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# Äänekoski bioproduct mill's transport links - Railway project

## Value-for-money report – Implementation stage

Rami Tuokko, Jani Saarinen, Antti Piirainen

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*Cover photo: Finnish Transport Agency's photo archive*

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# Abstract

*The decision to implement the Äänekoski railway project was made in the spring of 2016. The Finnish Transport Agency made a decision to launch the implementation stage of the project on 26 April 2016. The decision was based on a financial grant of EUR 80 million and a target cost of EUR 63.63 million confirmed by the alliance at the development stage. The target cost included the alliance's risks and opportunities as well as the client's purchases, but the scope of the project differed to a degree from the original. Although the scope of the project was mostly based on the original project concept, some works were left out due to the limited budget, in addition to which new critical works (such as EUR 2 million for a bridge in Vihtiälä) were identified during the development stage which it made sense to carry out in connection with the project. The Finnish Transport Agency consequently applied for EUR 10 million more funding at the end of the development stage, which was granted towards the end of 2016. Thanks to the additional funding, the project budget increased to EUR 90 million, and the target cost was raised correspondingly to EUR 72.41 million. Most of the works in lot 1, which had been left out of the plans during the development stage, could therefore be re-included in the project. The project's final target cost stood at EUR 74.56 million at the end of the construction stage, which was approximately EUR 2.15 million above the target. The final budget forecast was EUR 91.5 million at the end of the construction stage.*

The target cost was established on the basis of the works specified by the client during the development stage as well as the project's goals and requirements. The project's goals and planning during the development stage as well as the project plan were used to steer purchases, planning, the choice of implementation solutions and the practical aspects of the alliance contract during the implementation stage, subject to the limits set by the project budget. The scope of the alliance contract was established successfully, and the correct works were included. However, the final decision on the scope of the project was taken too late, and planning and cost analyses could not be carried out to the desired extent. No notable omissions or need for sudden changes were identified in the contents of the project plan. However, it became evident even before the end of the procurement stage that the budget would not be sufficient for implementing the project to its most economically advantageous extent and that considerable prioritisation would be needed. The alliance revised its plans during the implementation stage on the basis of the higher-than-expected grouting needs in the Kangasvuori tunnel, for example. Some further optimisation took place during the implementation stage on the basis of the client's objectives, life-cycle costs and the budget, but the tight schedule limited possibilities for more extensive impact assessments, and the focus was on implementing the project plan devised at the development stage on schedule. The alliance tried to also base the implementation stage on a planning process steered by the client's objectives, taking into account changes in scope and standards and comparing alternative planning and implementation solutions against the budget, but these efforts were not particularly

systematic and often relied solely on the competence of the project's key personnel. The solutions implemented by the alliance were largely consistent with the objectives set at the end of the development stage.

The alliance had a cost-effectiveness assessment group, which was tasked with assessing the feasibility of the target cost. The group also included impartial third parties to ensure transparency. The report of the cost-effectiveness assessment group states that the project's target cost was at the right level. Some of the synergies and benefits forecast at the development stage did not materialise, which was part of the reason why the budget was exceeded by EUR 2.15 million. Exceeding the budget can be deemed to constitute a failure to meet an objective.

The alliance completed the works included in the implementation stage and commissioned the track without a day to spare. The alliance only took approximately 16.5 months to complete the works included in the construction stage, which can be deemed an exceptionally good performance considering the scale of the project. Delaying the commissioning of the track from what had been scheduled would have resulted in huge costs for the new Äänekoski bioproduct mill and its stakeholders in particular. By meeting the commissioning deadline, the project can be deemed to have generated considerable value far beyond the parties involved in the alliance. Managing the commissioning of the track and the opening of the new bioproduct mill according to exactly the same schedule was a remarkable success.

With the exception of safety-related targets, the project met all of its key performance targets exceedingly well. The key performance indicators can be deemed to have been sufficiently challenging, although some of the key performance targets (downtime) could have been even more ambitious. The indicators nevertheless steered the works well and in the right direction.

The alliance's focus during the implementation stage was on cooperation, and the principles of the alliance approach were evident at least in the activities of the project team. Extending the alliance approach to subcontractors, on the other hand, was not completely successful. The alliance was able to identify operating models that need further development and also managed some improvements in its procedures during the implementation stage. The alliance made use of modern technology, processes and teamwork models, such as the Big Room concept, phase scheduling and the takt time ideology.

# Foreword

The planning and construction works involved in the Äänekoski bioproduct mill's transport links project were based on the alliance contracting model. The alliance consisted of the Finnish Transport Agency as the client and VR Track Oy as the service provider.

This report describes the Äänekoski bioproduct mill's transport links project and the implementation stage of the alliance contract from the perspective of value for money. The report describes the most important processes, solutions and decisions from the perspective of executing the contract and analyses how well the goals set for the alliance contract were met.

The objective of the report is to demonstrate the value of the project for the sponsors and the most important stakeholders. The report also acts as a management tool. The management group, which was the alliance's highest decision-making body, and the project team, which was responsible for the operative management of the alliance, regularly reviewed the value-for-money aspect of the project as well as progress.

The report was written and compiled by an impartial alliance expert Rami Tuokko from Vison Oy in cooperation with the parties involved in the alliance, i.e. the Finnish Transport Agency and VR Track Oy, as well as other interested parties. Several members of the alliance contributed information to the report.

The report is based on the alliance formation and development stage reports, which have been published on the Finnish Transport Agency's website.

Helsinki, January 2018

Finnish Transport Agency

# Contents

# 1 Value-for-money concept and reporting

The value-for-money concept and reporting allow alliances to demonstrate to decision-makers and clients how well the goals set for a project have been met in an open and transparent manner. The value-for-money concept gives decision-makers and clients a logical model for evaluating progress from project planning and identifying the required works to project completion and commissioning. The value-for-money ideology gives attention not only to low costs and fast turnaround times but also to other factors that generate value for clients and users. These include, among others, taking clients' and users' objectives, social and environmental requirements and stakeholders' views into consideration and aiming for high standards and promoting innovation. Value-for-money reporting also promotes continuous development and helps to identify both successes and areas in need of improvement.

The following is one way in which the value-for-money concept has been defined

> *"Value for money is the relationship between benefits (quality, end product requirements, social and environmental requirements) and the cost and risks required for achieving the benefits."*
> Department of Treasury and Finance, Australia

The value-for-money report for the Äänekoski railway project is based on fi e components: (Figure 1)

1. The client identified the equired works and set a framework for costs
2. The client set targets, i.e. value-for-money criteria, for the project and the alliance contract
3. The client formed the alliance on the basis of the client's objectives
4. The alliance worked towards meeting the client's value-for-money criteria during the development stage
5. The alliance worked towards meeting the client's value-for-money criteria during the implementation stage
6. The client / third-party evaluator reported how successfully the alliance had met the objectives set for the project and the alliance contract

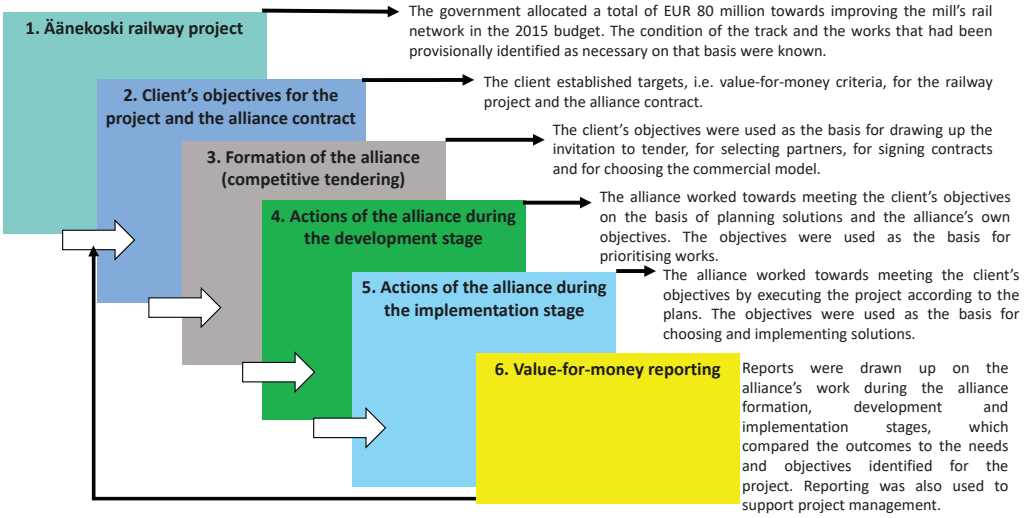



*Figure 1. Value-for-money concept in the context of the Äänekoski railway project.*

Efforts were made to promote value-for-money management in the Äänekoski railway project by means of reporting during the alliance formation, development and implementation stages, for example, and by reviewing reports in the management group's meetings.

This report is part of the Finnish Transport Agency's communications and reporting on the Äänekoski transport links project. Reporting is a way to document the outcomes of projects and to record the Finnish Transport Agency's and its partners' experiences of project implementation. Reporting supports project management and promotes the openness and transparency of alliance activities, which is especially important in the case of projects that are financed by government funds. This report is also hoped to benefit other clients and service providers in the transport sector as well as anyone interested in integrated contracting models.

It is important to measure how effectively alliances are able to meet the objectives and criteria set from the perspective of value for money. Value-for-money reporting gives alliances an opportunity to demonstrate

- How successfully the client's objectives were met
- How well the alliance's competence matched the project's requirements
- Where the alliance succeeded and where it failed
- What the alliance learned from the project

Success in choosing the implementation model and partners for a project as well as planning and implementing a project generates value for clients and contractors alike. From the perspective of the value-for-money ideology, clients should not strive exclusively for the lowest price but value for money and the best possible outcome considering the outlay. Value for money is generated, among other things, by the ability to stick to budgets and deadlines, putting the client's or users' needs first, quality, safety, good public relations and taking social and environmental requirements into account. The most value for money is born when the decisions made and the results achieved exceed the client's targets and generate added value for all parties involved in a project.

Projects and their objectives are public information, which is why alliances need to report on their success in meeting objectives transparently. Value-for-money reporting is all the more important in the case of projects where the service provider has, instead of giving a fixed price, quoted a fee on the basis of open books. Value-for-money reporting is used to demonstrate whether the target cost set at the end of the development stage was sufficiently ambitious and therefore in line with the value-for-money ideology. The final costs of a project need to be compared against a correctly chosen target cost. Projects based on the alliance contracting model are always aimed at providing value for money. Success in this is measured by means of value-for-money reporting.

# 2 Äänekoski railway project

## 2.1 Starting point for he project

The opening of Metsä Fibre's new bioproduct mill in Äänekoski in the autumn of 2017 created a situation where substantial repairs had to be carried out on a badly deteriorated track with insufficien  capacity to deal with the increasing demand on an unusually tight schedule. The government allocated EUR 80 million for improving the track in the 2015 budget. The Finnish Transport Agency stipulated that the improved rail link had to be commissioned on 15 August 2017 at the latest. The deadline was based on the scheduled commissioning of the mill and there was no leeway. The warranty period for the alliance contract was fi e years.

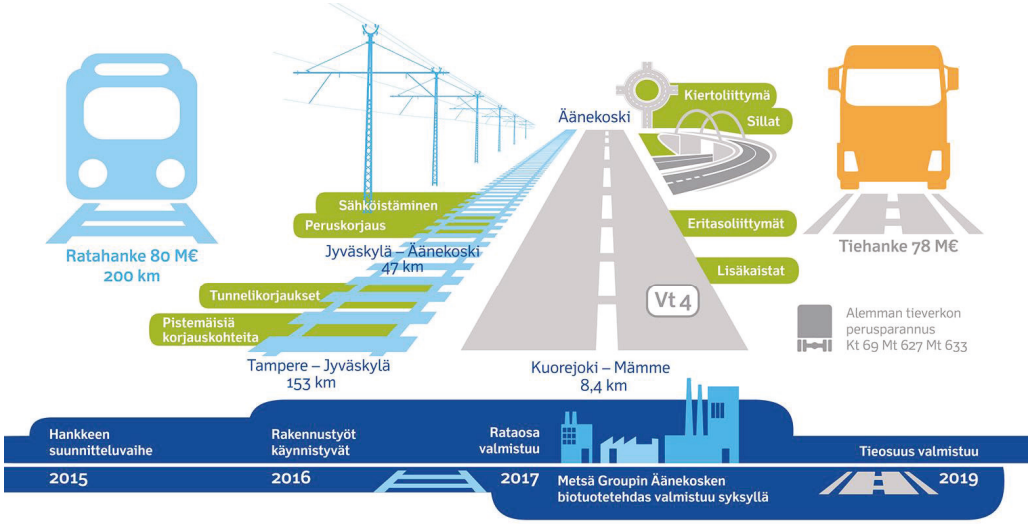



*Figure 2. Progress of the Äänekoski transport links project.*

The Äänekoski railway project was launched as soon as a decision was made to open the bioproduct mill. Successful implementation of the railway project would improve the operating conditions of the mill and increase the vitality of the entire region of Central Finland.

## 2.2 Objectives of the project

Ensuring the reliable operation and efficienc  of the rail network, cutting maintenance costs, increasing cost-effectiveness, environmental friendliness and improving safety as traffi  volumes increased were important starting points for the project. The Äänekoski bioproduct mill needed reliable rail transport links and sufficien  capacity to operate. The most important objective in terms of the project schedule was not delaying the commissioning of the bioproduct mill due to incomplete works on the track.

The client set goals for the project in connection with deciding on the method of implementation. The objectives were cost-effectiveness, i.e.not exceeding the project budget, environmental friendliness, reliability and sufficient rail transport capacity for the mill, sticking to the schedule, i.e. commissioning the track on 15 August 2017 at the latest, safety of train and other traffic, i.e. zero accidents during the works, construction safety, i.e. no work-related accidents or injuries, minimisation of disruptions to train transport, i.e. zero downtown resulting from the works and maximising the scale and life-cycle sustainability of the improvement works, efficient interaction between the project partners and stakeholders as well as a positive public image for the rail link and the project.

The client's objectives were used as the basis for formulating key performance targets and indicators during the procurement stage, which were largely the same as the targets and indicators that had proved effective in the Lielahti–Kokemäki project. The chosen targets and indicators also worked well in the Äänekoski project. The key performance targets were a good match for the client's objectives despite the fact that there were no specific incentives for optimising maintenance and life-cycle costs and public relations, for example. The indicators were revised during the development stage, but not enough time was given to examining and simulating them due to the tight schedule in particular. The requirements set for key performance areas in alliance projects must be ambitious and challenge the alliance to achieve exceptional performance. The key performance targets in the Äänekoski project were not notably higher than in the Lielahti–Kokemäki project. The key performance indicators were readjusted when changes were made to the contract. The Indicators were revised on the basis of the changes in the nature of the project. More weight was given to passenger transport, as more works on the section of the track used for passenger transport were added. The schedule indicator was revised to better suit the project, and the different sections of the track were separated more definitively.

## 2.3 Scope of the project

**Works involved in the railway project and lot-based approach**

The works had already been divided into lots 1–3 on the basis of priority in the needs assessments produced by the client during the procurement stage, and this approach was used as the basis for choosing which works to include in the project. Lot 1 consisted of critical works and lots 2–3 included complementary works that would be carried out if there was room in the budget. Works were prioritised on the basis of the increase in direct and indirect costs resulting from growing train traffic. The division was relatively rough, and individual sub-projects in lot 1 could consist of works of very different priorities. The priorities established by the client during the procurement stage were used as the basis for planning during the development stage. The alliance applied the lot-based approach and formulated a project package and target cost that best met the client's objectives. Prioritisation involved examining which works would be the most difficult and considerably more costly to implement at a later date after the increase in train traffic volumes. It would have made sense to carry out considerably more extensive works than what were included in the project, as the total cost of all the necessary works was approximately EUR 188 million, but the budget and the additional funding limited the scope of the project.

The works that were given the highest priority included geotechnical repairs, drainage works and basic superstructure improvements in the rail yards and tunnels in particular, while it was decided that basic improvements on the open-air sections of the track and safety measures in the tunnels, for example, could be implemented later, if necessary, during shorter gaps in traffic. The description of lot 1 given during the procurement stage was extremely rough, and efforts were made to add as much detail as possible during the development stage. However, several works received too little attention or were not identified at all due to the short time available for the development stage. The most challenging sub-project involved the Kangasvuori tunnel, on which not enough background information could be obtained due to the tight schedule, as a result of which there was little comparing of different alternatives. This created challenges in terms of the schedule, for example, later on during the implementation stage, as plans had to be revised. Works during the implementation stage were carried out in accordance with a project plan and a revised project description based on the lots redefined during the development stage and the chosen priorities with relatively small changes to the scope and contents of the project apart from the additional funding. Several new small-scale works and interfaces that had not been identified in connection with determining the target cost during the development stage were nevertheless added during the implementation stage, and these contributed to the increase in costs during the implementation stage.

Moreover, the project plan described the works and the required standards based on a life-cycle warranty according to which the operability of the entire system would be guaranteed for a period of at least 10 years, excluding any works that were not included in the railway project. Due to the life-cycle warranty, the project's work specifications and design principles as well as planning coordination and structural engineering had to ensure that no structural repairs would need to be carried out for a period of 10 years after commissioning the track. The materials were not chosen on the basis of the cheapest price, and instead the alliance tried to find options that would last for at least 10 years. More attention than usual was also given to the smooth flow of traffic, for example, by studying track capacity by means of simulation, which revealed a need for more safety devices. The project scope was further revised by integrating the safety devices along the track serving Äänekoski's new bioproduct mill with Äänekoski station's systems.

The scope of the project required very little work during the implementation stage, as approximately 80% of the construction plans were ready for implementation after the development stage. Works that had been identified as important, such as the Vihtiälä bridge, had been added to the project during the development stage. The contents of the project were discussed in more detail especially before moving from the development stage to the implementation stage and when the availability of additional funding was confirmed. Works were prioritised on the basis of factors such as quality, the elimination of speed limits and life-cycle impacts, subject to the limits set by the schedule and the budget. Adequate comparisons between alternatives were not always carried out. Due to the limited budget and the tight schedule, the life-cycle perspective was not always taken into account, but several solutions and material choices that were in line with the life-cycle ideology and that factored in future needs nevertheless came about. Comparisons were carried out in the case of complex systems, and the quality requirements for macadam, for example, were studied with care.

A more detailed plan for deciding on changes to the scope of the project during the implementation stage and analysing their impacts (e.g. on the schedule and the key performance targets) would have been useful from the perspective of managing the scope of the project. Clearer principles should have been agreed beforehand for drawing the line between internal revisions to the target cost and scope revisions that caused changes in the target cost. The changes introduced to the scope of the project as a result of the additional funding made the already-tight schedule considerably more challenging. The change also affected the key performance targets, although they were only laid down when the change to the scope of the project was approved.

**Jyväskylä–Äänekoski line**

All the works that required longer interruptions in train traffic were carried out as planned on the relatively well-functioning Jyväskylä–Äänekoski line. The biggest investment involved replacing the superstructure along the entire 47 kilometres of track. The track's foundations and substructures were also repaired, drainage was improved, superstructures at stations were renovated, points were replaced and Vihtavuori station was reopened. Safety and capacity along the line were also improved by means of modifications to safety devices and new intermediate block stations. Level crossings were eliminated and improved to meet the Finnish Transport Safety Agency's regulations and the Finnish Transport Agency's guidelines. The badly deteriorated 2.7-kilometre Kangasvuori tunnel was renovated by grouting and shotcreting the stone surfaces of the vault and the entrances to the tunnel, by building safety structures at both entrances and by redirecting drainage. No other similar railway tunnel repairs have been carried out previously in Finland without closing the track to traffic. The works required developing a range of new methods, and tunnel construction experts were also consulted.

The alliance commissioned Ratatek Oy to design and carry out the electrification of the 47-kilometre line, including any sidings at stations, and to perform a wide array of critical works relating to electrification.

