Capacity allocation in unmonitored railway yards

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Background

- Trafikverket is the only IM for main railway lines (monopoly)
- RUs (costumers) apply for services (capacity) such as Infranord AB, Green Cargo AB, SJ AB, Region Stockholm Trafikförvaltningen, etc..
- Allocating available capacity aims at achieving maximal socioeconomic efficiency.

Flemingsberg station

Malmå godsbangård

Background

- Trafikverket is not the only service provider for several types of service facilities.
- Different business model and legislations for service facilities (SF) than national railway infrastructure (RI)
- Some SF are not monitored (not even control tower)
- Trafikverket lacks planning support for detailed capacity allocation, the service is not provided in the annual timetable
- Capacity is allocated in an operational basis

Infrastructure type	Public	Private
Freight terminal/port		✓
Loading sites (part of terminal)	✓	✓
Train formation areas	✓	✓
Station house	✓	
Tracks for holding	✓	✓
Depots		✓
Main railway lines	✓	

Background

The capacity allocation problem

- Uncertainty in demand for some of the railway service facilities, due to:
  - No track monitoring systems
  - Horizontally separated market and competition
- The Swedish Railway Law provides in 7 kap 8 § that the fees for using service facilities may not exceed the cost of providing the services, plus a reasonable profit
  - Service fee is not directly associated to the cost of the service
  - Low service fee
  - Economically unsustainable system
- Hard to decide if:
  - the capacity ceiling has been reached
  - more capacity exists than what the market needs

Zone	Charge
Zone A	SEK 5.50 per commenced hour and commenced hundred meters of track.
Zone B	SEK 0.30 per commenced hour and commenced hundred meters of track.

Phase One: Current system

The capacity allocation process

- Tracks for shunting or holding through an online form.
- No penalty for late changes
- RUs will be invoiced according to the actual operations
- Theoretical yearly capacity of railway service facility definition:

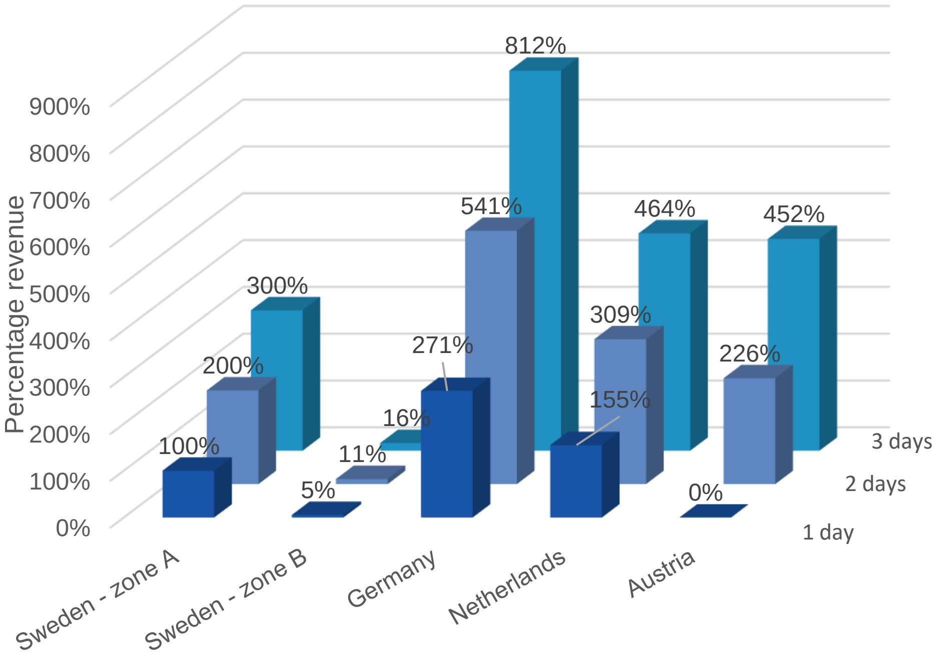
It is the number of 100-meters of track length multiplied by hours in calendar year, (i.e. 8760 h) and expressed with 100 meter-hour

Årsta kombiterminal och Älvsjö godsbangård (VÄTE Rail, Trafik och Teknik AB)

Phase One: Survey of other models

Charges:

