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Reducing the Cost of Railway Vehicle – Key Lessons from the Aerospace, Automotive and Marine Industries

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Abstract

Whether considered as the purchase price or Life Cycle Cost (LCC), the overall cost of a railway vehicle is increasing. Many factors contribute to this increase, such as regulatory compliance, sustainability, advancement of technologies and user preferences. This paper presents results of a study that was aimed at conducting a cross-transport industry investigation of the commonalities in the processes of procurement, engineering design, manufacturing and maintenance (PDMM). It assesses the potential economic benefits of applying similar methodologies to the rail industry. Cost drivers in the rail industry that could be ameliorated by greater commonality and standardisation were identified and assessed. Best practices in the Aerospace, Automotive and Marine (AAM) industries were captured, adapted and applied to the rail industry to assess their potential for cost reduction. The recommendations from this study are beneficial to the railway industry through implementation in the railway industry of best practice PDMM processes used in the AAM industry.

Key Words:
Cost Reduction; Railway Vehicle; Cross-transport industry investigation, cost benefit analisys
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1. Introduction

The overall cost of a railway vehicle is increasing, whether considered as the purchase price or Life Cycle Cost (LCC). Many factors contribute to this increase, such as regulatory compliance, sustainability, advancement of technologies and user preferences.

This paper presents the outcomes of a research entitled **C**ommonality **A**nd **S**tandardisation of **P**rocesses for cost-**E**ffective **R**olling stock (CASPER).The aim of the project was to undertake a feasibility study by conducting a cross-transport industry investigation of the commonalities in the processes of procurement, engineering design, manufacturing and maintenance[1] (PDMM), and assess the potential economic benefits of applying similar methodologies to the rail industry. Cost drivers in the rail industry that could be ameliorated by greater commonality and standardisation were be identified and assessed. Best practices in the Aerospace, Automotive and Marine (AAM) industries were captured, adapted and applied to the rail industry to assess their potential for cost reduction.

2. Methodology

The CASPER project was divided in three work streams (see Figure 1). Work Stream 1 (WS1) provided a benchmark of the PDMM practices in the AAM industries from which best practice was captured and analysed as shown in Figure 2 (O'Neill et al, 2013). The term automotive industry encompasses all road vehicles (cars, buses and trucks). The primary objective of Work Stream 2 (WS2) was to identify how PDMM processes are currently undertaken in the rail industry, including

[1]The term maintenance has been applied in this document to mean keeping a piece of equipment in an optimal working condition. This may entail preventative maintenance, condition monitoring and repairs.

any recent developments and improvements and identify opportunities for further development. Through engagement with rail industry stakeholders, Work Stream 2 captured the primary cost drivers within the industry and identified the main blockers to achieving cost reductions (Anderson et al, 2013). Data and information generated in both workstreams was collected through Literature review; Interviewing of key stakeholders; and Case studies. The outcomes of WS1 and WS2 were used to conduct a gap analysis, which formed the basis of the activities in WS3. A preliminary cost benefit analysis (CBA) for the rail industry was made recommendations for best AAM practices that had a potential to significantly reduce train system costs.

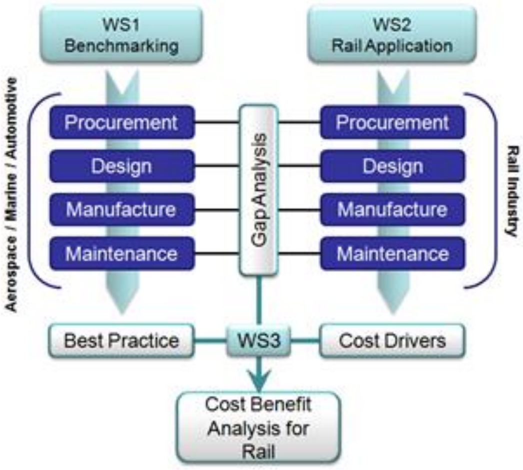

Figure 1: Project methodology flow

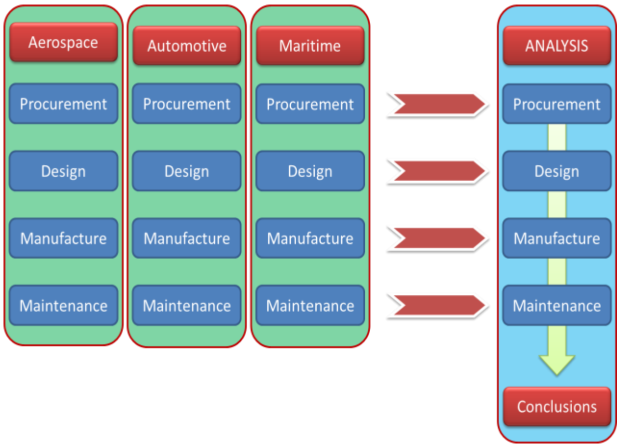

Figure 2: WS1 Benchmark flow chart

3. Results

From the outcomes of WS1, a combined list of sixty seven 67 PDMM solutions was identified from the AAM industries as being opportunities for cost savings in the railway industry (O'Neill et al, 2013).

