The Helsinki Rail Loop, the additional track of Pasila and the improvement of the Helsinki railway yard

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Finnish Transport Agency

Content

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1 Helsinki Rail Loop

1.1 Summary

The Helsinki Rail Loop is a new underground double-track rail line beneath Helsinki city centre. The loop-shaped railway starts in Pasila and the trains will run in two parallel tunnels. The length of the Helsinki Rail Loop is 8 km of which 6 km is an underground double-track railway. The Helsinki Rail Loop will have three underground railway stations: Töölö, City Centre and Hakaniemi.

The Helsinki Rail Loop is part of the current Helsinki Region Transport System Plan (HLJ 2011), the Letter of Intent has been signed between Helsinki Region's municipalities and three government ministries concerning land use, housing and transport (MAL) for 2012–2015, it is included in the Government transport policy report approved in 2012 as well as in the agreement between the Helsinki Region's municipalities and the three government ministries concerning the promotion of housing and supporting major infrastructure projects. The Helsinki Rail Loop is also included in the investment programme 2016–2025 for the draft Helsinki Region Transport System Plan (HLJ 2015), which is currently being circulated for comments.

The cost estimate is MEUR 956 (MAKU 152, 2005=100); of which track sections are 57 % and stations 43 %. The construction time is approximately 7 years.

The construction of the Helsinki Rail Loop will expand the service area of Helsinki's public rail system and make the city centre more accessible. The Helsinki Rail Loop will boost passenger rail traffic, speed up public transport, alleviate train delays and improve the trip convenience and operational reliability of railway traffic. The long distance passenger will have shorter travel times and they will be able to travel closer to their destination in the centre of Helsinki. The improvement of the operational reliability is based on the fact that it allows commuter train operations to use the new loop link instead of changing the direction of the train in the congested railway yard of Helsinki, which is the railhead of the Finnish railway network. This relief capacity for the long distance trains and makes the train traffic management more efficient.

The Helsinki Rail Loop will bring more public transport users and speed up public transport journeys in the Greater Helsinki Area. The speed of the train will be 80 km/h. Loop time from Pasila to Pasila will be 12 minutes. Trains will operate at five minutes intervals in both directions.

The estimated passenger volume for the three new stations along the Helsinki Rail Loop in 2025 is approximately 160,000 users per weekday. It has been estimated that there will be 6 500 more public transport journeys a day (an increase of 0,5 % at the regional level). The total journey time will decrease 2 900 hours / day. The time and service level benefits of the users are the main benefits of the project (approximately 14 m€ / year). The most significant economic effects for operators are caused by the increased need for maintenance and savings in the operating costs.

The cost-benefit ratio of the project is approximately 0.5. If the journey time would be 11 minutes instead of 12 minutes, the cost-benefit ratio would be 0,6.

The Helsinki Rail Loop together with the renewal of the safety device and automatic train control enables more frequent traffic which will improve the service level. It is also a strategic choice which will improve the development of the land use and traffic system.

The Helsinki Rail Loop impacts serves the objective to development of the public transport at the Helsinki metropolitan area. It speeds up the journeys which other end is at the city centre. In addition to these time savings, it also decreases the need for changes and shortens the walking distances, which both are relevant part of level of service provided by the public transportation system. Time savings and improved level of service for the travellers at Helsinki metropolitan region are the most important single benefits in the cost-benefit calculation.

The impacts on the delays and reliability of the train operations are not yet fully known at this planning phase and it is expected that their effect may be more than estimated in the current calculation.

The role of The Helsinki Rail Loop as part of the overall development of the public transportation is important especially in providing the improved level of service for the commuter train traffic and for the cost of providing the service.

The project supports the regional objective to develop the urban structure and land use based on effective railway traffic. In the mid –term the value of land will increase especially areas effected by the The Helsinki Rail Loop, this will most likely increase positive land use impacts on the larger railway based area as well

1.2 Current situation

Traffic in Helsinki railway yard has increased 40 % in last 10 years. It has been estimated that the number of the inhabitants in Helsinki will increase 30 % by the year 2050. In the current situation, the volume of train traffic between Helsinki and Pasila is approximately 74 trains per evening peak hour and almost 1,000 trains per day.

The amount of traffic has increased but the number of the tracks has not. The current railway yard and its layout are not functional as the demand has increased. The increased traffic is a challenge as there is not enough capacity and the ability to recover from the disturbances is low. The traffic is very vulnerable to distractions and delays and problems easily delays long distance and commuter railway traffic.

Because the Helsinki is the railhead of the Finnish railway network, all local and long distance trains must change directions at the cramped railway yard of Helsinki. This makes congestion even worse.

1.3 The project content

The Helsinki Rail Loop is a new underground double-track rail line beneath Helsinki city centre. The loop-shaped railway starts in Pasila and the trains will run in two parallel tunnels. The length of the Helsinki Rail Loop is 8 km of which 6 km is an underground double-track railway. The Helsinki Rail Loop will have three underground railway stations: Töölö, City Centre and Hakaniemi.

Figure 1. The Helsinki Rail Loop.

The objective of the Helsinki Rail Loop is
1. to improve punctuality of the train traffic which is caused by the inadequate capacity of the Helsinki railway yard, severe winter conditions and operating model of the local and long distance traffic.
2. to increase the local and long distance traffic
3. the improvement of the public transport of the Metropolitan Area

The Helsinki Rail Loop increases the capacity and reliability of the train traffic by allowing commuter train operations to use the new loop link instead of changing the direction of the train in the congested railway yard of Helsinki which is the railhead of the Finnish railway network. It is estimated that after implementing the Helsinki Rail Loop, 70 % of the traffic decreases in the railway yard of Helsinki. This relief capacity for the long distance trains and makes the train traffic management more efficient.

The construction of the Helsinki Rail Loop will expand the service area of Helsinki's public rail system, making the city centre more accessible. The Helsinki Rail Loop will boost passenger rail traffic, speed up public transport, alleviates train delays and improves the trip convenience and operational reliability of railway traffic. The long distance passenger will have shorter travel times and they will be able to travel closer to their destination in the centre of Helsinki.

The Helsinki Rail Loop will bring more public transport users and speed up public transport journeys in the Greater Helsinki Area. The speed of the train will be 80 km/h. Loop time from Pasila to Pasila will be 12 minutes. Trains will operate at five minutes intervals in both directions.

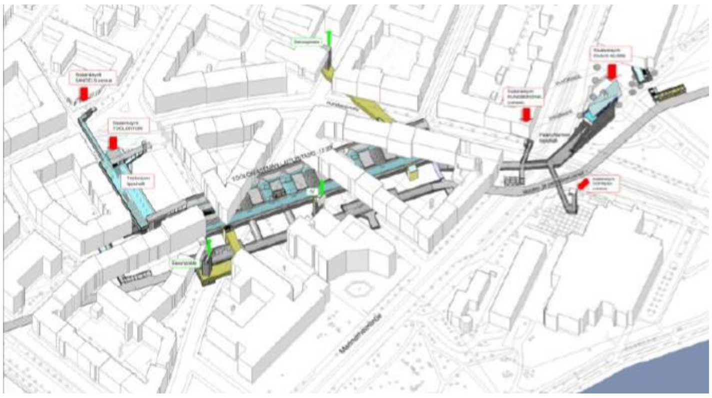

Figure 2. Töölö station.

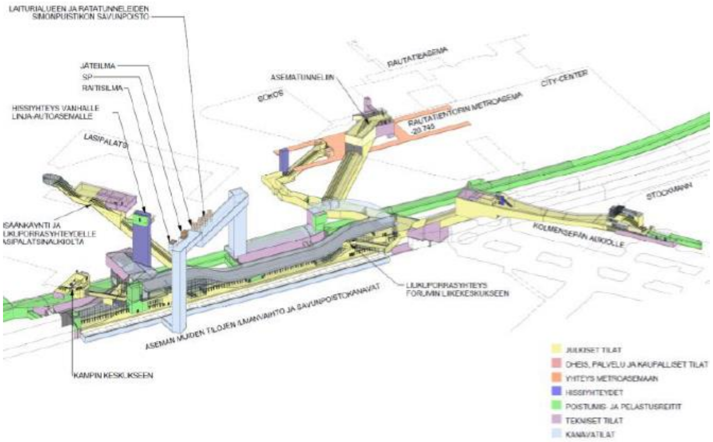

Figure 3. The City Central station.

Figure 4. Hakaniemi station.

The cost estimate is MEUR 956 (MAKU 152, 2005=100); track sections 57 % and stations 43 % (table 1). The construction time is approximately 7 years.

Table 1.

Cost division	%
Tracks	51 %
Planning tasks 2,5 %	1 %
developer consultant 5 %	3 %
risk estimate 5 %	3 %
Tracks total	57 %
Töölö station	10 %
City central station	17 %
Hakaniemi station	11 %
Planning tasks 2,5 %	1 %
developer consultant 5 %	2 %
risk estimate 5 %	2 %
stations total	43 %
TOTAL	100 %

This evaluation is based on the assumption that following projects have been implemented:

- Pasila-Riihimäki
- the additional track of Pasila
- the improvement of the Helsinki railway yard

In the current situation, the volume of train traffic between Helsinki and Pasila is approximately 74 trains. The additional track of Pasila and the improvement of the Helsinki railway yard enable that the traffic of 104 trains per hour.

1.4 The traffic estimates

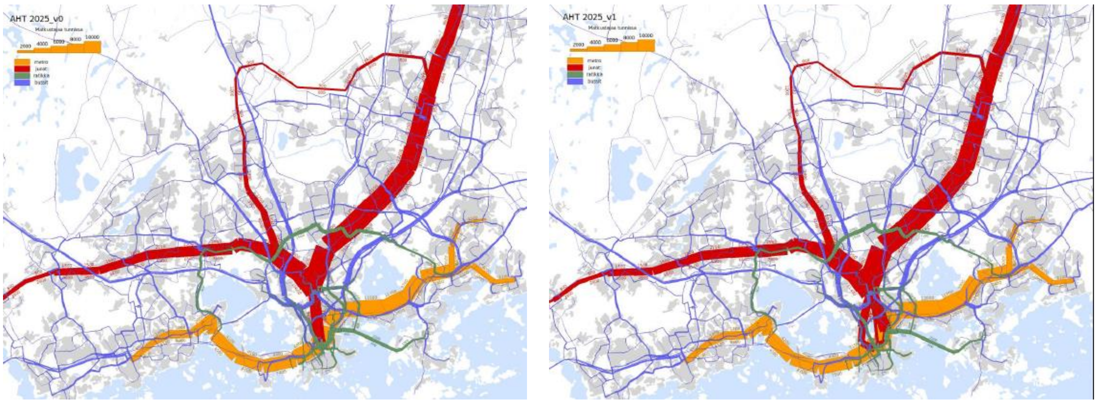

Figure 5. The traffic estimate 2025 (left: the project not implemented, right: the project implemented).

