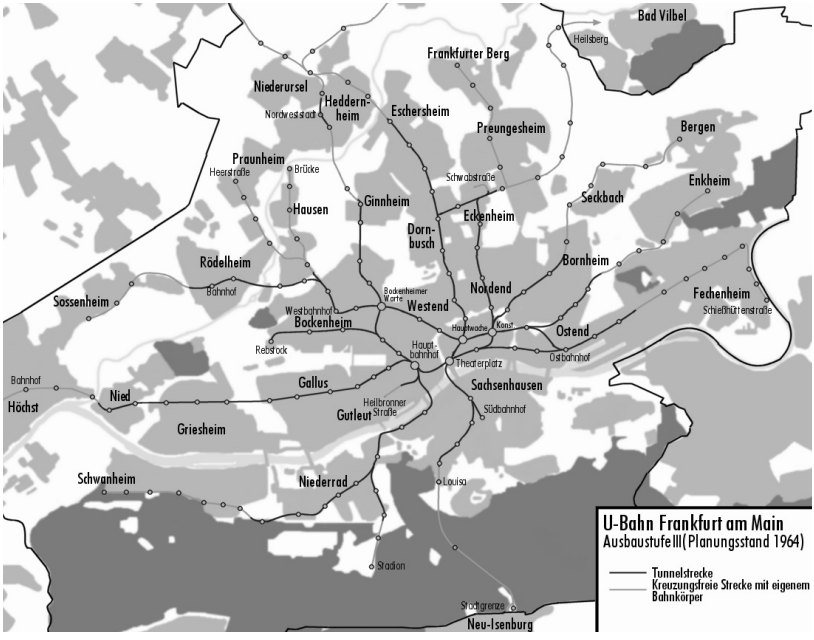

Figure 2 – Frankfurt Light Rail. Construction phase 3. Planned network of 1964. Darkened lines indicate the underground ones. Lighter grey lines indicate separated surface ones including suburban train lines.
Source: GROSS, P. (2006)

There were various plans to extend the line 'DII' northwards line *(Figure 3)*, but it was rejected by the ruling green-black government due to financial concerns in 2006. As a result of the public pressure,

the project in 2009 was still alive called as the *Ginnheim Curve (Ginnheimer Kurve)* (GÖPFERT, C–J. 2010).

