SWEDISH NATIONAL AUDIT OFFICE

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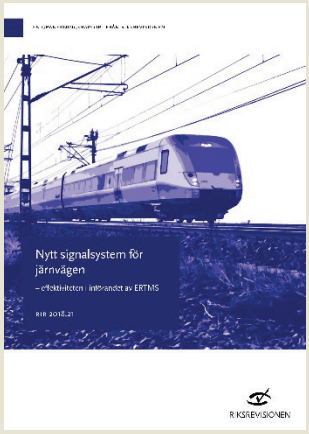

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New signal system for the railway

– efficiency in the implementation of ERTMS

Summary and recommendations

The Swedish NAO has audited the Government and the Swedish Transport Administration's planning and implementation of the common EU signal system ERTMS (European Rail Traffic Management System), which is part of the aim of achieving cross-border rail traffic within the Union. The implementation of ERTMS will be coordinated with a reinvestment in the current outdated signal plant. The Riksdag has decided that all railway reinvestments shall adhere to the EU's requirements on interoperability.

ERTMS has thus far been implemented on a few pilot tracks in Sweden. According to the EU's timetable, significant parts of the Swedish rail network shall be fully equipped with ERTMS by 2030 at the latest. The plan is for the remainder of the Swedish railway to be equipped with ERTMS by 2035. The estimated cost for the entire implementation of ERTMS including the reinvestments is approximately SEK 30 billion.

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Purpose and questions

The purpose of the audit is to assess the efficiency of the planning and the implementation thus far of ERTMS in Sweden, given the requirements stipulated in Swedish legislation and EU regulation. The audit is based on three audit questions.

1. Has the Swedish Transport Administration produced good-quality cost estimates and promoted the efficient use of resources?
2. Has the Transport Administration presented the expected effects of implementing ERTMS?
3. Does the Government and the Transport Administration's planning ensure the efficient implementation of ERTMS?

Results of the audit

Has the Swedish Transport Administration produced well-founded cost estimates and promoted the efficient use of resources?

The audit shows that the Transport Administration and previously Banverket (the former Swedish National Rail Administration) seriously underestimated the cost of developing a functional ERTMS system corresponding to the EU's specifications and national requirements. Developing a new signal system based on computer technology has proven to be more resource-intensive than expected. The Swedish national plan for the transport system 2010–2021 presented an estimated cost of SEK 1.17 billion to develop the ERTMS system. This cost was greatly underestimated and has since tripled due to multiple adjustments, a baseline[1] replacement and alignments of the system, as well as the introduction of increased testing capacity. The Swedish NAO therefore concludes that the cost estimates for developing the system have not been well-founded.

Since 2008, alterations and additional work for the system development have been ordered in the sum of over SEK 1.2 billion. The price of such alterations is regulated in the framework agreement that has been established between the Transport Administration and the systems supplier. The framework agreement regulates, inter alia, costs per hour. However, the quantity of work is variable. In practice, this means that the Transport Administration and the suppliers have had to negotiate the price when the need for alterations has arisen. The Swedish NAO sees a risk in the situation creating a weak

[1] Technical specification determined at the EU level.

negotiating position for the Transport Administration. There is a risk that further cost increases may arise in the future. The Swedish NAO is of the opinion that the Transport Administration should take measures to prevent such a development, for example by structuring the software development to reduce the scope of those components that need to go through new approval processes following changes to the software.

The estimated costs for implementing ERTMS in the rail network differ between the national transport plans from 2010, 2014 and 2018.[2] There are two explanations for this. The first one is that the scope of the measures has changed. The second one is that the methods for estimating the costs have differed between the plans. The Swedish NAO finds it positive that several methods have been used in the 2018 plan for estimating the cost of the Iron Ore Line (Malmbanan), as this line has constituted a departure point for calculating the cost for remaining sections.

However, the Swedish NAO notes that the uncertainty in the calculations has been underestimated on multiple previous occasions. The calculated cost for implementing ERTMS on the section called ScanMed East[3] was initially underestimated by around SEK 400 million in the 2010 plan as a result of how various external factors were taken into consideration in the estimation. It subsequently emerged that the cost for the same section had been underestimated by a further SEK 600 million in the 2014 plan, due to the fact that the ranges of uncertainty used in the calculation model were too small.