Figure 3 shows the process applied for selection of the final 8 AAM industry cost reduction solutions for implementation in the railway industry (Matsika et al, 2014). The solutions identified from WS1 were assessed to determine their impact on AAM Industry. A score of high, medium and low was assigned to each solution. A gap analysis was conducted on those solutions which had a high impact. Only those solutions deemed to present a high opportunity for implementation in the railway industry were considered for Cost Benefit Analysis.

From the above selection process, eighteen (18) AAM solutions are considered to have high impact - four for each of procurement and manufacturing, and five for each of design and maintenance. Below is the list of the high impact cost saving solutions for PDMM.

Procurement

- Low customisation (Automotive, Aerospace, Marine)
- Procurement model that has reduced number of intermediaries (Automotive, Aerospace).
- Lean Six Sigma Approach (Just-in-time; Vendor stocking; Standardisation of materials, processes and delivery conditions; Outsourcing) (Marine).
- Systems buying and reduction of supplier base (Automotive, Aerospace, Marine)

Design

- Common platform/chassis design (Automotive)
- Common components and sub-systems (Automotive, Marine)
- Experience from legacy vehicles (Marine)
- Reduction of types of vehicles (Automotive, Aerospace, Marine)
- Design for Manufacture and Assembly (DFMA) (Aerospace)