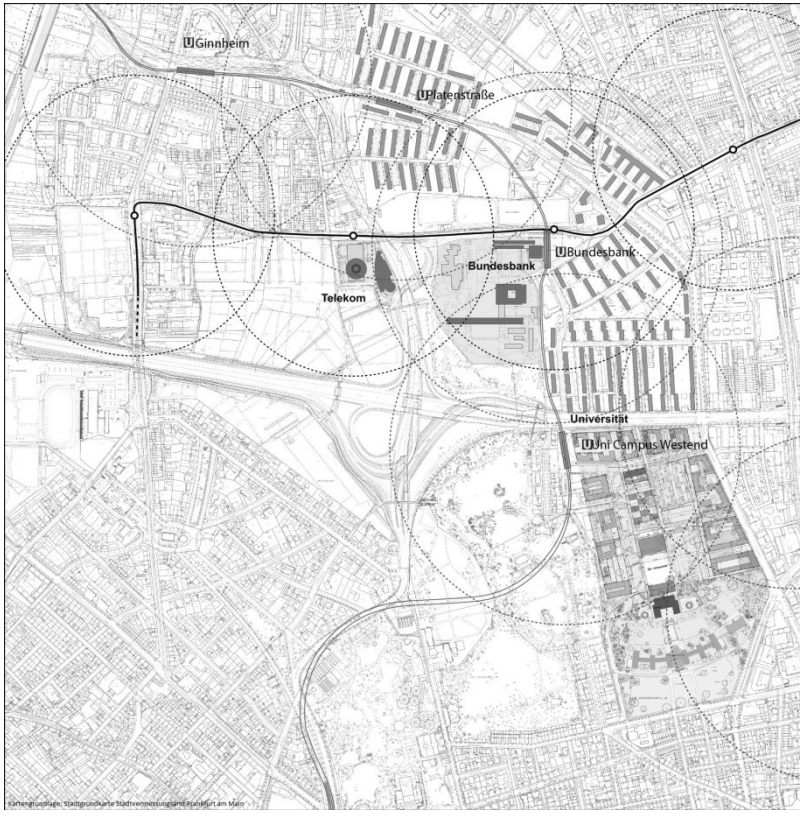

Figure 3 – The workability of plans to lengthen the line 'DII' based on public initiation.

Source: GINNHEIMER KURVE (2013)

There was a dedicated website designed to introduce the plans including all its positive aspects. Some major points are:

- The integration of the *Unicampus Westend* university district (27,000 employees and students) into the fixed-rail system released the crowdedness (and also replacing) of bus lines 36 and

75. There have been eight new blocks built on the Campus area since 2006 and residents of the university district have gradually moved there from *Bockenheim*, thanks to the extension of the line (LEITZBACH, K. 2013).

- Better access to the *National Bank (Bundesbank)* (HENTSCHEL, D. 2011).
- The improvement of the public transport of densely populated *Platenstrasse* area (population of 21,000) which was already been given fixed-rail system in 1963. Following the former tramway line, transportation involved bus lines again connecting the central station and *Ginnheim*. In the external parts of the line, buses passed in every five minutes due to the transfer availability to subway line 'A' *(Miquel-/Adickersalle)*.
- Releasing the crowdedness of the inner parts of line 'A' *(Heddernheim-Südbahnhof)*. According to surveys, the number of passengers travelling on one way exceeded 12,000 at *Holzhausen* station between 7am and 9am.

Based on preliminary calculations, over 55,000 passengers would have travelled on the line. In order to protect the *Palmengarten* area and inner green areas *(Grüneburgpark)*, two-thirds of the line would have been built underground causing considerably higher construction expenses. Thanks to great publicity, the government approved of the plans again in 2011 as per the green-back coalition agreement. (KOALITIONSVERTRAG, 2011)

The question of constructing the line under the *River Main* in the southern area of the central station arose in the 1970s. Therefore, the station was designed accordingly and the previously abandoned track way now functions as a practice place for fire workers. Based on plans, the above surface part of the line would have started at the university hospital building' *(Universitätsklinikum)* and engineers would have utilised those non-functional tracks. The express train system of south western districts changed considerably in the 1964 plans. The number of passengers and environment protecting measures would not demand a new line (DIII). The transportation is fully covered by the tram

lines 12, 15, 21 and also temporary ones 19 and 20. The planning of future western and southern districts is out of scope; it is important to protect green areas, and also the price of rental homes and private housing in the area would be considerably lower due to the heavy noise load of the passing planes as the airport is very close (ROGGENKAMP, H. 2000) *(Figure 4)*.

3.2. 2003: Rebstock

Rebstockpark is not a separate district, but one of the parts of *Bockenheim*. However, it is geographically isolated thanks to the nearby highways A648 and A5, and, also the tracks of the former goods-station. This 100 hectares area was the first airport of *Frankfurt* (until 1936), then the public park *(Volkspark)* was opened there in 1962 followed by the aqua park *(Rebstockbad)* in 1982. After the year 2000, the city underwent some major changes. The market town *(Messe)* was given a parking lot of 5,400 vehicles. As per city plans in the 1990s, 5 to 10 story buildings were built as residential areas of 4,500 people and places of employment for a further 5,500. The construction process includes an elementary school which is expected to be completed by 2016 (W&W AG 2012).

Rebstockpark did not necessarily demand the establishment of the fixed-rail traffic; however, it was of great interest in the plans. In 1988, it was decided to reuse the *Bockenheim industrial area* and to build a centre of offices along with homes and green areas. Between 1995 and 2006, a new residential district was opened known as the *City West*. In the area next to the highway A648, there are several hotels, insurance companies and banks besides various enterprises giving employment to 18,000 people. *Voltatrasse* can be regarded as the ridge of the residential district with population of 5,000. Until 2003, public transport demands in the area were surved by bus lines 50 and 33.

