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Summary:

Cost-benefit analysis of development of Oslo Port and two alternative solutions

Background

Oslo Port is Norway's largest public port for the loading and unloading of general cargo, and is dominated by imported and exported general cargo, which accounts for more than 95 per cent of the general cargo handled by the port. The volume of large unit loads in Oslo port is nearing full capacity. Unless steps are taken to increase capacity, problems will be encountered in only a few years. Nor is there much available capacity in the other ports in the Oslo area. This means that unless steps are taken to increase capacity in the ports in the Oslo area, maritime transport will encounter capacity constraints, which will mean that cargo transport will be transferred from sea to road.

Oslo Port Authority recently presented a development plan for Oslo Port for the period 2000–2020, in which solutions to the port's capacity problems are proposed. The main initiative involves developing and improving efficiency in the East and South Port, but Filipstad too will be temporarily developed to provide extra capacity until the South Port has been completed. In total, there are plans to expand the port area by 362 decares. In addition, investments will be made in Rail mounted Gantries (RMG-cranes) for the Ormsund terminal, which will mean a doubling of the port's land productivity. If this plan is realised, 354 decares of land currently in use by the port can be freed up for other use.

This cost-benefit analysis has been commissioned by Oslo Port Authority. The objective of the analysis is to ascertain whether the proposal contained in the Strategic Plan is profitable in socio-economic terms compared with the other proposals. The analysis is based on a base alternative which assumes that already approved and budgeted measures in Oslo Port will be implemented, i.e. the development of Filipstad and the first stage of the measures designed to improve capacity in the Ormsund terminal. No capacity-enhancing investments in the other Oslo Fjord ports have been included in the base alternative. We assume that capacity available in these current facilities is no more than is necessary to meet expected growth in traffic in each of these ports. In the base alternative, it is assumed that the increased traffic that Oslo Port is unable to meet will come via Sweden. That means either by sea between Gothenburg and the Continent, with

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short-haul transport to/from Norway by road transport or railway, or by road transport all the way between Norway and the Continent.

In the report, the development of Oslo Port is compared with two alternative solutions: One of these takes as its basis that no other capacity-enhancing measures in Oslo Port will be implemented other than those included in the base alternative. The increase in traffic that Oslo Port is unable to meet will be spread over five ports in the Oslo Fjord area,[1] and these must be developed for this purpose. The other alternative assumes that a central port will be built 50 to 80 kilometres south of Oslo, and that the handling of all general cargo will be moved from Oslo Port once the new central port is completed in the year 2015. We have looked at two alternative locations, on the east and west of the Oslo Fjord, respectively. This alternative is a hypothetical example designed to show the consequences localisation in this area will have for direct and external transport costs. However, this does not mean that we have looked more closely at the specific location of such a port.

Assumptions

Prognoses for cargo loading

The time horizon of the analysis is the year 2030. The analysis is based on Oslo Port Authority's prognoses for developments in the loading and unloading of foreign general cargo until the year 2020. We have disregarded any further growth in the loading/unloading of general cargo after the year 2020. The analysis does not include domestic general cargo, since the share of general cargo over public quays in Oslo amounted to 2.2 per cent in 1996, and has fallen strongly in recent years.

According to Oslo Port Authority's prognoses, the loading/unloading of general cargo in the port will increase by 150 per cent by the year 2020, while container loading/unloading (total for lo/lo an ro/ro) is expected to increase by more than 350 per cent during the same period. In total, container traffic accounted for around 40 per cent of foreign general cargo handled by the port in 1996, calculated in tonnes, while lo/lo containers accounted for approx.18 per cent.

Ferry traffic and bulk goods have not been included in the analysis, because the capacity for bulk cargo is expected to be sufficient even in the long-term, while ferry traffic is dependent on a location close to the traffic basis and will be developed in pace with future growth within the relevant port areas.

Direct investment costs

Investment costs relating to the development of Oslo Port are based on *Utviklings-plan for Oslo havn 2000–2020 (Development plan for Oslo Port 2000–2020)*.