Nonetheless, in the most recent estimate for the national plan 2018–2029, the total cost for implementing ERTMS has decreased slightly. The estimated cost for the Iron Ore Line and ScanMed East, which figure early on in the implementation plan, has increased. However, this increase is counteracted by the fact that the estimated cost for the rest of the rail network, figuring later on in the implementation plan, has decreased. One reason for this is that the Transport Administration has introduced a work method in order to save resources through so-called learning effects. By working with a line production principle, it is expected that the efficiency will be able to increase in elements coming later on in the implementation plan. The Swedish NAO finds it positive that the Transport Administration is planning for a work approach that can keep costs down and increase productivity. At the same time, there is a lack of documentation on where and how this streamlining will be realised more specifically in the ERTMS role out. This means that the cost presented in the plan is based on assumptions that are not particularly supported and well documented.

[2] All cost estimates in this report have been adjusted to the price level for the 2018 plan.

[3] The ScanMed East essentially corresponds to the section also known as Corridor B, which runs between Stockholm and Malmö, via Hallsberg and Norrköping (including the Southern Main Line).

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Has the Transport Administration produced the supporting documentation and data required to show the effects of ERTMS?

The Transport Administration has performed analyses of operational reliability by comparing the ERTMS lines – the Bothnia Line, the Ådalen Line and the Haparanda Line – with lines on the core network that have the existing ATC (Automatic Train Control) signal system as well as with the smaller range of lines that have modern ATC interlocking system.[4] The analyses indicate that the ERTMS lines show good results and that they generally perform better than the ATC lines. However, there are problems in the comparability between the ERTMS and the ATC lines that cannot be taken into account despite the Transport Administration having conducted some twenty different analyses to validate the results. The assessment of the Swedish NAO is that the analyses provide credible indications of increased operational reliability with ERTMS. But the differences between the comparison groups means that there is significant uncertainty when quantifying the benefits. This uncertainty was not presented clearly enough in conjunction with the Transport Administration's overall impact assessment in 2017.

In previous documentation, the Transport Administration and Banverket (the former Swedish National Rail Administration) have suggested that ERTMS can significantly increase capacity. This has been one of the central arguments for its implementation but, as of a few years ago, it is no longer relevant. In the economic assessment from 2013, the economic benefits of the alternative scenario amounted to SEK 25.9 billion (mainly through shortened travel times resulting from increased capacity, compared with the estimated total cost of SEK 27 billion). When an economic assessment was conducted in 2017, a benefit of only SEK 3.9 billion, resulting from increased operational reliability, was included in the alternative scenario, compared with the total cost of SEK 30.2 billion. The calculation period was shorter in the calculation done in 2017 than that of 2013, and the size of the estimated benefits is therefore not directly comparable. However, even aside from this, the difference in the result is still considerable. The Swedish NAO deems it noteworthy that changes to assumptions and methods can give such different outcomes.

The overall aim with ERTMS is to promote interoperability between national European rail networks and to promote cross-border traffic. There are however a number of factors apart from the signal system that still complicate cross-border traffic. The Swedish NAO concludes that the introduction of ERTMS in Sweden does not entail any significant

[4] Modern computerised ATC switchgear is used in places, but the vast majority are based on older relay technology.

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benefit in terms of improving cross-border traffic within the foreseeable future. Furthermore, the Swedish Transport Administration has not quantified any benefits of increased cross-border traffic in their economic assessments.

Overall, the Swedish NAO finds that there have been deficiencies in the supporting documentation throughout the planning process, but that since 2017, the Transport Administration has presented sufficient data for the assessment of the effects of ERTMS. The uncertainty of the assessment of the increase in operational reliability should however have been communicated clearer.

Does the Government and Transport Administration's planning ensure the efficient implementation of ERTMS?

According to the Swedish NAO, the efficient implementation of ERTMS in Sweden requires a plan that, on the one hand, is based on the need for reinvestment in the signal plant and, on the other, coordinates this with EU requirements of ERTMS in a way that provides adequate conditions for the rail operators to adapt their operations to the timetable. The Swedish NAO finds that the analyses of the implementation of ERTMS as presented by the Transport Administration have been characterised by flawed investigative logic and that economic analyses of alternative implementation strategies have not been conducted in a relevant and timely manner. There have also been deficiencies in the coordination of the need for reinvestment pertaining to the existing signal plant and the need for implementation of ERTMS. This inadequate coordination has resulted in a lack of preparedness for conducting the required reinvestments when the ERTMS timetable has been pushed back, and it also risks creating unnecessary cost increases in the future. Overall, the planning thus far has not been conducted in a manner that provides the necessary conditions for implementing ERTMS while at the same time effectively addressing the need for reinvestment in the signal system.