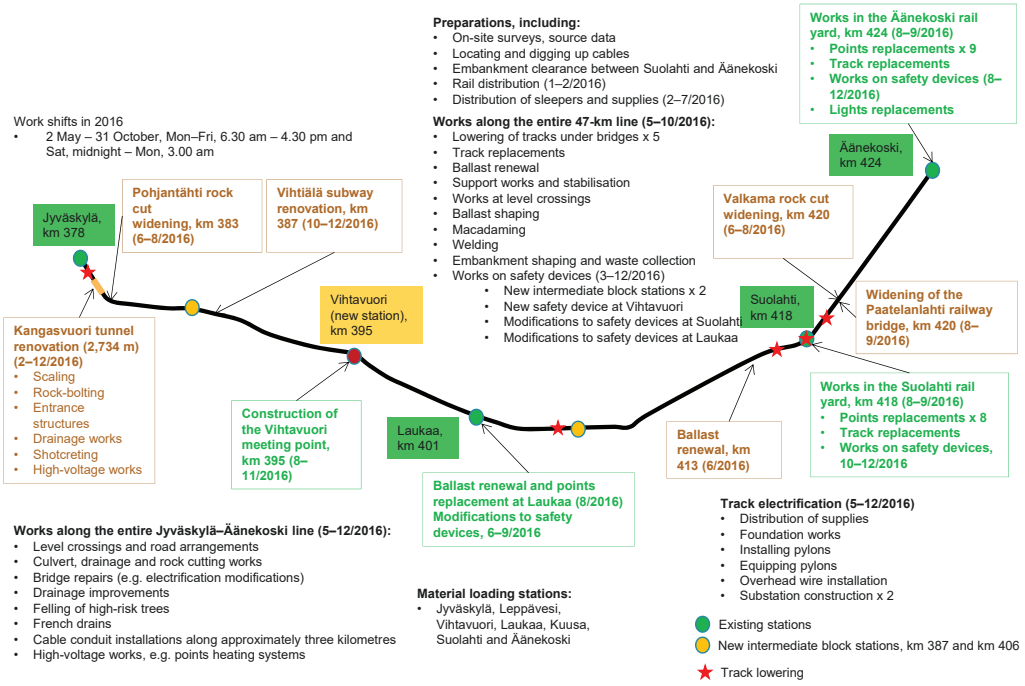



*Figure 3. Key works during the implementation stage (Jyväskylä–Äänekoski) in 2016.*

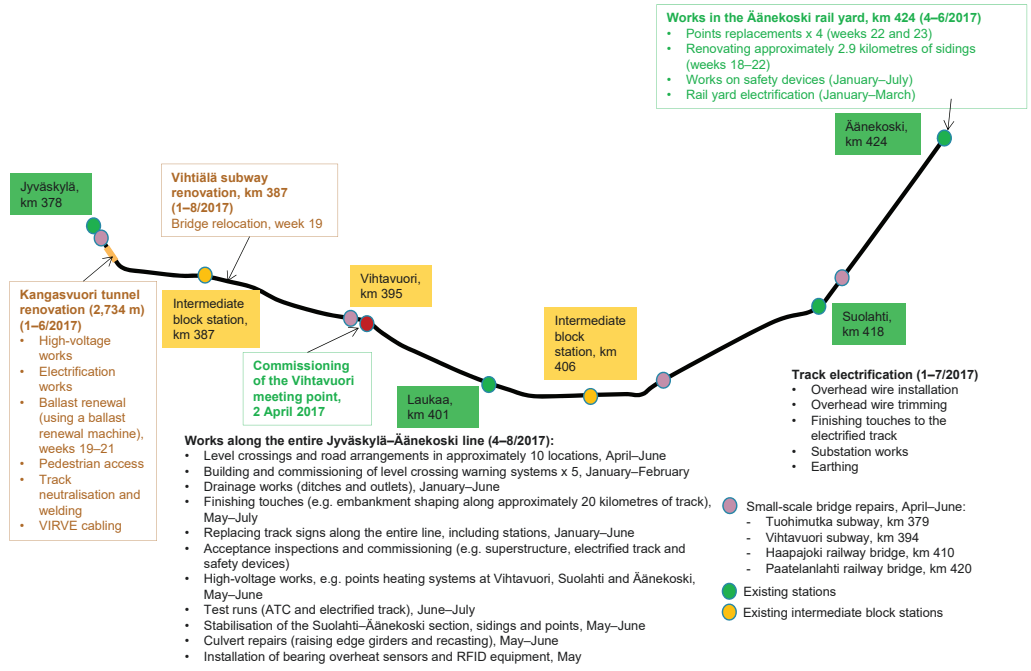



*Figure 4. Key works during the implementation stage (Jyväskylä–Äänekoski) in 2017.*

## Other lines

The alliance was also responsible for partial improvements on the Tampere–Jyväskylä line. Investments along the line included adding new signalling blocks between Tampere and Orivesi to improve safety, repairing superstructures and carrying out geotechnical repairs on the Paasivuori and Lahdenvuori tunnels (new reinforced concrete entrance structures were built for the Keljonkangas II and Matomäki tunnels).

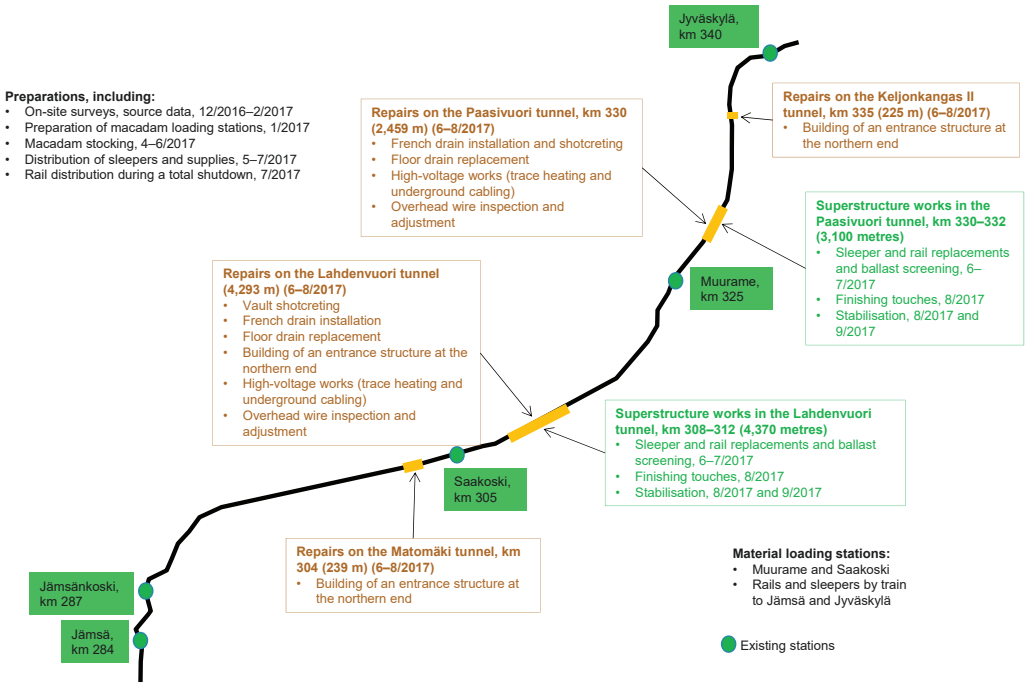



*Figure 5. Key works during the implementation stage (Jyväskylä–Jämsänkoski).*

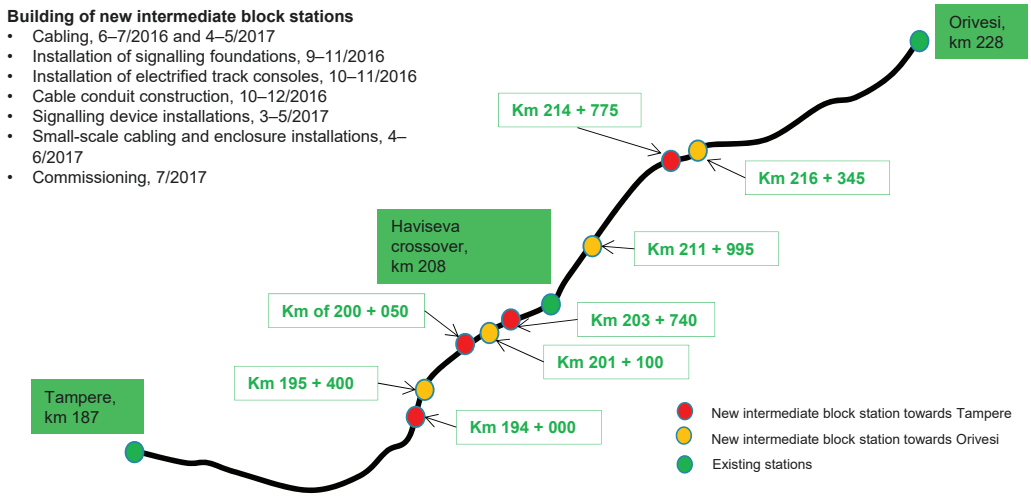



*Figure 6. Key works during the implementation stage (Tampere–Orivesi).*

Technical specifica ions for the works carried out on each section of the track are included in a document detailing the works involved in the project. Quality requirements for the works were laid down in the project's design principles.

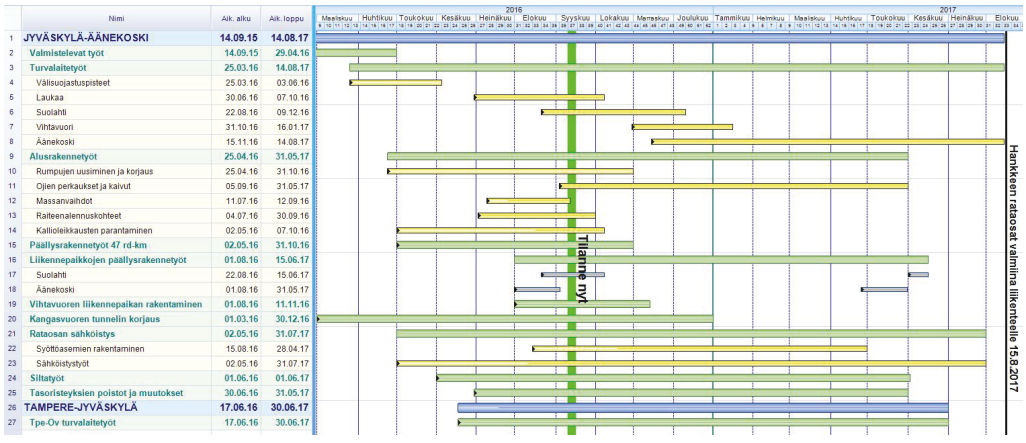
## 2.4 Project schedule and temporary traffi arrangements

Earthworks and other preparations along the Jyväskylä–Äänekoski line began even before the development stage had ended in the winter of 2016. Construction works started at the beginning of the implementation stage at the end of April 2016. The progress of works was planned carefully, and the line was ready for commissioning on schedule in August 2017. Work on safety devices and electrifica ion continued from the beginning of the implementation stage until the acceptance inspection. Building 47 kilometres of electrified track (including tunnels) and two electricity substations in 14 months is an almost unprecedented feat in Finland.

The schedule was extremely tight, and sticking to it was crucial for the project. Works between Jyväskylä and Äänekoski were carried out on weekdays between 7.00 am and 3.30 pm when the line was completely closed to traffic Works were also carried out between midnight on Friday and 3.00 am on Monday every weekend throughout the implementation period. The Kangasvuori tunnel was the biggest challenge in terms of the schedule. Works on the substructures, superstructures, bridges and level crossings were accepted in the summer of 2017.

New signalling block stations were added between Tampere and Orivesi to allow trains to move along shorter sections of track without causing a bottleneck for traffic Works on safety devices continued from the summer of 2016 until the summer of 2017.

A rough schedule of the works during the implementation stage is shown in Figure 7 below. A more detailed overall schedule can be found in Appendix 1.




| | Nimi | Alk. alku | Alk. loppu |
|---|---|---|---|
| 1 | JYVÄSKYLÄ-ÄÄNEKOSKI | 14.09.15 | 14.08.17 |
| 2 | Valmistelevat työt | 14.09.15 | 29.04.16 |
| 3 | Turvalaitetyöt | 25.03.16 | 14.08.17 |
| 4 | Välisuojastuspisteet | 25.03.16 | 03.06.16 |
| 5 | Laukaa | 30.06.16 | 07.10.16 |
| 6 | Suolahti | 22.08.16 | 09.12.16 |
| 7 | Vihtavuori | 31.10.16 | 16.01.17 |
| 8 | Äänekoski | 15.11.16 | 14.08.17 |
| 9 | Alusrakennetyöt | 25.04.16 | 31.05.17 |
| 10 | Rumpujen uusiminen ja korjaus | 25.04.16 | 31.10.16 |
| 11 | Ojien perkaukset ja kaivut | 05.09.16 | 31.05.17 |
| 12 | Massanvaihdot | 11.07.16 | 12.09.16 |
| 13 | Raiteenalennuskohteet | 04.07.16 | 30.09.16 |
| 14 | Kallioleikkausten parantaminen | 02.05.16 | 07.10.16 |
| 15 | Päällysrakennetyöt 47 rd-km | 02.05.16 | 31.10.16 |
| 16 | Liikennepaikkojen päällysrakennetyöt | 01.08.16 | 15.06.17 |
| 17 | Suolahti | 22.08.16 | 15.06.17 |
| 18 | Äänekoski | 01.08.16 | 31.05.17 |
| 19 | Vihtavuoren liikennepaikan rakentaminen | 01.08.16 | 11.11.16 |
| 20 | Kangasvuoren tunnelin korjaus | 01.03.16 | 30.12.16 |
| 21 | Rataosan sähköistys | 02.05.16 | 31.07.17 |
| 22 | Syöttöasemien rakentaminen | 15.08.16 | 28.04.17 |
| 23 | Sähköistystyöt | 02.05.16 | 31.07.17 |
| 24 | Siltatyöt | 01.06.16 | 01.06.17 |
| 25 | Tasoristeyksien poistot ja muutokset | 30.06.16 | 31.05.17 |
| 26 | TAMPERE-JYVÄSKYLÄ | 17.06.16 | 30.06.17 |
| 27 | Tpe-Ov turvalaitetyöt | 17.06.16 | 30.06.17 |

*Figure 7. Implementation schedule according to the project plan.*

The project was divided into several sub-projects, and the schedule was split into overall schedules, timelines, six-week plans and stage-specific schedules, which were displayed on the walls of the Big Room. Scheduling is discussed in more detail in Section 3.3.4.

Progress was keenly monitored throughout the project. Acceptance inspections were held for different components of the works at different times to allow maintenance staff to take over. A universal warranty period was established for all the works, which began from the technical acceptance inspection of the entire construction stage on 19 September 2017.

Temporary traffic arrangements and shutdowns were planned and coordinated by a traffic planning group, which included not only representatives of the project organisation but also traffic planners and the operator's staff. Disruptions to traffic were discussed with the operator (VR) on the basis of the alliance's proposals, and the aim was to find solutions that were as efficient as possible from the perspective of both the project and train traffic. Traffic planning meetings numbered approximately 15. The traffic planning group disseminated information about the planned shutdowns via the Finnish Transport Agency's network statements. Thanks to efficient interaction, temporary traffic arrangements relating to shutdowns could be agreed even at short notice. In the autumn of 2016, for example, weather conditions were found to still be favourable in November, and the alliance decided to modernise two more sidings in Suolahti. Timely interaction with the operator and traffic planners enabled a two-week gap in traffic on both sidings, which allowed the works to be carried out efficiently. This lightened the workload during the summer of 2017. The alliance agreed gaps in traffic directly with traffic planners and operators, which eliminated the need to consult the Finnish Transport Agency and increased the accuracy and efficiency of the information exchanged. Thanks to the alliance, information was communicated well enough in advance to allow disruptions to train traffic to be minimised or replacement services to be provided.

From May 2016 onwards, works on the Jyväskylä–Äänekoski line were carried out during eight-hour periods in between rail services and during longer weekend shutdowns of approximately 50 hours each. Works on the Tampere–Orivesi line were carried out in between rail services, and the superstructures of the Suolahti and Äänekoski tracks were worked on during longer shutdowns.
In 2017, works were carried out in between rail services until May, after which weekend shutdowns of various lengths (12–59 hours) were utilised for works on the Tampere–Orivesi and Jyväskylä–Äänekoski lines. There were also 10 six-hour shutdowns and 10 nine-hour shutdowns at weekends during the spring to allow for preparations. Shutdowns of 59 hours were needed for the challenging works involving the moving of the Vihtiälä bridge and ballast renewal in the Kangasvuori tunnel along the Jyväskylä–Äänekoski line in 2017. Sidings in Äänekoski were modernised during shutdowns of approximately seven weeks and renovations on the tunnels and superstructures of the Jämsänkoski–Jyväskylä line during periods when the line was completely closed to traffic for six weeks at a time.

## 2.5 Target cost and incentive scheme

The target cost and the scope of the project were revised on the basis of the alliance's proposal in accordance with the terms of the alliance contract, and the Finnish Transport Agency approved the changes. Revision 1 during the development stage involved moving certain works that had been scheduled for the implementation stage to the development stage. Revision 1 did not have an impact on the target cost or the total value given for the project in the procurement notice and the decision on the

award of the contract, as it only involved moving works from the implementation stage to the development stage.

The target cost estimate was increased on two occasions during the implementation stage: first by revision 1 in August 2016 and again by revision 2 in March 2017. The alliance's proposal to change the scope of the project was supported by sufficient justifications, and the Finnish Transport Agency approved the changes. The revisions involved re-including certain works that had been left out for cost reasons back in the scope of the contract. The works involved preparations relating to the additional budget and, for example, time-consuming cable material purchases, which had to be initiated for safety reasons and due to weather conditions (winter). Other works that had been left out due to financial and administrative reasons (revision 2 during the implementation stage) could not be re-included in the contract at this stage, although the possibility of additional funding during 2017 was already known. Revision 2 became possible when EUR 10 million more funding was allocated to the project in the 2017 budget. Revision 2 was based on the cost estimate revised during the implementation stage and the additional funding, and it involved re-including works that had been included in the original scope of the project but that had been left out and had not been re-included in the contract by revision 1. Revisions 1 and 2 during the implementation stage restored the original scope of the contract with regard to the works, the fees payable to service providers and the target price.

Although the target cost estimate was ambitious, the key performance targets specified for downtime in the incentive scheme were slightly easier to achieve in 2016 than intended. The project organisation benefited from one longer shutdown in 2016, and the line was, as a rule, only open to traffic once a day, which made it considerably easier to keep to the target than in 2017, when trains operated on the track several times a day. The target schedule was extremely tight, and a tighter schedule would not even have been beneficial for the project.

Costs were reimbursed and fees paid in accordance with the alliance's commercial model. Payments during the implementation stage were made on the basis of open books by reimbursing service providers for their costs directly and adding the fees based on their tenders on top. The contractor was paid a fixed fee based on the tendered percentage, and engineers were paid the tendered percentage fee as during the development stage.

### 2.5.1 Target cost before the additional funding

The target cost confirmed at the end of the development stage was EUR 63.63 million. EUR 43.61 million was reserved for covering the costs that had been cut during the development stage (of which EUR 2.61 million was for planning), EUR 6.35 million was reserved for fees (of which planning accounted for approximately EUR 1.24 million), EUR 12.05 million was reserved for the client's purchases and other costs (approximately EUR 8.4 million for electrification) and EUR 1.55 million was allocated to the alliance's risk reserves. EUR 2.8 million was allocated to the client's risk reserves and the bonus pool (of which the bonus pool accounted for EUR 1.375 million), EUR 13.7 million was reserved for the client's strategic purchases and approximately EUR 1.3 million was reserved for project preparations. The project's budget therefore amounted to EUR 80 million. The target cost was based on the scope specified during the development stage and a target cost analysis performed on this basis as well as the commercial model adopted for the implementation stage. The

alliance's service providers were committed to sticking to the target cost and to splitting the associated risks and benefits in accordance with the alliance's commercial model. It nevertheless became evident even before the end of the development stage that the most economically advantageous option (lot 1) could not be implemented without exceeding the target cost and that approximately EUR 10 million would be needed to carry out the most critical works. An application was consequently filed for a further allowance of EUR 10 million.