- Other countries' network statements did not address the capacity allocation for unmonitored facilities
- Each country uses different pricing strategies and tiers
- Austrian model charges after the second day, Dutch model charges per minute.
- Charges in Sweden are the lowest
- Low fee leads to demand to make further investments

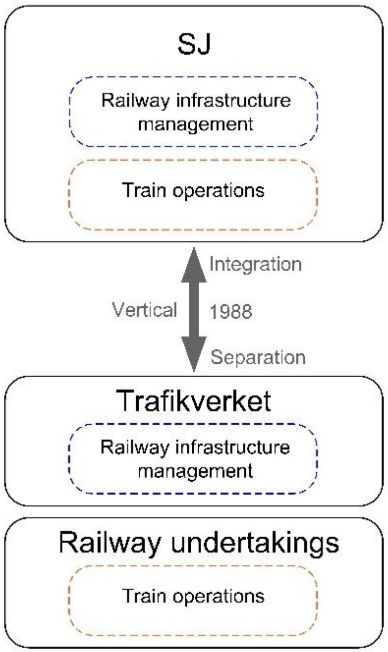


Revenue as a function of reservation duration

Phase One: Alternative pricing principles

<u>Marginal cost pricing principle:</u>

- European Conference of Ministers of Transport recommends MC and FC
- The price of capacity unit to equal the extra cost of utilizing an extra unit of capacity.
  - Disregards fixed costs
  - Suitable for utilizing existing capacity
  - Used in railway lines
  - 5% cost recovery and price-sensitive RUs
- Requirements for pricing:
  - The pricing should be cost-based pricing
  - The revenue should not be less than the maintenance costs
  - The revenue may allow for a profit that is considered reasonable.
  - The pricing principle should allow TRV to evaluate capacity



Vertical separation in the railway infrastructure market.
Based on (Ait-Ali, 2019)*

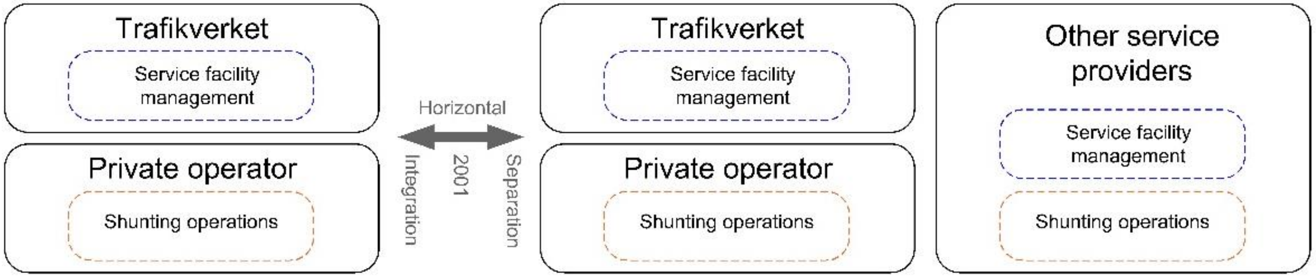
* Ait Ali, A. & Eliasson, J. (2019). Railway capacity allocation: a survey of market organizations, allocation processes and track access charges. Stockholm: VTI

Phase One: Alternative pricing principles

<u>Full cost pricing principle:</u>

- Recommended by the European Conference of Ministers of Transport.
- Infrastructure manager as a commercial organization needing to recover its costs.

  – Suitable to recover the full cost of a service
  – Leads into more horizontal separation
  – Suitable to identify possibilities for investments or capacity reduction



Vertical and horizontal separation in the railway infrastructure market. Based on (Ait-Ali, 2019)*

* Ait Ali, A. & Eliasson, J. (2019). Railway capacity allocation: a survey of market organizations, allocation processes and track access charges. Stockholm: VTI

Phase Two: Automatic monitoring of capacity utilization

RFID and OCR - Intelligent Video Gates

- System description and track occupancy detection
  - The main technical components of the IVG concept are: Cameras, RFID reader and Illuminators
  - The cameras and readers are positioned at entrance and exit tracks

- Cost for investment and maintenance
  - Depends on the included features
  - costs are relatively high as several components are included

IVG in vicinity of Port of Gothenburg (top) at Kville shunting yard and at Nuremberg marshalling yard, Bavaria, Germany (bottom). (Kordnejad et al., 2020b)

Phase Two: Automatic monitoring of capacity utilization

RFID, GPS and On-board Sensors:

- System description and occupancy detection
  - Motes technology: powerful computer chip capable of communicating with other chips.
  - The RFID reader reads wagons equipped with RFID tags at entrance and exit
  - The accuracy level might not suffice for shunting yards as GPS technology is used.