The establishment of the fixed-rail public transport between the two areas was decided upon excessive preparatory works and research. Based on 1964 plans, the terminus of the line crossing *Altstadt* (the elder district) was also in scope (GROSS, P. 2006). Therefore, 1986

can be regarded as the turning point in *Frankfurt* public transportation. The opening of the subway line 'C' caused the termination of several central tram lines (*Bockenheimer Landstrasse* and *Hauptwache*) and it resulted in remarkable protest from the public (KYRIELEIS, S. 1996).

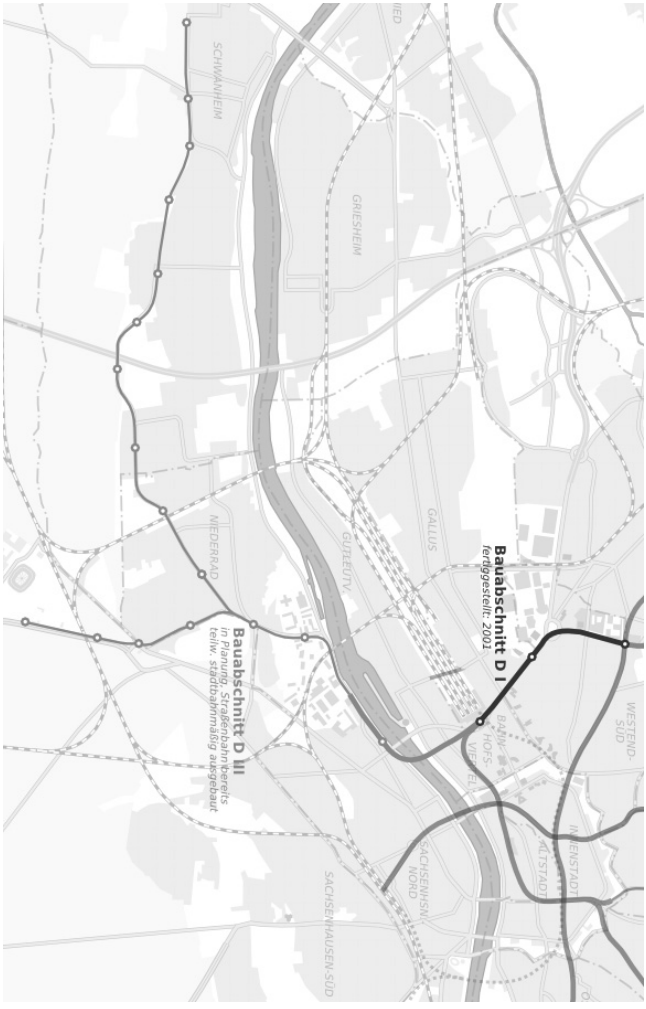

Figure 4 – The plans of the subway line DIII in the southern area of Main

Source: PLANUNGSVERBAND (2006)

Also, the inflated prices of establishing the subway line made the tram option as the preferred one. The 2.4 km, mostly single-way *Rebstock* line (17) with five stops, was opened in December 2003, connecting two areas. In the spotlight of protecting the central alley *(Hamburger Alley – Figure 5)*, a single-track tram line was built in 135 meters in this street (KÖHLER, I. 2006).

Figure 5 – Single-way tram line in the green area at Hamburg Alley
Photographed by SZELESI, T. (2014)

Overcoming the initial difficulties, the line well accomplished its purpose; the tram departed in every 10 minutes then it was changed to 7.5 minutes (originally in every 15 minutes). The new era started in 2014 as the tram line 17 became a cross-city line *(Rebstock and Neu-Isenburg)* after 11 years.