### 2.5.2 Target cost after the additional funding and changes to the scope of the project

The Finnish Transport Agency applied for additional funding from the Parliament of Finland. The application was submitted as soon as the implementation stage began, as works that were crucial to the project had had to be left out of the scope of the project. The reasons given in the application were that it would be considerably cheaper to upgrade the safety devices along the Tampere–Orivesi line and to repair the tunnels and superstructures on the Jämsänkoski–Jyväskylä line in connection with the project in order to minimise traffic disruptions and restrictions, for example, and to ensure sufficient capacity and the efficiency of goods transport. Preparations had already been made for closing the line completely and making temporary traffic arrangements due to the works in question, and a replacement bus service had been provided for passengers and an alternative route for freight trains for a period of between six and eight weeks during the works. The total closure of the line would not have been necessary without the works enabled by the additional funding, but, had the works not been carried out, the inconvenience would only have been postponed and affected the operation of the new bioproduct mill in 2018 and 2019. No detailed analyses were performed on the option of carrying out the works outside the project, but the benefits of including them in the project were clear to see, as having to make arrangements once the mill was already operational would have resulted in considerable costs. A further EUR 10 million was allocated to the project towards the end of 2016.

The additional funding raised the project's appropriations to EUR 90 million, and most of the works included in lot 1, which had been left out during the development stage, could be re-included in the scope of the project. The project's target cost was increased correspondingly by approximately EUR 10 million. The scope of the works involved in the project was widened on two further occasions during the implementation stage (revision 1 and revision 2), as a result of whichthe target cost rose to EUR 65.02 million after revision 1 and to EUR 72.41 million after revision 2. The final target cost of EUR 72.41 million consisted of EUR 51.40 million for covering costs, EUR 7.35 million for fees, EUR 11.81 million for the client's purchases and other costs (approximately EUR 8.4 million for electrification) and EUR 1.86 million for the alliance's risk reserves. EUR 1.56 million (maximum) was allocated to the bonus pool, EUR 15.11 million was reserved for the client's strategic purchases, approximately EUR 1.18 million was reserved for project preparations and EUR 0.17 was allocated to temporary traffic arrangements.

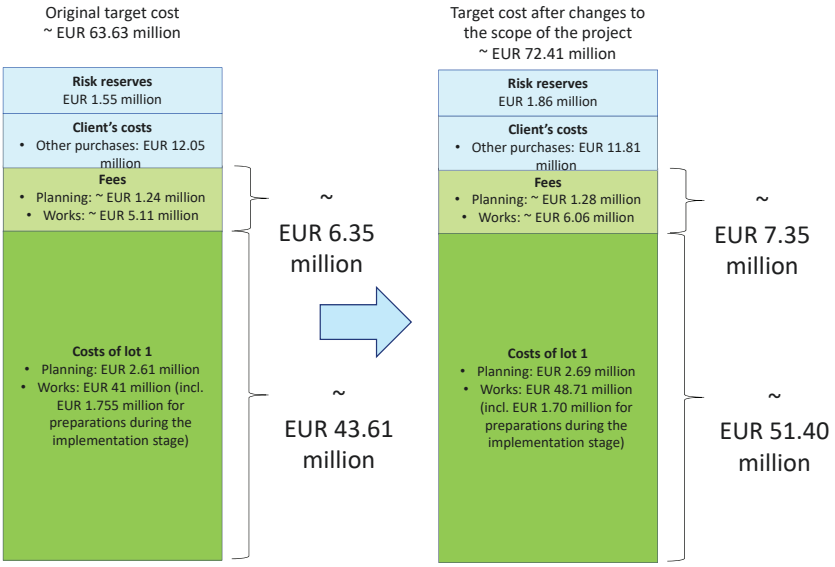



*Figure 8. Breakdown of the project's target cost before and after changes to the scope of the project.*

### 2.5.3 Incentive scheme

The principles of the incentive scheme for the implementation stage were based on the normal alliance practice of paying bonuses for coming in under the target cost and exceeding key performance targets and imposing penalties for exceeding the target cost and failing to reach key performance targets. The components of the incentive scheme are shown in Figure 9. The incentive scheme for the implementation stage also included a condition according to which the client could cut the bonuses and fees as a result of certain unacceptable events. No such events took place during the implementation stage.

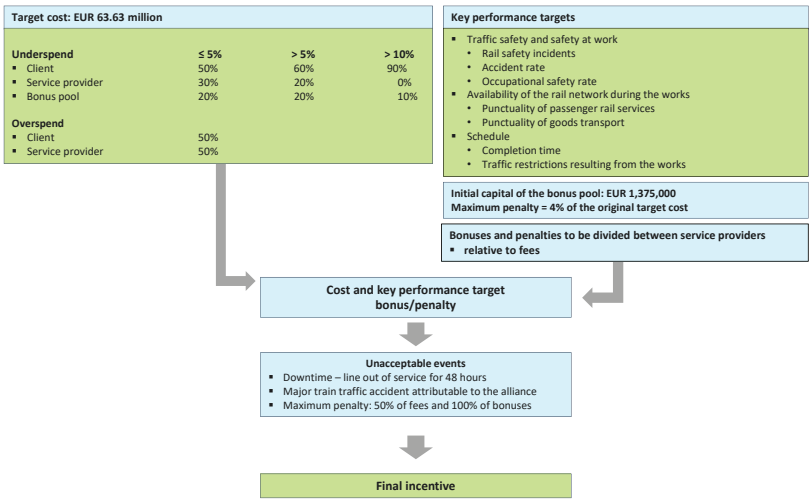



*Figure 9. Incentive scheme for the project.*

The divisions relating to exceeding or coming in under the target cost, indicators, the size of the bonus pool and the maximum penalty were confirmed in the alliance contract for the implementation stage. The targets were made ambitious in order to force the alliance to come up with new operating models and approaches to reach good results.

The key performance indicators and success relating to the targets are shown in Table 5 (in Section 4.1).

### 2.5.4 Incentive scheme for staff and subcontractors

Some of the incentives included in the alliance's incentive scheme were also extended to the project staff and subcontractors.

The performance-related bonus scheme for project staff is described in more detail in the alliance's development-stage value-for-money report. Project bonus contracts were also drawn up for the service provider's other staff, on the basis of which bonuses were paid for reaching key performance targets and coming in under the target cost. Moreover, instant bonuses were awarded for good performance during the implementation stage in order to encourage staff to meet the goals of the project. This category included important safety-related observations and actions as well as innovations, promoting public relations and improving efficiency. Project staff were paid a total of approximately EUR 35,000 in performance-related bonuses on the basis of the outcomes of the development stage, during which approximately 60% of the targets were met.

A further EUR 35,000 was budgeted for performance-related bonuses during the implementation stage. Targets relating to the schedule were met with flying colours, but financial targets were not reached. No performance-related bonuses were paid during the implementation stage.

A relatively large proportion of the construction work was delegated to subcontractors (Figure 9). A separate incentive scheme was devised for the most important subcontractors during the development stage. Efforts were made to extend the subcontractors' incentive scheme to all major subcontracts that were important in terms of the project's schedule. The subcontractors' incentive scheme was based on the principles of the alliance's incentive scheme. The bonuses were linked to the alliance's key performance targets and capped at two per cent of each contract's value. Eligibility for the subcontractors' bonus was based on performance-related minimum requirements derived from the alliance's key performance indicators. The amount of the bonus was mostly based on each subcontractor's occupational safety rate and the completion time of the subcontract. Subcontractors' targets were chosen on the basis of the aspects on which they had control. Penalties relating to the schedule were made tighter than those laid down for completion and interim goals in Section 18 of the 1998 general terms and conditions for construction contracts, for example, in accordance with the Finnish Transport Agency's model.

Bonus payments to subcontractors varied according to how successful each subcontract had been. The subcontractors' incentive scheme was found to have a varying effect on subcontractors. Extending the alliance-based operating model to subcontractors was not a complete success even though the incentive schemes were similar to those of the alliance and more versatile procurement procedures arose that made it possible to increase subcontractors' level of commitment. Despite good performance levels, the alliance-based operating model was not sufficiently evident in subcontractors' practices. However, emphasising the importance of the schedule by means of severe penalties and incentives helped to achieve timely completion and therefore generated value for money. A relatively wide range of competitive tendering practices and subcontracting principles were employed to find subcontractors. However, there would have been potential for setting targets that were more diverse and more in line with the alliance's practices as well as for better communications and a more effective incentive scheme. For example, extending the alliance's own

incentive scheme to the most important subcontractors could have made subcontractors more committed to meeting the project's common goals. Introducing subcontractors to the alliance-based approach could also have added even more value.

## 2.6 Stakeholders and parallel projects

Stakeholder relations were planned and implemented through a stakeholder relations group, which operated under the construction team. The progress of parallel projects and coordination between projects were discussed in the projects' joint management group.

The project's most important stakeholders included Metsä Fibre, Metsä Board, Valtra, the Central Finland Centre for Economic Development, Transport and the Environment, the Finnish Transport Safety Agency, the local authorities of Jyväskylä, Äänekoski and Laukaa, the track maintenance provider Destia Rail Oy, landowners, road users, private road and cable owners, VR Group and VR Transpoint as well as the media. The local authorities and the environmental authorities of the Central Finland Centre for Economic Development, Transport and the Environment were engaged in continuous interaction concerning local and regional land use, the environment, permits and commissioning issues through negotiations and consultations. An inventory was carried out on areas of outstanding natural beauty and nature conservation areas to form a basis for discussions and planning. The project organisation also cooperated with fire and rescue services, the police, the Regional State Administrative Agency and the National Land Survey of Finland.

Maintenance works were carried out during the project the scale of which was determined in collaboration with the track maintenance provider by means of control meetings and a maintenance plan. As a rule, servicing technical systems or works carried out by the normal maintenance provider, regular maintenance, inspections or similar responsibilities were not included in the alliance's duties.

The following parallel projects had indirect impacts on the railway project:

- Roadworks, EUR 78 million
- Construction of the Äänekoski bioproduct mill, EUR 1.2 billion
    - Overlaps between contracts, superstructure works, works involving safety devices, electrification of the mill's rail yard
    - Area division and land use planning
    - Temporary traffic arrangements
    - Supplies
    - Commissioning issues and permits
- Finnish Transport Agency's other projects
    - Repairs on Markkula bridge and embankment
    - Construction of Länkipohja bridges
    - Overhead wire replacement
    - Repairs on the Valtra track in Suolahti
- Local maintenance works

Sticking to the schedule and successful commissioning required close cooperation between the most important stakeholders. Stakeholders were consulted to identify the most important risks associated with parallel projects and coordination needs with the operator, for example. The management group in charge of the mill and the project convened once a month. Issues such as purchases, commissioning and permits were discussed and coordinated by means of the management group's meetings. Commissioning permits for the mill were also discussed in connection with the railway commissioning process. The commissioning process involved close cooperation between the mill and the alliance, which made it possible for the railway project and the mill to get their authorisations through parallel processes and at the same time. This was thanks to measures such as joint meetings, which were attended by the mill contractor and logistics manager, the mill's railway contractor, the Finnish Transport Agency, the alliance's service provider, representatives of the track electrification contractor and the goods transport operator VR Transpoint. The active participation of all interested parties made it possible to plan commissioning all the way to test runs and the first official freight train service.

In addition to management group meetings, the railway project and the mill project were coordinated by means of tours of the facilities given to project staff as well as various scheduling and coordination meetings at approximately two-month intervals. Coordination was especially important in the autumn of 2016 and in the winter of 2017. Works relating to the mill project decreased in the spring of 2017 when the mill's testing phase began. The mill's working group was invited to the railway works site on 10 November 2016, and a working group representing the railway project also visited the mill's construction site. The two projects were coordinated successfully, and both projects were constantly aware of each other's schedule and progress. This made it possible to commission the mill exactly on schedule on 15 August 2017. The alliance's contribution to ensuring that the mill's internal tracks and logistics solutions were completed on time was considerable.

# 3 Implementation stage

## 3.1 Progressing to the implementation stage and works included in the implementation stage

The alliance moved on to the implementation stage by signing an implementation-stage alliance contract on 28 April 2016. The implementation stage began on 1 May 2016, and it is due to end at the end of the warranty period on 19 September 2022. The condition for progressing to the implementation stage was that the parties involved in the alliance could agree on the target cost and other goals for the project. The implementation stage covered all the planning and construction needed to execute and complete the project, including a five-year warranty period.

According to the implementation-stage contract, the alliance's duties were as follows:

- Planning the construction works and implementation of the project
- Carrying out the construction works included in the project specification
- Commissioning and acceptance inspections in accordance with the commissioning and acceptance procedure agreed during the development stage
- Ensuring the compliance of the implementation stage with performance requirements and any works required during the warranty period

The works involved in the implementation stage were laid down in more detail in the implementation-stage project plan.

The alliance's operations during the implementation stage were based on the client's objectives and the implementation-stage project plan. The project plan described the technical and financial targets set for the implementation stage as well as the process for executing the project. The implementation stage was launched on the basis of the project specification. The development stage had been short, and there was no sufficiently clear plan for the operation of the organisation, the staff's roles and responsibilities and construction-related processes and practices at the beginning of the implementation stage, as a result of which there were still some practicalities to organise. Clear and well-organised procedures were nevertheless established during the implementation stage.

## 3.2 Organisation, management and operating models during the implementation stage

**Project organisation (alliance)**

The implementation of the project was coordinated by an alliance formed by the Finnish Transport Agency and VR Track Oy, in which the Finnish Transport Agency was the client and VR Track Oy was the service provider. The project organisation consisted of the alliance's management group, project team, working groups and other teams, which mostly comprised staff of the alliance partners. Staff were chosen

partially on the basis of previous project experience, and some members of staff had also worked together on previous occasions.

The organisational structure adopted at the beginning of the implementation stage was based on different technologies. The basic idea guiding the organisation during the implementation stage was bottom-up management, which was a success on the whole. Teams consulted working groups, which drew up proposals, including potential alternatives, to the project team. If the project team did not have the authority to decide on a working group's proposal, it drew up a proposal to the management group. There were some challenges relating to organisation and the division of responsibilities as well as management during the early part of the implementation stage. Changes in key staff and handovers, for example, when new technology coordinators took over created additional challenges. The project organisation became more efficient and better able to manage the big picture during the implementation stage, and teamwork improved considerably towards the end of the project. The single biggest change to the organisation was a move from a technology-based structure to an organisation based on individual track sections, which was a major contributor to the success of the project. The technology-based organisation worked well during the early superstructure works, but it made more sense from the perspective of managing the big picture to organise works according to individual track sections towards the end of the implementation stage.

The management group consisted of two representatives of the Finnish Transport Agency and two representatives of VR Track Oy. The meetings were chaired by the client's and the service provider's project managers. No deputies were appointed for the members of the management group. The management group's meetings had a quorum if at least one representative of each alliance partner was present. Many of the issues discussed in the first management group meetings were matters that may not have needed the management group's attention and that had not been prepared sufficiently thoroughly, which is why a practice of preparatory meetings was adopted. This made it possible to influence the proposals presented to the management group beforehand and to give more time to reviewing and discussing proposals, which in turn made the management group better equipped to make decisions. Efforts were also made to improve the management group's decision-making ability by analysing the decisions made relative to the issues at hand. The project team steered the alliance's operations and drew up proposals relating to the most important issues to be decided by the management group. The project team also coordinated the activities of working groups and teams. The project team consisted of representatives of the client, the service provider and the client's consultant, Sweco PM Oy, and it was headed by the alliance's project manager.

The project team had working groups focusing on construction/implementation, cost control, quality control, safety, risk management and support functions working under it, and each working group had various teams reporting to it. The organisation of the working groups and teams was streamlined during the implementation stage by amalgamating functions and eliminating overlaps, for example. Deputies were also appointed for the heads of working groups and teams. The main responsibility for managing and reporting on the quality, schedule and finances relating to the outcomes of planning lay with the construction/implementation team. The teams and individual members of staff were responsible for identifying planning needs and the scope of planning sufficiently early and clearly. The scope and format of production-related plans as well as delivery schedules were determined by the construction/

implementation team. The schedule for planning, procurement and construction was reviewed at joint scheduling briefings on Thursdays. The construction team also addressed critical planning-related issues, such as deviations from the schedule. The commissioning team formulated requirements for the scope and format of plans required for authorisations for placing in service and drew up schedules. A team in charge of land use and environmental issues drew up plans required for various permit processes. Plans relating to land use and environmental permit processes were drawn up taking into account the relevant quality standards and format requirements. The construction/implementation team also provided the alliance with information and materials for other purposes, such as communications and work plans as well as quantitative data for cost estimates.

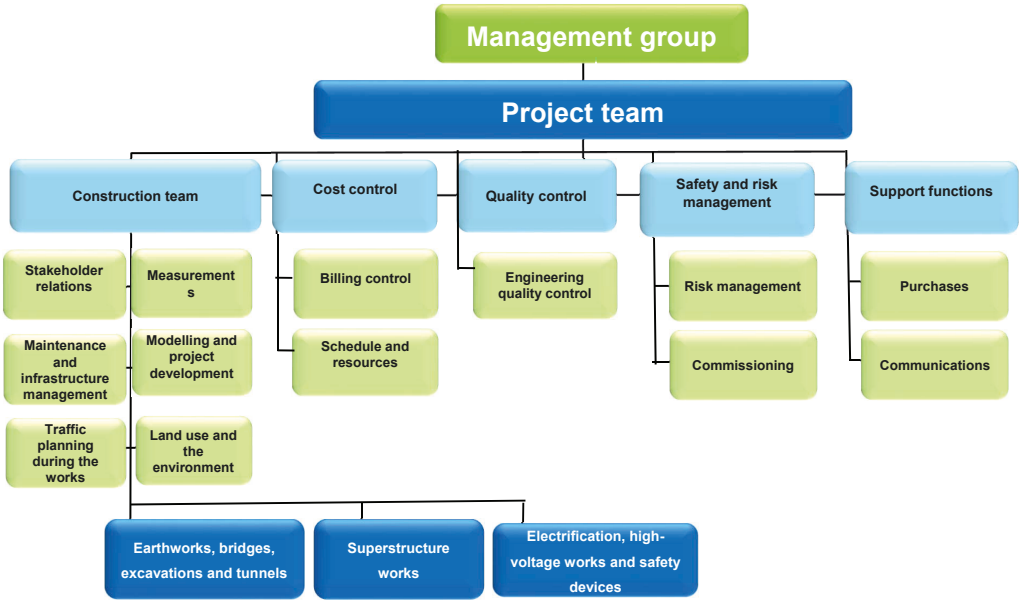



*Figure 10. Organisation at the beginning of the implementation stage.*

**Changes in the project organisation**

Some changes were introduced to the implementation-stage project organisation during the implementation stage. The changes challenged the alliance but were necessary for implementation and made it easier to complete the implementation stage. The aim was to increase efficienc in order to keep to the tight schedule and to focus more and more on meeting the project's objectives. The most significant changes in the organisation during the implementation stage are shown in Figures 11–12.

