



Mind the Gap...

and the curve, and the spec sheet

Common cost drivers in
Infrastructure & Vehicles

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STADLER

Part 1: Infrastructure Cost Drivers

FOUR MAIN DRIVERS

- Horizontal alignment
- Vertical alignment (gradient)
- Track form and surface
- Power supply, OCS, and stop design

Each one is a commitment.

- Each one is more cost efficient to get right at concept stage than at any point afterwards.





Don't Fight the Geometry

HORIZONTAL ALIGNMENT

What not to do:

- Force the alignment to follow road geometry without modelling the track-vehicle interface. Every tight radius adds cost in earthworks, track hardware, and vehicle wear and permanently limits your fleet options.

Rule of thumb:

- Minimum curve radius should be determined by service need and vehicle, not the road. Agree it early.
- Make sure that geometry is designed to limit the use of extra infrastructure such as lubricants.



The Gradient Tax

VERTICAL ALIGNMENT

What not to do:

- Accept steep gradients without considering the whole-life impact. Every extra percent of gradient is a permanent energy surcharge, increased brake wear, and a constraint on future fleet procurement. Some vehicles simply cannot run steep grades – at least not without customization.

Rule of thumb:

- Gradient costs are paid twice - once by the builder, forever by the operator.
- Steep gradients limit service speed and can require higher motorization of the vehicle.



There Is No Free Trackbed

TRACK FORM & SURFACE

What not to do:

- Choose track form solely based on cost alone.

Rule of thumb:

- Keep in mind how the track bed propagates noise and vibrations, not only from the trams but also from other vehicles crossing it or sharing the space.
- While maintenance factors and vehicle rail interactions are important to keep in mind it's not the only factors that should be considered. How does the track fit in the urban environment?



Power supply / OESS and Stop design

What not to do:

- Require catenary free operations without considering the impact on weight, range and operation patterns. Is it really needed or just nice to have?
- Design platforms and stops to require operating bridge plates or platforms that are an odd height.

Rule of thumb:

- Platform height and power demand are network-wide commitments.
- OESS will add weight to the vehicles which might require infrastructure changes and will impact running dynamics.

Part 2: Vehicle Cost Drivers

Spec decisions made at the start of a project echo through every maintenance interval, every energy bill, and every platform rebuild **for the next 35 years.**



Overheard from engineering department...

There are more antennas than wheels on
modern trams

Bogie Modifications

What not to do:

- Require a bespoke bogie design, such as requiring space for extra equipment, change axle loads etc.
- Often a bespoke bogie means it is a new bogie that will have to go through all testing and approvals.

What to do:

- Communicate in the RFP/RFI what you want the vehicle to do. If you want track diagnostics to monitor infrastructure, mention that instead of making changes to the bogies. Let the supplier figure out the best solution.



Carbody Modifications

What not to do:

- Specify a non-standard carbody with features such as extremely large windows, non-standard placement of doors etc.

What to do:

- The manufacturers have built many vehicles and know what customization can be done without impacting crash safety, performance etc, and without causing a significant redesign. Have a dialogue with the manufacturers before putting requirements in your RFP.



More Antennas Than Wheels

WiFi. CCTV. TCMS. PIS. Radio. GPS. Track monitoring. Driver assistance. Cybersecurity monitoring have gone from nice to have to essential.

What not to do:

- Treat digital and communications systems as a footnote in the procurement spec. Cybersecurity requirements are a major cost driver.

What to do:

- Make sure that every single requirement is vital and not casually included because it is nice to have.
- Evaluate what kind of system is needed for a good passenger experience.



Overheard from the engineering department...

In many tenders more pages are dedicated
to communication than traction and brakes

Four Systems To Not Underestimate

SIGNALLING

- ETCS, ATP, ATC are a significant vehicle AND infrastructure cost. The digital trackside-to-train interface is essential and needs to be planned carefully together with your suppliers – especially if you purchase both rolling stock and signaling at the same time.

PASSENGER INFORMATION SYSTEMS

- Real-time displays, audio, app feeds, accessibility compliance. PIS has grown from a nice-to-have into a major contract line. Budget and timeline accordingly and figure out what your passengers need.

CYBERSECURITY

- Cyber certification, secure boot, intrusion detection, and ongoing patching are now mandatory procurement requirements and they have a whole-life cost.

COMMS & TCMS INTEGRATION

- The Train Control and Management System must talk to everything else. Communicate with your intended suppliers and see what solutions are available and evaluate what you need.

