

Rail Vehicle Acquisition Strategy – Considerations



Acquisition Criteria

The development of the rail vehicle park is influenced primarily by the following factors:

- future prospects of rail transport;
- provision of space;
- size of units;
- availability of resources;
- financing ability;
- definition of quality standards;
- nature of infrastructure;
- modernisation or new acquisition.

These factors are discussed in detail below.

Future Prospects

Prior to initiating the acquisition of new vehicles a clear eco-

nomical, ecological or political commitment regarding rail vehicles is required. The following aspects should be taken into account:

- Peak and permanent capacity, coping with crowds (see section on size of units below).
- Protection of the environment (fine dust exposure, CO₂ emissions, car-free city, etc.).
- Level of pre-eminence (independent rail bodies, unrestricted passage).
- Economic position of the population (personal mobility).
- Structure of the road network.
- Matters of metropolitan prestige.

The aspects mentioned above have to be considered from a long-term perspective, as the investment in rail infrastructure and vehicles is normally arranged and amortized over a period of roughly 30 years.

Provision of Space

In order to plan and survey the provision of space for a rail system, it is necessary to consider the allocation of passenger traffic among the various transport modes (i.e. modal split). The modal split is the consequence of the mobility behaviour of potential users, and is influenced primarily by the quality and quantity of the supply of transport.

The provision of space is an important component of overall rail network and line planning. The good adaptation of the network structure to the real transport requirement (i.e. passenger numbers, place of embarkation, destination) will significantly raise the system's public appeal: for example, the need to change trains should be minimized as should the necessity of shifting between transport modes.

The starting position for establishing the space requirement is to undertake appropriate statistical surveys (i.e. passenger count and polls). The established space requirement will be used to formulate the provision of space. Thus a methodical exhaustion of the peak and overall capacity has to be defined (i.e. the planned and profitable degree of capacity); also, the individual demand of the respective clientele (social classes, age structure, disabled people) has to be taken into account as this will affect the proportionate composition of seating and standing facilities. Average travel times must also be taken into consideration.

Size of Units

Determining the optimal size of units depends on various factors:

- Provision of space in terms of axle and directional requirements.
- Frequency of trains during peak periods.
- Frequency of trains during off-peak periods.
- Size of train units during peak periods.
- Size of trains during off-peak periods.
- Profitability related to vehicle type.
- Infrastructure (length of rail stop, clearance).
- Workshops (length of workshop zones, clearance).

Rail lines with constantly high degrees of utilization may be served by large units (i.e. multi-articulated vehicle), while lines with extreme daytime and weekday fluctuations should preferably be equipped with separable units.

Safety aspects also have to be taken into account when determining the size of the units. Trains made up of several individual carriages and with a lower number of staff, especially attached carriages, afford ample opportunities for potential vandals or other offenders.

Physical attacks and vandalism can be reduced by the use of multi-articulated vehicles.

The choice of unit size also has a decisive influence on the purchasing price of the vehicles.

Additional driver work stations, control units, couplings, pantographs, etc., have a negative impact on both acquisition costs and the maintenance requirement.

Availability of Resources and Financing Ability

After establishing the requirement and securing financing, the most straightforward way to acquire vehicles is to prepare the requirement specification with a subsequent invitation to tender. The assessment of the price-performance ratio is followed by selection, post-negotiation and purchase. However, due to political and economic considerations alternative methods are often used, and financing possibilities (i.e. subsidies) as well as national and regional employment policies become decisive. If subsidies are only available to a limited extent or not at all, it is possible to apply interim solutions (i.e. modernisations) for fast and cost-effective improvements on both passenger and transport services. In most cases the purchase and modernisation of vehicles are implemented as a mixed concept.

Political commitments to safeguarding employment lead to the following options (often combined with one another) regarding acquisitions and modernisation:

- abandonment of new acquisitions;
- new acquisitions only within the scope of available options;
- new acquisitions with own creation of value (i.e. final installation or skeleton construction);
- improving and maintaining the existing vehicles, including the removal of weak points through modernisation in own workshop.

The availability of resources and the financial situation are not only significant with respect to the choice of the procurement method but also with regard to the determination of the technical specification of the vehicles. Therefore, execution, comfort and the extent of equipment required are determining factors. We can give the following examples:

- Choice of materials for the skeleton construction (aluminium, stainless steel, construction steel).
- Type of control (electronic or electro-mechanical).
- Air-conditioning or simple heating coils.
- Transfer of signals (hard wired or BUS control).
- Breaks (electro hydraulic, electro mechanical, fully mechanical, pneumatic).

High maintenance costs (i.e. expenses for materials and external services) during running operations are mainly caused by electronic assembly groups and special, difficult to copy constructional parts provided by systems suppliers. If a company restricts itself to the simplest technologies and standards, the share of own contributions, own products and substitutes from the local trade market can substantially limit maintenance costs.