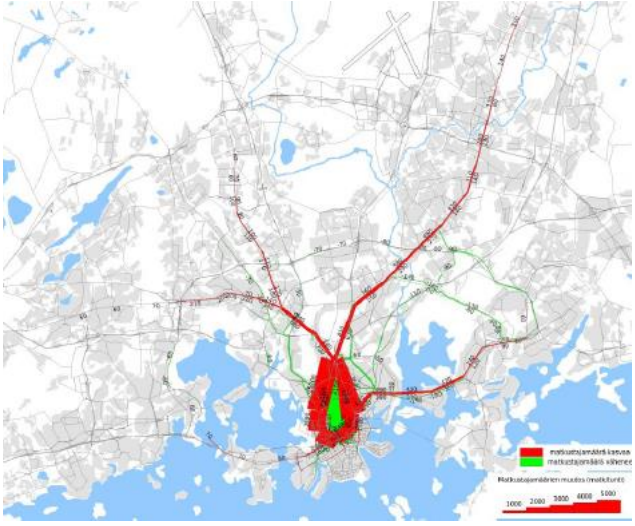

Figure 6. The increase of the traffic 2025 (the project implemented).

1.5 Cost-benefit analysis

The impacts:

- the journey speed from door to door improves from 27,8 km/h to 28,1 km/h
- The total journey time will decrease 2 900 hours / day (6 second /journey)
- There will be 6 500 more public transport journeys a day (an increase of 0,5 %).
- the share of the public transport increases from 37,2 % to 37,4 %
- the production cost of one journey decreases 1,1 % (0,02€/journey).

The benefits of the Helsinki Rail Loop is 16 m€ / year in 2025 and 19.5 m€ / year in 2040. The time and service level benefits of the users are the main benefits of the project (approximately 14 m€ / year). The most significant economic effects are caused by the increased need for maintenance and savings in the operating costs.

The cost-benefit ratio of the project is approximately 0.5. However, the ratio will increase through the benefits arising from land use (urban intensification and improved commuting to work) and the reliability of operations (more frequent service intervals and the benefits to long-distance traffic). If the journey time would be 11 minutes instead of 12 minutes, the cost-benefit ratio would be 0,6.

CAPITAL COSTS OF INVESTMENT COSTS (million EUR)	**903,90**
Construction costs	775,30
Interest costs during construction	128,60
COSTS (-) AND BENEFITS (million EUR)	
Maintenance of railways	**-71,30**
Producer surplus, goods transport	**88,50**
Ticket revenues	46,30
Operating cost savings	45,60
parking of the private cars	-3,40
Changes in external costs	**340,70**

current passengers	**303,80**
time savings	199,00
improvement of the service level	104,80
new passengers	24,50
time savings in the road traffic	12,40
Accident savings	26,90
Reduction of road traffic accidents	26,90
Air pollution	1,50
Railway traffic	-0,60
Road traffic	2,10
Changes in public revenues	**-2,50**
Track access charges revenue	1,70
Taxes and payments of the road traffic	-8,80
VAT of the public transport tickets	4,60
Residual value	**62,60**
COSTS AND BENEFITS (million EUR)	**446,40**
Benefit cost ratio (BCR)	**0,49**

A sensitivity analysis to be conducted on the benefit-cost analysis provides information on the uncertainties involved in the set calculation parameters. The sensitivity analysis is performed by comparing the impact of the factors critical to the BCA with the key indicators set for project appraisal.

In the Helsinki Rail Loop it is sensible to estimate the alternative in which

- the journey time is 11 minutes instead of 12 minutes =>CB 0,58
- there are terminals for feeder bus traffic => CB 0,52
- the Helsinki–Turku railway section in Espoo will not be constructed => CB 0,46
- the pricing of the road traffic will increases => CB 0,49
- alternative land use 2040 => CB 0,50

- construction time is 5 years instead of 7 => CB 0,51
- investment cost is -15 % => CB 0,57
- investment cost is +25 % => CB 0,44

The construction investment and the journey time have the strongest influence on Cost-Benefit ratio.

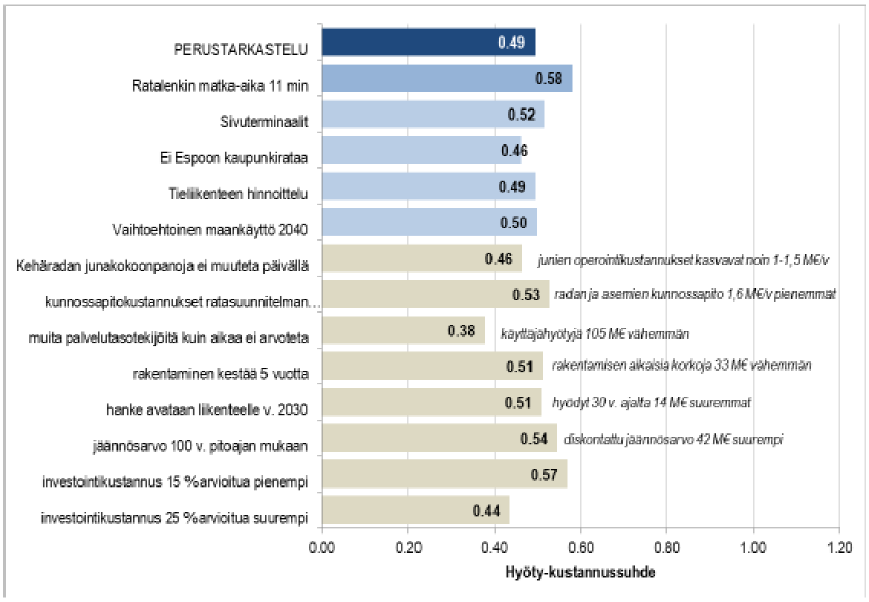

Figure 7. The sensitivity analysis

2 The Additional Track of Pasila

2.1 Background

The main line between Helsinki and Riihimäki is one the most heavily trafficked track sections in Finland, carrying both passenger and freight traffic. The direct connection line between Kerava and Lahti, opened for traffic in the autumn of 2006, changed considerably the structure of the railway transport system in South Finland. Eastbound long-distance train traffic from Helsinki was transferred onto the new line, as well as some of the freight transport operations. A new commuter train service, under the name Z, started operating on the new line between Helsinki and Lahti. Major changes were also implemented in the traffic elsewhere in the railway network system. Transferring eastbound long-distance traffic onto the new direct connection line reduced available train services from Riihimäki to Helsinki, when eastbound long-distance trains stopped operating on the main line. For this reason, adding a third scheduled commuter train service each hour from Helsinki to Riihimäki is deemed necessary. Given the existing rail infrastructure, however, integrating a new service with the present traffic pattern is very difficult, because increased supply of scheduled train services on the main line between Helsinki and Riihimäki would create pressures concerning the passing places for long-distance and commuter trains, a problem which cannot effectively be eliminated by means of the existing rail infrastructure. The problem is further exacerbated by the forecast increase in the supply of long-distance traffic.

In 2006–2007, the Finnish Rail Administration Agency commissioned a number of studies, based on schedule planning and simulations, whose aim was to evaluate, among other things, potential development measures for increasing carrying capacity on the main line between Helsinki and Riihimäki while simultaneously reducing train traffic's vulnerability to disruptions. According to the studies, the primary factors restricting the carrying capacity of the railway network in the entire southern Finland are the congestion of the Helsinki rail yard, the rather limited carrying capacity for long-distance traffic on the Helsinki–Pasila–Kerava section and the lack of available passing places on the northern side of Kerava. In the Pasila–Kerava section, Tikkurila was highlighted as a particularly problematic site. The solutions put forward for eliminating the problems include increasing the number of tracks with dedicated platforms at Tikkurila, the construction of an additional track of Pasila and the addition of tracks both at Kerava and north of Kerava.

In the future, the entire Central Pasila area will undergo major changes, because the station building at Pasila will be expanded and completely overhauled, when the construction works of Pasila's new central block Tripla start in 2015. The Tripla is due to be completed by 2021. The additional track is part of this overall project entity, and must be implemented concurrently with the other construction works associated with the Tripla block.

In 2015, the Ring Rail Line will be opened to traffic, connecting the main and coastal lines and the Helsinki–Vantaa Airport. The line is a double-track metropolitan line, on which trains are scheduled to operate at ten-minute departure intervals during peak hours.

2.2 Project input data

Pasila Station is situated on the most heavily trafficked track section, three kilometres north of the Helsinki Central Railway Station. Traffic in the Helsinki rail yard has increased by 40% during the past ten years. In the current situation, the volume of train traffic between Helsinki and Pasila is approximately 74 trains per evening peak hour and almost 1,000 trains per day. The tracks at Pasila station are used by both the trains operating on the northbound main line from Helsinki and the local, commuter and long-distance trains on the so-called coastal line between Helsinki and Turku. In addition, the tracks at Pasila are used for depot traffic to and from the Ilmala Marshalling Yard (Figure 1).

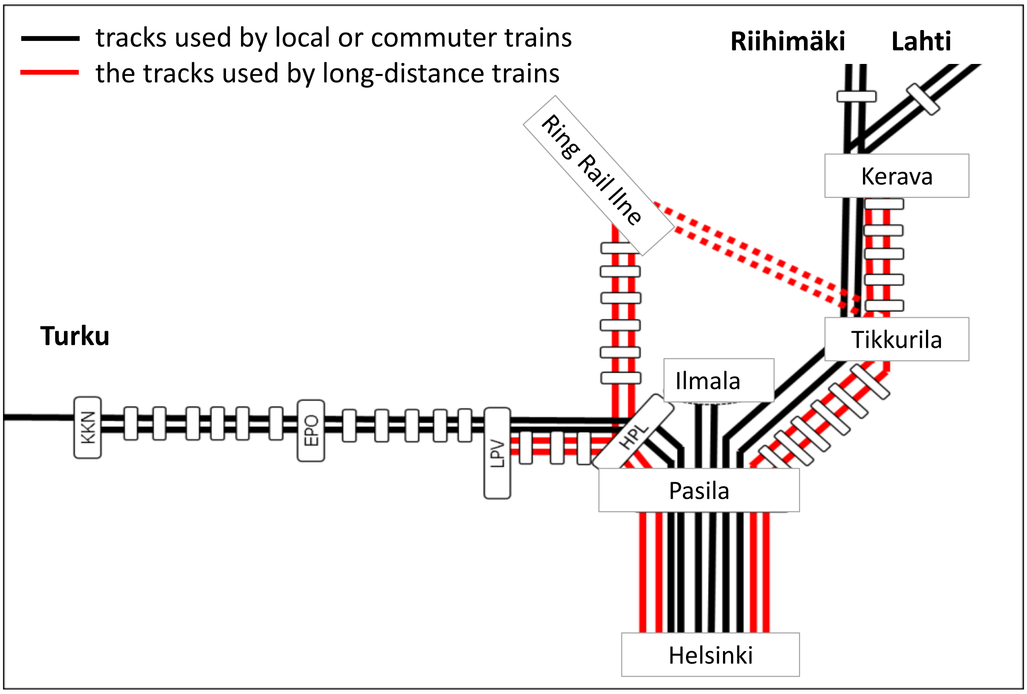

Figure 1. *The location of Pasila Station (PSL) on the railway network in the Helsinki Metropolitan Region. The red lines depict tracks used by local or commuter trains and the black lines depict the tracks used by long-distance trains and the Ilmala Depot (ILR). The figure shows also the Ring Rail Line between Vantaankoski and Tikkurila to be opened for traffic in 2015 (VSK–TKL).*

The improvement in carrying capacity between Pasila and Riihimäki involves a number of various development items and implementation stages. Out of these three separate projects were formed, which are the increasing in carrying capacity between Pasila and Riihimäki, the construction of an additional track of Pasila and the development of the Helsinki Rail Yard.

