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The service life of transport infrastructure: An ex-post analysis of rail and roads

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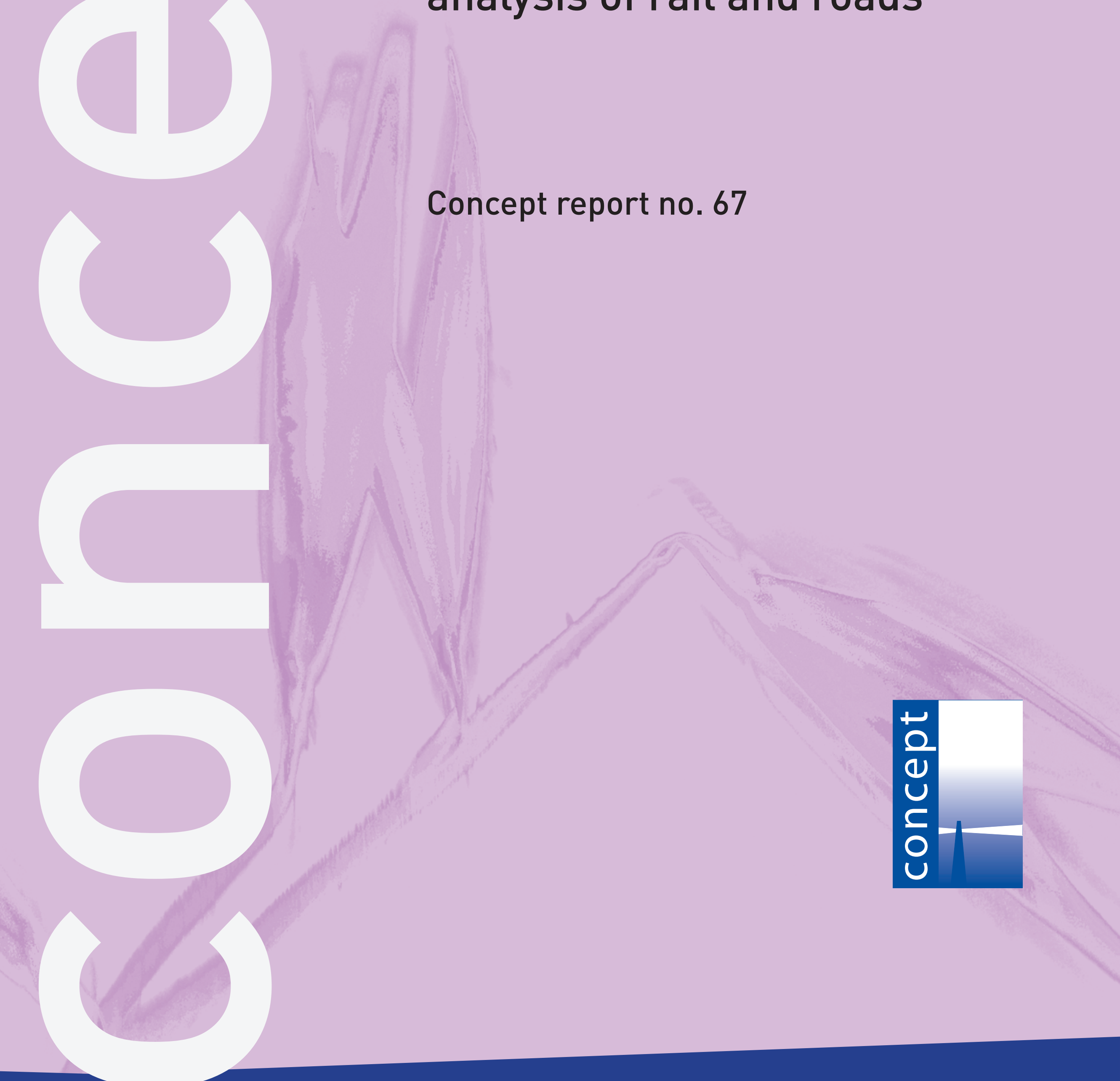

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The service life of transport infrastructure: An ex-post analysis of rail and roads (English summary)

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English Summary

The life expectancy of infrastructure is a vital assumption in cost-benefit analyses. That is, how long one expects the investment to produce welfare effects for society. This study examines the ex-post service life of Norwegian transport infrastructure by looking at how long the infrastructure has been used before it has been upgraded or replaced. We look at road and railway infrastructure and use several data sources.

We distinguish between technical and economic life. The technical service life indicates how many years the physical infrastructure can be used according to the technical condition and safety requirements. While the economic life indicates how long the infrastructure can serve its purpose. However, in cost-benefit analysis, the main focus is the analysis period, i.e. the period a calculated effect is included in the analysis. As a rule, the analysis period should equal the economic life. But the economic life can also be longer than the analysis period, which is handled by using a residual value.

The changes that we have seen in the assumption of economic life and analysis period in Norwegian cost-benefit analysis over the past decade inspired this study. First, the guidelines for the analysis period were increased from 25 to 40 years in 2012, based on the recommendations from the Hagen Committee (NOU 2012: 16). Thereafter, the expected economic life of road projects was increased from 40 to 75 years for road projects (excluding minor improvements) in connection with the National Transport Plan for the period 2022–2033. A lifetime of 75 years has, however, been practiced for a long time for railway investments. These changes significantly increased the calculated benefits of transport infrastructure investments (Halse et al., 2021). However, despite the importance of economic life, no previous studies have examined the ex-post economic life of infrastructure. Therefore, the purpose of this study was to examine what economic life has been historically, to be able to say something about what is reasonable to expect in the future.