- Cost for investment and maintenance
  - Relatively low compared to the IVG

Phase Two: Automatic monitoring of capacity utilization

RFID and Trackside sensors:

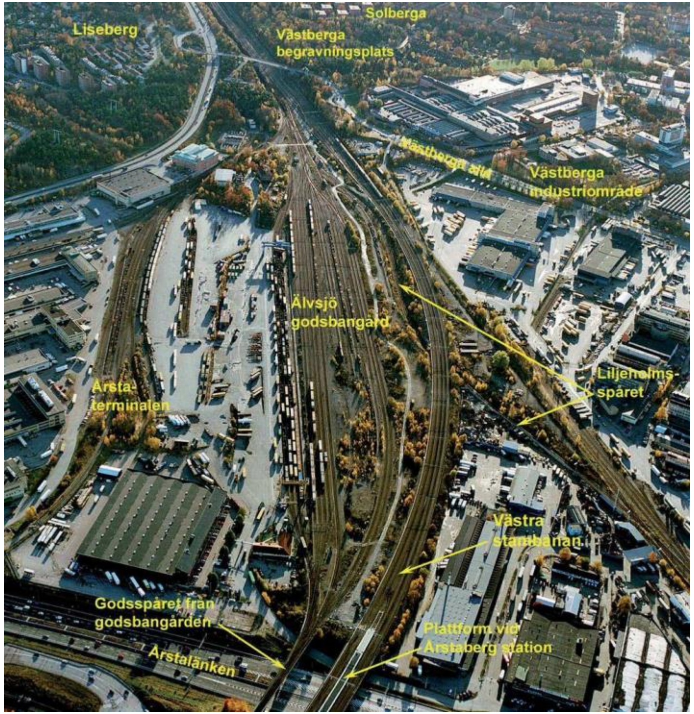
- System description and track occupancy:
  - The track sensors are charged by minor movements.
  - Demonstration project of the system in cooperation with KTH Wireless in Frövi, Sweden.
  - The RFID reader reads wagons equipped with RFID tags at entrance / exit

- Cost for investment and maintenance
  - Porotype stage: development cost for these innovative sensors is the main uncertainty.
  - Limited number of components: relatively low investment and maintenance costs compared to the IVG

Phase Two: Case study of Älvsjö shunting yard

<u>Characteristics of the yard:</u>

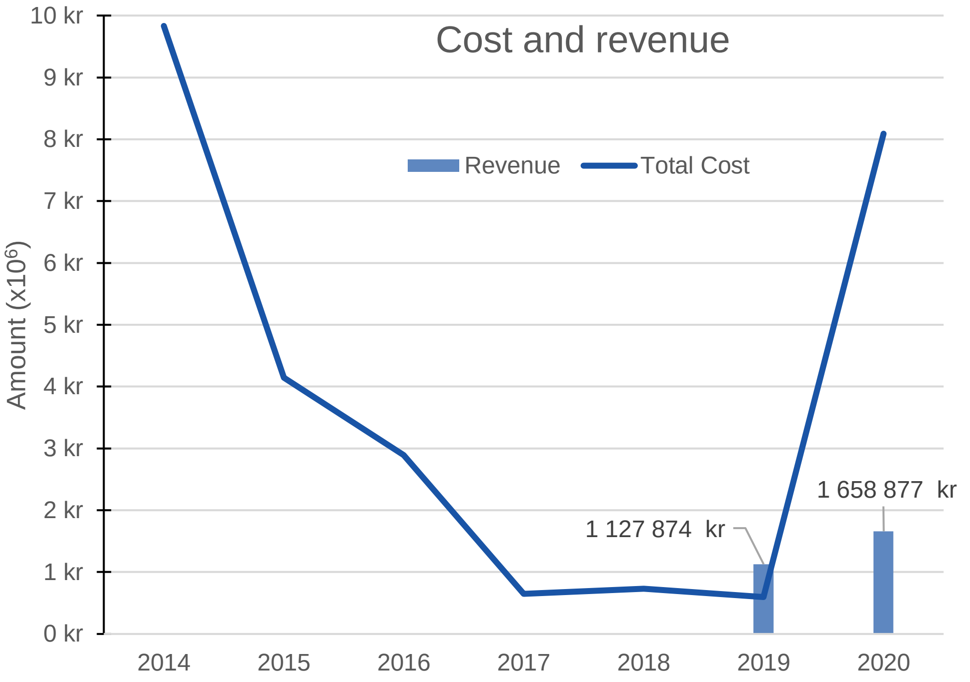
- Localization
  - Älvsjö Godsbangård is located Stockholm municipality, adjacent to Årsta intermodal terminal.
  - Älvsjö Godsbangård has a total track length of 7642 m divided over 20 tracks.