The project for increased carrying capacity between Pasila and Riihimäki seeks to improve carrying capacity by means of additonal track sections and reconfiguration of stations. The project is designed to be implemented in two stages. The first stage includes the modification of tracks and turnouts at Tikkurila Station, discovered to be the most significant bottleneck; the additional track added for freight traffic in the Kyrölä–Purola section; an extra turnout at Hyvinkää; and the reconfiguration of the rail geometry in the Riihimäki Passenger Rail Yard.

In order to eliminate the bottleneck at Tikkurila, the division of the station's tracks is designed to be altered with dedicated platforms assigned for the use of long-distance and commuter trains. Currently, both long-distance and commuter trains have three tracks with dedicated platforms. One of these tracks will be reassigned for long-distance trains, after which long-distance traffic will have two tracks in both directions. This is necessary in order to ensure that the capacity of the tracks with dedicated platforms is equivalent to the capacity of the line tracks. After the Ring Line is completed, the two tracks remaining in the use of commuter traffic is sufficient, because Tikkurila will no longer be the terminus for commuter trains.

The need for an additional track of Pasila results from the same reasons as in Tikkurila. At Pasila, there are only three tracks available for the main line's long-distance trains. By constructing an additional track, four tracks will be available for long-distance traffic, in the same way as at Tikkurila Station. This will be implemented by adding an extra track with a dedicated platform on the western side of Pasila Station. At the same time, the functional use of the Pasila tracks will be moved westward on both sides of the station, after which there will one additional track available for the main line's long-distance traffic (in the figures, the existing track 5b and the future track 6). With the construction of the additional track and a new platform, the Pasila tracks will have consecutive numbering, i.e. track number 5b will be taken out of use (figures 2 and 3).

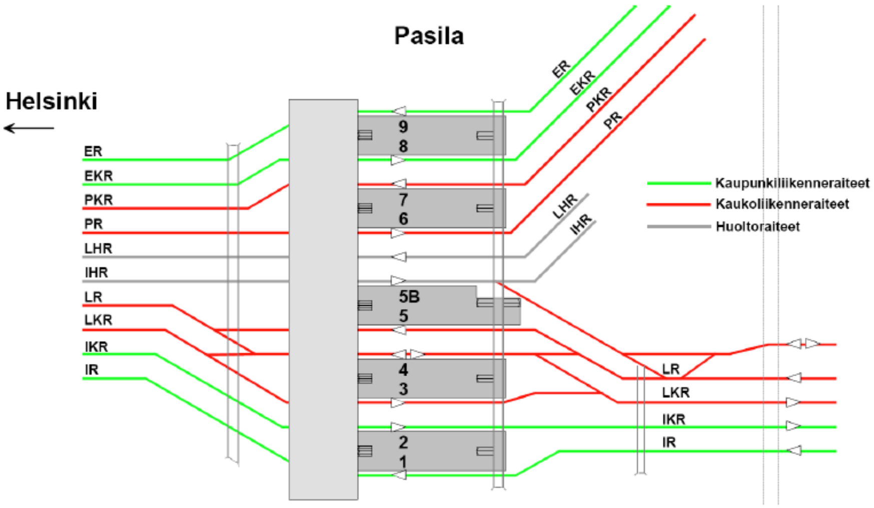

Figure 2. *Current Pasila track configuration*.

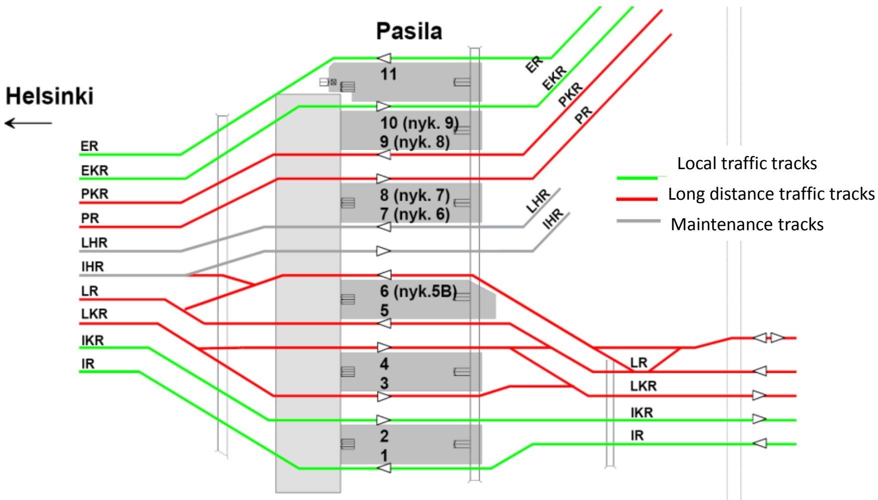

Figure 3. *Pasila track configuration after completion of the additional track (track 11).*

2.3 Project content

The additional track of Pasila is approximately 1.5km long. The additional track will be constructed on bridges and other special structures. A platform of 250m in length will be placed between the new track and the southbound middle track (currently the edge track). The platform will serve only the passengers of the southbound track. The platform is 7.5m wide, and will be constructed using prefabricated reinforced concrete elements on both sides.

The changes in the safety equipment will be implemented through a connection to the existing Helsinki signalling centre and by using the same signalling system that most of the area's existing signal posts employ today. The changes in rail geometry and the new turnout arrangements will require implementing changes in the safety equipment on the existing eight tracks, as well as on the new additional track. The placement and operating principles of the safety equipment will remain largely intact, but some of the signal posts must be relocated to conform to the current technical guidelines.

Due to the changes in the rail geometry, modifications will be made to the existing electrified track. In the new Pasila platform area, new multi-track overhead portals for electrified track will be erected, which are uniform with the existing platform pylons. As a rule, the electrification of the new western track in the platform area will be implemented using overhead lines running on portals. Changes in rail configuration will be implemented beyond the platform areas, and individual overhead line pylons or portals will be used.

According to the track plan, the cost estimate is MEUR 37.6 (MAKU 111.9, 2010=100). A significant portion of the costs arise from various specialist engineering structures (table 1).

Table 1. Cost estimate for the western additional track in Pasila according to the track plans, itemised by measure (MAKU 111.9, 2010=100).

Measure	Cost estimate EUR 1,000
surface structure	3,233
safety equipment technology	2,429
electrified track high-voltage technology	3,644
specialist engineering structures	18,646
abutments	3,892
landscaping	174
site works	5,674
purchaser tasks	4,939
TOTAL EXPENDITURE	**37,633**

2.4 Status of design and the implementation schedule

A track plan has been prepared for the project. The track plan cannot be approved in the absence of a valid zoning plan. The zoning plan is due to be completed by June 2015, in which case the track plan could be approved in the autumn of 2015. The construction plan is designed to be prepared in 2015–2016, and the additional track would be constructed in 2018–2020. The additional track is designed to be constructed in close collaboration with the implementation of the Central Pasila Tripla project.

2.5 Description of impacts

2.5.1 Service level of transport provision and incident sensitivity

Together with the other development measures designed for the Pasila–Riihimäki section, the project enables an increase in the capacity on the main railway line in such a way that the provision of commuter train services between Helsinki and Riihimäki can be increased from two to three train departures per hour. The sensitivity to disturbances on the main line is reduced, and the journey times of trains become shorter both in commuter and long-distance traffic, due to the impact of the combined measures. As a result of shorter departure intervals, commuter passengers will receive service level benefits. The simulation studies carried out in connection with the planning of increased serviceability of the rail yard demonstrate that the additional track of Pasila will also significantly increase the service level of the maintenance tracks and the long-distance tracks of the main line.

Pasila is being developed into a hub of public transport providing easy connectivity between trams, buses and commuter and long-distance trains. A direct train connection runs even today via Pasila to Saint Petersburg. The significance of Pasila as a node of cross-border transport will increase further when the Ring Rail Line is completed, which will provide a direct train connection to the airport. The serviceability of pedestrian traffic will also improve with the implementation of the new connections. A covered ride-and-park facility accommodating 3,400 cycles is designed in connection with the Tripla block. The project also promotes unobstructed access and travel.

2.5.2 Passenger volumes

The passenger volume forecast for 2015 on the main line north of Pasila is 27 million passengers per annum, out of which seven million are long-distance journeys and 20 are million commuter journeys.

According to the estimates prepared in connection with the main line studies, improved punctuality and the increased number of scheduled departures will increase both the attractiveness of and demand for rail transport. According to the estimates prepared in connection with the main line studies, the demand for train journeys in commuter traffic on the main line will increase by approximately 0.4 million and in long-distance traffic by approximately 40,000 passengers per annum.

2.5.3 Traffic safety, noise and vibration

The project will cause transfer of journeys from road transport to railway transport. Such a transfer has a positive impact on the development of road-traffic accidents and emissions.

In the area of Central Pasila, noise from road traffic is the most significant source of noise (Finnish Transport Agency, Study on Noise Disbenefits in Central Pasila, 2011). With the implementation of the additional western track, railway traffic will be distributed onto a greater number of tracks, but this will have no impact on the noise emanating from railway traffic or the overall noise impact.

2.5.4 Land use and urban milieu

The additional western track will be constructed in an urban milieu which is undergoing significant changes in terms of both land use and cityscape. The design has taken into account all future changes in land use to the extent that such information has been available. The abutments implemented with separate façade cladding structures will feature prominently in the cityscape, creating a unique character for the area.

Together with the other development measures undertaken on the main line, the additional track of Pasila will support the long-term development targets set for land use along the main line. A more compact community structure increases the use of rail transport, alongside its other positive impacts.

2.5.5 Construction-time disbenefits

The preparation works preceding the taking into use of the tracks do not produce any significant traffic-related impacts. During the preparatory phase, the tracks currently in use can be operated as normal. On the tracks adjacent to the work site, traffic may need to be disrupted for short periods, which can be scheduled to take place in the night time.