How the benefit and cost effects are distributed over the lifetime is also essential for the economic analysis. However, we limit the scope of this study to life expectancy. The reason is that this requires less information about the projects. In principle, only the start and end points are needed, while the distribution of benefits and costs over time will require significantly more information. We leave this task to further research.

The report has the following structure. Chapter 1 introduces the theme. Chapter 2 discusses the definition of service life and assessments of associated assumptions. We suggest that service life can be divided into actual vs expected and technical vs service.

Chapter 3 reviews national and international practice on service life, analysis period, and treatment of residual value in economic analyses. This review shows a significant variation in service life, analysis period and residual value. We also see that the Norwegian assumptions about service life, analysis period and residual value are high compared with other countries.

Chapter 4 reviews the literature that examines the expected technical and economic life. We find no previous studies looking at the actual economic life of transportation infrastructure. The review, therefore, includes studies that look at technical life and studies that examine the service life of fixed capital assets in national accounts. We find results that harmonize with the differences in assumptions between countries from Chapter 3. The lifespan of transport infrastructure is mainly between 30 and 60 years in these analyses, i.e., somewhat below the longest lifespan of 75 years that can be used in cost-benefit analyses in Norway. On the other hand, this range is consistent with the main estimate for life expectancy in Norway, which according to current guidelines, is 40 years.

In Chapter 5, we present the method and data used in the study. We first go into the chosen method of survival analysis. This analysis technique, most common in health and engineering sciences, is used to estimate how long components or patients live and examine factors that affect longevity. This methodology addresses the censoring bias that arises when all existing infrastructure has a known opening year (start time) but an unknown end point (residual life).

The chapter also presents the seven different datasets used:

- Railway sections in Norway
- Bridges in the county of Akershus
- Tunnels in the county of Rogaland

- Norwegian bridges over 400 meters
- Bridges built after 1960
- Europaveg 18 (Ørje – Kristiansand)
- Europaveg 6 (Svinesund – Hedmark border)

For railways, data are used for opening, closing, and significant changes for railway lines. This provides an almost complete overview. For road sections, a total count is more demanding. Different sources are therefore used here. Most emphasis is placed on the data for service life for two European road sections, E6 and E18, in Southern and Eastern Norway. These have been selected because we have quite good sources of what has happened on the stretches in recent decades.

Chapters 6 and 7 present and discuss the results. The analysis of railway lines indicates longevity. Historically, the lifespan has been well over 100 years, and most stretches have survived several stages of technological development. On average, the lifespan before the sections have been closed is over 120 years, while it has typically been 60 years from the opening year until significant alterations (events) have taken place. Historically, therefore, life expectancy, on average, has been well over 75 years. A life expectancy of 75 years acts as a conservative estimate for life expectancy, including the risk of unexpected events and conditions that cannot be predicted today.

For road infrastructure, the picture is more complex. According to the analysis of European road sections in Eastern Norway, the results indicate a lifespan of just over 40 years. More precisely, it took over 40 years, from the opening year to a significant upgrade. The data material indicates a longer life for bridges and tunnels in history. For bridges, the results indicate lifetimes between 60 and 70 years, while the lifespan of tunnels is even longer. These results are not comparable since most of the bridges and tunnels are on county roads, while the sections analysed are European roads. Overall, the results indicate a lifespan of between 40 and 60 years for road infrastructure, which is well below the estimated service life of 75 years used today.

Although the results differ somewhat and do not give a complete picture of the life of roads and railway lines, these results can contribute to the debate about economic life and analysis period in cost-benefit analysis. First and foremost, our ex-post analyses show that the actual lifetime of transport investment varies greatly. We see no reason for this variation to be reduced in the years to come. If the infrastructure in history were to have a lifespan of 75 years, this means that infrastructure built just before World War II will provide benefits until 2014. But how much was known in the late 1930s about the future requirements for performance, capacity and quality for transport infrastructure in the 1990s? The changes in the future may also be less extensive, and the Ministry of Finance's quality assurance regime can contribute to better project selection. Still, we cannot rule out that the changes in transport needs and technological development will be as significant as in the decades we have behind us.

More knowledge about the factors that affect the ex-post service life can reduce the uncertainty in life expectancy. A possible implication of the findings is that life expectancy should be able to vary and thereby reduce the uncertainty in actual life expectancy.

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Forskningsprogrammet Concept skal utvikle kunnskap som sikrer bedre ressursutnytting og effekt av store, statlige investeringer. Programmet driver følgeforskning knyttet til de største statlige investeringsprosjektene over en rekke år. En skal trekke erfaringer fra disse som kan bedre utformingen og kvalitetssikringen av nye investeringsprosjekter før de settes i gang.

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The Concept research program aims to develop know-how to help make more efficient use of resources and improve the effect of major public investments. The Program is designed to follow up on the largest public projects over a period of several years, and help improve design and quality assurance of future public projects before they are formally approved.

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