INNOVATIVE RUNNING GEAR SOLUTIONS FOR NEW DEPENDABLE, SUSTAINABLE, INTELLIGENT AND COMFORTABLE RAIL VEHICLES

D2.4 Assessment of the potential benefits of novel materials

Leader/Responsible of this Deliverable: Riccardo Licciardello, DICEA

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CI	Classified, information as referred to in Commission Decision 2001/844/EC	

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PUBLISHABLE SUMMARY

The benefits of the adoption of novel materials and associated manufacturing methods are summarised in this report and the implications for standards are outlined.

A comparison of the two following scenarios was performed:

- benchmark scenario – trainset type 8000 running on line 10 of Metro Madrid;
- innovation scenario – similar trainsets replacing the benchmark ones on line 10 with bogies composed of several parts produced by Additive Manufacturing (AM) and with a composite carbon-fibre / steel bogie frame.

The innovation scenario was explored for incremental economic impacts (both rail-sector and non), social impacts, environmental impacts and Regulatory/Standardisation impacts.

The innovations require some changes to the typical life-cycle.

For AM the source material may be similar to existing solutions (steel) or different (aluminium alloy) but it is in powder form. Instead of casting, the process requires a Selective Laser Melting (SLM) machine (a “3D printer”) to shape the powder. A scenario that was explored is also the manufacturing on the operator’s premises of spare parts using a dedicated SLM machine. This possibility however seems not to be very promising.

For the production of the innovative bogie frame with side-frames bonded to a central transversal steel beam, additional source materials with respect to the usual life-cycle are required: PA12 filament (composed of 41% carbon fibre and 59% nylon 12) including a small quantity of structural and coupling elements in steel.

The rail-sector economic analysis, referred to the operator which is also infrastructure manager in this case study, was performed according to an approach based on Cost-Benefit Analysis. It is not intended as an accurate Cost-Benefit Analysis (CBA) but rather a preliminary rough attempt at capturing the knowledge generated within the RUN2Rail project in a “CBA form” targeted to the end-users. Key inputs were the results of the LCC analysis performed for the AM axle-box and the composite bogie frame.

With the inevitable limitations, the results are however interesting and show that three cost items, under the assumptions of the study, contribute by about 100 k€ per trainset (Net Present Value) or 5-10 k€ (annual) each to the benefits. These are additional passenger capacity, infrastructure maintenance and energy. This means that these three items are capable of generating benefits of the order of 300 k€ which are to be compared with an investment estimated at 200-400 k€ per trainset. The wheel maintenance costs appear to have a small contribution. Another key impact are eventual one-off costs for discontinued parts and redesign. A sensitivity analysis to the key inputs with major uncertainty was performed (choices regarding additional passenger capacity by

the operator, demand characteristics and track maintenance costs). All in all, it is the light weighting that creates the bulk of the benefits. The single-axle running gear concept, that was not assessed in detail, offers moreover a much larger light-weighting potential (as shown e.g. in RUN2Rail WP3) than the conventional bogie concept addressed.

External to the rail sector, the rail sector benefits described above could entail other positive economic impacts affecting for example companies already using AM and/or composite materials to produce mechanical parts. These companies could expand their businesses thanks to the increase in rail-sector demand. Related to this are the social benefits of the creation of new jobs and new companies. Regarding the key social impact that is transport safety, an overall improvement could be expected due to a favourable modal shift.

The environmental impacts of the new technologies are analysed in detail in this report, given their important implications if the technologies were to be adopted widely in such a large industry. The list of considered impact categories include for example climate change, ozone depletion, resource use, land use.

Regarding the R&S impacts, current standards are often conceived for existing commonly used materials and methods, with no specific pass-fail criteria for novel materials. This can be a barrier to the adoption of novel materials and techniques which could otherwise increase the efficiency and performance of the railway system. Results from the AM material tests from RUN2Rail can be used to inform alternative test methods or computer simulations that can be adopted as a basis for pass-fail criteria in upgraded standards. This will allow manufacturers to consider the use of these novel materials and methods where they would give performance or cost benefits.