The intersection of the line 'DII' at *Messe* stop could have given the opportunity to build both underground and surface subway line bases on the *Stuttgart* and *Hannover* plans (these long-range ideas were also included in the plans of the line 'U5'). However, it would have also meant the termination of the tram line 16 and the establishment of the DII at the same time with unpredictable expenses.

3.3. 2010: U9 Riedberg failure

In the 1990s, it was decided to build a residential district in the northern area of *Frankfurt*. *Riedberg* is still not a separate district, but part of *Kalbach*. The investments for green areas were launched in 2001 on the former 266 hectares plough-land. As per the long-term city development conception, *Goethe University* embraced 56 hectares, also parks and green areas embraced 92 hectares and on 60 hectares there were residential properties. Calculations expect the growth from 13,000 to 15,000 of inhabitants, 3,000 places of employment and 8,000 alumni by 2020 (SCHULTHEIS, J. 2008).

Thanks to the comprehensive city plans, drafts already included the conception of public transport. According to previous estimations and calculations, the integration into the fixed-rail traffic seemed to be the best conception. The establishment of the line crossing *Riedberg* (south western and north east directions) was among city plans from the beginning.

Subway line constructions started in 2008 and the completed line was opened in 2010. This one does not belong to the system of the *Oberursel* and *Homburg* line 'A', but it is part of stage IV of the line 'D' *(Figure 6)*. The line 'U8' provides direct connection with the downtown and the line 'U9' links together *Niedereschbach* and *Ginnheim*. Due to the impact of the crisis, the number of newcomer residents decreased. The biggest fall back happened in a number of private properties, but there was a small increase in the number of rental homes (as the expansion of the campus was planned). The latter did not mean an increase in the number of passengers as the majority of tenants lived and/or studied locally. The progression of re-urbanisation stopped the

process of the migration to newly built suburban areas. Prices of rental homes in the suburban areas were the same in the centre; therefore the discomfort of commuting and its price stole the great popularity of the area. The *Rhine–Main Public Transport Federation* launched a pilot project in 2013 in cooperation with the company controlling rental homes. Home owners of 229 were offered government-supported (66%) travel passes. The project became unsuccessful. Even the assembling of the tram carriages was changed on the 'U9' in the 2013 scheduling. In 2014, the running time was shortened to a large extent to reduce expenses; at weekends there is no traffic after 10 pm and the first tram departs at 7 am in the morning on Sundays.

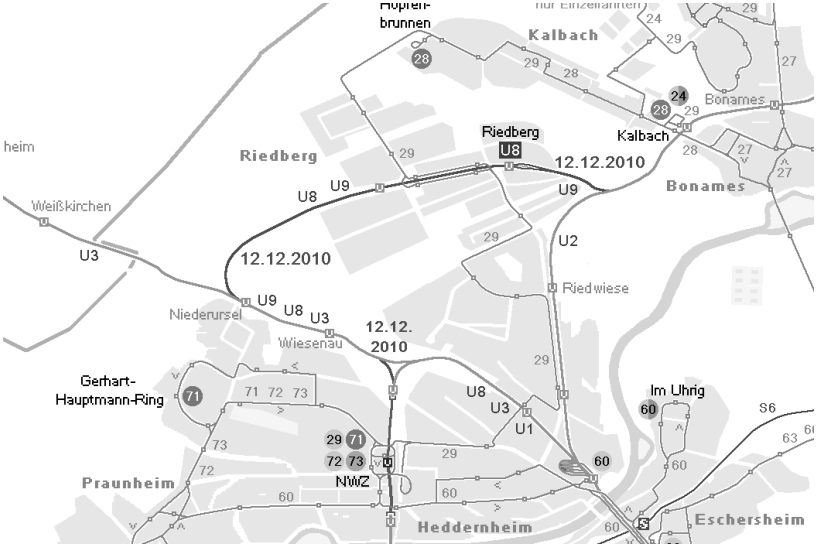

Figure 6 – The subway line 'D IV' crossing Riedberg
Source: RODMANN, B. (2011)

The *Riedberg case* proved that hierarchy indeed existed within the system of the public transport, too. Based on economic conditions, the establishment of the fixed-rail traffic was a viable solution. The company *TraffiQ* ordering public transport services got into a peculiar

situation due to the negative impact of the economic crisis, newly built rail-way infrastructure and the satisfaction of already existing demands. Suspending the traffic would have triggered the full stop of investments and would have led to migration from the area. After the first three unsuccessful years, the reduced number of departing vehicles meant and immediate solution in 2014. Recently (2014) launched building projects in the western area of *Riedberg* maintain long-term plans for the fixed-rail system.