Investment costs related to the increased harbour area in the five Oslo Fjord ports are based on the equivalent costs per developed square metre that formed the basis

[1] The five Oslo Fjord ports over which the increased traffic is spread are Borg, Moss, Drammen, Larvik and Grenland.

of the development of the East and South Port in Oslo. In estimating the costs of investing in harbour cranes and terminal trucks, we have taken the conditions in the Ormsund terminal as a basis for estimating requirements as regards cargo loading. We have ignored any available capacity within the present port facilities in the harbours in question, as well as any need for investments in roads in order to adequately handle more traffic from the five ports.

Investment costs related to the building of a central port have been based on previous estimates by Berdal-Strømme. However, the cost of investing in Rail mounted Gantries (RMG-cranes) has been added, since Berdal-Strømme's estimates anticipated continued operations in Oslo Port.

Transportation and transport costs

Transportation, the distribution of means of transport and transport costs are calculated for each alternative solution using the network model NEMO. NEMO is multimodal, and the model's network represents infrastructure such as roads, railways and ports. Time costs for goods in transport and waiting costs for cargoes related to the number of calls made by scheduled vessels in the various ports are part of the time costs.

External costs

Environmental costs, wear and tear costs, accident costs and noise costs related to increased transportation have been calculated on the basis of model calculations using NEMO.

The costs of maritime accidents are calculated on the basis of information of accidents at sea in the Oslo Fjord in 1980–1996 and the fairway north of 57 grades 30 minutes, as taken from the DAMA register.[2]

Noise costs resulting from increased road transport are estimated on the basis of the number of people affected by the anticipated growth in traffic along the most important main roads, based on the various locations of ports.

In assessing the value of emissions of CO_2 we have taken the average of an estimated duty per tonne of CO_2 emissions based on a national and international agreement in respect of the Kyoto agreement.

Other marginal costs are based on previous estimates of average national values.

Terminal noise

The fact that Norway's largest general cargo port is located in the middle of the country's capital city means that a relatively large number of people are affected by noise from harbour operations. Since it is uncertain whether increased harbour operations in the Ormsund terminal will lead to an increase in terminal noise, we have not included the costs of increased terminal noise, but have calculated the welfare gains where harbour operations have been discontinued.

[2] The DAMA register (DAtabank for securing MAritime operations), is kept by Veritas, the Coast Directorate and the Norwegian Maritime Directorate.

Using a GIS model which includes mapping data for Oslo, and which is linked to a register of real estate, addresses and buildings, we have obtained information regarding the number of households affected. We have used a survey (Larsen et al., 1997) in which noise is valued on the basis of people's willingness to pay to avoid traffic noise.

Freed-up land

Both the development of Oslo Port and the building of a new central port would mean that areas currently used by the port would become available for other purposes. We have used as our basis the appraisal of the land that was carried out in connection with the Report to the Planning and Building Department (1998).

Reclaimed land

All present land in Oslo Port has been reclaimed from the sea. Additional reclaimed land will therefore produce increased value for Oslo Port Authority. This value is calculated on the basis of an equivalent price per square metre for the various port areas as in the assessment of an alternative cost of the port land.

Results

Based on the assumptions made, we have calculated the net present value of the three projects. The projects are mutually exclusive, i.e. only one of them can be implemented.

Transportation

Transportation by ships is calculated on the basis of the distance travelled between ports in the Oslo Fjord, or Gothenburg, and ports on the Continent. We have chosen to follow the goods from their country of origin or destination, since in the base alternative it is assumed that part of the growth in traffic that Oslo Port is unable to meet will be shipped by road transport all the way to the Continent.

Under these conditions, transportation and the distribution of means of transport are calculated using NEMO and are shown in table 1.