Phase Two: Case study of Älvsjö shunting yard

Capacity allocation process:

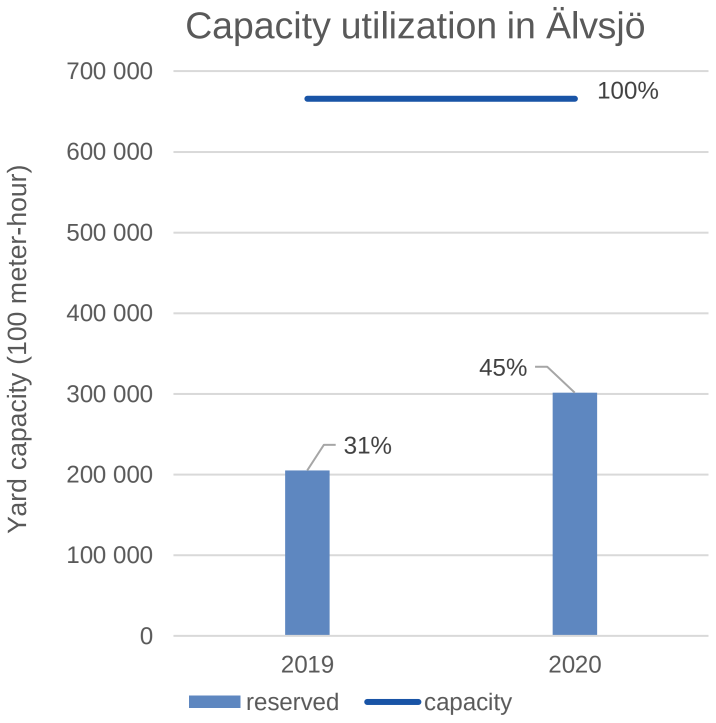
- Economic evaluation
  - ➢ In reality, Älvsjö Godsbangård have had a total service revenue:
    - in **2019** around 1,127,874 kr, that is around **189%** of the costs of the yard in that year.
    - in **2020** around 1,658,877 kr, that is around **21%** of the costs of the yard in that year.
  - ➢ Revenue is not correlated directly to the costs of operating the yard.



Phase Two: Case study of Älvsjö shunting yard

Capacity allocation process:

- Evaluation of the capacity utilization
  - Älvsjö Godsbangård can theoretically provide **665760 of 100 meters.hours** per calendar year.
  - According to capacity reservation forms filled by RUs in the years 2019 and 2020
    - **In 2019**, 205068 (100 meters.hours) has been requested, with a **utilization rate of 31%**
    - **In 2020**, 301614 (100 meters.hours) has been requested, with a **utilization rate of 45%**
  - Contradiction between RUs feedback
    - Theoretical capacity vs operational capacity
    - Lack of monitoring possibilities in yards and reliability of data



Phase Two: Case study of Älvsjö shunting yard

Capacity allocation process:

- Proposed alternative for capacity allocation:
  - ➢ Full-cost as a pricing principle.
  - ➢ If the capacity not utilized throughout the year, this would suggest that:
    - The total costs are high due to excess capacity.
    - Better to reduce the capacity to increase the utilization rate of the facility.
  - ➢ If yard's capacity was still utilized throughout the year, this would suggest that:
    - New investments to increase the capacity would gain enough revenue to keep the yard operational
    - To which extent new investments can be carried out depends on the willingness to pay
  - ➢ Penalty for late changes in reservation
  - ➢ Capacity exchange program: the goal is to keep the infrastructure utilization rather than to revenue maximization

Phase Two: Cost-Benefit Analysis Framework

Generalization from the case study:

- Model formulation
  - **First step:** estimate total costs of the yard and pre-define the amount of the costs to be recovered.

$$R_{T,i} = \alpha_i \sum_{t=1}^{T} C_{t,i} \qquad (1)$$

$R_{T,i}$ = planned revenue for yard i within design period T (SEK),
α_i = percentage of total costs to be recovered in yard i,
$C_{t,i}$ = estimated total costs in yard i for year t (SEK).