3.4. 2011: tram line 18 – Frankfurter Bogen and the New Atterberry residential district

The 72 hectares area between highway A661 and the eastern part of *Preungesheim* is called the *"Frankfurt Arch"* residential area *(Frankfurter Bogen)*. Between 2004 and 2014, new homes were built in three steps for 5,000 residents within green zone investments along with social infrastructure (kindergarten and day-time home). On the edge of the arch-shaped residential area includes not only blocks, but detached houses and row houses, too. There have been built five to eight story blocks in the inner areas. In the beginning of 2014, 90% of the area was used for new buildings; however, the number of residents is still much below expectations resulting in empty homes. The shopping mall is planned to be opened in 2016 (KYRIELEIS, S. 2012).

The former area of *Kurhessen barracks* was rapidly used for building new homes between 2003 and 2006. Firstly, it was called *Wermacht* under *National Socialist* ruling. Then, the *American Army* named it as *New Atterberry*. Brown zone investments were remarkably important as they involved not only the organisation of the area, but also its protection (restoring damaged parts). Furthermore, based on studies by *Frankfurt* government, it could be possible to build homes for 8,000 to 10,000 residents within additional green zone investments (AS & P, 2010). The plans would have a negative impact on the environment and most importantly, the natural airway of the city would be terminated. Moreover, investments would partly influence traffic of the highway A661 resulting in a possible money loss.

Plans of establishing the tramway along *Friedberger Landstrasse* were designed in 1996. The budget of the plans was passed by the general assembly, but designing was not finished until 2006 due to the building of the subway line DII. The government urged the start of the works, but the constructions started only in 2008 due to preparatory duties of public utilities.

The 3.5 km section was opened in December 2011. Interesting fact that the dedicated lane for public transport in the street *Friedberger Landstrasse* was also used by buses (VGF, 2011). For sustainable reasons, the tram line 18 was planned to be as an alternative for the bus line 30 departing outside of rush hours in inner parts of the city *(Figure 7)*. The days of the formerly most popular bus line are numbered as the government does not intend to cover its expenses (LINHART, P. F. 2005).

Based on preliminary estimations, 13,000 passengers were expected on a daily basis. However, utilisation exceeded 14,000 in 2012 and exceeded even 16,500 in Q3 of 2013 (TraffiQ, 2014). The line's capacity is still not fully used so that further city plans could be possible in the long term. It can be regarded as the most successful public transport project in the few years costing 55.1 million Euros (~44 million GBP).

3.5. 2014: tram line 17 – Stressemannalle – Neu-Isenburg

The connection between *Neu-Isenburg* and *Frankfurt* central station (fast connection in 18 minutes) was already among plans in 2006 by *Traffic Committee of the City Council*. The ways to cover its expenses were on schedule on the 11th October 2013 and the constructions started in December 2013 *(Figure 8)*. The line 17 has its final station next to *Frankfurt* central station. From December 2014, travelling will be available to *Neu-Isenburg* on the newly built 1.1 km tramway on *Stressemannalle*. The whole process of constructions also included the renovation of the road. The number of parking lots will be increased and 46 new trees will be planted as a replacement of the previously felled 23 of those. The major part of the track-way will be grass-

covered (around 70%) as increasing green areas is of high importance in the plans.

