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PASSENGER TRAIN OPERATIONS

TRANSPORTATION

TECHNICAL UNITS

- **SECTION**: Part of the jouney characterised for having the same train composition and no manoeouvre takes place.
- **JOURNEY:** Journey between two consecutive commercial stops, that is, between two stops where passengers can board or alight.
- **TRAIN SET:** Set of vehicles for transport of passengers that have a common origin and destination.

THERE CAN BE TRAINS WITH ONE OR MORE SET OF TRAINS

TRAIN: PRODUCTION UNIT
TRAIN SET: SERVICE COMMERCIAL UNITS

PRODUCTION UNITS

A train is made up of several vehicles:

- Trailer train: locomotive + coaches
- Self propolled train: differente vehicles

KILOMETRE.VEHICLE (km.coach, km.locomotive, etc...). Is the sum of the journeys (measured in km) of the differente vehicles of the train.

- **MEAN TRAIN FORMATION:**

$$\text{mean train formation} = \frac{\text{km.vehicle}}{\text{km.train}} \geq 1$$

PRODUCTION UNITS

- **GROSS TONS.KM**(GTK). Total mass of the train were the comercial load and the unloaded train weight in operational conditions.

COMPONENTS WEIGHT THAT SUM UP THE TOTAL TRAIN WEIGHT
Locomotive weight in operational conditions (with its guide, tools and maximum fuel) +
Weight of the unloaded towed vehicles but in operational conditions (with its guides and supplies) +
Weight of the passengers that are on the train and of their baggages +
Merchandise weight the train is transporting =
TOTAL WEIGHT OF THE TRAIN

PRODUCTION UNITS

- **PASSENGER WEIGHT**. Mean weight of the passengers plus their baggages (80 kg).

- **GROSS COMPLETE TONS KILOMETER (GCTK)**:

$$GCTK=\sum m_i \cdot l_i$$

where

m_i is the mass of the train in each section

l_i is the length in km of the section

PRODUCTION UNITS

- **GROSS KILOMETER TOWED TONS** (GKTT):

$$GKTT=\sum m_i \cdot l_i$$

where:

m_i is the weight of the towed vehicles in each section

l_i is the length in km of each section

Used for energetic consumption share

Example:

A train with a formation of 10 coaches that weight 150t. The locomotive weights 90t:

GKTT=150t

GTK=150t+90t=240t (a 40% more than GKTT)

PRODUCTION UNITS

- **SEATS**. Give an idea of the maximum capacity in a certain moment:
  - For medium and long distances:

    seats=seats+beds+sleeping berths
  - Suburban lines:

    seats=seats+stand up seats
- **SEATS.KM**:
  - The give an idea of the train offers and its utilization rate

$$\text{seats.km} = \sum_{\text{n}^{\text{o}}\ \text{section}} \text{seats}_{\text{section}} \cdot \text{km}_{\text{section}}$$

PRODUCTION UNITS

The axles have been an important element in the traditional railway system cost share in the international traffic

- **AXLES.KILOMETRE** (axles.km).

$$\text{axles.km} = \sum \text{axles}_{\text{total}} \cdot \text{km}_{\text{section}}$$

The axles of a train are the sum of the axles of each of the vehicles that form the train.

VEHICLES	Nº AXLES
Locomotive	4 or 6 axles
Towed vehicles: coaches, baggage and conventional wagons	4 axles
Some articulated vehicles	A pair of axles per 2 coaches + another pair to close the train set
Talgo	1 axle per coach + 1 axle to close the train set

DEMAN PARAMETERS

- **PASSENGERS.** Is the number of people that in a certain moment get in the train.
  - **BOARDING PASSENGERS** (Pb). All of the passengers that get into the train in a certain moment of the journey.
    - It is used to estimate: station rate, ticket prize, boarding features.
  - **MAXIMUM PASSENGERS** (Px). Passengers the train is carrying in a certain moment of the journey.
  - **MEANS PASSENGERS** (Pm). It is the number of passsengers that, on average, the train has in a certain moment of its journey:

$$Pm = \frac{\text{Passengers.km}}{\text{km.train}}$$

$$\boxed{Pb \geq Px \geq Pm}$$

DEMAN PARAMETERS

- **PASSENGERS.KM** (Pk):

$$Pk = \sum_{n^0 \text{ passengers}} \text{journeys (km)}$$

It is a representative parameter of the traffic.