Table 1 shows that the share of transportation by railway is highest in the event of a new central port on the eastern side of the Oslo Fjord in the year 2020, and transportation by road will be lowest if the port is in Oslo, highest if the central port is located on the western side of the Oslo Fjord. Total transportation will be lowest if the growth in transport is spread over all ports in the Oslo Fjord area, since some of the cargo which today uses Oslo Port comes from areas where transportation to the port would be reduced if other ports were used. This traffic could benefit from using other ports, providing it was offered the same opportunities as in Oslo, i.e. high frequency and departures to many destinations.

Table 1: Estimated transportation in the different port scenarios, year 2020. All figures in million tonnes/km.

	Sea	Railway	Road	Total
Basic alternative	6950	1026	1540	9517
Oslo Port, fully developed	7726	909	506	9141
Oslo to capacity, remainder to five other ports in the Oslo Fjord	7620	814	615	9050
Central port, Oslo Fjord East	7431	977	761	9169
Central port, Oslo Fjord West	7493	833	843	9168
No capacity-enhancing measures in Oslo, surplus traffic via Sweden	6786	1165	1828	9779
Differences in relation to the base alternative:				
Oslo Port, fully developed	776	-117	-1034	-376
Oslo to capacity, remainder to five other ports in the Oslo Fjord	594	-221	-833	-460
Central port, Oslo Fjord East	481	-50	-799	-347
Central port, Oslo Fjord West	543	-194	-697	-349
No capacity-enhancing measures in Oslo, surplus traffic via Sweden	-164	139	288	263

Modern logistics with central warehouses, high product differentiation and a great demand for swift and reliable delivery times lead to many small but frequent shipments. To achieve economic profitability, shipments over long distances to and from Norway must be put together so that they fill a cargo unit (goods vehicle, container or railway wagon). This means that a great deal of cargo passes through the central warehouse in Oslo for consolidation before being exported and for unpacking in the case of imports. Using NEMO in the analysis has its weaknesses here, since it does not follow each individual shipment, but instead regards transportation as continuous annual flows. Consequently, we are not fully able to model that companies find it profitable to send many small shipments to Oslo for re-packing, and that this is one reason why Oslo Port has been chosen as port of shipment. This effect means that we have possibly underestimated transportation by road in the case of a two-port solution. This can be changed in the long term, however, if companies change location.

Net present value

Table 2 shows the results of estimates of net present value for the three alternatives. Present value means the sum of money today (1998) that is equivalent to the various expenses and savings at a later point in time, discounted at a rate of 7 per cent. This concept reflects the fact that one NOK today will not be worth as much as one NOK tomorrow.

Table 2: Net present value of three port alternatives, compared with the basic alternative which includes approved and budgeted measures in Oslo Port. All figures in NOK millions (1998).

	Present value, Oslo Port	Present value, two-port solution	Present value, new central port
1. Investments with a 40-year lifetime (roads, railways)			82
2. Investments with a 30-year lifetime (quays)	473	435	738
3. Investments with a 25-year lifetime (buildings)	0	130	145
4. Investments with a 15-year lifetime (port cranes)	198	114	278
5. Investments with a 10-year lifetime (term. trucks)	8	119	3
Total, investments (1+2+3+4)	*679*	*797*	*1246*
6. Reduced transport costs	1234	1182	490
7. Reduced wear and tear costs	285	278	185
8. Reduced environmental costs	222	206	126
9. Reduced accident costs	101	67	57
10. Reduced noise costs	82	98	45
11. Terminal noise	5		12
12. Environmental costs related to increased passenger transportation	-3		-5
13. Value of freed-up land	656		725
14. Value of reclaimed land	71		
Net present value: (6+…+14)-(1+…+5)	*1973*	*1033*	*389*
Cost-benefit ratio: (6+…+14)/(1+…+5)	*3.91*	*2.30*	*1.31*

Compared with the base alternative, all the alternatives are highly socially profitable. The reduction in transport costs alone means that the present value of two of the projects will be positive. The reduction in the external costs alone are enough to make the net present value of the development of Oslo Port positive. The net present value of the development of Oslo Port is almost twice as high as the second best alternative.