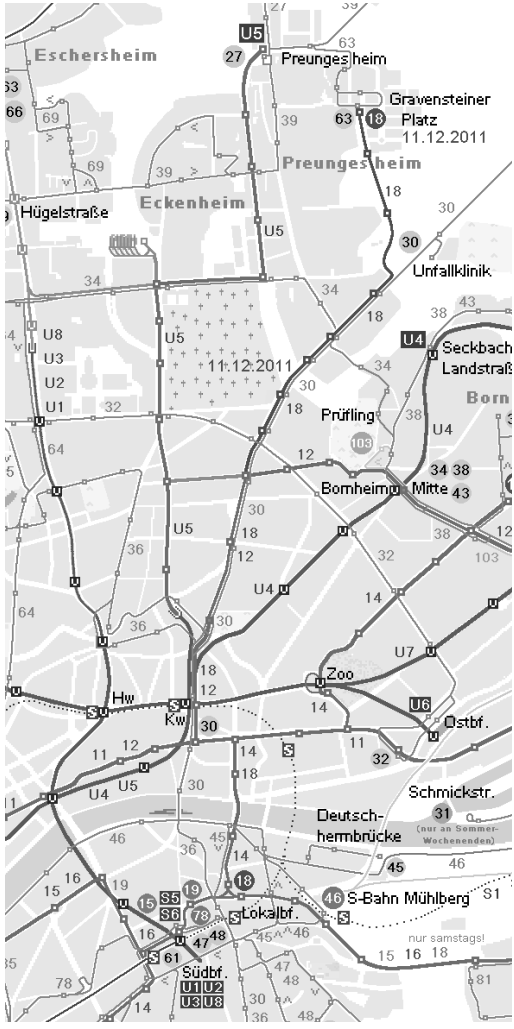

Figure 7 – Tram line 18 opened in 2011 - Gravensteiner Platz – KW: Kostablerwache – Lokalbahnhof

Source: RODMANN B. (2012)

Figure 8 – Building of tram line 17 is in progress
Photographed by SZELESI, T. (2014)

Demolishing the 680 m² playground on the *Stresemannalle* triggered overheated debates and tension in the preparatory planning phase. As a compromise, the playground was rotated by 90 degrees and was expanded with an extra 120 m² of public space.

Heimat Siedlung residential area *(Sachsenhausen)* was crossed by the newly built modern line. Based on plans, 1,072 homes and 50 shops were built between 1927 and 1934 (STADT FRANKFURT, 2012). The connection with *Sachsenhausen* centre *(Schweitzer Platz)* was provided by *Waldbahn's* east-west line in the first two years. Then, the

integrated and electrified line to *Neu-Isenburg* provided the connection with the residential area. The area was fully built in by the end of the 1950s so that the direct connection with the downtown came into plans. Buses 35 and 69 (had been in operation since 1960) on the north-south line were replaced by the new tramway from 2014. The better accessibility of the area by public transport may result in increasing home prices in the suburban *Heimatsiedlung* residential area *(Figure 9)*.