The strategy of utilising own resources does not only apply to revitalisations and modernisations: it can also be implemented in the case of newly built vehicles. A relevant example can be found in the development and production of "Leoliner" type trams for Leipziger Verkehrsbetriebe [Leipzig's public transport system] in Germany.

Whatever the proportion of new acquisitions versus vehicles to be modernised, the decision still has to take operating costs into account. Among others, the following criteria should be considered:

- Energy consumption and use of resources.
- Servicing and maintenance costs.
- Necessary equipment and qualification requirement for workshops and personnel.
- Effect of wear and tear on infrastructure.
- Ease of care.

Definition of Quality Standards

In addition to legal regulations and European standards, brochures, information leaflets and recommendations on the quality of rail vehicles are prepared by the Association of German Transport Companies (Verband Deutscher Verkehrsunternehmen, VDV) as part of its committee work. These resources reflect the present state of technology and can be taken into account during evaluation and approval procedures.

However, keeping to a specification guideline which has been regulated down to the last detail is inevitably associated with high acquisition and operating costs. In particular, the younger EU accession countries do not have sufficient funds and therefore have to define a quality standard of their own for an interim period. The co-determination of trade unions and works committees must also be subordinated to existing possibilities. As a result, some subjects such as comfort and design have to be looked at and adapted to current requirements. Other instances include:

- heating and air conditioning (ventilation by means of airstream);
- upholstering of seats;
- ergonomics of the seats and the driver workplace;
- noise development;
- barrier free access;
- passenger information;
- practicality of fittings contra designer concept.

Nature of Infrastructure

Modern vehicles are frequently incompatible with existing infrastructure, e.g. low-floor technology and existing railway lines. Due to their low construction volumes, low-floor vehicles have often been calculated close to their maximum load. In the interest of saving weight and energy, material cross-

sections are often reduced to the necessary minimum. As a result, these vehicles quite often show low overload characteristics, especially when the infrastructure was designed for robust high-floor vehicles.

When deciding whether or not to acquire new vehicles, the following criteria should be examined and integrated into strategic considerations:

- clearance profile;
- smallest curve radius;
- distances from track centre;
- platforms;
- execution of points and crossings (low or flat groove);
- technical conditions of the points (riffles, impacts, fractures, junction curves);
- position of the overhead line (with respect to the track centre);
- position of track separators and switch contacts;
- technical condition of the overhead contact system (unevenness, height differences);
- depots (lengths of storage siding, train washing systems, sanding);
- workshops (lifting systems, transmission lines, work pits, siding lengths, special resources and equipment, etc.);
- profile contractions.

Modernisations

The modernisation of tram and city-based rail systems can help a public transport company to attain the following goals:

- Extension of the lifecycle of robust vehicle concepts.
- Replacement of discontinued components and aggregates.
- Increased availability through reducing constructive weak points.
- Improvement of driving comfort and driving dynamics.
- Creation or support of barrier-free access.
- Redevelopment of the driver's working areas.
- Energy saving effects.
- Reduction of noise emission.
- Reduction of maintenance costs.
- Standardisation of spare parts.

Extending the Lifecycle of the Tram Car Body

The condition of tram car bodies, which are currently produced using low-alloy or non-alloy construction steels, should be optimized in such a way that they can be retained for additional service years (i.e. between 16 and 24 years).

The following measures should be implemented:

- Disassembly and sand-blasting of the car body.
- Repair of rusted through spots.
- Removal of material laminations.
- Use of corrosion protected or refined materials (e.g. hot-dip galvanized) for vulnerable areas of the shell construction such as access shafts, window balustrades and gutters.
- Conservation of the shell construction.
- Applying a sealing compound in gaps.
- Cavity conservation.
- Careful application of varnish with a defined layer thickness.
- Use of elastic sealants at dynamically highly loaded places (e.g. at the transition of steel - glass-reinforced plastic (GRP)).
- Use of weatherproof control cabinets.
- Installation of door leaves in GRP or aluminium.

Reduction of Noise and Sound Emission

Effective sound and heat insulation can be achieved through the application of suitable materials. Sound absorbing materials such as "Phonkiller" (thickness circa 5 mm) can be used for sound insulation and de booming of interior areas of the tram car body (sheet metal). To improve heat insulation, mineral wool with a density of 20 kg/m³ should be installed in the cavities of the tram car body (side panels and roof).

Rotating equipment and the chassis are the source of a great deal of noise. Exchanging rotating transformers for static ones reduces these particular noises inside the vehicle. The turning noises of wheels as well as powertrain emissions can be significantly reduced through the use of sound absorbers and other noise absorption devices.

The squealing of wheels is the result of the side slip angle of the wheels in curves. This can be reduced by using drive head lubricants, either built into the vehicle or applied in a stationary position. However, the negative influence on the static friction between wheel and rail has to be taken into account.