The technology-based organisation was streamlined before the organisation based on individual track sections was adopted. Larger working groups were formed by amalgamating the groups responsible for implementation, finan es and commissioning and safety, and new teams were set up under these groups. Teams responsible for planning coordination and measurements were established under the construction/ implementation team. The schedule and resources team, which had previously reported to the cost control group, began to report to the implementation group instead. The cost control team and the billing control team started to report to the finan e group. Teams responsible for key performance targets and cost-effectiveness assessment were also established under the finan e group, and the purchases team, which had previously been part of support functions, began to report to the finan e group. More teams were added to the commissioning and safety groups

as the implementation stage progressed. Quality control, which had been a separate group, started to report to the commissioning and safety group, and a third party (Sweco PM) was put in charge of quality control. An engineering quality control team operated under the quality control group. A team in charge of maintenance planning, which had operated under the construction team, began to report to the commissioning group. Innovation management and development were added to the tasks of the risk management team. Separate support functions teams for communications and assistance and a new project development team were set up under the project team.

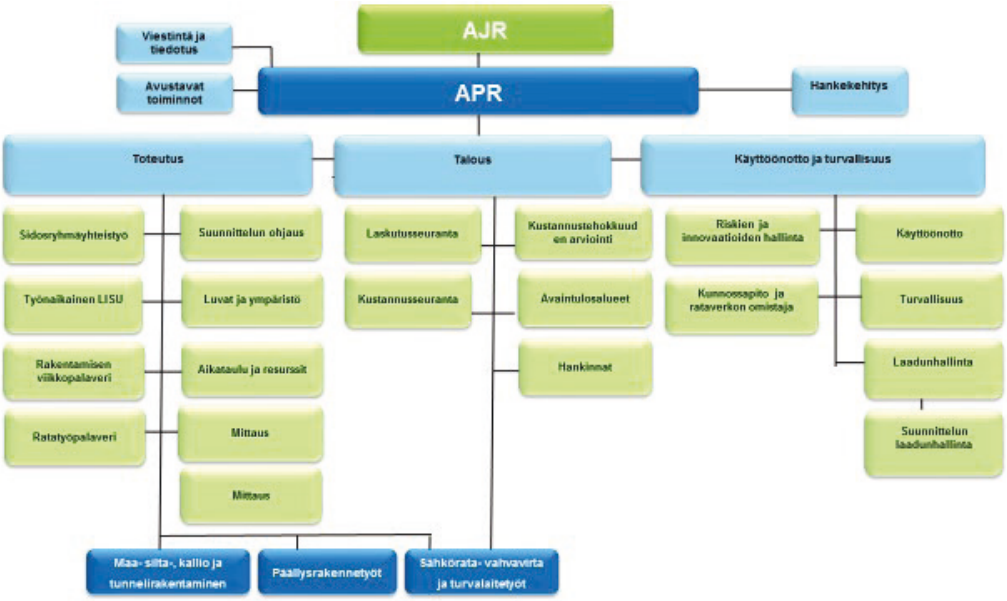



*Figure 11. Streamlined technology-based organisation in the autumn of 2016.*

The technology-based organisation worked well at the beginning of the implementation stage, but once the superstructure works had been completed, the organisational structure proved challenging for managing other works and there were too many overlaps. The teams responsible for different technologies were unable to engage in sufficien interaction, and challenges emerged in coordinating works involving different technologies. A major change was therefore effected and a locality-based organisational structure adopted (two track sections headed by line coordinators). The line coordinators had overall responsibility for the big picture, which made works easier to manage and coordinate. However, the division of responsibilities was not based purely on sections of the track, and instead the line coordinators' specialist expertise was taken advantage of flexibly in other areas as well. Weekly briefings were held for each line. Processes and practices were also further streamlined in connection with the reform. The new organisational structure was found to make the implementation stage more likely to succeed thanks to better coordination, a more practical division of roles and responsibilities and the elimination of overlaps, for example. However, the change had to be managed, and the challenging restructuring process took six months from the autumn of 2016 until early 2017.

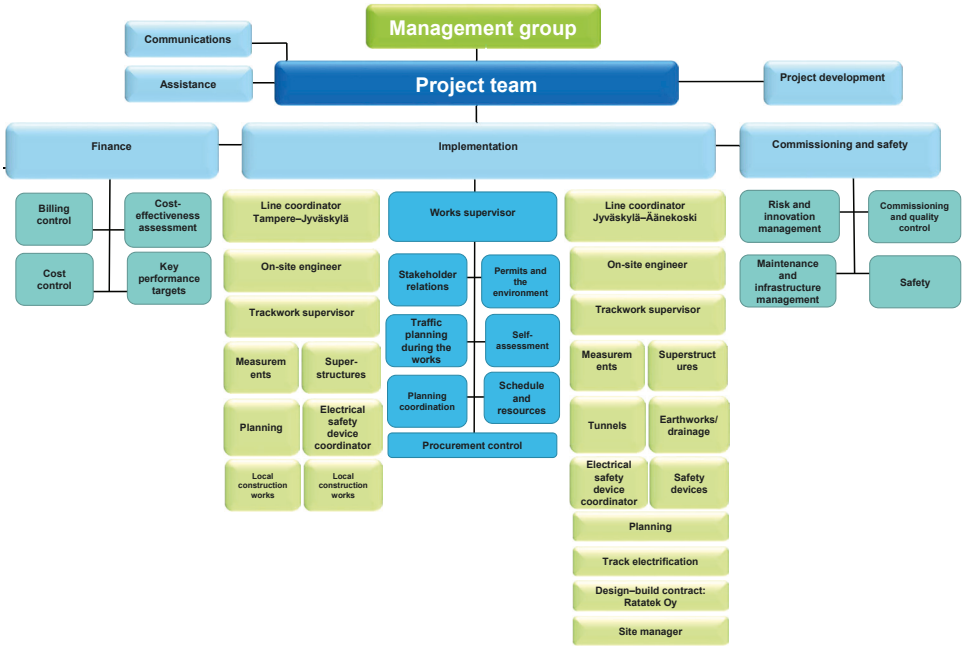



*Figure 12. Line-based organisation.*

Several challenging changes in staff, including the appointment of a new project manager, coincided with the major organisational reform. The alliance's development-stage project manager was appointed at the beginning of the development stage on the basis of what was best for the project. The implementation-stage project manager until the end of 2016 was an individual who had been assessed during the procurement stage, but a new project manager was needed when that individual changed employers. An individual who had previously acted as a technology coordinator (and as the works supervisor at the beginning of the development stage) accepted the role in January 2017. The decision was discussed extensively within the project organisation. The project team took the decision on the new project manager on the basis of what was best for the project. The management group provided assistance during the organisational reform and in the choice of the new project manager but allowed the project organisation to come up with its own proposal. The management group approved the project team's proposal of a new project on 16 January 2017.

Staff morale suffered at times due to the tight schedule and managerial challenges, for example. The alliance-based approach began to work better towards the end of the project, however, and the organisation learned and developed. The management group introduced a number of leadership practices relating to decision-making and staff involvement, for example, during the implementation stage. The management should have given more attention to involving the project organisation, delegating responsibilities and the alliance-based approach during the early part of the implementation stage. The job descriptions and responsibilities of the members of the project organisation also should have been planned better. No individual job descriptions were drawn up, which created some confusion regarding the division of roles and responsibilities. This, along with the pressure created by ambitious targets, also contributed to the low morale. The alliance invited a psychologist to attend meetings of the project team and to lead mutual discussions on leadership as well as to come up with exercises in self-reflection. Teamwork improved towards the end of the implementation stage, and preparing for total shutdowns, for example, brought the entire team together when everyone understood the importance of success and the cooperation that it required. Nevertheless, the challenges should have been addressed earlier.

Limited resources in planning, for example, made the schedule more challenging at times. The location of the Big Room was a problem in terms of the availability of resources, and it also increased travel and accommodation costs considerably. Compared to other similar projects, however, enough human resources were secured and the shortages related to a few bottleneck resources and were partially due to an uneven distribution of work between members of project staff.

On-site organisation

The on-site organisation was overseen by the construction/implementation team and consisted of teams in charge of earthworks, bridges, excavations and tunnels as well as superstructure works and electrifica ion, high-voltage works and safety devices at the beginning of the implementation stage (Figures 13 and 14). Ratatek Oy was commissioned to design and carry out electrifica ion. The alliance partners coordinated the boundaries between the electrifica ion contract and other construction works by participating in the on-site electrifica ion team. The technology-based organisation was replaced by a line-based organisation at the beginning of 2017. Separate on-site organisations were set up for the Tampere–Jyväskylä line and the Jyväskylä–Äänekoski line, which worked under the supervision of implementation teams headed by line coordinators. The change made it easier to complete the implementation stage, and the two "line teams" made moving members of the on-site organisation of the Jyväskylä–Äänekoski line to the section between Jämsänkoski and Jyväskylä during the total shutdown extremely smooth.

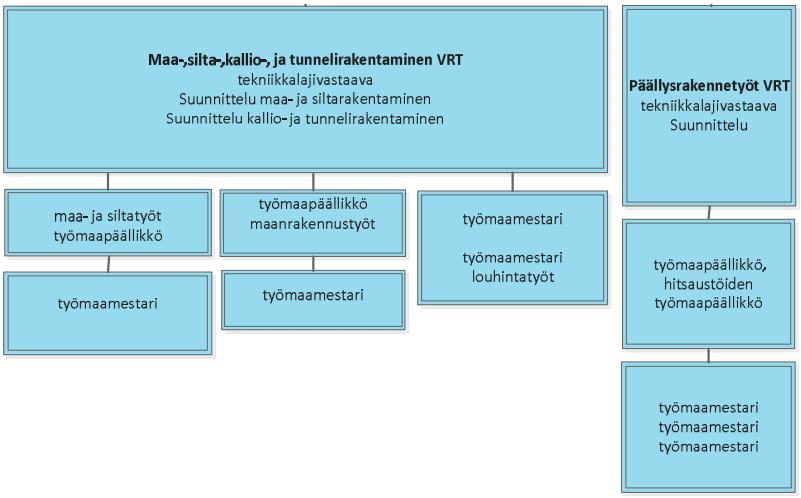



*Figure 13.* *On-site organisation for earthworks, bridges, excavations and tunnels as well as superstructure works.*

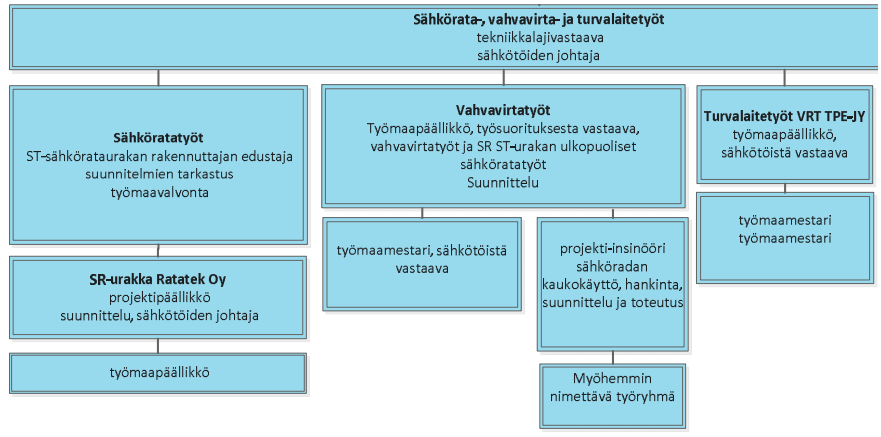



*Figure 14.* *On-site organisation for electrification, high-voltage works and safety devices.*

**Work methods and processes**
Weekly meetings were held from Tuesday until Thursday in the Big Room at Kyyhkysentie in Jyväskylä during the implementation stage. Weekly meetings that were critical for coordination purposes were based on a weekly calendar. These included meetings of the project team and the construction team (during alternate weeks) as well as weekly planning reviews and overall schedule reviews, weekly technology meetings and coordination meetings. The meetings were well planned and based on proposals from individual teams. Self-reflection was used to assess the success of the meetings of both the management group and the project team and to improve procedures. The main role of the meetings was to approve proposals. Individual teams were responsible for the preparatory work. Visual aids (post-it notes) and remote participation were used in phase scheduling, weekly planning and overall schedule planning, for example. Several small changes were made to the weekly routine during the implementation stage due to organisational reforms and to set a good working rhythm. The changes created some challenges in learning and adapting to new routines, but they eliminated overlaps and promoted the implementation of the project.

## 3.3 Processes and project management during the implementation stage

### 3.3.1 Planning during the implementation stage

Efforts were made to also use a planning process based on the client's objectives (Target Value Design) during the implementation stage, which meant that the planning process and the decisions made were based on the client's objectives and conditions. In practice, the conditions were the schedule agreed during the development stage, the target cost and the scope of the project. The solutions and chosen methods had to meet the goals set for the alliance contract. The client made decisions about the scope of the contract, the required standard and planning principles by guiding the alliance to meet the conditions. The alliance was responsible for coming up with solutions and methods that met the client's objectives and conditions. The focus during the implementation stage was on planning work methods. The increased scope of the project resulting from the additional funding had been mostly planned during the development stage. Progress relative to objectives was monitored weekly throughout the implementation stage, and the alliance organisation improved its methods and steered the execution of the project in order to meet the goals. Incentives relating to key performance targets made it possible to meet the project's original objective and desired impact. Costs and the schedule in particular were prioritised: they guided the project more than other objectives, and solutions were mostly chosen on their terms. The schedule was finalised at an early stage of project planning. It would have been considerably easier to stick to the schedule without the works enabled by the additional funding; after the new works were added, normal performance would not have been enough for meeting the deadline.

In addition to the key performance targets, the client's other goals for the project also steered the choice of solutions and comparisons between alternatives, the planning of methods, the evaluation of the project's positive and negative impacts as well as decision-making. However, there was no systematic management by objectives.

Although the key performance targets did not include indicators for the quality of the end product and there was no strong commercial incentive based on life-cycle considerations, these issues were also addressed in connection with decision-making. There was also social pressure to meet the targets. The society's and the mill's objectives were met by timely commissioning. This also contributed to creating a positive public image for the project.

Plans produced during the implementation stage primarily served construction but also permit processes and the client's, the service provider's and third parties' archives. Plans had to be detailed enough to either carry out construction with the alliance's own resources or, if necessary, to put works out to tender. Planning of the alliance's workload and cost calculation progressed side by side during the implementation stage. Work methods could be optimised according to the objectives as the scope of the project became clearer.

### 3.3.2 Ideas and innovations

Innovation was encouraged during the implementation stage by a systematic process aimed at turning ideas into innovations, the main stages of which are described in the development-stage value-for-money report.

The objectives of the process were as follows:

- Turning ideas into innovations
- Adopting a more innovative attitude
- Minimising waste

Not all the targets set for innovation were met, and there were few innovations that had any major impact on costs. The alliance's daily practices did not promote innovation systematically enough, and making the process work in practice was challenging due to the tight schedule and budget, for example, which is why the project organisation felt that there was not enough time or opportunities for innovation. Several small innovations that improved quality or cost-effectiveness were created, however, although not all of them were documented.

The project's most important innovations are listed in Section 4.3.

### 3.3.3 Cost control and forecasting

The service provider's costs were entered into VR Track's C7 system and categorised according to a project number list based on stages of work and individual tasks. Costs were monitored comprehensively, and itemised lists were reviewed at regular cost control meetings. Subcontracting costs and bonus pool payments were also included in target cost forecasts.

A summary of the project's cost control was kept in the Finnish Transport Agency's SAMPO system and reviewed monthly by the cost control team. Cost forecasting meetings were held monthly via Skype. The meetings involved reviewing itemised lists of costs and updating forecasts with the help of the technology coordinators' expertise. The cost forecast changed all the time as works progressed and plans became clearer (when actual bills were compared against estimates). Costs and forecasts also steered planning, execution and purchases. The lot-based approach required continuous understanding of incurred, committed and forecast costs in order

to make decisions at the right time and on the basis of accurate information. The cost control model and forecasts helped to prioritise works and manage the project.

### 3.3.4 Scheduling

A target schedule was drawn up for the implementation stage using the overall schedule given in Appendix 1 (a diagram of times and locations per track section and a task-specific timeline). The alliance's project team set interim goals for scheduling and determined a number of "critical deadlines". The implementation schedule was monitored and steered by means of joint phase scheduling, weekly planning and technology-specific timescales. Scheduling was a high priority, as the deadline was tight and meeting it was crucial for the success of the project.

The alliance made active use of a Last Planner phase scheduling system on the Big Room wall for managing the project's overall schedule in terms of construction, planning and project administration (project team and technology/line coordinators). This became increasingly important towards the end of the project, and the Last Planner system was found to be the best tool for long-term schedule planning. The wall schedule also showed the line shutdowns during which works could be carried out and critical deadlines for works relating to stakeholders, such as the track leading to the mill and the operator's test runs on the electrified track.

Planning meetings were held weekly in the Big Room. All technology coordinators also attended the meetings at the beginning of the implementation stage, some via Skype. Weekly one-hour planning reviews involved the project manager explaining the works carried out during the previous week. The cumulative progress of on-site works was monitored with the help of a quantity monitoring table on the Big Room wall, which was updated on a weekly basis. The table was also turned into a electronic Excel version, which was appended to weekly bulletins, for example. Any works that were running behind schedule were highlighted in red in order to make the table easier to read, and these works were given special attention when the quantity monitoring table was discussed at the weekly planning reviews in order to find solutions. The completion percentage of works was monitored and the following two weeks were also reviewed and guarantees given of the execution of works at the weekly planning meetings. If the execution of specific works could not be guaranteed, tasks were delegated to others. Decisions to delegate works and reasons for doing so were discussed on a case-by-case basis. The correlation between weekly plans and the phase schedule and overall schedule was monitored actively. Scheduling and coordination also featured in technical meetings, which involved managing weekly schedules for each track section and agreeing on the works to be carried out and the persons responsible for the works. The joint scheduling meetings and workshops gave the project organisation a good idea of the big picture and made it possible to coordinate aspects of the project that were crucial for the successful execution of the works involved.

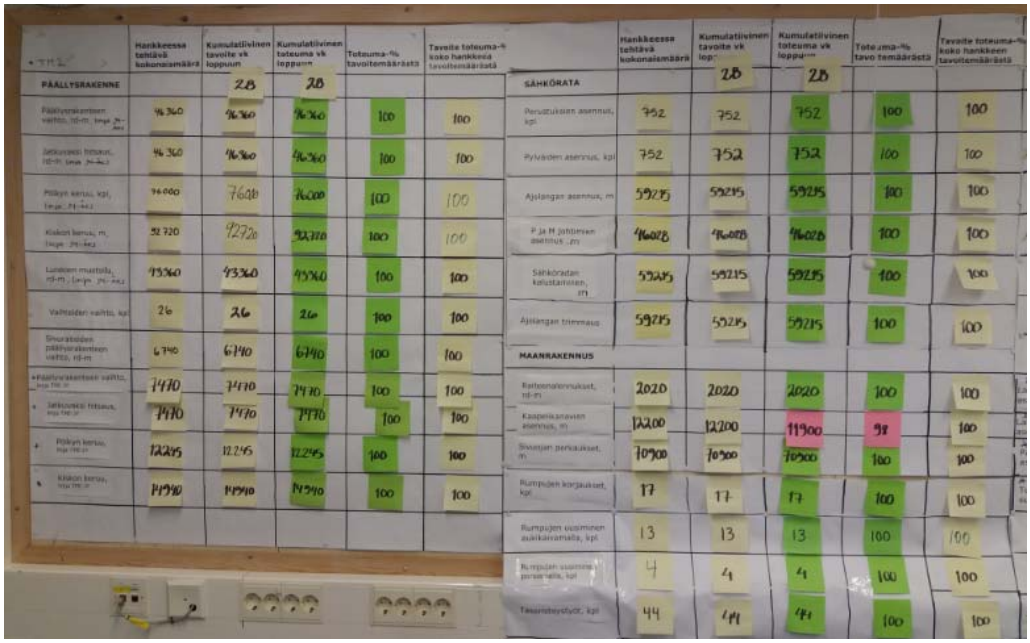


*Figure 15 Quantity monitoring table*

Some members of the project organisation found scheduling too laborious and involving too many parties and felt that schedules contained too much detail especially at the beginning of the implementation stage. Overlapping scheduling and coordination meetings were eliminated during the implementation stage.