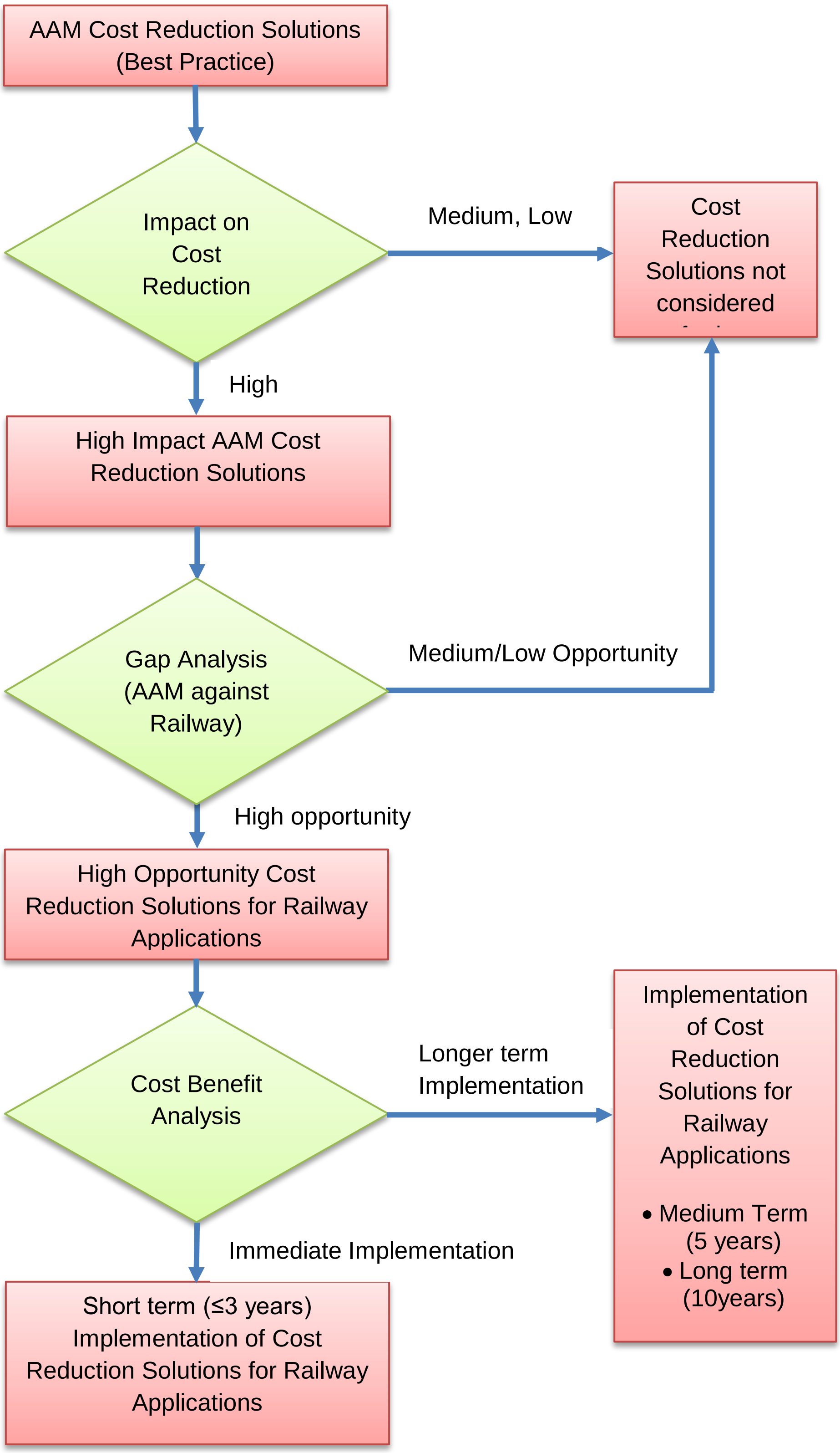

Figure 3: Selection Process of AAM Industry Cost Reduction Solutions for Railway Application

Manufacturing

- Automation of production process (commonality and standardisation of components and systems to provide opportunity for increased batch sizes) (Automotive; Aerospace).
- Modular design/production (Marine).
- Jigless manufacturing (Aerospace).
- Pre-fabricated sections (Marine).

Maintenance

- Design for reduced maintenance (reliability) (Aerospace, Automotive)
- Sharing purchases of parts and inventory (Aerospace)
- Condition monitoring of components for early detection of diversion from optimal performance (Aerospace).
- Splitting of contracts for different components and systems (Aerospace)
- Step-by-step procedures for vehicle maintenance with help from manufacture (Aerospace, Automotive).

In order to determine the relevance and ease of implementation of these solutions, a gap analysis was conducted. A comparison is made between what is best practice in the AAM industry against the railway industry to deduce the gap, and also provide an indication of the ease with which such gaps can be closed. Below is a summary of the outcomes (Matsika et al, 2014).

Procurement

The greatest opportunity lies in reducing railway vehicle customisation. This is because while the gap between railway and AAM industries may be wide, it is relatively easy to close the gap. Lower customisation promotes standardisation of railway vehicle types, components and subsystems. The second opportunity relates to adopting a procurement model that aims to reduce the number of intermediaries. Based on literature and interviews conducted in this research, the passenger marine industry has the least number of intermediaries, thereby reducing procurement costs.

Design

The greatest opportunity lies in reducing the number of types of railway vehicles and associated components and subsystems. This promotes standardisation. It is important to note, however, that the gap between the best practice for common components and subsystems is smaller than that of reducing the types of trains, yet it is easier to close the gap for the former than the latter.

The second set of opportunities relates to adopting a common platform (chassis). However, there exist a number of examples in the railway industry where common platform has been applied to reduce PDMM costs. Two such examples are the Siemens Desiro, and Bombardier TRAXX locomotive family covers all types of railway applications.

Manufacturing

Automation of production process presents the highest opportunity because it has the largest gap. However, closing the gap may be a challenge bearing in mind the investment required to acquire and install automated workshops. Automation becomes economical due to commonality and standardisation of components and systems to provide opportunity for increased batch sizes.

The second opportunity is modular design which is currently practiced in the railway industry but at a limited scale. A combination of automation and modular design could potentially present a high cost saving opportunity for the railway industry.

Maintenance

The table below on maintenance shows that the largest gaps exist for ‘Sharing purchases of parts and inventory’ and ‘Splitting of contracts for different components and systems’. Unfortunately, implementation may not be easy. The highest opportunity for cost reduction lies in ‘Design for reduced maintenance’ and ‘Step-by-step procedures for vehicle maintenance with help from manufacture’ which are relatively easier to implement.

From the gap analysis, the following eight solutions (two per PDMM) are recommended for application in the railway industry, as shown in Table 1.

These are solutions that have produced high impact cost reductions in the AAM industry. They also present a relatively large gap compared with the railway industry and could be relatively easy to implement. It is worthwhile noting that the majority of these solutions come from the automotive and aerospace industries.