Choosing the Best-Value through High-Impact features

High-Cost impact decisions

(Minimal passengers-perceived value)

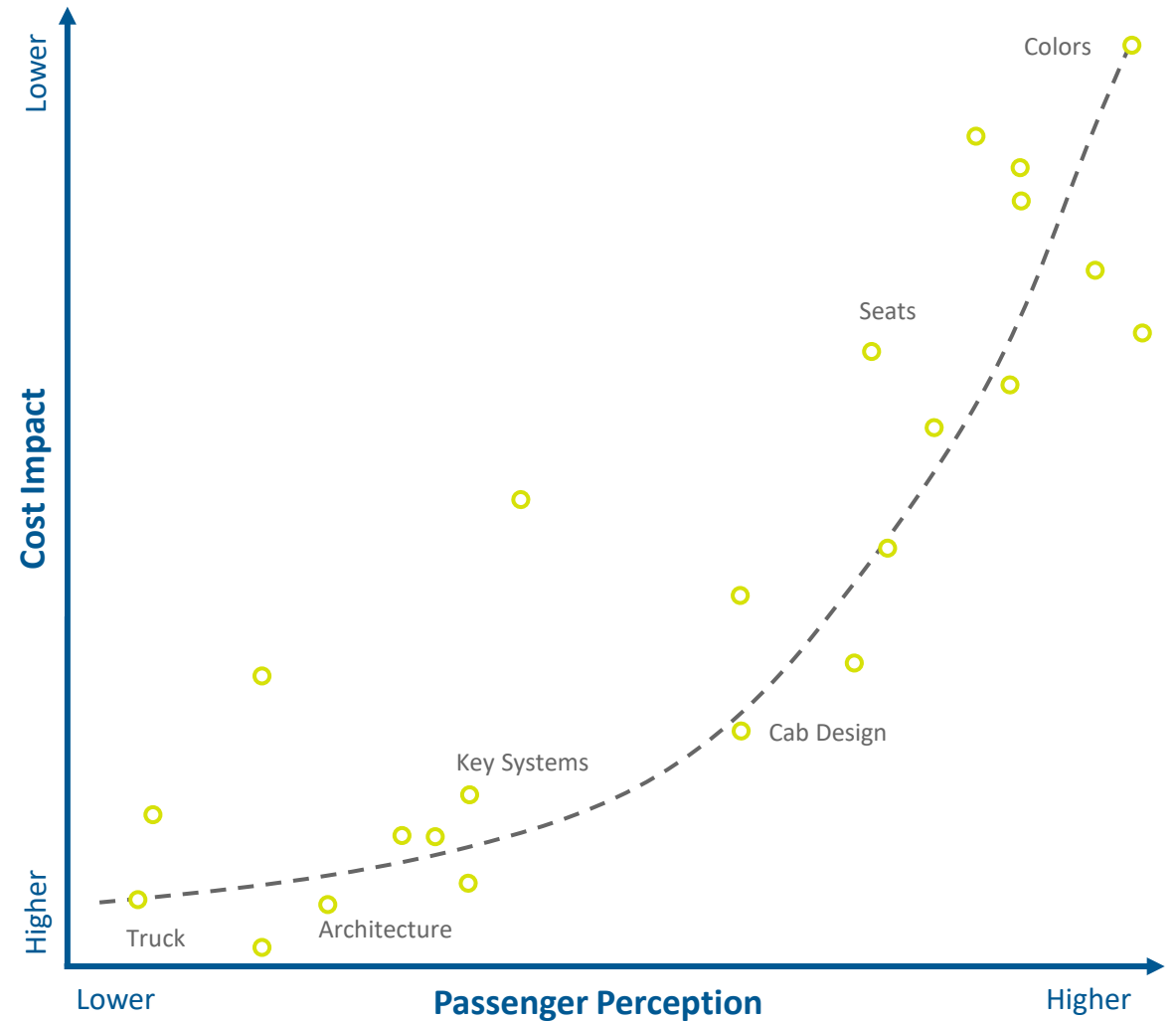
- Major design changes
- New truck design
- Structural modifications
- System overhauls

Low-Cost impact decisions:

- Minor component adjustments
- Cosmetic changes
- Some software updates

Goal:

Balance design customizations to optimize cost and functionality, delivering the best possible passenger perception



The Bottom Line

SYSTEMS & INFRASTRUCTURE

- Infrastructure and vehicle decisions are not independent. Optimize them together to avoid generating extra cost drivers on both sides.
- The right time to resolve interface conflicts is before the contracts are placed.

VEHICLES & MODIFICATIONS

- Many vehicle customizations might not be necessary but costly - consider them carefully and communicate with suppliers.
- Modern trams have more antennas than wheels. The digital systems program is now a primary cost driver.

WHOLE-LIFE PERSPECTIVE

- The procurement budget is the opening move. The whole-life model is what matters.
- Cybersecurity, signalling integration, and TCMS are not afterthoughts. They are procurement line items with long-term budget implications.

INTEGRATION & TIMING

- Integration is not a phase. Infrastructure, rolling stock, and systems teams belong in the same room from the start. Make sure that each part of the project are interfacing with other parts properly.

Mind the gap... and the budget... and the passenger experience.

THANK YOU.

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