Reduction of Breakdown Susceptibility

A public transport system based on trams can only be operated profitably and attractively if all available vehicles are highly reliable and experience only a few service interruptions. An increase in availability is always associated with a reduction in workshop and operating reserves and thus the number of vehicles (i.e. tied-up capital). For details see paragraph on electric equipment below.

Improvement of Comfort

Important components of the interior design of the vehicles include the side panel and ceiling decorations, the light fittings, the handrail system as well as the seating arrangement. A wide range of products are available on the market; there are also technological possibilities with respect to own productions to create an attractive appearance.

The use of flame resistant materials is recommended. Strict requirements have to be adhered to, such as the use of halogen-free cables if a vehicle travels through a tunnel, even if only in a few sections.

At present, top hung windows are preferred to sliding windows as they provide security against passengers leaning out; however, the possibility of natural ventilation is also reduced.

The floors have to be designed in such a way that no water is able to penetrate. Plastic coated multi-layered wooden boards which have been equipped with an anti-slip floor cover are mainly used for this purpose.

With respect to seating, shape, appearance and sitting comfort must all be taken into account. Upholstered seats are comfortable for the passengers but require a lot of maintenance and cleaning. If upholstered seats are used they must be protected against vandalism.

Traditional heating coils, which only are only effective in certain areas and only operate with great loss of heating, can be replaced by convection radiators.

Handrails should provide safety and be vandalism resistant, elegant and low maintenance. Powder coated steel tubes and fittings or brushed stainless steel tubes are preferred options.

Ceilings and side panels should also be covered with materials which are easy to clean, (including the removal of graffiti). In addition, anti-graffiti surface coatings can be applied.

Today, passenger information systems and modern sales technology are the norm. These include, among others:

- Automatic front display for route and line numbers.
- External side display.
- Display of the line number at the rear.
- Interior display of stops, respective display of line route.
- Acoustic information system.
- Mobile ticket automats.
- Electronic ticket cancelling apparatus.

Driver Working Area

The tram driver's cabin has to be designed separately from the passenger area in accordance with the latest ergonomic developments. All control elements have to be arranged clearly with easy access.

An air conditioning system should provide a pleasant room climate (adjustable temperature, fresh air). The driver's seat should be cushioned, depending on weight, and be easily adjustable in accordance with requirements.

It must be possible to electrically adjust all outside mirrors from the inside. Any required visibility conditions of the driver have to be taken into account.

Malfunction indicators facilitate diagnosis in the case of faults in the vehicle. As a result the driver might be able to remove the fault himself and provide the control centre with qualified information concerning the fault.

Bogies / Chassis

The amount of unsprung weight has to be reduced through the additional installation of elastic connections such as MEGI primary suspension and rubber cushioned wheels.

The installation of wheel flange lubrication systems reduce wear and tear of the steel tyres and avoid curve squealing.

Further optimisation of the chassis could include:

- oil-proofing of the gearing mechanism;
- installation of anti-blocking systems;
- installation of wear-resistant emergency brakes;
- examination of the combination of friction and wear pad;
- increase of jacking forces of magnetic rail breaks;
- electro-pneumatic sand stores.

Electric Equipment

With respect to modernising the existing vehicle park, the direct current electrical equipment should be replaced with the wear-resistant and almost loss-free working three-phase alternating electrical current on an IGBT basis. This change makes it possible to achieve both a reduction of breakdown susceptibility and high drive dynamic comfort. Energy savings of up to 40% may be achieved if a network energetic recovery system is employed during braking. The driving engines are also without collectors in this process, which implies almost maintenance-free operation.

Important rationalisation can also be achieved by exchanging rotating engines for a recharging board network with an

electronic recharger. The use of this technology is also an advantage in terms of noise minimisation.

Pantographs should have an electronic operator rather than the use of a tripping line.

Inside the vehicles, all installed lighting systems should be almost loss-free through the use of low voltage fluorescent lamps and LED technology.

Modern outward opening sliding doors or outward swing doors should replace traditional folding doors.

Security can be improved with the use of sensitive monitoring systems such as sensor bars, motor current monitoring and light barriers, which provide the best possible anti-trap protection.

Secondary functions such as video monitoring systems, diagnosis systems and passenger counting facilities may be installed if required.

Creation of low-floor facilities

An important component in making local public transport more attractive is the creation of barrier-free access to stops and vehicles. Thus the present-day acquisition of new vehicles involves at least 60% low-floor facilities.

In the case of modernisations it is also possible to integrate low-floor facilities into existing high-floor vehicles. The appropriate parts can be installed in articulated vehicles while large-capacity vehicles can be altered constructively to be equipped with low floor access. These measures usually result in low floor facilities at 25-40 percent.