The takt time ideology was piloted for the first time in a Finnish infrastructure project in connection with the repairs on the four tunnels along the Tampere–Jyväskylä line. The works were carried out during a six-week shutdown (23 June – 4 August), as repairing tunnels while trains are running is expensive and time-consuming. The takt time approach was designed to enable the tunnel works to be planned and executed on the basis of a continuous flow process and a takt time schedule. The aim was to maximise the volume of repairs that could be carried out during the total shutdown and to minimise costs, to ensure that on-site management and subcontractors were committed to contributing to takt time planning and to executing the tunnel works on the basis of a continuous flow process as well as to complete the tunnel repairs themselves according to a takt time. Takt time production requires careful planning of resources (shift-specific resource and logistics planning) and logistics, daily management (stand-up meetings and meetings of on-site management) as well as executing the works according to a takt time as planned. The takt time schedule was produced by the Metsä Fibre bioproduct mill alliance with Vison Oy's assistance. The planning resulted in a clear shift-specific division of responsibilities and guided the works. The approach also enabled leaving almost a week of the total shutdown spare and rescheduling the building of a French drain and sleeper distribution in the Paasivuori tunnel for the shutdown. Weekend shifts were planned mostly as back-up, and night shifts were dedicated to works that required a lot of space and few human resources, such as logistics.

The following tunnel sections were repaired:

- Lahdenvuori tunnel (4,293 m) and Paasivuori tunnel (2,459 m)
- Matomäki tunnel (304 m)
- Keljonkangas II tunnel (193 m)

The takt time approach was extremely successful even though not all works were included, (additional) works were easy to incorporate into the schedule and resources could be used extremely flexibly considering the changes. The organisation was also able to react to disruptions and problems, such as broken machinery, faults / cable failures, unexpected cable discoveries, logistics / sleeper distribution and a reduction in shotcreting (grouting was done in advance) in a flexible and controlled manner. A detailed model that was much clearer than a line-of-balance schedule was developed for visual planning and management. The works were split into clear segments (100-m tunnel blocks). The works to be carried out during each shift and in each tunnel block were known in advance. This made it easier to schedule in additional works, move resources about and react to problems.

*Figure 16 Takt time planner*

### 3.3.5 Communications and interaction

The project organisation held open days for the media on 1 June 2016, 21 September 2016 and 12 July 2017, for example. Journalists were invited to learn about the project and visit the site. Letters from the public were dealt with in a centralised manner. Heikki Heikkinen from VR Track was in charge of communications. Information about level crossing closures was communicated weekly in newspapers, and consultation events and targeted notices were used to inform schools within the area affected by the electrification of the Jyväskylä–Äänekoski line, for example. Press releases and notices of construction works were distributed to properties near the site. The Finnish Transport Agency created a website and a Facebook profile for the project. WhatsApp was used for instant messaging on site. The Buildercom portal was used as the project bank. The data transmission protocols were agreed in advance, and communication was based on a folder structure. There was plenty of information available, but it was difficult to find. Communication between construction and planning staff worked well, but there were some problems with the exchange of information between the Big Room and the planning group office. Saving new versions of plans in the project bank could have been better. Coordinating planning using a Windows-type folder structure with the metadata-based project bank also created some challenges. Weekly bulletins and group text messaging were used for

internal communications. Builders used WhatsApp for instant messaging. Having the Big Room made internal communications and the exchange of information considerably more efficient. Planning meetings that were held on a case-by-case basis during the implementation stage proved to be a good practice for managing information and ensuring internal communications, and the meetings held towards the end of the implementation stage were consequently extremely well planned.

### 3.3.6 Management of risks and opportunities and safety

Risk management was a continuous process that involved discussing risks and opportunities in teams on a weekly basis and coordinators classifying the threats identified by the teams. Threats were classified based on track sections, teams, the life-cycle stage, the target of the threat and the project's objectives. Risk workshops were held approximately once a month. There were four risk workshop groups, which planned risk management of the most notable threats identified by teams. The risk management plan was reviewed by means of expert interviews held with team coordinators approximately once a month. Efforts were also made to actively eliminate risks and control them by planning risk management measures. Risk management experts drew up monthly risk management reports for the project team. The reports contained a brief summary of risk management actions taken and the number and scale of risks, the number of pending and completed measures and risks that had materialised.

The management of risks and opportunities was the responsibility of a team operating under the safety and risk management group. Risks were reviewed quarterly by technology coordinators in order to minimise any identified risks. Risks were also discussed in expert workshops (such as a risk workshop covering all works scheduled for a total shutdown). The discussions focused on risks that had materialised and changes to risk assessments. These changes were compiled in a risk matrix in the project bank. Risks and opportunities were identified with the help of the Finnish Transport Agency's guidelines and checklists as well as a checklist compiled specifically for identifying opportunities during the railway project.

Innovation and the identification of risks and opportunities were coordinated by reorganising working groups during the implementation stage. A single working group was given responsibility for both innovation and risk management during the implementation stage, which made it possible to incorporate innovation more efficiently into the risk and opportunity management process.

More attention should have been given to the identification of risks during the development stage and at the beginning of the implementation stage as well as when the scope of the project was revised. Risks had been underestimated with regard to both the target cost and the additional funding, which made the project's budget tighter as risk costs exceeded the risk reserve.

The principle guiding occupational safety management was that each worker was responsible for their own safety, and this was ensured with the help of site supervisors and training provided by the main contractor. The project also had its own safety coordinator according to normal practice. The meeting of safety targets was promoted by regular safety and coordination meetings and safety briefings, for example. Safety was also discussed in the meetings of the alliance's management group and the project team. Safety observations were recorded in VR's incident

reporting system and the Finnish Transport Agency's safety concern and risk management system.

### 3.3.7 Quality control

Quality control during the implementation stage was based on an information management guideline, work, quality and safety plans for each stage of work, a quality assurance matrix and an archiving plan. The archiving plan was drawn up according to the Finnish Transport Agency's instructions. The plan listed all the documents produced in the course of the project, and it acted as a list of the project's quality assurance documentation. Quality assurance and compiling the quality assurance documentation were the responsibility of on-site engineers on each section of the track. The implementation process was monitored by means of self-assessment by each organisational group.

The plans factored in measures relating to quality control as well as the requirements set for technical standards. Analyses focused on the feasibility, functionality and cost-effectiveness of plans, success in meeting deadlines and the costs of drawing up plans. All plans were checked before they were supplied to the end user (by someone other than the person who drew up the plan). Any problems with quality were reported.

Planning ensured that the work methods chosen were the right ones, fit for purpose and efficient. Technical standards were monitored by means of the on-site staff's expertise and with the help of quality documentation and regular spot checks. One challenge relating to the quality documentation was the fact that documents were supplied in a haphazard and irregular manner, which meant that the quality control group had to compile the documentation section by section or separately for each stage of work.

Quality assurance of each stage of construction work began by drawing up a work, quality and safety plan. The plan described previous stages of work, the machinery and human resources available for the work, a description of the works and the phasing of the works, the schedule, quality assurance actions and documentation, the most notable risks and measures to prevent them as well as the individuals responsible for the stage of work in question. Drawing up work, quality and safety plans was the responsibility of the on-site coordinator or manager of the stage of work in question, assisted by the technology coordinator with regard to work methods and the phasing of the work, for example. Checks were mostly carried out by a consultant of Sweco PM, and plans were approved by technology coordinators. Work, quality and safety planning as well as the progress of all quality assurance documents for each stage of work were monitored with the help of a quality assurance matrix categorised according to technology.

Technical quality control documents were well organised and compiled systematically. The handover documentation given to the client was comprehensive and of high quality. The documentation was also more comprehensive than usual. The consultant was given an opportunity to comment on the handover documentation and contributed to the success of quality assurance. The alliance also updated information about all the actions taken in the course of the project in the Finnish Transport Agency's registers.

### 3.3.8 Authorisation and commissioning procedures

Authorisation and commissioning procedures were coordinated by the safety and risk management group, which was responsible for ensuring that authorisation for placing in service would be given by the Finnish Transport Safety Agency at the end of the project. The working groups' operations were overseen by the project team, which discussed decisions relating to authorisations and commissioning in its meetings. Special attention was given to procedures relating to authorisations for placing in service during the project, and the authorisation process shown in Figure 17 was followed in commissioning. The project team worked hard to make the process understood by the project organisation.

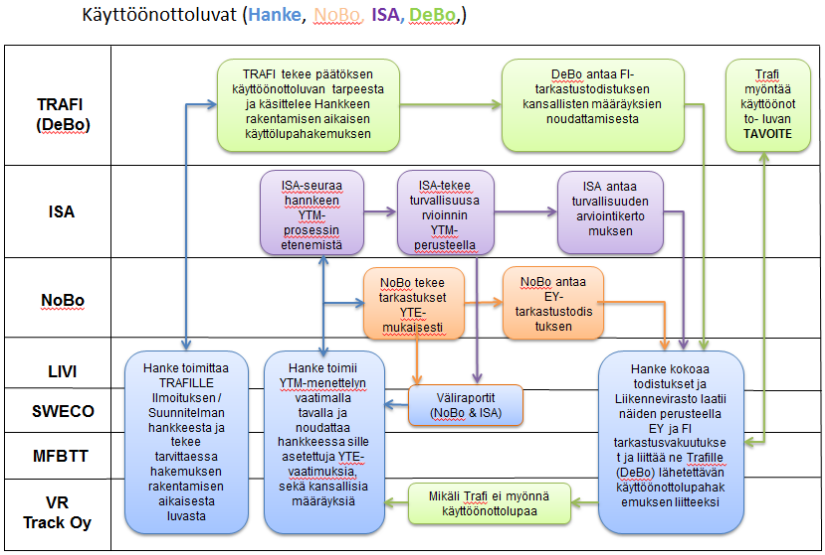



*Figure 17 Process relating to authorisations for placing in service*

Commissioning the works on schedule required special measures due to the fact that the last partial commissioning processes took place so close to the final commissioning. The project organisation liaised proactively with the authorities throughout the project, and authorisations and commissioning issues were frequently discussed with Metsä Fibre and local authorities, for example, which was crucial due to the tight schedule. The actions and time needed for successful commissioning were recognised at the very beginning of the implementation stage with the help of the Last Planner system, for example. A lot of attention was given to understanding the commissioning process, and the project organisation laid down detailed plans for ensuring that the works could be commissioned on schedule. Authorisations and commissioning issues were also frequently discussed with Valtra and local authorities.

The works were commissioned successfully and on schedule. The alliance had set up a special commissioning team, but conditions for success were created together. Meetings were held with the NoBo, ISAs, the DeBo and the Finnish Transport Safety Agency before plans were finalised and in order to discuss the project as well as plans and commissioning processes. Although the works were commissioned during the government's holiday season, there were no delays resulting from government offices being short-staffed, as the project organisation had liaised closely with the Finnish Transport Safety Agency in advance and kept it up to date by means of meetings held between two and six times a year. Plans were reviewed in great detail with the NoBo.

Equivalent conicity, which had not been tested in previous projects, was the only challenge, and authorisation for it was only secured at the last minute.

### 3.3.9 Elimination of waste and waste workshops

A waste workshop was held on 11 October 2016 in order to minimise waste. The objective of the workshop was to identify and eliminate the most notable sources of waste and to agree on responsibilities.

The most notable sources of waste identified by the alliance were as follows:

- Inefficient use of planning resources (several planners who only worked for a few hours but still had to be trained)
- Waiting around for machinery and workers
- Unnecessary work (e.g. meetings)
- Issues with coordination

Data sheets on sources of waste were analysed to find out the biggest reasons for waste and ways to reduce waste. The division of responsibilities relating to eliminating waste was not as efficient as it could have been, and not all identified sources of waste were eliminated systematically. Some of the identified sources of waste were also beyond the alliance's control.

### 3.3.10 Procurement

Procurement was coordinated by means of a procurement plan and procurement guidelines, which laid down procurement procedures and practices, the subcontractors' incentive scheme and a procurement strategy as well as authorisation thresholds for purchases, for example. All purchases were recorded in a procurement list, which was reviewed by the project team and the management group. Euro-denominated authorisation thresholds and procedural guidelines were laid down for purchases and changes in scope in the procurement guidelines. All purchases were based on competitive tendering. Bids were compared on the basis of the estimated value of the contract as well as the quoted prices (total prices or comparison prices determined on the basis of volumes and unit prices). Moreover, any purchases in excess of EUR 100,000 were analysed for quality and technical and operational performance using a value-for-money table. The value-for-money ideology also featured in the discussions of individuals who made decisions on smaller purchases. However, not all procurement discussions were systematic, and quality and cost-related factors were mostly evaluated on the basis of the expertise of the individuals planning each contract. The management group reviewed the project team's proposals of any purchases in excess of EUR 1 million and also decided on whether they would go ahead.

## 3.4 Changes introduced to the scope of the project during the implementation stage

**Changes in the scope of the project**

The scope of the project that was possible within the budget was unsatisfactory, which is why the Finnish Transport Agency decided to apply for additional funding for the execution of crucial works that were included in lot 1 but that had had to be left out of the scope of the project at the very beginning of the implementation stage. The alliance and the Finnish Transport Agency agreed that works should not be left out of the scope of the project as had been done at the beginning of the development stage if this damaged the quality of the end product and that instead the cheapest way would be to carry out all the planned works as a single project within the schedule. It was decided that it would be considerably more economical to carry out the works that had been left out of the scope of the project as part of the project and that they would greatly improve the operating conditions of the Äänekoski bioproduct mill by ensuring continuous transport links and the required rail network capacity. Closing the line to all traffic when the mill was already operational, which would have had to be done for the tunnel works, for example, would have resulted in a huge opportunity cost. The priorities chosen during the development stage showed that it would have been cheaper to carry out an even more extensive array of works in the course of the project, but the approximately EUR 10 million of additional funding allowed the execution of the most crucial works included in lot 1 (especially regarding tunnels) that had been left out. The additional EUR 10 million was granted with this in mind, and the cost estimate of the railway project was revised to match the need to repair deteriorated structures in accordance with the original scope of the project.

Works had been prioritised on the basis of the client's objectives during the development stage, and the most practical alternatives had been evaluated. Several different alternatives were explored with regard to intermediate block stations on the Tampere–Orivesi line, for example, which resulted in adding new intermediate block stations to the scope of the project. The most important tunnel works were chosen to be covered by the additional allowance of EUR 10 million. The most important works that had to be left out of the final scope of the project became a legacy for the project and maintenance staff. The areas most affected by the changes in the scope of the project were the Tampere–Jyväskylä line and the Jyväskylä–Äänekoski line. The changes required little additional planning, as the works had already been largely planned in connection with the prioritisation process during the development stage. The changes to the scope of the project were approved by the management team as revisions 1 and 2. The works added to the scope of the project as a result of the additional funding are listed in Table 1.

*Table 1. Most important revisions to the scope of the project (including revisions 1 and 2 during the implementation stage)*

| **Works** | **Line** |
|---|---|
| Construction of additional intermediate block stations between Tampere and Orivesi | Tampere–Jyväskylä |
| Replacing superstructures in the Paasivuori and Lahdenvuori tunnels<br>- Lahdenvuori, 4,370 m<br>- Paasivuori, 3,100 m | Tampere–Jyväskylä |
| Replacing floor drains in the Lahdenvuori and Paasivuori tunnels<br>- Lahdenvuori, 6,193 m<br>- Paasivuori, 3,110 m | Tampere–Jyväskylä |
| Geotechnical repairs on the vaults of the Lahdenvuori and Paasivuori tunnels | Tampere–Jyväskylä |
| Installation of trace heating for the drainage systems of the Lahdenvuori and Paasivuori tunnels | Tampere–Jyväskylä |
| Construction of tunnel entrance structures<br>- Keljonkangas II<br>- Lahdenvuori, northern end<br>- Matomäki, northern end | Tampere–Jyväskylä |
| Safety measures relating to the Tuohimutka subway, Vihtavuori subway, Haapajoki railway bridge and Paatelanlahti railway bridge | Jyväskylä–Äänekoski |
| Removal of point Jy V160 and associated safety device works | Jyväskylä–Äänekoski |
| Safety devices (warning system and parts for the Vihtavuori level crossing) | Jyväskylä–Äänekoski |
| Level crossing works (Vihtavuori and Ankeriasjärvi) | Jyväskylä–Äänekoski |
| Replacing the Kangasvuori GSM-R cable by the VIRVE system | Jyväskylä–Äänekoski |

The effects of revision 1 on the target cost are shown in Table 2 and the effects of revision 2 in Table 3. The total impact on the target cost amounted to EUR 8.78 million. EUR 0.55 million of traffic arrangement costs associated with revision 2 were excluded from the target cost.

The total costs resulting from revisions 1 and 2, i.e. their impact on the budget, amounted to approximately EUR 11 million, including the client's costs. The changes to the scope of the project (revision 2) also affected the maximum amount of the service provider's bonus pool (including the maximum amount of penalties) relative to the new scope as well as the client's strategic material costs.

Moreover, revision 2 affected the key performance targets, as the alliance decided to increase the weighting of the punctuality of long-distance passenger transport at the expense of goods transport and to make the downtime targets and scheduling targets tighter. The changes are shown in Table 7.

*Table 2. Effects of revision 1 on the target cost*

| **Yhteenveto tilausmuutos 1** | | | | |
|---|---|---|---|---|
| Korvattavat kustannukset rakentaminen | | | | 1 115 000,00 € |
| Palveluntuottajan palkkio rakentaminen | | | | 138 817,50 € |
| REM-materiaalit | | | | 132 625,50 € |
| **Vaikutukset tavoitekustannukseen yhteensä** | | | | **1 386 443,00 €** |

*Table 3: Effects of revision 2 on the target cost*

| **Yhteenveto tilausmuutos 2** | | | | |
|---|---|---|---|---|
| Korvattavat kustannukset rakentaminen | | | | 6 526 509,10 € |
| Palveluntuottajan palkkio rakentaminen | | | | 812 550,38 € |
| Korvattavat kustannukset suunnittelu | | | | 70 704,76 € |
| Palveluntuottajan palkkio suunnittelu | | | | 42 069,33 € |
| Tilaajan alihankinnat | | | | 80 000,00 € |
| Liikennehaittakorvaukset (siirto) | | | | - 550 000,00 € |
| REM-materiaalit | | | | 100 483,80 € |
| Hankkeen riskit | | | | 311 577,14 € |
| **Vaikutukset tavoitekustannukseen yhteensä** | | | | **7 393 894,51 €** |

# 4 Value for money

## 4.1 Client's objectives

The alliance met its key performance targets with flying colours and with a score of +77 (max. +100), as a result of which the service provider was paid a key performance target bonus of EUR 1.2 million (maximum bonus: EUR 1.56 million).

*Table 4. Key performance target bonus*

| | Toteuma | Painoarvo | Painotettu arvo |
|---|---|---|---|
| Liikenne- ja työturvallisuus | 24 | 30 % | 7 |
| Käytettävyys ja häiriöttömyys | 100 | 30 % | 30 |
| Aikataulu | 100 | 40 % | 40 |
| ATA-SUORITUSTASO YHTEENSÄ | | | 77 |

The biggest benefit of the alliance-based approach that had been identified at the alliance formation stage was the alliance's ability to turn the project around quickly (despite no plans having yet been drawn up), which was crucial for the timely commissioning of the bioproduct mill. The project was completed on schedule and the railway opened to traffic on 15 August 2017. All construction-stage documentation had been handed over and authorisations for placing in service secured for the Jyväskylä–Äänekoski line by 14 August and for the Tampere–Jyväskylä line by 30 August 2017, and all remaining technical documentation was handed over on 19 September 2017.