During the construction and electrification of the portals carrying the overhead lines, so-called total blackouts of power supply will be required on the work site in order to ensure safety of the construction work. Such pre-planned outages required by the construction work can be scheduled together with the railway undertaking in order to cause only minimal disruption in rail operations.

The new tracks will be taken into use during week-ends, during which only three out of the existing four tracks are available for operation in the direction of the coastal line. During peak traffic, trains may be delayed by a few minutes due to the above arrangement, and the trains operating on the metropolitan tracks may not be able to stop at Ilmala Station. It may be necessary to cancel some scheduled departures. Two tracks are sufficient for night-time operations.

Individual tracks of the main line may temporarily be taken out of operation due to the construction works. The traffic-related impacts are mainly limited to changes in the platforms from which the trains depart. Works on the maintenance tracks closes down one of the two tracks to the Ilmala Marshalling Yard, which may require the re-organisation of maintenance traffic.

2.6 Socio-economic profitability of the project

The socio-economic benefits provided by the additional track of Pasila cannot be assessed as distinct from the overall development entity comprising the main line and other train traffic in the Helsinki Metropolitan Region. The project is also part of the development plan of the entire Central Pasila area.

In rough terms, the profitability can be assessed, for example, on basis of the project appraisal concerning the increased carrying capacity in the Pasila–Riihimäki track section. The additional track of Pasila was included in the reference scenario of the project appraisal, i.e. the investment costs arising from the additional track were not taken into account in the final project appraisal. On the one hand, the benefits of the project will not be realized, at least not to their full extent, without the implementation of an additional track of Pasila, and on the other hand, the benefits of the additional track of Pasila will not be realized without the development of the main line between Pasila and Riihimäki.

According to the project appraisal concerning the increased carrying capacity in the Pasila–Riihimäki track section, the benefits from additional track of Pasila are produced by train passengers' time savings, service level benefits, increased producer surplus and reduced external costs (noise, accident and emissions costs).

The investments costs for the Pasila–Riihimäki project, without the additional track of Pasila, are MEUR 114.5 and the benefits over a period of 30 years MEUR 203.3. When the investment costs of the additional track of Pasila, including interest payments accrued during the construction period, are factored in, the total costs increase to approximately MEUR 155. Hence, the total benefits of the main line development project exceed the investment costs of the project. The additional track of Pasila and Pasila–Riihimäki are economically viable on the basis of a socio-economic cost-benefit analysis (cost-benefit ratio is 1,3).

2.7 Conclusions

The additional track of Pasila and Pasila–Riihimäki are economically viable on the basis of a socio-economic cost-benefit analysis (cost-benefit ratio is 1,3).

The additional track of Pasila is a vital part of the development of the main line between Pasila and Riihimäki. The additional track of Pasila must also be regarded as part of the Central Pasila Tripla project, comprising an urban entity of three blocks, which will accommodate office and residential buildings, a shopping centre, hotels and the new transport hub of metropolitan public transport.

Tripla will be completed by 2021 in Central Pasila around the existing Pasila Station. The construction of the new track in connection with the development of Central Pasila is both meaningful and cost-efficient.

The additional track of Pasila, together with the other developments on the main line, enables the increasing of the carrying capacity of the congested Pasila–Riihimäki section, while increasing the supply of scheduled departures from two to three commuter trains per hour. By means of the additional track, a fourth track is made available for long-distance trains, i.e. two tracks in both directions. The implementation of the project also allows taking into use all capacity available at Pasila above the ground level. The project produces significant time savings for both commuter and long-distance travellers and improves the service level of commuter transport. The project will reduce the transport system's accidents and emissions.

After the Tripla project, the additional track, the development of the rest of the main line and the Ring Line are completed, Pasila will become a major hub for public transport providing straightforward change opportunities between buses, trams and trains. Pasila Station will acquire greater significance as a node of cross-border transport. The implementation of the track plan will also promote significantly the serviceability and obstruction-free travel of pedestrian traffic.

For the reasons stated above, it is justified to construct the additional track of Pasila.

3 The Helsinki Railway yard

3.1 Background and objectives

Traffic in the Helsinki rail yard has increased during the past years. The current track system and operating mode of the rail yard do not serve in an ideal manner the needs of increased and changed traffic. The operation of the Helsinki rail yard and possible disturbances in the area are critical for the operation of the whole rail system in Finland. Therefore, it has been considered necessary to develop the capacity, functionality and disturbance-resistance of the rail yard.

The goal of the project is to increase the rail capacity between Helsinki and Pasila, reduce the harm and inconvenience due to traffic incidents by speeding up the recovery of train traffic from incidents, for example, and improve punctuality in train traffic.

3.2 Project and reference scenario

3.2.1 Comparison alternative

The starting point for planning has been a so-called (VE0+) alternative which includes the implementation of a western extra track at Pasila (image 1). The comparison alternative does not include the City Rail Loop. The appraisal of the traffic-related effects of the project also partly includes the situation in which the City Rail Loop will also be implemented (so-called HELPI alternative).

In the comparison alternative, the maximum speed in the track section between Helsinki and Pasila is 80 km /h.

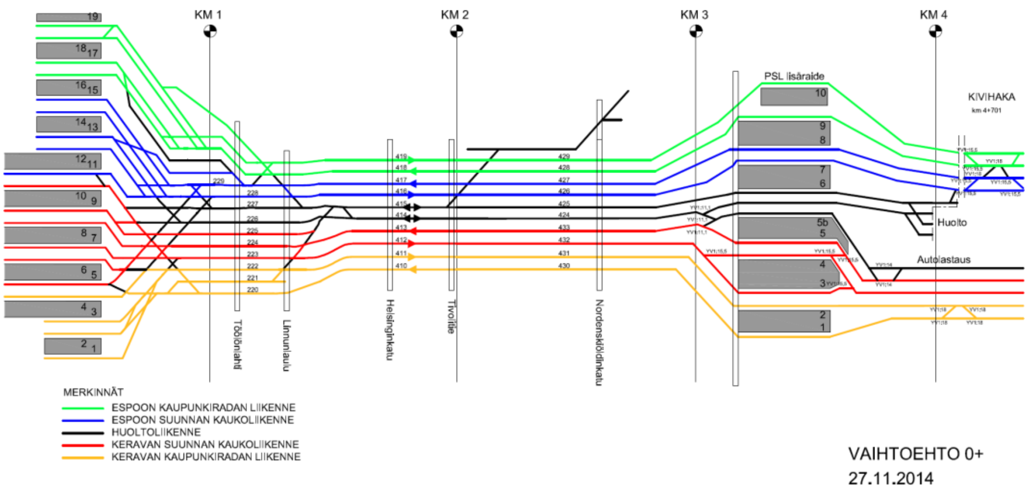

Image 1. Track infrastructure according to comparison alternative (0+).

3.2.2 Project content

The project contains new turnout connections between Helsinki and Pasila that enable connections from a service track to the tracks along the main line, for example. New turnout arrangements will be implemented mainly using short single slip switches and double slip switches. The most significant changes compared to the track system of the comparison alternative are the following:

1. A new place for changing tracks north of Pasila (image 2, item J)
2. A new service track connection to connection tracks in Ilmala (image 2, item I)
3. A new turnout connection V202–V215 that enables the division of long-distance traffic on the main line to tracks 224 and 225 (image 2, item B)
4. A new turnout connection V282 that enables the division of arriving traffic on the main line to tracks 220 and 221 (image 2, item A)
5. New places for changing tracks on the Kerava and Espoo city tracks (image 2, items F and C)
6. A new place for changing service tracks (image 2, item D).
7. New turnout connections that improve the use of service tracks (image 2, items G and H)
8. A new junction line for disturbances and service operations from service tracks to city tracks (image 2, item E).

The project also includes changes to signalling systems at the rail yard. The distances of city tracks between Helsinki and Pasila will be condensed so that a signal interval can be added. With the help of new signal intervals, the minimum interval between trains can be shortened and capacity can be increased. Due to safety aspects related to shorter signal intervals, the maximum permitted speed between Helsinki and Pasila will be reduced to 60 km/h. The functionality of Pasila will be improved with new signal posts that show advance information (platform signal posts).

The cost estimate of the project is MEUR 60. The construction is designed to be implemented in four stages.

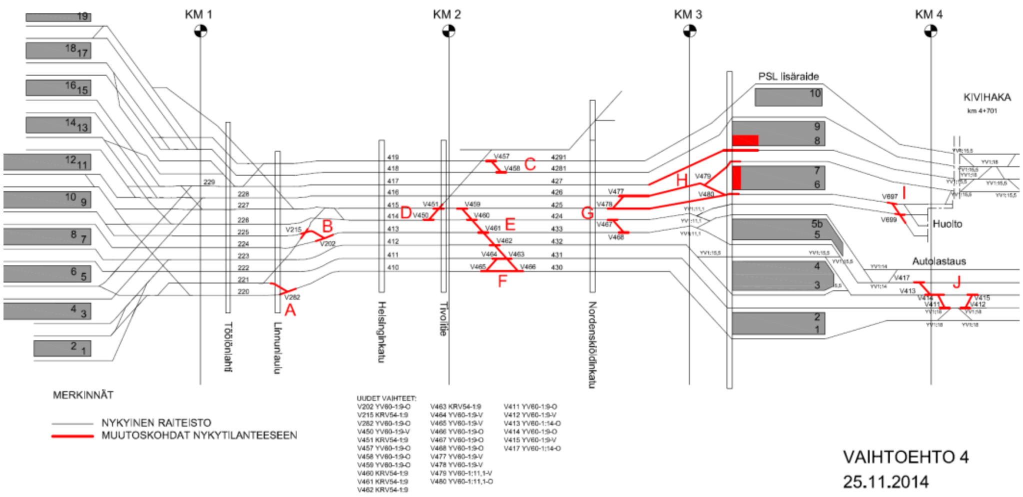

Image 2. Changes in rail configuration included in the project.

3.3 Impact assessment

3.3.1 Scope and methods of the investigations

The project appraisal examines the immediate effects of the project in an area that includes the operation area between Helsinki and Pasila, the rail section between Pasila and Oulunkylä on the main line, and the rail section between Pasila and Huopalahti along the coastal line. The appraisal does not include the demand effects of various modes of travel nor the effects on other transport systems, such as the supply of bus traffic and external effects of road traffic.

The effects examined as part of the project appraisal are based on simulations of traffic at the rail yard, current and forecasted rail traffic passenger volumes, expert estimates, and methods and unit costs related to assessing effective impact and profitability as presented in the appraisal guidelines for rail projects by the Finnish Transport Agency[1].