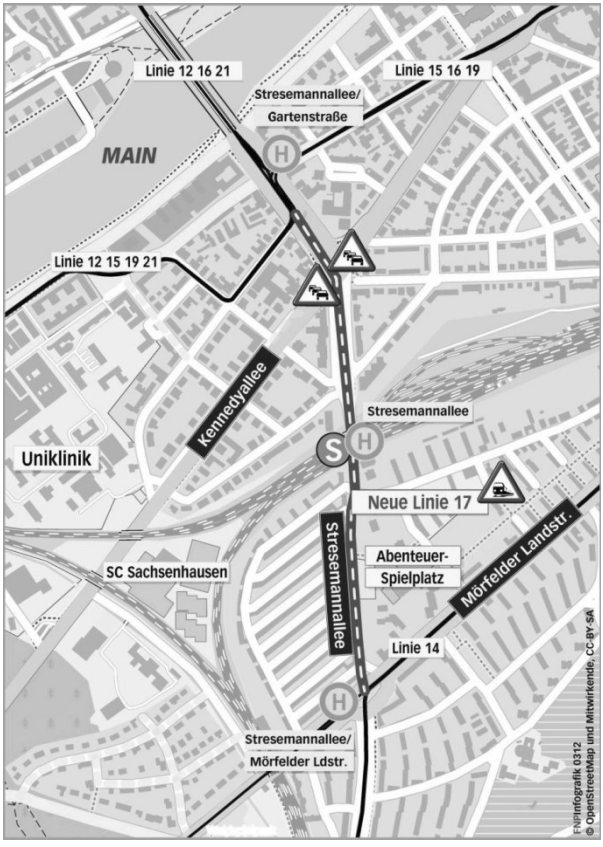

Figure 9 – The building of the tram line 17 on the Stresemannalee
Source: FNP (2012)

3.6. 2021: U5 Europaviertel

The central goods railway station was situated in the western area of Frankfurt between 1888 and 1998 and then the area was abandoned for seven years. Renovations were started in 2005 and they are planned to be finished by 2019. The 900,000 m^2 of area gives job to 30,000 and 8,000 to 10,000 homes. On the eastern side of the area, the market district provided a place for exhibitions and a shopping mall *(Skyline Plaza)* and also a skyscraper was built called Tower 185. On the western side, residential area is planned along with social institutions. To satisfy passengers' demands, the district was given a bus line in 2009 which was expanded to residential districts on the western outer areas. The express train crosses the area in north–south direction, but the two stops (*Messe* and *Galluswarte*) are situated far from each other. The fixed-rail traffic has also a separate lane (to both directions) on the east–west avenue *Europa Alle*. Since significant number of passengers was expected, the establishment of the subway line was decided.

The settling of the line was obvious; however, both underground and surface constructions were involved in plans. If the whole line had been built underground, extremely high expenses would have been rejected by the City Council. Besides the expenses, the high level of underground water would also have meant construction issues. Finally it was decided to build an underground station on the front edge of the former goods railway station and then the rest of the 2.7 km line was about to be built on the surface which would also be the western expansion of the subway line U5 at the same time. There was a 53,000 m^2 green zone area planned *(Europagarten)* with recreation purposes. The new subway line would cross this area. In order to protect the homogeneous surface, new fixed rail lines were designed based on the situation and position of crust blocks (also a new method in *Germany*, IN FAHRT, 2014) *(Figure 10)*.

The financial background of the establishment of the subway line was voted on October 2013 and the first preparatory works of the public were initiated in January 2014. As the whole construction pro-

cess requires 6 to 7 years, including the testing periods, passengers may first use the expanded U5 line in 2021. Construction expenses have been estimated to be 217 million Euros (~173 million GBP), but additional 50 million Euros (~40 million GBP) have been estimated in further calculations.

Figure 10 – The conception of the subway line U5 crossing Europa Alle. The underground stage (Europagarten) can be seen in the foreground and the residential area with the business district in the background.
Source: IN FAHRT (2014)

3.7. An opportunity: Kleyerstrasse

After the year 2000, the district *Gallus* underwent significant changes. There have been office blocks and residential properties built on the former areas of the factory *(Adlerwerke)*. This progress can be observed, if you have a look at *Kleyerstrasse (Figure 11)*. An additional 4,500 homes are to be built in the next 5 to 8 years. In December 2013, tram traffic was temporarily stopped due to a low number of passen-

gers and has recently been replaced by bus line 52 on the same route departing more frequently. The tram traffic can be continued again in case of a higher number of passengers (investigated by *TraffiQ* responsible company for maintaining public transport). However, this would require higher extent of infrastructure development including the establishment of the double-track tram-way traffic on street *Rebstöcker*. It is also considering that the line may be expanded as far as *Sondershausen Street* which was also a conception accepted between 1912 and 1944 (HOFFMANN, M. 2011). Also, there are 800 homes in the area having the potential for further investments (*Mönchhof* residential and labour zone).