Keeping to the schedule required an exceptional performance from the alliance. The fact that the railway was commissioned and the technical acceptance inspection carried out on time can be considered an excellent achievement compared to similar projects. Meeting the deadline would not have been possible with any other method of implementation (perhaps with the exception of a project management contract with a target budget). Scheduling was extremely successful despite the occasional challenges, and the importance of completing the project on schedule was recognised as the most important goal in everything that the alliance did. Meeting the deadline generated considerable value for money, as it had positive impacts beyond the alliance project and the client. A delay in the commissioning of the Äänekoski bioproduct mill as a result of the late completion of the railway project would have resulted in a substantial opportunity cost for the mill and damaged the Finnish Transport Agency's image considerably. Success in meeting the deadline combined with the excellent results relating to other targets such as downtime also helped to boost the client's image, which was an important goal for the client.

Another important objective was to carry out all the necessary improvement works cost-effectively and with a budget of no more than EUR 80 million. The alliance failed to meet this goal, as the critical works included in the client's lot 1 were never realistic with a budget of EUR 80 million. The alliance was forced to apply for additional funding and raise the target cost. Even after the raise, the target cost was exceeded. Although commissioning the works on time was a great success, aiming for timely completion made the alliance somewhat wary to develop and adopt innovations. The

project organisation did not want to risk missing the deadline, and not much effort went into piloting new solutions due to the tight schedule. Meeting the deadline also required more resources than what had been planned, which contributed to the increased costs. This, together with the overly optimistic target cost resulting from the short development stage, contributed to the fact that the cost target was not reached.

The key performance targets were met with flying colours, which also led to exceptional results in terms of objectives that were important to the client. Similar results have not been achieved for downtime in passenger and goods transport, for example, in other projects that have been equally challenging in terms of schedule. The alliance can be said to have succeeded in the project on the whole, with the exception of the budget and safety-related objectives. A lot of good work was nevertheless done for safety, and the processes were efficient despite the few unfortunate accidents at work. The responses to the accidents and the corrective actions taken were also exemplary. The aim had been to make the minimum requirements for the key performance indicators tighter than the industry average. Progress relative to key performance targets was monitored weekly, and results were communicated to the entire project organisation by means of weekly reports. The process was not coordinated at first but became more structured at the beginning of the implementation stage. The alliance's excellent performance in terms of the key performance targets can in any case be deemed to have generated value for the client's money, and efforts to meet the objectives were systematic and some of the results achieved were exceptional.

The key performance targets related to rail safety incidents, the accident rate and the level of occupational safety. Rail safety incidents were monitored on the basis of incident types. In addition to the key performance targets, safety objectives during the implementation stage included a number of measures the execution of which was monitored as the implementation stage progressed (results in Table 4).

*Table 5 Safety objectives and performance during the implementation stage*

| Railway safety | Failure | Minimum requirement | Excellent | Notes | Final |
|---|---|---|---|---|---|
| Number of collisions | > 0 | 0 | 0 | | 0 |
| Derailments resulting from the works | > 0 | 0 | 0 | | 1 |
| Signals passed at danger | > 0 | 0 | 0 | | 0 |
| Inadequate track work procedures | > 5 | 2 | 0 | | 4 |
| Safety reviews by the Finnish Transport Agency | > 3 | 2 | 0 | | 0 |
| Points forced open | > 2 | 1 | 0 | | 2 |
| Other rail safety incidents | > 10 | 3 | 0 | | 2 |
| **Rail safety incidents, total** | **20** | **8** | **0** | **Key performance target** | **9** |
| **Safety and quality** | **Failure** | **Minimum requirement** | **Excellent** | **Notes** | **Final** |
| Accident rate | 25 | 10 | 0 | **Key performance target** | **11.1** |
| Occupational safety rate | 85 | 93 | 98 | **Key performance target** | **96.5** |
| Safety briefings | < 30 | 50 | 100 | | 150 |
| Safety concerns | < 80 | 100 | 200 | | 276 |
| Job-specific safety plans | < 30 | 50 | 100 | | 115 |
| Monitoring of fitness for work | < 100 | 250 | 400 | | 414 |

The key performance targets relating to incidents resulting from the works were not met, as a total of nine incidents were recorded during the project. The reasons for accidents and incidents were investigated thoroughly with the help of the 5 x Why technique.

The occupational safety rate was also monitored by means of the main contractor's weekly occupational safety reviews, which were calibrated at regular intervals. The target was reached, as the average occupational safety rate was 96.5%. A total of seven accidents occurred during the implementation stage, and the accident rate was 11.1. The minimum requirement for the accident rate was not satisfied, and the target was not reached.

Although the indicator values suggested that performance relative to the target was satisfactory at best, the project organisation was pleased with many aspects of how safety issues were managed and problems solved. All the accidents occurred within a short period of time during the autumn of 2016, which could have been partially due to fatigue and loss of concentration resulting from the hectic schedule.

**Availability and downtime**

The most important actions taken during the project to ensure the punctuality of rail transport included careful scheduling and coordination. Availability and downtime were measured on the basis of the punctuality of both passenger and goods transport.

The effects of disruptions on key performance targets were analysed with the help of the following questions:

- Was the disruption caused by the project?
- What other consequences did the disruption cause and who is responsible for paying compensation?
- How should the effect of unplanned speed restrictions on the punctuality of rail services be addressed?

Disruptions resulting from the project were monitored throughout the project. Performance with regard to either passenger or goods transport was not perfect, but the alliance achieved excellent results in terms of both. The punctuality percentage of goods transport was 99.65% and that of passenger transport as high as 99.96% during the project, and both results can be deemed to be exceptionally good considering the scale of the project.

With regard to goods transport, works only overran on a few occasions in the early autumn of 2016, and contingency plans were drawn up for disruptions as a result. Only very minor disruptions were caused to train traffic after the improvements. In any case, the project's results in terms of disruptions were excellent relative to any other similar project.

| Key performance target category | Alliance's target | Weighting | Indicator category | Percentage | Performance level indicator | Measuring technique | Performance level | | | Final |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Failure, -100 | Minimum requirement, 0 | Excellent, +100 | |
| Traffic safety and occupational safety | **The project causes no occupational or traffic safety incidents** | **30%** | **Traffic safety** | **20%** | **Number of rail safety incidents resulting from the works** | **Incident reports** | **20** | **8** | **0** | **9** |
| | | | **Occupational safety** | **40%** | **Occupational safety rate, %** | **Occupational safety rate** | **85** | **93** | **98** | **96.5** |
| | | | | **40%** | **Accident rate** | **Sick leaves exceeding one day per million working hours (alliance staff)** | **25** | **10** | **0** | **11.1** |
| Availability and downtime | **The project causes no disruptions to train traffic, and the lines remain open during the works**<br><br>**Disruptions to traffic resulting from the works will be minimised** | **30%** | **Functionality of the infrastructure** | **20%** | **Punctuality of long-distance passenger transport, %** | **Successful arrival at a station (less than five minutes behind schedule)** | **90** | **97** | **99.5** | **99.96** |
| | | | | **80%** | **Punctuality of goods transport, %** | **Successful arrival at a station (less than 15 minutes behind schedule)** | **90** | **97** | **99.5** | **99.65** |
| Schedule | **The lines will be reopened to traffic by 15 August 2017**<br><br>**The mill has access to the track, all project documentation has been handed over and all required authorisations have been secured** | **40%** | **Reopening the lines to traffic in the agreed condition and on schedule** | **50%** | **The lines (Jyväskylä–Äänekoski and Tampere–Jyväskylä) must be reopened to traffic on 15 August 2017** | **There must be no obstructions resulting from the works on the track** | **More than three obstructions resulting from the works** | **One obstruction resulting from the works** | **No obstructions resulting from the works** | **No obstructions resulting from the works** |
| | | | | **25%** | **The construction-stage acceptance inspection on the Jyväskylä–Äänekoski line must have taken place** | All construction-stage documentation must be complete | **31 December 2017** | **15 October 2017** | **15 August 2017** | **15 August 2017** |
| | | | | **25%** | **The construction-stage technical acceptance inspection must have taken place** | All construction-stage technical documentation must be complete | **31 December 2017** | **15 October 2017** | **19 September 2017** | **19 September 2017** |

*Table 6. Key performance targets and performance (final key performance targets, including changes made in connection with revision 2)*

# 4.2 Target cost, risks and scope of the project

The procurement stage ended up costing EUR 1.18 million, and the development stage ended up costing EUR 6.56 million. Including revisions 1 and 2, the budget for the implementation stage was EUR 65.86 million. The final cost of the implementation stage at the end of the construction stage stood at EUR 68.98 million. The cost estimate rose from the target cost during the implementation stage, and the target cost was eventually exceeded by EUR 2.15 million. The service provider was responsible for EUR 1.07 million and the client for EUR 1.07 million of the overspend.

Much of the overspend was due to the overly optimistic target cost and the inadequate risk reserve as the scope of the project grew from the original estimate. The short development stage did not allow for enough planning to ensure a reliable cost estimate, and the soundness of the plans and benefits to be derived from synergies were overestimated. Too many works were included in the client's budget, which led to the budget being exceeded. Works on the Jyväskylä–Äänekoski line were completed according to the project plan, and the biggest change was the increased scope of works relating to the Kangasvuori tunnel. Considerably more level crossings were eliminated and improved than what had been planned originally, in order to comply with the Finnish Transport Safety Agency's regulations and the Finnish Transport Agency's guidelines. Landowners filed numerous complaints relating to private roads, which is why level crossings, instead of eliminating them, had to be brought up to standard and, in cases, equipped with safety devices, which also increased costs considering that the target cost was based on these level crossings being removed. Works on other sections of the track were completed according to the project plan, and the biggest changes to the scope of the project resulted from unexpected working conditions in the Lahdenvuori and Paasivuori tunnels. Many of the synergies on which the target cost was based were not realised. The tight schedule and having to rush works meant that fewer minor synergies were found than what had been expected.

*Table 7. Final costs*

| Toteutusvaiheen rakentamisen korvattavien kustannusten koontitaulukko (mukana TAS valmistelutyöt) | | | | | |
|---|---|---|---|---|---|
| | | Laskenta € | Tavoite € | Toteutunut € | Jäljellä (vrt. tavoite) |
| **JOHTO JA YLEISKUSTANNUKSET** | | | | | |
| | Johto | 4 805 424 | 4 689 529 | 2 434 529 | 2 255 000 |
| | Matkat ja majoitukset | 3 107 866 | 3 030 127 | 4 238 749 | -1 208 622 |
| | Mittaus | 783 680 | 764 706 | 673 640 | 91 066 |
| **PÄÄLLYSRAKENNETYÖT** | | | | | |
| | Päällys TPE-JY, Linja- ja tunneliosuus | 2 206 231 | 2 206 231 | 1 712 801 | 493 430 |
| | Päällys JY-ÄKI, Linja- ja tunneliosuus | 6 151 422 | 5 982 579 | 6 656 486 | -673 907 |
| | Päällys JY-ÄKI, Ratapihat | 2 282 691 | 2 219 926 | 1 925 515 | 294 411 |
| | Päällys TPE-ÄKI, Sepeli | 2 905 950 | 2 833 356 | 3 067 355 | -233 999 |
| **TURVALAITETYÖT** | | | | | |
| | Turva TPE-JY | 4 143 089 | 4 085 913 | 4 248 395 | -162 482 |
| | Turva JY-ÄKI Linjaosuus | 1 806 223 | 1 756 559 | 1 513 327 | 243 232 |
| | Turva JY-ÄKI Ratapihat | 3 705 137 | 3 603 260 | 3 287 385 | 315 875 |
| **SÄHKÖ- JA VAHVAVIRTATYÖT** | | | | | |
| | Sähkö TPE-ÄKI Linjaosuus ja tunnelit | 1 913 568 | 1 868 165 | 1 610 987 | 257 178 |
| | Sähkö JY-ÄKI Ratapihat | 487 613 | 474 206 | 415 953 | 58 253 |
| **ALUSRAKENNE- JA KUIVATUSTYÖT** | | | | | |
| | Maa Alusrakenteet | 1 556 499 | 1 513 701 | 1 336 336 | 177 365 |
| | Maa Rummut | 966 961 | 940 373 | 990 381 | -50 008 |
| | Maa Salaojat ja avo-ojat | 423 254 | 411 616 | 643 326 | -231 710 |
| **KALLIO- JA TUNNELITYÖT** | | | | | |
| | Tunnelit TPE-JY, Lahdenvuori ja Paasivuori | 1 316 514 | 1 316 514 | 1 682 860 | -366 346 |
| | Tunnelit JY-ÄKI, Kangasvuori | 3 617 648 | 3 518 177 | 5 282 546 | -1 764 369 |
| | Kallioleikkaukset JY-ÄKI | 535 161 | 520 446 | 922 835 | -402 389 |
| **SILTATYÖT** | | | | | |
| | Silta Vihtiälän kannenvaihto | 2 063 741 | 2 006 996 | 2 376 416 | -369 420 |
| | Silta Muut siltatyöt | 1 032 444 | 1 006 980 | 1 348 181 | -341 201 |
| **MUUT RAKENTEET** | | | | | |
| | Tasoristeykset ja muut rakenteet | 2 804 060 | 2 740 828 | 3 631 441 | -890 613 |
| | | | | | |
| **PALVELUNTUOTTAJAN TYÖT YHTEENSÄ** | | **48 615 175** | **47 490 190** | **49 999 444** | **-2 509 254** |

The biggest overspends relative to the target confirmed at the end of the development stage are shown in Table 8 below and savings in Table 9.

*Table 8. Most notable overspends*

| **Works according to the project plan** | **Overspend** | **Reason and consequences** |
|---|---|---|
| Planning | EUR 0.68 million | The scope of the project increased significantly from what had been originally planned. |
| Travel and accommodation | EUR 1.21 million | The estimate based on the average number of human resources turned out to be inaccurate. More human resources had to be employed due to the tight schedule. Considerably more money was also spent on car expenses than what had been estimated. |
| Superstructure works on the Jyväskylä–Äänekoski line | EUR 0.67 million | The finishing touches were not organised efficiently, and some of the works were carried out at inopportune times due to the tight overall schedule. |
| Superstructure materials for the Tampere–Äänekoski line (macadam) | EUR 0.23 million | More macadam was needed than what was expected. |
| French drains and open ditches | EUR 0.23 million | The scope of the project increased significantly from what had been originally planned. Two critical locations that had not been taken into account in the cost estimate (Äänekoski and Suolahti rail yards) were found to have inadequate drainage during the implementation stage. |
| Works relating to the Lahdenvuori and Paasivuori tunnels | EUR 0.37 million | The rock faces had to be repaired with the help of contractors who charged for the work on an hourly basis. The contractors were assisted by the project organisation's staff and supervisors. Replacing the floor drains in the tunnels was not as efficient as planned. |
| Works relating to the Kangasvuori tunnel | EUR 1.76 million | Considerably more drainage (1.3 km of trench excavation) and grouting were needed in the tunnel's substructure than what had been planned. There were omissions in the plans, and the cost estimate was overly optimistic. For example, excavating shafts in the tunnel floor was missing from the plans. There were also problems with competitive tendering and coordinating works involving different technologies. |

| | | |
|---|---|---|
| Rock cutting along the Jyväskylä–Äänekoski line | EUR 0.40 million | The scope of the project increased significantly from what had been originally planned, and the market situation was challenging. |
| Bridge works | EUR 0.71 million | Inadequate plans for resurfacing the Vihtiälä bridge resulted in an overspend of EUR 0.37 million, and planning other works relating to the bridge was challenging (changes to the plans, delays), which caused changes to the order of works, standstills and unnecessary work. |
| Level crossings | EUR 0.89 million | The scope of the project increased significantly from what had been originally planned. There were problems relating to private roads. Other structures had not been given enough attention in the cost estimate (e.g. tree removal). Works that had originally been included in the electrification contract were moved to this category (e.g. installation of electrified track mountings in the Kangasvuori tunnel, which cost approximately EUR 0.3 million). |

*Table 9 Most notable savings*

| **Works according to the project plan** | **Saving** | **Reason and consequences** |
|---|---|---|
| Management and administration | EUR 2.26 million | Areas of responsibilities were amalgamated, the organisation was streamlined and external consultants were employed.<br><br>Costs relating to the warranty period (EUR 0.4 million) were separated from the budget. |
| Safety devices | EUR 0.40 million | Successful solutions and efficient execution of works as well as clever purchasing led to savings of EUR 0.24 million on the Jyväskylä–Äänekoski line and to savings of EUR 0.32 million in rail yards. Problems with finding opportune times for executing works resulted in an overspend of EUR 0.16 million on the Tampere–Jyväskylä line. |
| Superstructure works on the Tampere–Jyväskylä and Jyväskylä–Äänekoski lines | EUR 0.49 million | Efficient planning and the use of less materials than anticipated resulted in savings on the section between Kangasvuori and Äänekoski. Works were carried out serially, and planning and execution were centralised, which increased efficiency considerably. |
| Superstructure works on the Jyväskylä–Äänekoski line and in rail yards | EUR 0.29 million | Some rail yard track replacements could be carried out on two parallel tracks simultaneously, and several old points could be upgraded at the same time, which increased efficiency. |
| Electrification and high-voltage works | EUR 0.26 million | The savings were thanks to successful solutions and efficient execution as well as the integration of works that could be carried out simultaneously. |

More risks materialised during the construction stage than had been anticipated, which increased the project's costs and made it more challenging to keep to the schedule. The risk reserve calculated for the target cost turned out to be inadequate.

The biggest risks and opportunities during the project related to tunnels. The biggest risk that actually materialised occurred in the Kangasvuori tunnel, where the materialisation of the risk resulted in costs of almost EUR 1.8 million. The volume of materials had been underestimated, and delays with drainage works also prevented the completion of superstructure works on schedule. Estimates relating to the execution of the works were unrealistic, and the workers encountered several surprises even though the tunnel had been scanned by lasers. The biggest problems were found underneath the superstructure and did not show up in the scans. Three or four times as much grouting as has been planned had to be done, and almost the entire length of the drainage works had to be excavated. Problems resulting from delays with drainage works were mitigated by rescheduling superstructure works relating to the tunnel from the autumn of 2016 to the spring of 2017. Lessons learnt from the Kangasvuori tunnel helped in the planning of tunnel works in 2017 and in identifying the associated risks and opportunities. The early arrival of winter, which had been identified as a major risk, also caused some works to be postponed until the spring, which increased the risk of not meeting the tight deadline. Another risk that materialised involved problems with coordination, which were addressed in weekly coordination meetings. Weekly coordination meetings relating specifically to the Kangasvuori tunnel were started, which helped to increase the efficiency of works in the tunnel.

A cost-effectiveness assessment group consisting of representatives of the service provider, the client and third-party cost experts carried out an independent assessment of the project's overall cost-effectiveness. The cost-effectiveness assessment was based on the works carried out in the course of the project and on workloads examined from three perspectives.

The perspectives used in the cost-effectiveness assessment were as follows:

- The service provider's cost report (retrospective cost analysis and final prices of the main stages of work based on volumes for the whole project)
- Reference analysis (cost estimate based on the same volumes but using a different project implementation model, i.e. turn-key or design-and-build contract)
- FORE analysis (cost estimate based on final volumes)

In terms of the total costs, including all variables and assumptions, the cost-effectiveness assessment group estimated the project's final costs (EUR 91.10 million) to be slightly higher than those indicated by the reference analysis (EUR 90.53 million), while the FORE analysis gave by far the lowest costs (EUR 85.04 million). With only those works for which unit prices were available taken into account, the alliance project (EUR 46.43 million) was cheaper than the reference project (EUR 50.53 million) but still more expensive than the FORE analysis (EUR 41.03 million). It is important to keep in mind when interpreting the analyses that they involved a high degree of assumptions and overlooked details. The assessment group concluded that the alliance's final costs could be deemed to have been in line with the market, which means that the alliance's own target, which was to make considerable savings, was not reached. Some of the synergies and benefits

forecast during the development stage did not materialise, and the target cost, which had been deliberately made difficult to achieve, ended up being exceeded.