The project appraisal examines the effects of the project for a period of time that extends 30 years form the completion of the project. The project is estimated to be completed in 2020. Results for the first calculation period of the rail yard traffic simulations will be used as the starting point for assessing the effects for 2020–2029, and the results for the second calculation period for the effects for 2030–2049. The project appraisal also presents briefly the effects of the project during construction.

3.3.2 Rail transport supply

Rail transport supply that was used in the appraisal was based on the rail supply at different time intervals specified on the basis of interest group interviews. Rail transport supply is the same in comparison and project alternatives.

Currently, traffic at the rail yard during the peak hour in the evening (4 p.m.–5 p.m.) is 74 trains taking both directions into account. It is estimated that the rail transport supply will increase to 80 trains per hour by 2020 and later to 86 trains per hour. In addition, necessary service operations between Helsinki and Ilmala depot were taken into account (table 1).

[1] Instructions issued by the Finnish Transport Agency 15/2013

Table 1. Rail transport supply during the peak hours (3 p.m.–6 p.m.) at different time spans.

Train type/operation direction	The number of trains at 3 p.m.–6 p.m. (total for both directions)	
	2020–2029	2030–2049
Coastal line commuter trains	72	72
Coastal line regional trains	30	30
Coastal line long-distance trains	6	6
Main line regional trains	34	48
Main line long-distance trains	24	30
Main line commuter trains	72	72
Service operations	16	6
Total	**254**	**264**

3.3.3 Description of impacts

3.3.3.1 Travel times

The development of the Helsinki rail yard will affect the travel time between Helsinki and Pasila stations when the maximum speed of trains will be reduced. According to the planned operation model, the project will increase the scheduled travel time by 30 seconds assuming that departure times north (along the main line) and west (along the coastal line) from Pasila will be rounded up to the closest half a minute.

According to simulations, the actual travel times in an undisturbed situation (from when doors are closed to when they are opened) are 17–28 seconds longer to the direction of Pasila during the first calculation period (2020–2029) depending on the train type, and 17–29 seconds longer to the direction of Helsinki than those of the comparison alternative (table 1). On average, the travel time will increase by 20 seconds, which means an annual increase of around 0.14 million hours in travel time between Helsinki and Pasila. During the second calculation period (2030–), the average increase in travel time is more or less the same.

Table 2. Average increase in travel time according to simulations.

Train type	Average increase in travel time (s)	
	To the direction of Pasila	To the direction of Helsinki
Coastal line commuter trains	19	18
Coastal line regional trains	17	19
Coastal line long-distance trains	17	17
Main line regional trains	27	26
Main line long-distance trains	24	25
Main line commuter trains	28	29

3.3.3.2 *Train and passenger delays*

Train delays

Train delays refer to an increase in travel time compared to a regular situation. Simulations were used for examining peak hours (the time period between 3 p.m. and 6 p.m.). The delay sums were specified at the borders of the inspection area, that is, at the Helsinki Central Railway Station (trains arriving to Helsinki) and on the main line in Oulunkylä, and on the coastal line in Huopalahti or Ilmala depot (trains departing from Helsinki). The effects of the project on the length of delays were estimated in four kinds of disturbances (tables 3–6).

Table 3. Average delays that correspond to disturbance 1 (moderate delays, 50% of trains late) for the comparison alternative (0+) and the project alternative (HELRA).

Train type/operation direction	Average delay/train (s)	
	First calculation period 0+ /HELRA	Second calculation period 0+/HELRA
Coastal line commuter trains	0.2/0.4	0.2/0.4
Coastal line regional trains	4.4/3.4	10.3/8.2
Coastal line long-distance trains	27.7/23.9	76.4/68.5
Main line regional trains	16.1/12.9	14.0/12.0
Main line long-distance trains	78.6/73.7	97.5/102.5
Main line commuter trains	1.0/0.8	1.0/0.8
Service operations at Ilmala depot	30.8/30.6	79.6/79.2
Total	**13.1/11.9**	**18.7/18.4**

Table 4. Average delays that correspond to disturbance 2 (moderate delays, 100% of trains late) for the comparison alternative (0+) and the project alternative (HELRA).

Train type/operation direction	Average delay/train (s)	
	First calculation period 0+ /HELRA	Second calculation period 0+/HELRA
Coastal line commuter trains	1.5/1.1	1.5/1.1
Coastal line regional trains	6.7/3.7	11.0/7.7
Coastal line long-distance trains	119.8/11.4	61.3/51.7
Main line regional trains	22.5/20.5	35.9/28.4
Main line long-distance trains	147.6/143.1	116.2/118.2
Main line commuter trains	3.7/3.4	3.7/3.4
Service operations at Ilmala depot	42.9/42.5	111.4/111.4
Total	**24.8/23.3**	**26.3/24.4**

Table 5. Average delays that correspond to disturbance 3 (high-level delays, 30% of trains late) for the comparison alternative (0+) and the project alternative (HELRA).

Train type/operation direction	Average delay/train (s)	
	First calculation period 0+ /HELRA	Second calculation period 0+/HELRA
Coastal line commuter trains	70.8/67.4	76.0/81.2
Coastal line regional trains	54.8/51.5	51.6/48.7
Coastal line long-distance trains	148.0/141.5	260.5/256.2
Main line regional trains	102.7/105.5	157.2/122.3
Main line long-distance trains	230.1/233.4	280.9/246.8
Main line commuter trains	66.2/64.5	67.1/65.0
Service operations at Ilmala depot	183.6/190.2	59.7/68.4
Total	**95.9/95.0**	**112.7/103.1**

Table 6. Average delays that correspond to disturbance 4 (high-level delays, 50% of trains late) for the comparison alternative (0+) and the project alternative (HELRA).

Train type/operation direction	Average delay/train (s)	
	First calculation period 0+ /HELRA	Second calculation period 0+/HELRA
Coastal line commuter trains	90.1/80.7	90.1/85.7
Coastal line regional trains	72.4/66.3	99.6/93.6
Coastal line long-distance trains	142.0/131.7	350.0/339.3
Main line regional trains	144.9/144.7	216.8/194.6
Main line long-distance trains	336.1/329.8	401.7/386.5
Main line commuter trains	114.7/111.8	115.0/112.4
Service operations at Ilmala depot	226.6/226.3	260.2/262.1
Total	**135.4/110.3**	**166.2/157.6**

Sum of train delays at an annual level

Delays during peak hours were transformed to correspond to the traffic for the whole year by estimating the probability of various disturbances and by extending the peak hour delays to correspond to the whole year. Extension coefficient 500 was used. Based on expert estimates, there are always some kinds of disturbances related to traffic. The share of disturbances causing moderate delays is around 90%, and the share of disturbances causing high-level delays is around 10% (table 7).

Table 7. Probabilities of operation disturbances used in the appraisal.

Disturbance	Probability	
	1. calculation period	2. calculation period
Disturbance 1 "moderate delays", 50% of trains late	60%	60%
Disturbance 2 "moderate delays", 100% of trains late	30%	30%
Disturbance 3 "high-level delays", 30% of trains late	7%	7 %
Disturbance 4 "high-level delays", 50% of trains late	3%	3%

The implementation of the project will reduce annual train delays during the first calculation period by 47 hours/year. The greatest benefit will be achieved on long-distance and regional trains on the main line. During the second calculation period, delays will be reduced by 60 hours/year of which the share of regional trains on the main line is more than two thirds (image 3). If the City Rail Loop will also be constructed, train delays will be reduced by 220 hours/year during the first calculation period and by 314 hours/year during the second calculation period (image 4).

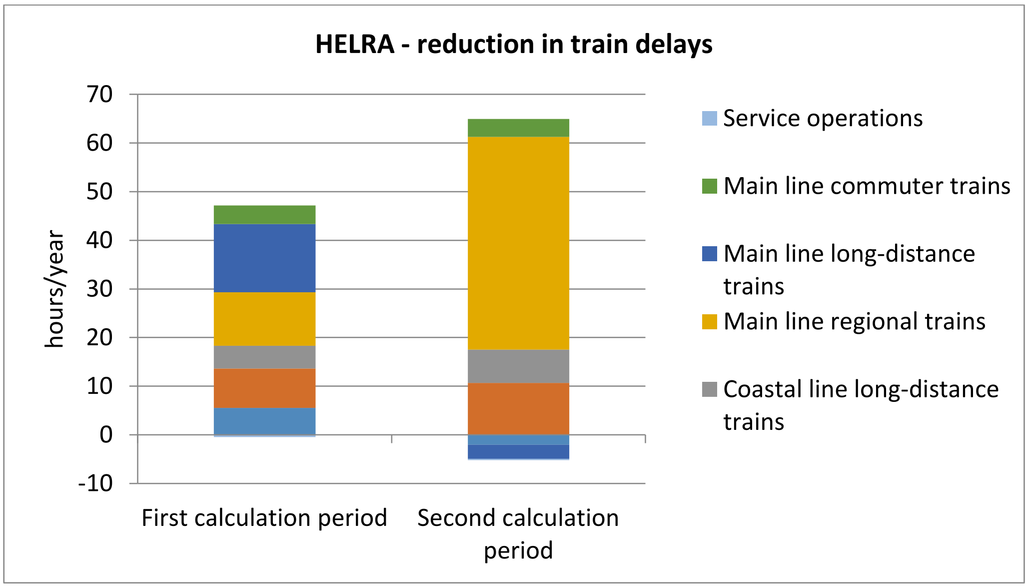

Image 3. Effect of the development of the Helsinki rail yard on reducing train delays at an annual level.

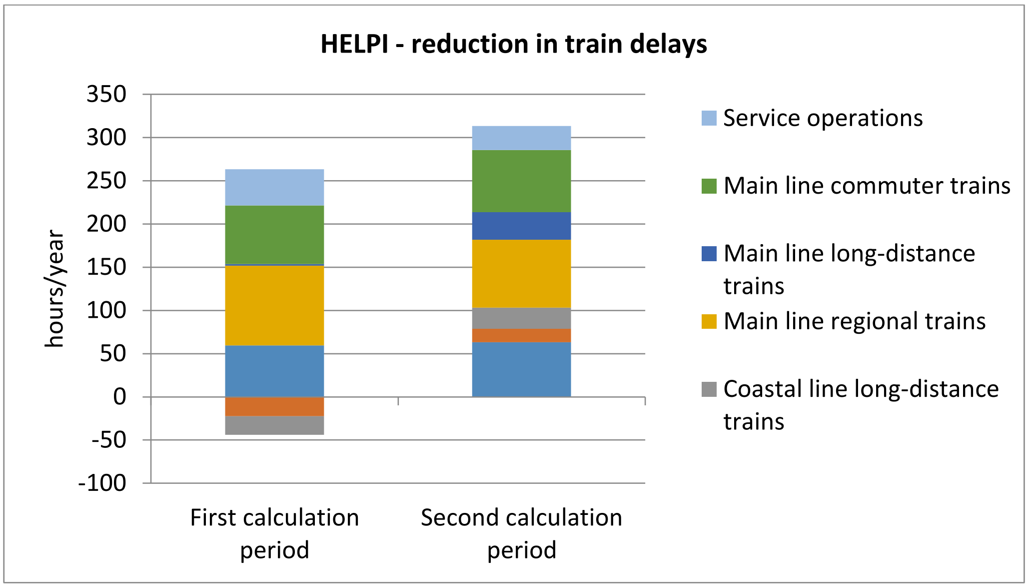

Image 4. Combined effect of the development of the Helsinki rail yard and the City Rail Loop on reducing delays at an annual level.