Figure 11 – The changing Kleyerstrasse. Will tram traffic be revived?
Source: HORST, H. (2013)

4. Conclusions

The ambitious plans for fixed rail traffic were changed to a large extent by the end of the 1990s. Primarily, the most popular and crowded lines were planned to be replaced by higher capacity subway lines. Also, in the beginning, the termination of under-utilised tram lines came into

focus (also avoiding parallelism), bus lines coming from various directions would have replaced them. After the year 2000, fixed rail traffic was established only on well utilised lines after careful preparations; popular and attractive areas were integrated into the network of public transport.

The development of subway lines has been limited due to high expenses of railway infrastructure and underground constructions. The development of tram-way traffic has been flourishing since 2000. The tendency of the building public transport network across the city is constant besides the integration of newly built residential areas in the framework of brown zone investments. This way, it is possible to establish a decentralised network of fixed rail transporting with the minimum number of transfers.

Regarding green zone city planning, bus lines need to have priority to any types of fixed rail traffic. Only those crowded, over-utilised bus lines might be replaced. The establishment of subway lines can be reasonable in regards to the number of passengers.

It is worth considering the traffic opportunities and their combinations similarly to 1964 conceptions in cases of big cities like *Budapest* regarding its population and agglomeration area (similar data to that of *Frankfurt*):

- planning transport lines crossing the city;
- multiple tram-way lines centred in one point departing frequently so that suburban areas are also integrated in the network of fixed rail public transport;
- integration of agglomeration areas into the tram-way or subway system;
- the possibility of the integration of various suburban train lines (like in *Budapest*);
- connecting tram way system with the train lines like in Karlsruhe with the help of direct integration of farer agglomeration areas into the city public transport.

The above listed items make the public transport only technically easier both in suburban areas and inside the city. It is also an im-

portant condition that there has to be a clear pricing system contributing to traffic planning. It is necessary to have economically effective pricing policies including the possible transfer among different areas. In the spotlight of these, it would be unnecessary to purchase multiple tickets resulting in cheaper and more attractive public transport.

The sustainable development is practically possible with the help of local fixed rail public transport system. The protection of environment is the most important factor having influences on various investments. All the projects and proposals are designed to consider the demands of the future generations in terms of development. Hence the system of fixed rail traffic is prone to contribute highly to future demands.

5. Evaluation of sustainability

The development of fixed-rail public transport system is one of the most important factors in the aspect of settlement sustainability, because they are able to cover huge urban and agglomeration areas without a significant impact on the environment. This transportation method on a daily service basis is considered as zero emission. In *Europe*, the tram service is now living its renaissance whilst also in the bigger cities of the world plan tramway developments (e.g. in *Shanghai*, *China*). It can be observed that the grandiose and expensive underground development is gradually being replaced by the light rail transit system which is an efficient combination of the underground and tram ways. Since the official opening of the first *Light Rail System (Stadtbahn)* in 1968, a unified and efficiently controllable public transport system has been developed. In the 1990s, the original plans of the Stadtbahn were abandoned, but a new grandiose network development and rationalisation began which has been carried out in many small or large stages. As part of the project, not only the tram network has been altered and renovated, but also many frequent bus routes have been replaced. Commuters who previously depended on their cars have also now changed to public transportation. According to survey results, the usage of tram and light train increased by 2.17% from 2012 to 2013 (VGF Geschäftsbericht 2013, 2014). Thanks to the

investments and developments, the public transportation has become faster, more comfortable and engaging.

6. Future research possibilities

The expansion possibilities within the agglomeration of the dynamically developing zero emission public transport system of *Frankfurt* has been the basis of a number of researches and debates. According to these, it is worth putting more effort into analysing the suburban railway that runs between the western agglomeration and the airport, known as *Regionaltangente West*. The advantage of the combined suburban speed-train and fixed-rail urban train systems may help lighten the routes crossing the city. Specialists' arguments about the total cost and return of the investment are unsettled, and the impact of the new system on *Frankfurt's* public urban transportation lies down the foundation of a new research on the topic too.

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