According to the cost-effectiveness assessment group's report, the project produced no notable savings or solutions or work methods that were considerably cheaper than the market price and that could be deemed to be directly attributable to the alliance model. It is practically impossible to take into account the effect of an exceptionally tight schedule on cost-effectiveness, and the cost-effectiveness assessment group felt that the alliance's biggest achievement was completing the project within a timescale that would have been extremely challenging or even impossible to achieve with other contract models.

## 4.3 Ideas and innovations

A lot of ideas were recognised, but putting them into practice and documenting them were not successful. Only a small percentage of the ideas recognised during the development stage were prioritised and put into practice. There was no further processing and systematic implementation of ideas, and there were no clear procedures or responsibilities relating to putting them into practice. The problems relating to implementing innovations was partially due to the fact that ideas were aimed at generating extremely substantial savings and that some of the ideas were unrealistic.

The objective of adopting a more innovative attitude was achieved to a degree. Apart from innovation workshops, the creation of innovations was largely uncoordinated. Improvements were introduced with regard to innovation during the implementation stage by incorporating innovation into the risk management process. This turned out to be a good solution, as identifying risks and ideas were mutually complementary processes. Innovation workshops were also organised during the implementation stage. There were few iterations and little revision planning relating to plans during the implementation stage due to the extremely tight schedule. Apart from the innovation workshops, innovations during the implementation stage mostly related to work methods. Several innovations mostly relating to work techniques were identified on a daily basis on site, which were nevertheless not documented. However, the majority of innovations originated from sources other than the workshops. The innovation workshops generated plenty of good ideas and innovations (the 19 most notable ideas were worth EUR 1.4 million). Putting the innovations made during the implementation stage into practice was slowed down or hindered by, among other things, the fact that all decisions required approval from outside the project. For example, contaminated soil from the tunnels could not be put back into the railway structure due to the challenges relating to getting permits. The cost-related and schedule-related benefits of innovations were assessed by means of a table of innovations and their effects in the project bank. The total benefits of innovations are listed in Table 10 below.

*Table 10 Engineering solutions aimed at ensuring that the client's objectives were met The colours in the table refer to the client's objectives as follows:*

| | |
|---|---|
| | Is profitable |
| | Increases the reliability of the schedule or shortens the turnaround time |
| | Reduces downtime or makes periods when works need to be carried out shorter |
| | Improves safety |
| | Improves quality |

| | Innovation/action | Effect |
|---|---|---|
| | The Kuusankoski bridge does not need to be widened. | EUR 400,00 was saved. |
| | Oil transformers do not need to be moved out of the tunnels or replaced by dry-type transformers. The old feed and heating cables can be kept where needed and new HF cables used in the conduits. | Using HF cables could save EUR 250,000 (realised partially due to lower material costs). |
| | Lighting in Äänekoski can be provided by means of HPS lamps. | Using HPS lamps saved EUR 120,000. |
| | Frost insulation can be placed underneath the ballast contrary to the railway engineering guidelines. | This saved a considerable amount of money and time. |
| | Different macadam types can be used in different places. | The optimised use of macadam saved money. |
| | Tunnel entrances can be built using prefabricated elements during a total shutdown. | Not having to cast structures on site saved a considerable amount of money and time. |
| | Trace heating pipes can be installed in connection with drainage pipes. | This saved time and money. |
| | The drainage depth of the tunnels can be optimised. | This saved time and money. |
| | Superstructure works in rail yards can be carried out efficiently in large lots by working on parallel rails or an entire line of points, for example, simultaneously. | This saved time and money. |
| | A takt time schedule can be drawn up for total shutdowns to ensure that works are completed on time. | This saved time and money and ensured that works during total shutdowns were completed on time. |
| | A longer total shutdown can be arranged for the Jyväskylä–Äänekoski line during a shutdown at the cardboard plant and used to carry out the most difficult works. | This saved money and ensured that works were completed on schedule. |
| | The ballast in the Lahdenvuori and Paasivuori tunnels can be screened instead of replacing it. | This reduced macadam consumption and the amount of contaminated soil and saved time and money. |

| | | |
|---|---|---|
| | Shotcreting machinery can be equipped with wheels. | Rolling stock was employed for the work in places, which saved time. |
| | Several innovations were made relating to scheduling practices and the process. | This made scheduling more efficient. |
| | Several innovations were made relating to the phasing of works. | This saved time and made the schedule more reliable. |
| | Tunnel works can be scheduled and resources allocated by modules. | This allowed for a more accurate schedule. |
| | Works in the Kangasvuori tunnel can be broken down into individual elements. | This increased supply and helped to disperse the risk as well as speeding up the schedule. |
| | Superstructures on the Jyväskylä–Äänekoski line can be replaced by means of excavation. | This was more cost-effective and sped up the schedule. |
| | The overhead lines in the tunnels on the Jämsänkoski–Jyväskylä line can be anchored at the edges of the work site to reduce the need for dismantling in the Lahdenvuori tunnel. | This sped up works during the total shutdown. |
| | All works on the Jyväskylä–Äänekoski line can be carried out in the daytime or during long weekend shutdowns. | This reduced labour costs and improved occupational safety. |
| | InfraKit can be used for locating machinery. | This made work easier. |
| | Tunnel works can be monitored with the help of a diagram. | This improved safety. |
| | Safety plans can be drawn up for works sites (including small ones) and used for identifying safety issues.<br>Even small-scale works can have quality control and occupational safety plans. | This improved safety. |
| | Several innovations were made relating to measuring success. | This improved quality. |
| | Innovations were made relating to machine control models. | This improved quality. |
| | A machine with a stencil can be put on rails to establish the structure gauge in the Kangasvuori tunnel. | This improved quality. |
| | The old lattice can be widened to make room for the electric rail structures on the Paatelanlahti railway bridge. | This improved quality and cost-effectiveness. |
| | A report can be drawn up on equivalent conicity. | This was a nationally important solution that can also benefit other projects. |
| | Sleeper distribution equipment was improved to enable machine-controlled sleeper installation. | This improved quality and saved time. |

Although not many new techniques and solutions were created, considerable savings were made by making the process more efficient and speeding up schedules, for example.

## 4.4 Lessons learnt from the implementation stage

**Performance**
Considerable savings were made in superstructure works by increasing efficiency. The adoption of a new technique saved money in the superstructure works between Jyväskylä and Kangasvuori. The process along 40 kilometres of superstructure works became more efficient and superstructure works could be carried out in 600-metre stretches. A 600-metre stretch initially took 10 hours, but towards the end the time was reduced to eight hours. The results can be considered good compared to reference projects.

*Table 11. Efficiency compared to reference projects*

| Task | Average amount of work carried out in eight hours (alliance) | Average amount of work carried out in eight hours (reference project) | Unit |
|---|---|---|---|
| Replacing superstructures by means of excavation | 566 | 525*** | Metres of track per shift |
| Ballast screening | 424 | 392* | Metres of track per shift |
| Replacing rails | 827 | 601** | Metres of track per shift |
| Welding | 727 | 752* | Metres of track per shift |

* Lielahti–Kokemäki alliance project (source: value-for-money report)
** Lielahti–Kokemäki alliance project (source: value-for-money report); note: different rail fastening method
*** Vaala–Kivesjärvi line, 2015 (source: VR Track Oy); note: electrified track (but traffic shutdowns lasting between 1.5 and two hours more)

The cost target set for superstructure works was met comfortably on the Tampere–Jyväskylä line, but the costs on the Jyväskylä–Äänekoski line were well above target. The cost estimate was at its best comfortably within the target but rose considerably towards the end as the integrity of the structure was overestimated. Although the major superstructure replacement works progressed systematically, finishing embankments, collecting materials and stabilisation turned a forecast underspend into an overspend (works had to be carried out at inopportune times and around others, and resources were constantly reallocated to more important works). Supporting works could not be carried out in connection with the superstructure works themselves. Macadam consumption also exceeded estimates, which contributed to the increased cost of the superstructure works.

Works relating to safety devices were very efficient, and the cost target was met comfortably. Works on level crossings increased from the development stage, but they were nevertheless carried out relatively efficiently. Slight savings were made in terms of measuring costs by using a machine-control/data model. Electrification and

high-voltage works as well as works relating to safety devices could be carried out side by side, which shortened the timescale and increased cost-effectiveness.

The tight schedule in geotechnical works resulted in higher costs. The biggest problems related to works in the Kangasvuori tunnel, where workloads relating to grouting and excavation, for example, increased considerably. In addition to the unforeseen increase in workload, coordinating works in the tunnel was also challenging. Works in the Kangasvuori tunnel created pressure relating to the project's target cost and schedule. The schedule dictated how the works were executed, and the stages of tunnel works carried out during the total shutdown required careful planning and more resources than had been expected, which also increased costs. The cost estimate of tunnel works was also extremely tight due to the fact, among others, that no bids had been received for tunnel works when the cost estimate was drawn up and the estimate ended up being too optimistic.

The Vihtiälä bridge ended up needing more work than anticipated and the cost target was exceeded. Inadequate planning meant that the cost estimate was missing quantitative information (the cost estimate was not based on volumes). The Vihtiälä bridge was not included in the original lot 1, and it was only added to the scope of the project at the very end of the development stage. There was no time to plan works on the basis of accurate source data or to estimate costs on the basis of quantitative information, and the cost estimate for works relating to the Vihtiälä bridge therefore did not give enough attention to temporary arrangements during the works, such as diversions and traffic arrangements as well as support structures. On the whole, however, the works were carried out successfully. The plans for other bridge works were good, but surprises encountered on site increased costs.

**Innovation and quality control**

Alliance staff were encouraged to systematically come up with ideas and innovations in order to find cost-effective solutions with the help of instant innovation bonuses, for example. However, the tight schedule hindered progress, which was a major reason why there was less comparing of alternatives and developing and implementing new solutions than what had been anticipated, as big decisions had to be given priority in order to meet the deadline. Considerably more potential innovations were identified than could be developed or implemented. The innovation process would have been more efficient if there had been a planning template that could have been used, alongside the client's objectives, as a basis for systematically thinking about better solutions for daily work. As it was, ideas were left too abstract and many of them were not implemented. Several small innovations were nevertheless recognised during the implementation stage which enabled savings to be made, improved quality or made deadlines easier to meet. Several improvements relating to techniques were devised on site, which were nevertheless not documented.

Quality control focused too much on document management at the beginning of the implementation stage, and quality issues were not documented as efficiently as they should have been. A key improvement in terms of quality control towards the end of 2016 was the added attention given to self-assessment, which should have been done earlier. The responsibility for quality control was delegated to the safety and commissioning group during the implementation stage. The process was working well towards the end of the implementation stage, and authorisations for placing in service were secured on schedule and on the basis of high standards.

**Choice of planning and implementation solutions and cost control**

The client's objectives and cost monitoring data steered planning and the choice of solutions relatively effectively during the implementation stage. Different planning and implementation alternatives were compared against the client's objectives. However, this was not always done sufficiently systematically or documented well enough but was based on the expertise and experience of the alliance's staff. Alternatives were largely compared and chosen on the basis of previous experiences. The most important issues were addressed in project team meetings. Key performance indicators set a direction for the project, and the project can be deemed to have met the client's objectives in an exemplary manner with the exception of the budget and safety-related targets.

Cost forecasting resulted in more and more accurate estimates and allowed progress to be monitored on the basis of completed works. Data on completed works was successfully used to plan for the future and to make forecasts more accurate on the basis of the progress of works and planning. Costs also affected the choice of planning and implementation solutions, and measures were taken on that basis to save money in different areas, for example. However, the tight schedule meant that there was not enough time to compare planning solutions very extensively with regard to life-cycle costs or effects on quality, for example. Costs were monitored comprehensively and in real time, and information about costs was communicated efficiently within the project organisation. The target cost turned out to be slightly too optimistic, and the risk reserve was inadequate and synergies were overestimated.

**Schedule management**

Keeping to the extremely tight schedule required efficient time management. The importance of meeting deadlines and the tightness of the schedule were identified as critical for the success of the project ever since the development stage. A lot of attention was given to schedule management, and tools that supported traditional overall scheduling (PlanMan) and visual methods were employed, such as phase scheduling and weekly scheduling as well as the takt time ideology in the case of time-critical tunnel works, for monitoring purposes. Line coordinators and the project team found the Last Planner system effective, but some members of the project organisation found schedule management practices too cumbersome on the whole. The project organisation was involved in schedule management comprehensively and regularly, but working on the schedule was time away from other work. Schedule management was streamlined in connection with the organisational reform at the beginning of 2017 by adopting more flexible scheduling and production planning techniques and by making the weekly routine clearer. The end results speak for themselves, and meeting the extremely tight deadline shows that schedule management was successful. Successful schedule management also generated value for money by enabling flexibility in phasing and scheduling works. Changes in the order of works resulted in scheduling benefits and made up for delays caused by problems. Decisions on reallocating resources and changing the order of works were made efficiently and quickly. Any necessary changes could be made quickly and easily thanks to the detailed schedule. The shortage of planning resources and the tight schedule resulted in some challenges in planning works relating to bridges and level crossings as well as high-voltage works, for example. On the whole, however, the planning schedule was also managed successfully.

**Resources and subcontracting**

Planning resources were found to be inadequate in view of the tight schedule at times. Other simultaneous large-scale infrastructure projects also created challenges in terms of the availability of resources for tunnel works, for instance. For example, there was a shortage of wheeled excavators in the autumn of 2016. Finding competent excavator operators was difficult, and this slowed down progress on finishing the embankment, for example. When more machines became available, winter had arrived and works had to be suspended.

The same requirements mostly applied to subcontractors as to VR Track's staff. The operating cultures of the various parties were different, however, which meant that subcontractors had to be given training on the safety practices and rules to be followed during the project.

The project employed more than 200 people in total for much of the implementation stage, and there were numerous subcontractors on site. This required efficient coordination, communicating common goals and steering subcontractors' operating cultures.

The subcontractors' incentive scheme was found to steer the subcontractors covered by the scheme efficiently. Cooperation with other subcontractors was largely based on the traditional model. Purchases were mostly made on the basis of conventional competitive tendering, and subcontractors were not made to commit to common goals. Subcontracting was the responsibility of the individuals in charge of technology-specific contracts and purchases. Subcontracts that required contracting and human resources were based on the general terms and conditions of construction contracts. The alliance approach and team spirit could not be injected into these contracts. Subcontractors' staff found working on site similar to any other railway project.

**Organisation and work methods**

The perceived benefits of the alliance model included cooperation between the client and service providers, which was relatively successful regardless of the initial challenges. Side-by-side planning and construction, integration and flexibility were also visible in the work of the project team in particular, which means that the benefits sought by the alliance model were mostly realised.

There was some confusion relating to organisation and the division of responsibilities at the beginning of the implementation stage, and processes overlapped. The organisation reacted to the challenges, and major changes were made during the implementation stage by streamlining the organisation and especially by abandoning the technology-based organisation and adopting a line-based model instead. The changes made the alliance's work more efficient and helped to resolve the initial challenges as well as creating conditions for successful implementation. Changes in key personnel also created challenges at times. There were times when the client's instructions were felt to be inadequate, and the project organisation would have liked the client to participate more actively in the project team in order to speed up decision-making. This was an especially big issue during the development stage when priorities for the project were being devised. The client's scant participation was not, however, seen to hinder planning during the implementation stage, as the service

provider had a relatively large amount of freedom to draw up plans independently. The client's absence did cause some challenges in terms of getting approval for decisions relating to implementation solutions, for example. The client became considerably more involved in the project towards the end of the implementation stage.

Alliance leadership and the Big Room approach helped the project to succeed thanks to better communication and coordination of works, for example. The Big Room and working in the same space were taken advantage of extensively and systematically during the project. Workshops were well structured and planned, and visual methods were used as aids. The events usually involved approving ready-made proposals without discussing alternative solutions. However, preparing and organising workshops and documenting their outcomes could have been more efficient, and a practice of holding planning meetings before workshops was consequently adopted. The workshops and meetings held towards the end of the implementation stage were well planned and efficient. The weekly routine was a practical and efficient solution for guiding work. The fact that all key members of staff were regularly present from Tuesday to Thursday was beneficial for the decision-making process and for comparing alternatives. The organisation made time for workshops and open-minded discussions. The Big Room layout worked well considering the requirements of the project. In addition to private workspaces, there were meeting facilities available. The doors between rooms were kept open, which enabled quick and timely exchange of information even on spontaneous matters.

The project organisation evolved during the implementation stage and became better adapted to the project's requirements. It took some time to adjust to the changes, however, in addition to which amending weekly routines and working groups created some challenges in terms of learning new approaches and routines. The tools available for the project made work more efficient and targets easier to reach, but there were also some challenges relating to the extent to which they were used and the involvement of different parties.

**Implementation-stage incentive scheme**

The key performance targets relating to safety, downtime and the schedule were well chosen. The key performance targets can be deemed to have generated value for money, as they successfully focused the alliance's work on areas that were relevant in terms of the client's objectives. The incentive scheme adopted for the implementation stage steered work efficiently. Enough attention was given to the key performance targets, and succeeding in meeting them was genuinely in the service provider's interests. The key performance targets were met with flying colours with the exception of safety-related targets. The tight schedule and large number of subcontractors resulted in a few incidents and accidents, but some of the issues were coincidental.

# 4.5 Client's financial statements on the p oject

After the changes introduced to the scope of the project, the project's target cost was EUR 72.41 million. The client had also reserved approximately EUR 18.02 million for costs that were not included in the target cost, of which EUR 1.56 million were for the bonus pool, EUR 15.11 million for the client's strategic purchases, approximately EUR 1.18 million for project planning and EUR 0.17 for temporary traffi  arrangements. After the changes to the scope of the project (revisions 1 and 2), the total cost estimate stood at EUR 90.44 million (including the full amount of the bonus pool, which was not a realistic target after the approval of revision 2).

The target cost ultimately came in at EUR 74.56 million at the end of the construction stage, and the target cost was exceeded by approximately EUR 2.15 million. The overspend was split evenly between the contracting parties according to the commercial model, and the service provider was therefore liable for half of the overspend (approximately EUR 1.07 million). Costs excluded from the target cost amounted to approximately EUR 18.01 million at the end of the construction stage. Taking the service provider's share of the overspend into account, costs excluded from the target cost amounted to an estimated EUR 16.94 million. The client's strategic purchases came in under budget and amounted to EUR 15.01 million. Approximately EUR 1.2 million was paid to service providers from the bonus pool, and the amount was EUR 0.36 million below the maximum. The costs of temporary traffi  arrangements and expenses during the procurement stage amounted to approximately EUR 1.35 million in total. The client also kept a budget risk reserve of EUR 0.44 million for the warranty period.  The cost estimate proved accurate, and the project's final costs amounted to EUR 91.06 million. With the budget risk reserve, the project's budget spending estimate stands at EUR 91.5 million (Table 12).