Passenger delays

The effect of reducing train delays on passengers' travel times was estimated based on the train delays presented earlier and estimated passenger volumes. Delays were targeted at passengers on the main line commuter and regional trains between Pasila and Oulunkylä and passengers on the coastal line commuter and regional trains between Pasila and Huopalahti. Delays on long-distance trains were targeted at passengers between Helsinki and Pasila according to operation direction. The passenger volume forecasts for the first calculation period that were used were based on current passenger volumes and an estimated increase in the number of travels (table 8). During the second calculation period, the passenger volumes were estimated to increase by 10% compared to the first period.

Table 8. Passenger volume forecasts used in the project appraisal during the first calculation period (the volumes were estimated to increase by 10% during the second calculation period).

Track section	Million passengers/year		
	Commuter and regional trains	Long-distance trains	Total
Coastal line, Pasila–Huopalahti	19.3	1.6	20.9
Main line, Pasila–Oulunkylä	20.3	7.3	27.6
Main line, Helsinki–Pasila	15.3	6.2	21.5

In the comparison alternative, passengers' time delays will be a total of 202,000 hours/year during the first calculation period and a total of 258,000 hours/year during the second calculation period. On average, passengers' delays will be reduced during the first calculation period by around 10,900 hours/year, that is around 5%. During the second calculation period (medium term), passengers' delays will be reduced by around 11,900 hours/year, that is around 4% (image 5).

If the City Rail Loop will also be constructed, passengers' delays will be reduced by 16,400 hours/year during the first calculation period and by 36,400 hours/year during the second calculation period (image 6).

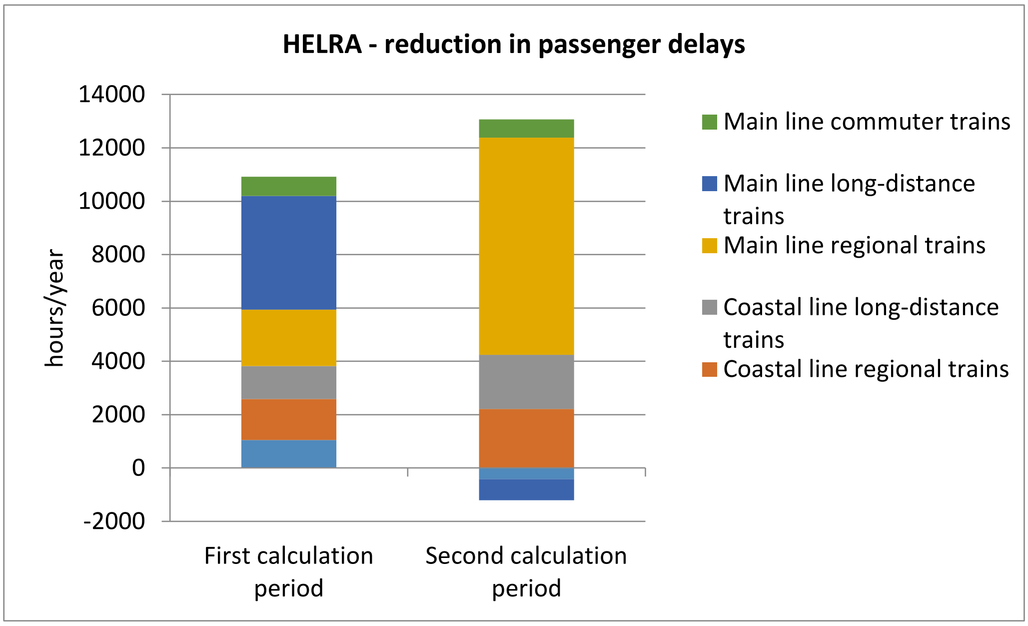

Image 5. Effects of the HELRA project on passengers' annual delays.

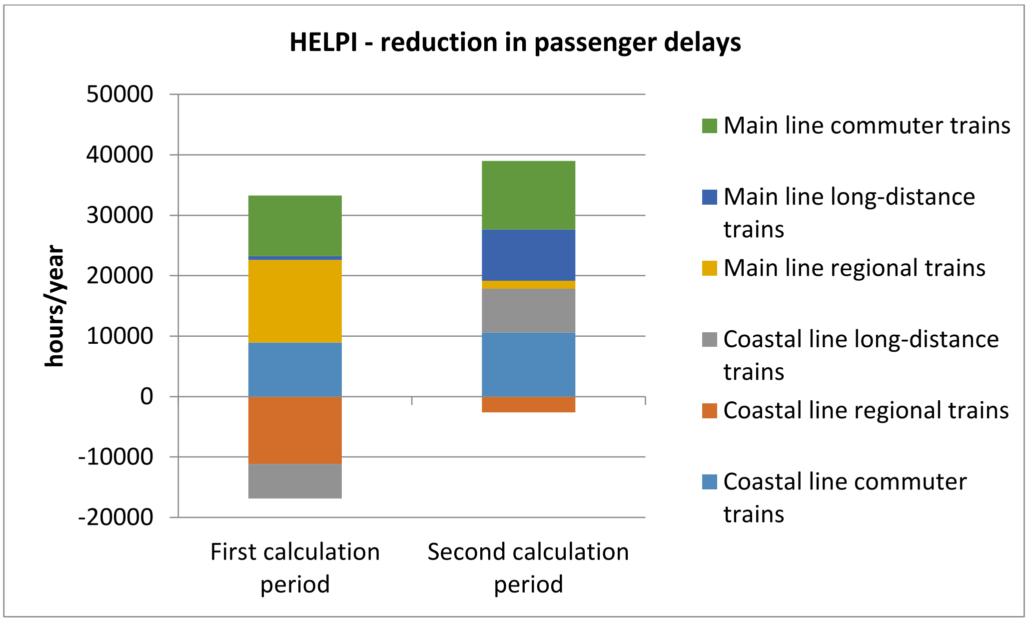

Image 6. Combined effects of the HELRA project and the City Rail Loop on passengers' annual delays.

3.3.3.3 Punctuality of trains

According to punctuality objectives of the Finnish Transport Agency and VR, the goal for long-distance passenger traffic is that at least 90% of trains would arrive at the destination five minutes late at most. In commuter traffic, the limit for a delay is three minutes, and the punctuality objective is 97.5%.

Simulations were used for specifying the percentages of trains that arrive late during the peak hours in the evenings in each kind of a disturbance. When the probabilities for disturbances presented earlier were taken into account, average shares of trains that arrive late could be determined in the comparison alternative and the project alternative, and in a situation in which the City Rail Loop will also be implemented. Based on the simulations, the project will clearly improve the punctuality of long-distance trains on the main line during the first calculation period. The project will not really have an effect on the punctuality of other trains. If the City Rail Loop will also be constructed (HELPI), especially the punctuality of regional trains on the main line will be improved compared to the comparison alternative, but on the other hand, the punctuality of regional and long-distance trains on the coastal line will be reduced (table 9).

During the second calculation period, the project will slightly improve the punctuality of regional trains on the main line, but on the other hand, it will slightly reduce the punctuality of long-distance trains on the main line. In a situation in which the City Rail Loop will also be implemented, the punctuality of all trains will be improved apart from long-distance trains on the main line whose punctuality will be reduced (table 10).

Table 9. Percentages (%) of trains arriving late during the first calculation period (2020–2029).

Train type	VE0+	Project	HELPI
Coastal line commuter trains	1.6	1.6	1.0
Coastal line regional trains	1.3	1.3	2.7
Coastal line long-distance trains	5.0	5.0	7.9
Main line commuter trains	2.0	1.9	1.1
Main line regional trains	5.3	5.5	1.0
Main line long-distance trains	14.8	10.6	12.8

Table 10. Percentages (%) of trains arriving late during the second calculation period (2030–).

Train type	VE0+	Project	HELPI
Coastal line commuter trains	1.7	1.7	1.0
Coastal line regional trains	2.1	2.1	1.7
Coastal line long-distance trains	8.7	8.7	4.6
Main line commuter trains	2.0	1.9	1.0
Main line regional trains	5.2	4.1	3.5
Main line long-distance trains	13.6	15.2	17.8

3.3.3.4 Functionality of the rail yard

All of the possible benefits of the project could not be demonstrated in simulations. Based on expert estimates, new junction lines that are included in the project create new, alternative train routes and enable new transport principles in case of disturbances. Significant benefits can be achieved with the help of junction lines, including the following:

- Junction line 228 enables a transport principle for commuter trains where every other arriving train can be directed to a backup route, if necessary. In that case, the delays of the first train will not reflect so strongly on the following train. The junction line can be used as an alternative route, but it cannot be used for the full benefit, as platform tracks cannot be accessed directly from track 221.

- Junction line V202–V215 enables a transport principle for long-distance trains where every other arriving train can be directed to a backup route, if necessary. By alternating the arrival tracks, the delays of the first train will not reflect so strongly on the following train. The new connection through track 225 is very useful, as it can be used for accessing all platform tracks that are currently used by long-distance traffic.

- Turnout connection V450–V451 will improve the current route between the coastal line's line traffic tracks and service tracks. However, during peak hours, using the connection is challenging due to the frequent operation interval on all tracks. Therefore, the new turnout connection would likely be used only for transferring equipment before and after peak hours.

- The planned new turnout connection V459, V460, V461, V462 & V463 will offer a solution to the need presented by interest groups to create a better connection from all main line tracks to service tracks and further to all platform tracks of the coastal line. However, during peak hours, using this connection is very challenging due to the frequent operation interval on all tracks. The new turnout connection could mainly be used for transferring equipment before and after peak hours. On the other hand, new connections that are planned north of Pasila will partly offer the same connections, and therefore, the benefit of the junction line will be minor. Maintenance will benefit from the switches in question thanks to larger working areas.

- With certain conditions, turnout connections V477 & V478, and V479 and V480 may improve the use of platform tracks 6 and 7 in Pasila and enable the use of the western maintenance track for traffic on the coastal line that departs from Helsinki. Efficient use of platform 6 by west-bound traffic requires changes to the interface and responsibility areas of remote control in Ilmala and the railway switchgear in Helsinki.

- Thanks to turnout connection V697–V699, service tracks can be used in a more flexible manner, which will ensure that the solution will benefit the whole planning area.