- **MEAN PASSENGER TRIP** (Tp):

$$Tp = \frac{Pk}{Pb}$$

MEAN TRIP OF THE MAXIMUM PASSENGERS (Tpx):

$$Tpx = \frac{Pk}{Px}$$

TRAIN USAGE PARAMETERS

- **TRAIN USAGE** (U):

$$U=\frac{Pb}{S}$$

where *S* are the seats offered by the train.

U>1: The seat can be occupied several times

- **TRAIN SATURATION** (TS). Measures the peak demand of a train along its journey.

$$TS=\frac{Px}{Pm}$$

A big value of TS means that seats are not being used to adapt it to the more demanded section: it is strongly recommended to increase capacity in that section

TRAIN USAGE PARAMETERS

- **PASSENGERS ROTATION** (PR). Measures the passengers that alight from the train and are substituted by others.

$$PR=\frac{Px}{Pb}\leq 1$$

- **TOTAL USAGE OF THE TRAIN** (A). It measures how much the offer (measured in seats.km).

$$A=\frac{Pk}{seats.km}$$

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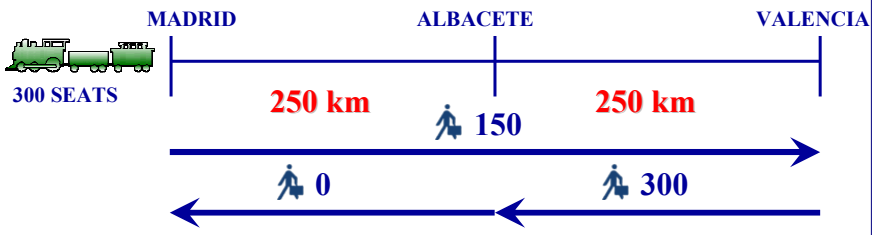
This parameter gives an idea of the real usage of the offered capacity

VERTICAL AND HORIZONTAL USAGE

- The total train usage is not a good parameter for taking decisions.
- It has to be distinguished if the usage has been obtained by transporting a lot of passengers a little distance or few passengers transported a great distance.

EXAMPLE: Calculate the train usage for each trip.



VERTICAL AND HORIZONTAL USAGE

- **VERTICAL USAGE** (Av): Gives an idea of the seat usage.

$$Av = \frac{Px}{S}$$

- **HORIZONTAL USAGE** (Ah): It gives an idea of the mean travel of the passengers compared with the train travel.

$$Ah = \frac{Pm}{Px}$$

VERTICAL AND HORIZONTAL USAGE

The equation of Ah can be rewritten as:

$$Ah = \frac{Pm}{Px} = \frac{Pkm/km.train}{Px} = \frac{Pkm/Px}{km.train} = \frac{\text{mean travel of the maximum passengers (Tpx)}}{\text{train travel}}$$

- **TOTAL USAGE** (A): It is verified:

$$Ah \cdot Av = \frac{Px}{S} \cdot \frac{Pm}{Px} = \frac{Pm}{S} = \frac{Pkm/km}{S} = \frac{Pkm}{Skm} = A$$

VERTICAL AND HORIZONTAL USAGE

- Calculation of the usage known the boarding passengers:
  - Usually, from the tickets the boarding passengers and the passenger.km can be calculated
  - Known the passengers rotation (PR) of the passengers (Pm/Pb)

$$Av = \frac{Pb \cdot PR}{S} \qquad Ah = \frac{Pm}{Pb \cdot PR}$$

  - Known the PR of a train during a certain period it can be applied to the boarding passengers which are known from another period to estimate the maximum passengers.