The reduction in the discounted value of transport costs is significantly higher for Oslo Port and for a two-port solution than it is for a new central port. This is partly due to the fact that the rewards in the case of a new central port in relation to the base alternative will only appear after the year 2015, while they will appear seven years earlier in the case of the two other alternatives, where no capacity problems are expected.

A comparison of the three scenarios from the year 2020, when all building work is complete, shows that the environmental costs are lowest in the case of the full development of Oslo Port, even though total transportation is lower in the two-port alternative. This is because road transport is 22 per cent higher for port cargo in the case of a two-port solution than in the full development of Oslo Port, and that the marginal costs are generally higher for road transport than for maritime and railway transport. Both the generalised transport costs (total of the time costs and direct transport costs) and wear and tear costs are lowest for the Oslo alternative in the year 2020, and highest in the case of a new central port.

Sensitivity analysis

The objective of a sensitivity analysis is to investigate whether deviation from the assumptions will lead to changes in the ranking of the projects.

We have taken into account the following deviations from the assumptions:

- 25 per cent lower growth in cargo loading than the prognoses on which the analysis is based
- investment costs increase by 40 per cent in relation to the estimates
- transport costs per tonne-kilometre are 20 per cent lower than anticipated in the calculations
- savings in external costs are approx. 40 per cent lower than anticipated
- lowest valuation is used when valuing areas which will be freed-up if Oslo Port is developed, while the highest valuation is used for land which will only be freed-up if a new central port is built
- the development of the Ormsund terminal produces a 50 per cent drop in the value of housing in adjacent areas

In table 3, we present the total effects of the listed deviations from the assumptions in the analysis. The table shows that if *all* the uncertain factors produce the worst possible effects, only the net present value of the development of Oslo Port will be positive. Furthermore, it appears that the ranking of the projects will not change even though we have factored in deviations from most of the assumptions.

Table 3: Net present value of alternatives 1, 2 and 3B, taking all uncertain factors into account. All figures in NOK million (1998).

	Present value, Oslo Port	**Present value, two-port solution**	**Present value, new central port**
1. Investments with a 40-year lifetime (roads, railways)			115
2. Investments with a 30-year lifetime (quays)	662	535	1033
3. Investments with a 25-year lifetime (buildings)	0	182	203
4. Investments with a 15-year lifetime (port cranes)	277	182	389
5. Investments with a 10-year lifetime (term. trucks)	11	167	4
Total, investments (1+2+3+4)	*950*	*1066*	*1744*
6. Reduced transport costs	525	515	70
7. Reduced wear and tear costs	56	57	47
8. Reduced environmental costs	51	51	34
9. Reduced accident costs	28	28	18
10. Reduced noise costs	16	16	16
11. Terminal noise	-142		12
12. Environmental costs related to increased passenger transportation	-3		-5
13. Value of freed-up land	-35		690
14. Value of reclaimed land	488		
Net present value: (6+…+14)-(1+…+5)	*34*	*-399*	-862
Cost-benefit ratio: (6+…+14)/(1+…+5)	*1.04*	*0.63*	*0.51*

Conclusion

In this report, we have calculated the net present value of three different methods of solving harbour capacity requirements in Oslo and the Oslo Fjord area. Based on the assumptions stipulated, all three projects are socially profitable compared with the option of not allowing maritime transport to develop in relation to market needs. The development of Oslo Port has the highest present value. The reduced generalised transport costs alone are enough to give the project a positive present value. In addition, the reduced external costs are alone enough to give the project a positive net present value.

A sensitivity analysis has been conducted which takes into account deviations from a number of assumptions on which the calculations are based. If these deviations yield the most unfortunate effects (worst-case scenario), only the alternative in which Oslo Port is developed will continue to have a positive present value.

The conclusion is therefore that developing Oslo Port is a clearly profitable project in cost-benefit terms, and the conclusion appears to be robust in the event of deviations from the assumptions on which the calculations are based.