- Turnout connections V411, V414, V413 and V417, and V412 and V415 enable a new place for changing tracks in Pasila that will enable many new connections and more flexible traffic management. Commuter trains travelling north will benefit the most. The place for changing tracks in Pasila creates new useful connections and more dynamic use of platform tracks in Pasila. In addition, it will be possible to turn commuter trains in Pasila in the future.

3.3.3.5 *Rail capacity*

According to simulations, shorter signal intervals between Helsinki and Pasila will reduce the minimum train intervals on city tracks from a couple of seconds to 20-30 seconds depending on the equipment and route used. Also, track maintenance and track equipment will benefit from new switches and connections. Shorter signal intervals will clearly improve the capacity and disturbance-resistance of the rail yard.

In the comparison alternative, the limit for the disturbance-resistant capacity between Helsinki and Pasila is estimated at 82 trains/hour. The appraisal has taken into account necessary change operations that are estimated to amount to 10 operations/hour, and which are not included in the above-mentioned 82 trains. In the project alternative, the disturbance-resistant capacity is 90 trains/hour, that is 8 trains/hour greater, which is explained by the new guide steps for city traffic tracks that enable an additional capacity of around 2 trains/h per city track. In the HelPi alternative, the lighter traffic on platforms in Helsinki will enable an increase of four train operations compared to the project alternative.

3.4 Effective impact of the project

The effects that were examined in the impact assessment were selected based on the objectives that were set for the project. The effects to be achieved and their meters are the following:

Objective	Meter
Increased track capacity between Helsinki and Pasila	• maximum number of trains/hour
Reduction in passenger delays	• annual sum of delays caused by disturbances (probabilities for disturbances have been taken into account)
Rail traffic punctuality	• percentage of trains that arrive or depart late (probabilities for disturbances have been taken into account)

When the effective impact is analysed, the effects of the project alternatives are examined in relation to what could be achieved with the project. The effective impact is estimated in relation with the comparison alternative in the following situations:

a) Helsinki rail yard has been developed according to the project alternative
b) in addition to the project alternative, also the City Rail Loop has been implemented

For the impact assessment, an effect axis was specified for the above-mentioned effects. The axis presents planned values and the worst and best values in this project for the comparison alternative and the project alternative for the effect being examined. The difference between the worst and the best value forms the so-called impact potential.

Effective impact is specified for each effect and alternative as follows:

$$V_i(ve) = \frac{v_i(ve) - v_i(huonoin)}{v_i(paras) - v_i(huonoin)} \qquad (1)$$

where

$V_i(ve)$ is the effect's i effective impact for alternative ve

$v_i(ve)$ is the value of the effect i being inspected for alternative ve

$v_i(huonoin)$ is the effect's i worst value

$v_i(paras)$ is the effect's i best value .

When the value for effective impact is 0 %, it describes the worst situation in this project's plans or a situation that has been included in possible solutions, and similarly, when the value for effective impact is 100 %, it describes the best possible situation in this project. When the effective impact is specified in this way, it indicates how many per cent of the effect potential of the project have been used.

Effective impacts for each effect are presented for the comparison alternative and project alternatives in table 11. The effective impact of the alternatives is also described using the difference between the effective impacts of the project alternatives and the comparison alternative, which is specified as follows:

$VE_i(ve) = V_i(ve) - V_i(vrt)$

where

VE_i is the effect's i effective impact difference for alternative ve
$V_i(ve)$ is the effect's i effective impact for alternative ve
$V_i(vrt)$ is the effect's i effective impact in comparison alternative vrt.

The difference between effective impacts indicates the extent to which a possible effective impact potential will be achieved and whether the effect of the alternative complies with the objective or is opposed to it when compared with the comparison alternative.

Table 11. Project's effect axes and effective impacts.

Vaikuttavuuden mittari	Suunta	Vaikutusakseli					Vaikuttavuus		
		Huonoin	VE 0+	HELRA	HELPI	Paras	VE 0+	HELRA	HELPI
RATAKAPASITEETTI									
maksimijuna-määrä (junaa/raide/h)	MAX	82	82	90	94	100	0	44	67
HÄIRIÖIDEN AIHEUTTAMAT VIIVEET MATKUSTAJILLE									
1. laskentajakso (1000 h/vuosi)	MIN	202	202	191	186	186	0	67	100
2. laskentajakso (1000 h/vuosi)	MIN	258	258	246	221	221	0	33	100
JUNALIIKENTEEN TÄSMÄLLISYYS (1. laskentajakso)									
Rantaradan lähijunat	MAX	98,4	98,4	98,4	99,0	99,5	0	0	56
Rantaradan taajamajunat	MAX	97,3	98,7	98,7	97,3	99,5	64	65	0
Rantaradan kaukojunat	MAX	92,1	95,0	95,0	92,1	99,5	39	39	0
Pääradan lähijunat	MAX	98,0	98,0	98,1	98,9	99,5	0	4	62
Pääradan taajamajunat	MAX	94,5	94,7	94,5	99,0	99,5	3	1	89
Pääradan kaukojunat	MAX	85,2	85,2	89,4	87,2	99,5	0	29	14
JUNALIIKENTEEN TÄSMÄLLISYYS (2. laskentajakso)									
Rantaradan lähijunat	MAX	98,3	98,3	98,3	99,0	99,5	5	0	62
Rantaradan taajamajunat	MAX	97,9	97,9	97,9	98,3	99,5	0	2	27
Rantaradan kaukojunat	MAX	91,3	91,3	91,3	95,4	99,5	0	0	50
Pääradan lähijunat	MAX	98,0	98,0	98,1	99,0	99,5	0	6	70
Pääradan taajamajunat	MAX	94,8	94,8	95,9	96,5	99,5	0	24	37
Pääradan kaukojunat	MAX	82,2	86,4	84,8	82,2	99,5	24	15	0

When the effective impact of the HELRA project and the HELPI alternative is compared to the comparison alternative (VE0+), it is estimated that the project objectives will be achieved as follows:

- The objective for track capacity will be achieved. Additional traffic that results from planned investment projects is able to operate at the Helsinki rail yard (six more trains after phases 1 and 2 between Pasila and Riihimäki have been completed). The construction of the City Rail Loop would further increase the capacity.

- According to set objectives, the project will reduce passenger delays. The construction of the City Rail Loop would not be of additional benefit before the second calculation period.

- During the first calculation period, the project will significantly improve the punctuality of train traffic only for long-distance trains on the main line. The effects of the project on other trains are minor. The construction of the City Rail Loop would improve the punctuality of all trains on the main line but it would reduce the punctuality of long-distance and regional trains on the coastal line.

- Also, during the second calculation period, the effects of the HELRA project on rail traffic punctuality would be quite minimal. The construction of the City Rail Loop would improve the punctuality of all trains apart from long-distance trains on the main line (image 7).

	0+	100 % 50 % 0 % 50 % 100 %	Change
Rail capacity			
Maximum number of trains (trains per hour)	84		+8 +12
Decrease in delays causing inconvenience to passengers			
1st calculation period (1,000h per annum)	202		+10.9 +16.4
2nd calculation period (1,000h per annum)	258		+11.9 +36.4
Punctuality of train services, 1st calculation period			
Coastal Line commuter trains (%)	98.4		0.00 +0.60
Coastal Line metropolitan trains (%)	98.7		+0.03 -1.42
Coastal Line long-distance trains (% points)	95.0		0.0 -2.89
Main Line commuter trains (% points)	98.0		+0.06 +0.91
Main Line metropolitan trains (% points)	94.7		-0.11 +4.29
Main Line long-distance trains (% points)	85.2		+4.17 +2.01
Punctuality of train services, 2nd calculation period			
Coastal Line commuter trains (%)	98.3		-0.06 +0.70
Coastal Line metropolitan trains (%)	97.9		+0.03 +0.44
Coastal Line long-distance trains (% points)	91.3		0.00 +4.06
Main Line commuter trains (% points)	98.0		+0.10 +1.08
Main Line metropolitan trains (% points)	94.8		+1.13 +1.74
Main Line long-distance trains (% points)	86.4		-1.61 -4.23

HELRA HELPI

Image 7. Differences between the effective impacts of the project alternatives and the comparison alternatives.

3.5 Benefit-cost analysis

3.5.1 Method

The benefit-cost analysis examines the following costs and benefits of the project to the extent that has been possible to include in the analysis:

- investment costs including planning costs and interest during the construction period
- residual value of investment
- maintenance costs of the rail yard
- change in producer surplus
- change in consumer surplus
- changes in external operation costs
- changes in public sector's taxes and payment income (including infrastructure charges and value added taxes).

All monetary effects are estimated for the inspection period, which covers the construction period and 30 years after the project has been completed. All costs and benefits are discounted at 4 per cent discount rate until the expected opening year, which is 2020. Monetary effects for 2020–2029 will be estimated based on the effects during the first calculation period, and the effects for 2030–2049 will be based on the effects during the second calculation period. Construction costs are based on the price level of 2014. Values used in the impact assessment are based on the values of appraisal guidelines for rail projects. The unit values of travel time and external operation costs are increased annually by 1.5% according to the instructions.

The profitability of the project is measured using the benefit-cost ratio, which is calculated using a net principle on the basis of the project's benefits, detriments, and planning and investment costs. The benefit-cost ratio indicates the ratio of the current net sum value of benefits and detriments and the current value of the investment.

3.5.2 Investment costs

The cost estimate of the rail yard development is MEUR 60. Costs result from procedures presented in table 7. The construction is designed to be implemented in four stages, and the cost estimate for each stage is as follows:

- Phase 1: MEUR 15
- Phase 2: MEUR 20
- Phase 3: MEUR 20
- Phase 4: MEUR 5.

The construction is estimated to be completed in four years, and the interest payments accrued during the construction period are MEUR 6.8. Thus, investment costs that are included in the benefit-cost analysis are MEUR 66.8.

The residual value of the project at the end of the appraisal period is MEUR 1.6, and it is based on the lifetime of the procedures included in the project. The procedures have residual value only when the lifetime is 30 years (table 12). The residual value is discounted in the benefit-cost analysis until the opening year.

Table 12. Procedures included in the pr

oject and their residual values.

Procedure	Cost (MEUR)	Lifetime (years)	Residual value (MEUR)
ground and foundation structures	4.0	50	1.6
track support	3.1	30	0
surface structure and track changes	3.4	30	0
switches	6.3	30	0
safety equipment	13.7	30	0
electrified track	6.6	30	0
power current	1.2	30	0
platform changes	0.2	30	0
temporary level crossings	0.4	-	-
site works	5.9	-	-
purchaser tasks	5.7	-	-
Research and risk provisions	9.5	-	-
Total	**60.0**		**1.6**

3.5.3 Maintenance costs of the rail yard

The project will increase the number of switches and tracks that need to be maintained. This will increase the need for maintenance at the rail yard. On the other hand, based on expert estimates, new turnout connections enable longer maintenance intervals and more efficient maintenance procedures while taking the traffic requirements into consideration better than before. Therefore, the project may even affect the maintenance costs in a positive way.