*Table 12 Financial summary*

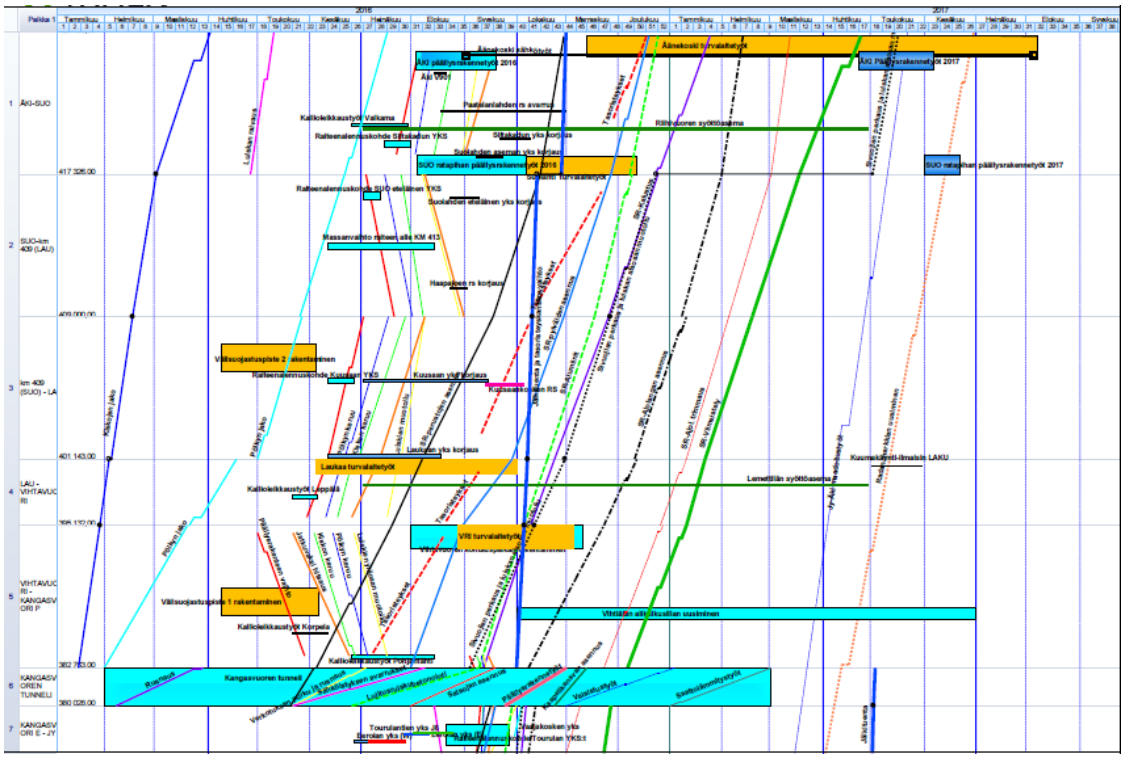
| **Budget spending, forecast on 22 November 2017** | | | |
|---|---|---|---|
| **Target cost (actual cost and cost estimate)** | 74 563 661,17 | EUR | |
| **Actual cost excluding risks** | *73 852 380,04* | *EUR* | Actual project cost excluding the risk reserve |
| **Risks included in the target cost** | *711 281,13* | *EUR* | Risk reserve for the warranty period (warranty-stage cost estimate) |
| **Railway project costs excluded from the target cost** | 16 936 338,83 | EUR | |
| **Service provider's share of the overspend (50%)** | *-1 074 428,91* | *EUR* | Forecast overspend on the target cost to be split 50/50 between the contracting parties |
| **Costs during the procurement stage** | *1 184 971,25* | *EUR* | Actual costs during the procurement stage |
| **Strategic materials** | *15 013 493,85* | *EUR* | Actual costs at the end of the construction stage |
| **Traffic arrangement costs** | *165 516,36* | *EUR* | Actual costs of the year 2016 (as of 20 December 2016) |
| **Bonus pool (payments)** | *1 204 784,57* | *EUR* | Key performance bonus based on the project's key performance target attainment (77) (total bonus pool: EUR 1,564,655.29) |
| **Client's budget risk** | *442 001,71* | *EUR* | Budget risk reserve |
| **Total budget spend** | 91 500 000,00 | EUR | |

## 4.6 Value for money generated during the implementation stage

*Table 13. Value for money generated during the implementation stage / challenges during the implementation stage*

| **Successes** | **Areas in need of improvement** |
|---|---|
| + Scheduling and sticking to the schedule | - Too many levels and repetitions in schedule management |
| + Timeliness of cost monitoring and forecasts | - Overspending |
| + Efficiency of superstructure works and techniques employed | - Inefficient coordination of works relating to the Kangasvuori tunnel |
| + Flexibility afforded by the implementation model and versatile scheduling processes in phasing works | - Inadequately planned start to the implementation stage (processes and responsibilities) |
| + Flexibility of the project organisation relative to the requirements of the project (organisational reforms during the implementation stage) | - Unclear division of responsibilities |
| + Well planned workshops and visual aids | - Inadequate implementation of innovations |
| + Success in meeting key performance targets | - Failure to meet safety-related targets |
| + Staff competence | - Changes in personnel |
| + Cooperation between the service provider, the client and the operator as well as the mill | - Insufficient client participation in decision-making |
| + Efficient commissioning | - Inadequate planning of principles for changing the scope of the alliance |
| + Improved project documentation and archiving methods | - Unsystematic approach to life-cycle targets and documenting decisions |
| + Cooperation with stakeholders | - Committing subcontractors to common goals |
| + Positive public image | - Underestimation of risks and overestimation of synergies |

# Overall project schedule



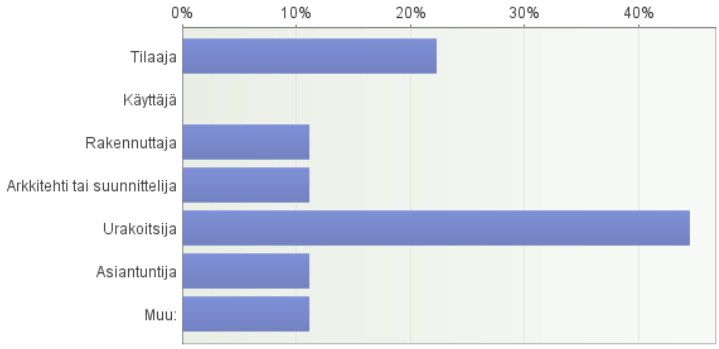
# Findings of the implementation-stage alliance survey

## 1. Respondent's contact details (responses analysed anonymously)

Number of respondents: 9

## 2. Respondent's role in the project

Number of respondents: 9

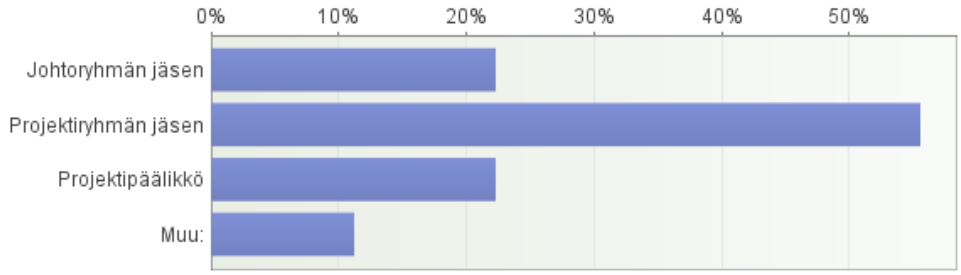



**Answers to open-ended questions: Other:**

- Service provider

## 3. Respondent's role in the organisation

Number of respondents: 9




**Answers to open-ended questions: Other:**

- Project engineer (schedule)

## 4. Contracting authority

Number of respondents: 9

- Finnish Transport Agency
- Finnish Transport Agency
- Finnish Transport Agency
- Finnish Transport Agency
- Finnish Transport Agency
- VR Track Oy
- Finnish Transport Agency / Projects
- Transport routes
- Finnish Transport Agency / Projects

## 5. Project

Number of respondents: 9

## 6. How would you rate the efficiency of the alliance model on the whole?

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| Efficiency of the alliance on the whole | 0% | 0% | 33.33% | 44.44% | 22.22% | 9 |

## 7. How would you rate the following factors relating to the efficiency of the alliance?

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| Alliance as an implementation model | 0% | 0% | 11.11% | 44.44% | 44.44% | 9 |
| Meeting the client's objectives | 0% | 0% | 11.11% | 55.56% | 33.33% | 9 |
| Contract template(s) | 0% | 11.11% | 11.11% | 55.56% | 22.22% | 9 |
| Commercial model | 0% | 11.11% | 11.11% | 44.44% | 33.33% | 9 |
| Incentive scheme | 0% | 0% | 55.56% | 11.11% | 33.33% | 9 |
| Open books principle | 0% | 11.11% | 0% | 44.44% | 44.44% | 9 |
| Alliance management and guidance | 0% | 0% | 33.33% | 66.67% | 0% | 9 |
| Cooperation and interaction between the contracting parties | 0% | 0% | 33.33% | 55.56% | 11.11% | 9 |
| Resources and competence of the contracting parties | 0% | 0% | 55.56% | 33.33% | 11.11% | 9 |
| Atmosphere at work and efficiency of the work community | 0% | 11.11% | 22.22% | 66.67% | 0% | 9 |
| Physical working environment. | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| Use of external experts | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| Total | 0% | 3.7% | 27.78% | 49.07% | 19.44% | 108 |

## 8. What are your views on the following statements?

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| The alliance generated value for money | 0% | 0% | 22.22% | 66.67% | 11.11% | 9 |
| The alliance promoted the project's interests | 0% | 0% | 11.11% | 66.67% | 22.22% | 9 |
| Total | 0% | 0% | 16.67% | 66.67% | 16.67% | 18 |

## 9. What was best about the alliance?

Number of respondents: 9

- Working together, common goals
- Openness
- The service provider's staff and the client's experts were a good combination with everyone working on what they knew best.
- Staying on budget despite the tight schedule, the schedule itself and changes to the scope of the project. Everyone stayed focused. The contents of the implementation-stage contract were agreed and preparations started even before the implementation stage.
- Efforts were made to meet the client's objectives and to aim for even higher quality and to develop the life-cycle of the end products. The train traffic arrangements / periods when works could be carried out as planned by the alliance were better than usual. New approaches were adopted in addition to which tried and tested methods were employed.

  Planning construction on site worked well, and construction was able to go ahead at full steam from the very beginning of the implementation stage (e.g. materials had been procured and distributed on site). The need to carry out construction works during the development stage was obviously unusual and due to the tight schedule.
- The schedule was extremely tight, which is why everything had to be done extremely efficiently. Construction could follow on directly from planning. New operating models were adopted, which benefited the alliance.
- Closer cooperation between the different parties
- Cooperation during the project was efficient even though the parties included the client, the service provider and various consultants. If felt that everyone found a suitable role in the project regardless of which organisation they represented.
- Comprehensive project management

## 10. How would you improve the alliance?

Number of respondents: 8

- Making even more use of new technologies
- The conscious decision to keep the development stage extremely short caused problems during the implementation stage. The target cost had to be established and works planned on the basis of incomplete source data. Enough time needs to be reserved for the development stage and the time must be used wisely. Major policy decisions need to be made at the very beginning of the development stage.
- The development stage was far too short considering the starting point.
- The rules for expanding the scope of the project and the resulting effects on costs need to be clearer. There were too many small revisions, and costs were not taken into account in the original pricing.

- Extensions to the scope of the project need to be based on joint decisions and not just on the client's requests.
- The development stage needs to be sufficiently long to allow enough time for planning, scheduling and calculating costs.
- The client's resources and experts need to be more committed to the project based on contractual provisions.
- The development stage needs to be put to efficient use. The development stage needs to be sufficiently long.
- The procurement stage and the bidding stage need to be more straightforward.
- Quality assurance processes need to be understood better during the procurement and development stages to ensure smooth quality assurance during implementation. Quality assurance relied too heavily on self-assessment and on hoping that quality would materialise on its own.
- Demonstrating cost-effectiveness by means of value-for-money reporting

## 11. What were the alliance's biggest challenges?

Number of respondents: 9

- Complicated competitive tendering process, short development stage
- Schedule and costs
- Extremely tight schedule and target cost considering the scope and complexity of the project
- People and approaches were very different at the beginning. It took a long time for pieces to fall into place and when they finally did, several key people changed employers. Thankfully new, competent individuals were found to take responsibility for the project.

  The biggest challenge was the extremely hectic pace. Everyone was exhausted towards the end of the year. There was too much focus on what needed to be done to meet the deadline at times instead of thinking about priorities and optimising resources. Poring over process diagrams was time wasted, as some of the staff had never worked with process diagrams before.
- The geographic location of the site was a problem, as it made it difficult to get people to the Big Room.
- THE DEVELOPMENT STAGE WAS TOO SHORT.
- There were problems with the management system, and procedures changed all the time.
- Tight schedule relative to the workload
- Inadequate information during the development stage
- Decision-making on the scope of the project was inadequate during the development stage. Major policy decisions relating to planning/implementation need to be taken at an earlier stage.
- The scope of the project needs to be agreed in detail during the development stage, and enough time must be reserved for analysis. Different operating models need to be adopted for different areas of work. There were too many new and unnecessary tasks at times that did not contribute to the goal.
- Schedule and scope of the project relative to funding
- Quality assurance in practice and not just on paper is a major challenge in alliance projects. Too much faith is perhaps put in self-assessment and in quality just materialising through that. The cost structure of the project was extremely confusing, and the alliance model currently enables procedures that are similar to those of contracts based on unit prices, where even the smallest increase in the scope of the project results in financial shortfalls.
- Cost-effectiveness

## 12. Other feedback and comments on the alliance's competence

Number of respondents: 5

- The contractor adopted a more alliance-based approach during the bidding stage, and the client should do the same.
- There were far too many scheduling tools in use. Reviewing the six-week schedule once or twice a week every week did not necessary produce the benefits it should have considering the resources it took and the associated costs.
- The project stayed on target thanks to competent staff.
- The alliance model is an extremely positive development in the industry on the whole, and there is definitely potential for the model in the future.
- Commitment and cooperation are huge assets for any project, but the evidence needs to be documented and lessons learned to improve the competence of alliance organisations.

## 13. Mood among the alliance team

Number of respondents: 9

| | **1** | **2** | **3** | **4** | **5** | **Total** |
|---|---|---|---|---|---|---|
| I agreed with the project's objectives | 0% | 0% | 11.11% | 22.22% | 66.67% | 9 |
| Everyone fully understood the project's objectives | 0% | 0% | 55.56% | 44.44% | 0% | 9 |
| The project's objectives were realistic | 0% | 0% | 11.11% | 66.67% | 22.22% | 9 |
| The project's objectives were useful | 0% | 0% | 0% | 55.56% | 44.44% | 9 |
| We worked together as a team | 0% | 0% | 11.11% | 66.67% | 22.22% | 9 |
| We kept each other up to date on work-related issues | 0% | 0% | 22.22% | 55.56% | 22.22% | 9 |
| Everyone felt that they were understood and appreciated | 0% | 11.11% | 22.22% | 66.67% | 0% | 9 |
| Information was shared efficiently within the project organisation | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| Everyone could challenge the principles of work | 0% | 11.11% | 66.67% | 22.22% | 0% | 9 |
| We looked for weaknesses in our work in order to improve our efficiency | 0% | 0% | 88.89% | 11.11% | 0% | 9 |
| We took suggested improvements into account in order to get the best possible end result | 0% | 0% | 55.56% | 44.44% | 0% | 9 |
| We were constantly looking for new, fresh ways to examine work-related issues | 0% | 0% | 33.33% | 66.67% | 0% | 9 |
| We devoted time to developing new ideas | 0% | 11.11% | 33.33% | 55.56% | 0% | 9 |
| We worked together to implement new ideas | 0% | 0% | 44.44% | 44.44% | 11.11% | 9 |
| Total | 0% | 2.38% | 35.71% | 48.41% | 13.49% | 126 |

## 14. Fairness of management during the project

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| Everyone had the right to voice their opinion and experiences in matters that concerned them personally | 0% | 0% | 22.22% | 33.33% | 44.44% | 9 |
| Decisions were logical | 0% | 0% | 22.22% | 77.78% | 0% | 9 |
| Decisions were not biased | 0% | 0% | 22.22% | 66.67% | 11.11% | 9 |
| Managers treated staff in a friendly and considerate manner | 0% | 0% | 22.22% | 77.78% | 0% | 9 |
| Managers treated staff with respect | 0% | 0% | 22.22% | 77.78% | 0% | 9 |
| Managers took staff's needs into account and listened to staff | 0% | 0% | 44.44% | 44.44% | 11.11% | 9 |
| The pay and appreciation received corresponded to staff's output | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| The pay and appreciation were appropriate considering the staff's performance | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| Total | 0% | 0% | 30.56% | 61.11% | 8.33% | 72 |

## 15. Other feedback and comments on the atmosphere at work

Number of respondents: 5

- The geographic locations were challenging and required travelling to other towns
- A tight schedule may drive people to resort to habits developed during previous projects and focus on issues that are important to them personally and not on the big picture and the alliance approach. Individuals who have no previous experience of working in an alliance are especially susceptible. The management system and alliance organisation need to be sufficiently clear and straightforward. Common goals need to be explained and emphasised all the time.
- Most engineers do not want to work in a noisy Big Room in a strange town. Some of the technologies and even individual engineers had to be dragged along and deadlines were not kept. On the other hand, there were people who were easy to work with and who could be trusted. The tight schedule and limited resources made it difficult to actually manage planning and meant that there were fires to put out all the time. It took until the end of the project to fully understand the process and have time to innovate solutions with the contractor. When works were rescheduled during the construction stage, overworked construction staff resorted to the excuse of not having received (fully complete) plans instead of trying to establish what level of detail should have been provided in plans to enable works.
- The atmosphere at work was extremely good on some levels.
- The atmosphere was good and marked by respect and appreciation. Problems could be solved quickly.

## 16. Other feedback and comments on the fairness of management

Number of respondents: 2

- Individuals still stood out despite the alliance approach.
- The alliance provided an opportunity for open and honest face-to-face discussions and taught staff to respect and understand other people's work more as part of an alliance.

## 38. How would you rate the project's implementation stage as a whole?

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| Implementation stage as a whole | 0% | 0% | 25% | 75% | 0% | 8 |

## 39. How would you rate the following factors relating to the project's implementation stage?

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| Implementation-stage project plan | 0% | 0% | 55.56% | 33.33% | 11.11% | 9 |
| Management of opportunities and risks | 0% | 0% | 33.33% | 55.56% | 11.11% | 9 |
| Management of ideas and innovations | 0% | 22.22% | 77.78% | 0% | 0% | 9 |
| Continuous improvement | 0% | 0% | 66.67% | 33.33% | 0% | 9 |
| Use of tools and techniques | 0% | 0% | 77.78% | 22.22% | 0% | 9 |
| Planning of commissioning and the warranty period | 0% | 0% | 25% | 62.5% | 12.5% | 8 |
| Management during the implementation stage | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| Total | 0% | 3.23% | 54.84% | 37.1% | 4.84% | 62 |

## 40. What are your views on the following statements?

Number of respondents: 9

| | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| The project was developed successfully during the implementation stage | 0% | 0% | 44.44% | 55.56% | 0% | 9 |
| The alliance improved its practices continuously | 0% | 0% | 22.22% | 77.78% | 0% | 9 |
| Total | 0% | 0% | 33.33% | 66.67% | 0% | 18 |

## 41. What was the most successful aspect of the implementation stage?

Number of respondents: 4

- Most of the project's objectives were met despite the tight schedule.
- Daily operations of the alliance on the whole
- Integration of the works site and the Big Room, as the site office was in the same premises as the Big Room
  The development of innovations and work methods continued.
  Staff competence
  Keeping to the schedule
- Comprehensive day-to-day project management, the project team's operations

## 42. What challenges were there during the implementation stage?

Number of respondents: 4

- Organisation of management and deciding on roles
- Several changes in key personnel
- Competency gaps in management, organisation and procedures were not streamlined
- Changes to the scope of the project

## 43. How would you improve the execution of the implementation stage?

Number of respondents: 4

- Clearer organisation and responsibilities and more flexible decision-making
- More focus on staff satisfaction and committing staff to the project
- Planning needs to stay ahead of construction.
- The need for supplies and other similar obstacles to construction need to be identified earlier.
- Planning lean techniques and the flow and stages of work boldly using new tools, such as allocating 70% to existing methods and the rest to new techniques; the more structured the organisation and teams, the more efficiently new approaches can be put into practice.

## 44. Other feedback and comments on the implementation stage

Number of respondents: 2

- More attention needs to be given to the alliance approach, i.e. producing better quality with the big picture in mind. The focus should be on managing the entire project. Keeping the big picture in mind produces a better end result.
- Dynamic decision-making and management of the alliance results in a successful project.

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