Table 1: Recommended Cost Saving Solutions

PDMM	Cost saving solution	Best Practice AAM Industry
Procurement	Low customisation	Automotive, Aerospace, Marine
	Procurement model that has reduced number of intermediaries	Automotive, Aerospace
Design	Common components and sub-systems	Automotive, Aerospace, Marine
	Reduction of types of vehicles	Automotive, Aerospace, Marine
Manufacturing	Automation of production process	Automotive, Aerospace
	Modular design/production	Marine
Maintenance	Design for reduced maintenance (reliability)	Automotive, Aerospace
	Step-by-step procedures for vehicle maintenance with help from manufacture	Automotive, Aerospace

An analysis of the implementation strategies of the eight solutions was made. The solutions have been categorised as institutional (organisational), technical, financial and railway operations. It was found that in order to overcome the cost drivers, the solutions strategies should be technical, institutional, financial and operational in that order of significance. The emphasis lies in the technical and institutional solutions mainly. An overarching barrier identified in implementation of these strategies is lack of incentives to promote such strategies.

A qualitative rather than quantitative CBA was conducted. This is because during the process of the interviews it was established the majority of information available was of a qualitative nature, with a particular focus on factors such as institutional structures and process. It was not possible for the interviewees from the other industries to provide quantified savings or benefits of the processes used, nor where the rail industry interviewees able to provide any significant data in relation to costs. Therefore a high-level assessment of the likely costs and benefit of the recommended solutions was conducted, which may help guide the railway industry towards the areas which would be worth further investigation. In Table 2, each of the eight recommended cost saving is assessed in terms of its expected cost of implementation in the rail industry and the financial benefits (to whole life cost) it is likely to bring. The costs, benefits and the resulting cost-benefit ration are shown using a three-point scale. The purpose of this table is to highlight the areas which the evidence from this study suggests would be most beneficial for rail industry to investigate further.

Table 2: Recommended Cost Saving Solutions

PDMM Action	Cost	Benefit	Result (B/C)
Low customisation	●	●●	●●
Procurement model that has reduced number of intermediaries	●●	●●	●
Common components and sub-systems	●	●●	●●
Reduction of types of vehicles	●	●	●
Automation of production process	●●●	●●●	●
Modular design/production	●●	●●	●
Design for reduced maintenance (reliability)	●●	●●●	●●
Step-by-step procedures for vehicle maintenance with help from manufacture	●●	●●	●

4. Conclusion

The gap analysis shows that the greatest cost saving opportunity for rolling stock lies in reducing customisation while promoting a reduction in the types of trains coupled with commonality of components and subsystems.

Commonality and Standardisation
Commonality and standardisation of designs and subsystems (reduction of bespoke design) provides the greatest potential is reducing costs of rolling stock in all the PDMM areas through:

- Reducing procurement costs through reduction of design specifications.
- Reducing design costs (because there is less need for investing in new designs).
- Reducing manufacturing costs through mass production of standard components and subsystems thereby benefiting from economies of scale.
- Reducing maintenance costs through reduction of the costs associated with re-training staff in maintaining new designs.
- Reducing the costs associated with compliance testing. With a one-off cost for compliance testing to meet requirements from EN Standards, the relative cost of such testing reduces.
- Potential sharing purchases of parts and inventory, a strategy from which the aerospace has benefited significantly.

A report by Rolling Stock Strategy Steering Group (RSSSG) (2014) indicates that an increase in the build rate (of electric trains) leading up to 2043 would still not guarantee a steady production rate. As long as the production rate is not steady, the unit cost of trains would remain high. Therefore, Commonality and Standardisation would remain a more viable and realistic means to increase economies of scale, thereby reducing cost.

Maintenance
Design for maintenance is recommended as a way to reduce rolling stock LCC. It also reduces the need for building costly depot and berthing sites. The huge human skill capacity that goes with running these sites also makes design-for-maintenance a potentially high cost saving strategy. While TSAs are seen to be a preferred way to increase reliability (and therefore availability), such contracts in UK are perceived to be inefficient and lead to higher costs. To improve the efficiency, it is recommend that the current long term contracts (about 25years) should be shorter (say 5 year rolling contracts) with mechanisms to incentivise cost savings.

Institutional Reform
The current UK rail industry structure may need to be revised to reduce 'middle organisations' (or intermediaries) and use of costly consultants. This is notwithstanding the fact that Government policy supports franchise-led rolling stock procurement, which is supported by the RSSSG (2014).

Nonetheless, three suggestions have come out of this study. Some stakeholders have suggested that in order to reduce procurement costs in the future, a "Strategic Purchasing Authority", similar to the one used for the London Olympics to procure rolling stock for the industry should be created with minimum government involvement and pressure. Another suggestion was procurement by the government or Treasury. The final suggestion bordering in keeping the current system was to grow the number of ROSCOs to increase competition and lower costs.

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