3.5.4 Change in producer surplus

Change in producer refers to the effects of the project on the difference between the operator's income (fare revenues) and expenditure (transport operating costs). The effects are partly dependent on the possible effects of the project on the supply and demand of trains and partly on the effects of the project on the functionality of the rail yard and train delays.

Improving the functionality of the rail yard and reducing delays affect the operation costs, for example, through changes to the need of backup equipment. However, it is very difficult to estimate the effect on savings that will be achieved. Instead, the increase of 30 seconds in scheduled travel time due to the project will not slow down the rotation of equipment. When speed is reduced, it will also marginally reduce the energy consumption of trains and its costs.

3.5.5 Change in consumer surplus

Changes in passengers' consumer surplus are made up of time costs and service level benefits. On the other hand, the project is not estimated to have an effect on ticket prices.

Travel time costs

The project will increase the time costs of everyone travelling between Helsinki and Pasila as the travel time will increase by around 20 seconds on average during undisturbed operation. This means that travel time will increase by about 0.14 million hours in 2025. When the average value of time for passengers is about EUR 10/hour, this means an additional cost of MEUR 1.4 for passengers. In the long-term, the detriment will increase a little.

On the other hand, the project will reduce the time costs of passengers as delays caused by operation disturbances will be reduced. The reduction of passenger delays that has been proven with the help of simulations will be 10,900–11,900 hours/year depending on the calculation period. Thus, passengers' travel time costs will be reduced by MEUR 0.11–0.13/year (image 8). The effect of the above-mentioned changes in time costs on the consumer surplus that can be measured is around MEUR 1.3/year negative. However, the improved functionality of the rail yard also affects the passengers' time costs although the effects on train delays could not be demonstrated in simulations.

Service level benefits

The project's impact on improving travel time punctuality is also a service level benefit that has not been taken into account in the average value of time presented earlier. According to studies carried out abroad, consumers experience the value of travel time caused by a delay clearly greater than the value of regular travel time. For example, in Sweden, it is estimated that the value of time during a delay is about 3.5 times the value of regular travel time. If this is taken into consideration, the benefits of delays alone that can be measured increase by almost MEUR 0.5 a year.

The project's possible service level benefits also include the effect that shortens waiting times and reduces the need to change the means of transport. If train connections will be increased, it can be assumed according to the project appraisal instructions that the waiting time will be shortened by 30% in urban traffic following the change in departure intervals. In long-distance traffic, the recommended length for waiting time is 16% of the scheduled interval.

It is estimated that the change in consumer surplus will be positive as a whole in the long run, when the need to increase train departures will be necessary.

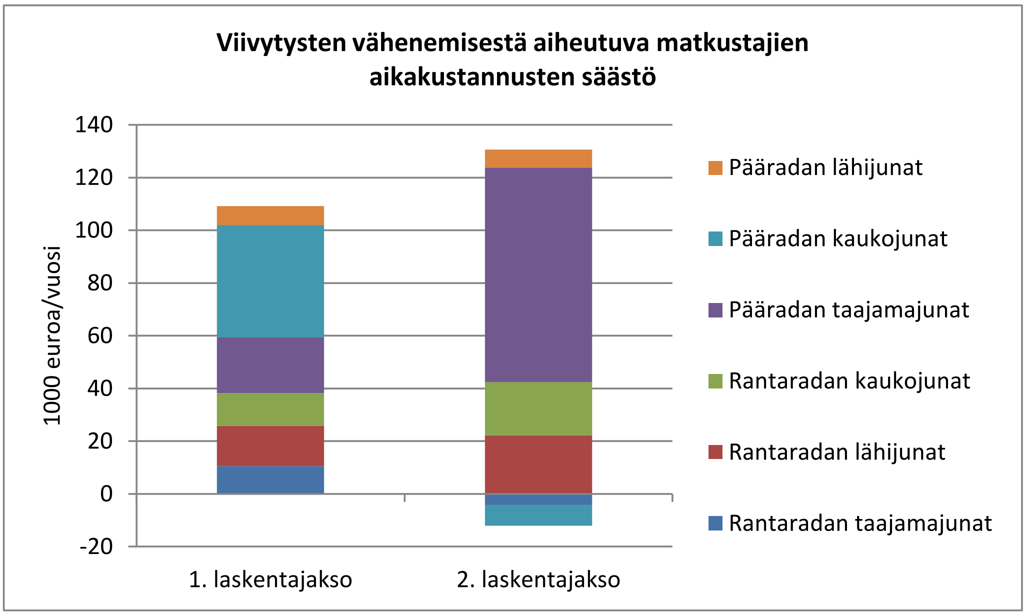

Image 7. *Passengers' time cost savings due to reduced train delays that could be measured (excluding the benefits from improving the functionality of the rail yard).*

3.5.6 External costs of operation

Emission costs of operation

The project will affect the transport emissions due to changes in energy consumption and journeys that will transfer from road traffic to trains.

The energy consumption of trains will be reduced when the average speed of trains will be reduced between Helsinki and Pasila from around 45–56 km/h to around 40–41 km/h; in other words, the reduction is around 5 km/h. According to the energy consumption models of trains prepared by the Finnish Transport Agency, the effect on all trains is an average of around 0.1 kWh/train km. Thus, energy consumption of trains will reduce by around 40 MWh/year. This means that carbon dioxide emissions due to electricity production will reduce by 9 tonnes/year (cost effect 350 euros/year). For other types of emissions, the reduction is 0.00–0.02 tonnes/year. The cost effect of this is minimal.

Possible transport system level benefits

The most significant effect on external transport costs may occur when road traffic journeys change into train journeys as a result of the increase in rail transport supply enabled by the project. The effects may be visible as reduced noise and emissions of road traffic, and fewer accidents.

3.5.7 Special taxes and payments on transport collected by the public sector

The project will not immediately affect the amount of special taxes and payments on transport collected by the public sector. However, there may be changes in the amounts of taxes and payments through the following indirect effects:

- the project will increase the supply of rail traffic in which case infrastructure charges will increase
- the project will increase the demand for rail traffic in which case the amount of value added tax included in ticket prices will increase
- energy taxes on road traffic (excise duty on liquid fuel and value added tax) will be reduced when passenger car journeys will transfer to trains.

3.5.8 Effects during the construction period

The project will be implemented in five years. It is clear that in the long run, the construction will cause detriment to traffic, which will be visible as longer train delays, for example. On the other hand, by lengthening the construction period, the construction can be implemented at phases and work can mainly be performed at night time and on weekends, which further reduces the detriments. However, it is very difficult to estimate the extent of the effects.

3.5.9 Benefit-cost analysis

Improving the Helsinki rail yard is part of a totality of developing rail traffic in the Helsinki region, which will improve the capacity and disturbance-tolerance of rail traffic in the Helsinki region. The development of rail traffic is enabled together with the additional track in Pasila and the Pasila–Riihimäki project.

It is not possible to calculate a benefit-cost ratio for the improvement of the Helsinki rail yard using the methodology for benefit-cost analysis for rail projects that is currently used as the project is a precondition for developing the rest of the rail traffic in the Helsinki region. The analysis does not include the benefits presented earlier that will be enabled by the project as a result of the improved functionality of the rail yard nor the benefits on the transport system level that result from the increase in rail transport supply. The project is especially closely connected to the Pasila–Riihimäki project of which the benefits (MEUR 203 during the calculation period of 30 years) cannot be achieved to full extent without improving the Helsinki rail yard. The common profitability of the projects is clearly visible by the fact that by adding the construction costs of the additional track in Pasila and the Helsinki rail yard and the interest payments for the construction period to the corresponding costs of the Pasila–Riihimäki project (a total of MEUR 200), the common benefit-cost ratio of the projects would still be 1.0.

3.6 Conclusions

The goal of the project is to increase the rail capacity between Helsinki and Pasila, reduce the harm and inconvenience due to traffic incidents by speeding up the recovery of train traffic from incidents, for example, and improve punctuality in train traffic. Based on the estimates prepared, the effects of the project are in line with the goals set.

The new turnout connections included in the project open new and improved modes of operation by creating new, alternative train routes and flexible transport principles that can be used in managing incidents. It was not possible to measure such benefits through simulations, and therefore they had to be left out of the benefit-cost analysis (CBA).

Implementing the project creates more rail capacity for future needs. Based on expert estimates, the current train services during peak hours (74 trains/h) will increase to approximately 80 trains after the Helsinki-Riihimäki renovation project is completed. In the long term, it is considered likely that the number of trains on the metropolitan tracks will increase so that the 5-minute intervals will change into 4-minute intervals during peak hours. This means that the number of trains will increase to approximately 92 trains per hour. This is possible, provided that the Helsinki rail yard is developed according to the plan that has been drawn up.

If the need for additional capacity is realised, the project will bring about many benefits at the transport system level, such as service level benefits for new and current train passengers, decreases in road traffic accidents and emissions, as well as a more compact community structure in the areas along the railway.

Only a concise selection of the most important effects of the project could be included in the project CBA; they include the journey time cost changes due to reduced speed in the rail yard and the reduced delays for passengers demonstrated by simulations. The CBA does not include the above-mentioned benefits from the rail yard functionality enabled by the project or the transport system level benefits enabled by the additional train services. For this reason, it was not possible to draw up a reliable estimate on the socio-economic profitability of the project However, implementing the project is justified, because it increases the flexibility of the rail yard traffic and transport arrangements significantly, improves the punctuality of rail transport, and enables the development of train traffic in the long term in both the commuter and the long-distance traffic of Helsinki.

Improving the Helsinki rail yard is part of a totality of developing rail traffic in the Helsinki region, which will improve the capacity and disturbance-tolerance of rail traffic in the Helsinki region. The development of rail traffic is enabled together with the additional track in Pasila and the Pasila–Riihimäki project. It is not possible to calculate a benefit-cost ratio for the improvement of the Helsinki rail yard using the methodology for benefit-cost analysis for rail projects that is currently used as the project is a precondition for developing the rest of the rail traffic in the Helsinki region. The analysis does not include the benefits presented earlier that will be enabled by the project as a result of the improved functionality of the rail yard nor the benefits on the transport system level that result from the increase in rail transport supply. The project is especially closely connected to the Pasila–Riihimäki project of which the benefits (MEUR 203 during the calculation period of 30 years) cannot be achieved to full extent without improving the Helsinki rail yard.

The common profitability of the projects is clearly visible by the fact that by adding the construction costs of the additional track in Pasila and the Helsinki rail yard and the interest payments for the construction period to the corresponding costs of the Pasila–Riihimäki project (a total of MEUR 200), the common benefit-cost ratio of the projects would still be 1.0.