  - **Second step:** calculate the total capacity of the yard during the design period:

$$A_{T,i} = 87.6TL_i \qquad (2)$$

$A_{T,i}$ = total yard i capacity during the design period T (100 meter-hour),
L_i = total tracks length in yard i (meters),
T = number of years within the intended design period.

  - **Third step:** calculate the price of 100 meters track length occupancy for one hour according to full-cost pricing principle.

$$P_{T,i} = \frac{R_i}{A_{T,i}} \qquad (3)$$

$P_{T,i}$ = price of occupying 100 meters track length in yard i for one hour duration (SEK/100 meters-hour).

Phase Two: Cost-Benefit Analysis Framework

Numerical example on Älvsjö shunting yard:

Year	2014	2015	2016	2017	2018	2019	2020
Total Cost (kr)	9 834 757	4 143 653	2 894 375	647 877	729 328	595 911	8 091 900

- Input for the example:
  - Let α_i be 110% to allow for full recovery of the total cost plus a reasonable profit of 10%.
  - Design period (T) = 7 years
  - Total tracks length in the yard (L_i) = 7642 meters.

- Step one:

$$R_{T,i} = \alpha_i \sum_{t=1}^{T} C_{t,i}$$
$$= 110\% \times 26{,}937{,}800$$
$$= 29{,}631{,}580\ (kr)$$

- Step two:

$$A_{T,i} = 87.6 L_i T$$
$$= 87.6 \times 7642 \times 7$$
$$= 4{,}686{,}074.4\ \ (100\ meter - hour)$$

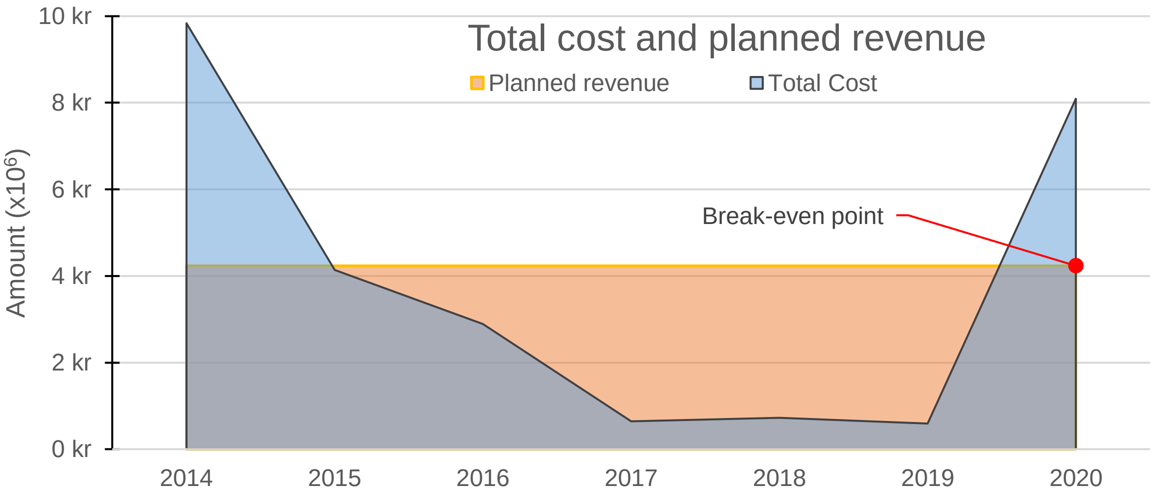
- Step three:

$$P_{T,i} = \frac{R_{T,i}}{A_{T,i}}$$
$$= \frac{29{,}631{,}580}{4{,}686{,}074.4}$$
$$= 6.32\ (kr/100\ meter.hour)$$

Phase Two: Cost-Benefit Analysis Framework

Numerical example on Älvsjö shunting yard:

- Thus, a service fee of **6.32 SEK** per allocated track length per track, per commenced hour and commenced hundred metres of track should have **recovered 110%** of the total costs
- This would allow for a **total revenue of 29,631,580 kr** during the design period



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Tack för uppmärksamheten!

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