For a long time, the Transport Administration has been approaching the ERTMS implementation with a traditional "investment logic" where various benefits that streamline transportation have been identified and estimated in order to justify the cost of the proposed measure. However, the overall implementation of ERTMS differs from regular investment projects since it encompasses reinvestment in the existing signal plant, which is approaching the end of its useful life. Unlike an investment project, the benefit is instead found primarily in the fact that the reinvestment enables the original function to be maintained. In addition, the benefit of ERTMS as a new signal system, as opposed to ATC, is relatively limited according to the Transport Administration's recent assessments.

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With a reinvestment perspective, a central question to investigate would instead have been which reinvestment alternatives (for maintaining the signal system's functionality) that could have been be coordinated with the requirements for the ERTMS implementation, while giving the lowest possible life-cycle cost. Relevant alternatives to consider in such an analysis include the pace and the order of the reinvestments and the implementation of ERTMS in the rail network, as well as the possibilities to make reinvestments separately from the plan for the ERTMS implementation. However, the planning has not used this approach, even though the Transport Administration has lately been steering towards such a direction.

In 2010 the Transport Administration produced a plan for phasing out critical interlocking systems in the signal plant. But this was not pursued as the Transport Administration figured that the phase-out could be done in conjunction with the transition to ERTMS. When the ERTMS implementation was postponed in 2014, this meant that the margins for phasing out the interlocking systems decreased. There were motives to postpone the implementation of ERTMS but the Transport Administration's plan for addressing the need for reinvestment was not adapted for such a decision.

Today, the situation is such that the adopted plan for the ERTMS implementation does not fully resolve the need for reinvestments in time. As a result, there will likely be advance reinvestments needed with respect to the ERTMS plan. The Transport Administration currently lacks a strategy for handling such reinvestments. These reinvestments may be ineffective compared to how the finished signal system is intended to function by 2035, and they may also entail increased costs. Each time a temporary modernised ATC reinvestment is made, the cost of converting to ERTMS at a later stage increases. The option of reinvestments using older ATC equipment produces only short-term solutions as the system will still need to be replaced during the ERTMS conversion, and also means increased costs. The Swedish NAO finds it problematic that different operational categories within the Transport Administration organisation are planning the reinvestments in the signal system on the basis of whether or not they are being carried out in connection with the ERTMS plan, as well as the fact that there is no coherent plan for how the work is to be performed.

The existing signal plant has around 750 interlocking systems units of 15 different types are in operation. The maintenance capacity is presently limited or critical for more than a third of these units. A shortage of spare parts and of competence presents risks for an inability to rectify faults that could arise in the system prior to the ERTMS transition. As with the current signal system, at the moment only the original supplier of an ERTMS system can supply many of the spare parts. According to the Swedish NAO, it is vital that the Transport Administration ensures that similar shortages do not arise in the

future as this may lead to cost increases for maintenance and reinvestments. One option for reducing the risk of a shortage of spare parts is to steer towards making sure that components in the system have an open interface instead of supplier-specific.

Recommendations

The Swedish NAO provides the following recommendations to the Transport Administration.

- The Transport Administration should develop a strategy for the scope and implementation of reinvestment measures that fall outside the current ERTMS plan, taking into account how the finished signal system is intended to function. This also includes having a coherent plan for minimising the cost for the entire reinvestment and conversion to ERTMS.
- The Transport Administration should conduct an analysis of the cost savings that can be achieved through so-called learning effects and the figures this may involve. The assumptions regarding learning effects used in the estimate of the costs in the national transport plan need to be better supported by data well in advance of the design and construction phase.
- The Transport Administration should develop a methodology and instructions for how economic analyses of major reinvestment projects are to be performed. This is needed to be able to consider different alternative approaches and timetables for the reinvestment that can impact the life-cycle cost and economic profitability.

Furthermore, the Swedish NAO considers it important that the Transport Administration completes the work already begun regarding two pressing points:

- The Transport Administration should take measures to prevent future cost increases in connection with the development of the ERTMS system. One possible path could be to structure the software development in a way that minimises the scope of those components that need to go through new approval processes following changes to the software.
- The Transport Administration should ensure that the current shortage of spare parts does not arise in the future with the ERTMS system and that the supply of spare parts can be achieved at as low a cost as possible. This can be done through the Transport Administration, during the next procurement, demanding that all spare parts where possible adhere to the common interfaces being developed in cooperation with certain European countries.