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Logistic Support, from Theory to Practice

Christian PONTICELLI , Eric RIBEYRE
ALSTOM Transport, Paris, France
christian.ponticelli@transport.alstom.com
eric.ribeyre@transport.alstom.com

Abstract

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The case of the Railway industry illustrates the variances between the formal Integrated Logistic Support approach and the actual organisation of operations and maintenance.
Intrinsic availability estimates and operational availability measurements as well as formal Life Cycle Cost calculations and actual costs of ownership show systematic variances. The variances between these similar concepts are explainable through the historical evolution of availability and LCC calculations from elements supporting design decisions, to elements supporting commercial and contractual decisions. The dynamic aspects of intrinsic availability and cost of ownership are illustrated by the role Return of Experience (REX) plays on both formal calculations supporting design decisions, and on the management and the changes of actual commercial and contractual relations based on these calculations and measurements.

Introduction

This paper intends to show the variances and links between the formal Integrated Logistic Support approach and the practical organisation of Maintenance activities in actual revenue service operations. It is based on our experience of the Railway industry and focuses on the Rolling Stock aspect of it. In the past decade, this industry has been undergoing a series of mutations that have put ILS activities under a different light. The industry mutations have been triggered by a series of economic and regulatory evolutions. Beyond the concentration trend, common to any maturing industry, there has been, mainly in Europe, an evolution from traditional state owned operators to privately owned new railway operators. This evolution is mainly due to a political will of the European Union, to open the market and increase competition and competitiveness of the Rail transports.
New entrants and new rail operators bring different expectations in term of global cost of ownership and asset availability. This in turn generates new strategies from the part of Rail equipment industry, evolving from a pure equipment provider towards an integrated equipment and service provider. New organizations, tools and processes are developed to support these strategies. ILS and service monetization become key activities in this context.

PLAN EN UNE PHRASE

The Rail equipment industry and its market.

Without entering into a detailed explanation of the segmentation of the Rail equipment industry and its market, suffice it to say that this market is characterised by a limited number of global and local suppliers, a diverse customer base, in terms of size and technical capacities, encompassing both private and government owned entities. Above all, what could characterise the industry are the relatively limited numbers of equipment. Only in some markets, such as North American freight, series of vehicles may pass the thousands mark. Yet, this seemingly ''artisanal'' industry has to cope with a sustained rate of changes and innovations, both in the technical, economic, environmental and legislative fields.

The last decade fundamental changes have faced Railway operators and hence their suppliers have had the impetus, for new entrants as well as traditional operators, to look at their investments in Rolling stock in a different way. Progressively, more emphasis has been put on the global cost of ownership.

The industry itself had to evolve to cater to the new requirements of its clients and develop or strengthen its competence in the field of Life Cycle Cost and Availability predictions. The resources put on RAMS departments and ILS teams have steadily increased. The expectations on the level of pertinence of their outputs are high.

In turn, the new requirements were passed over to the first and second tier suppliers of the train manufacturers. This all evolution is still under way and accompanied by changes in contractual relations and work-flow processes across the industry.

Cost of Ownership and Fleet Availability.

Cost of Ownership, or Life Cycle Cost (LCC) and Fleet Availability are two of the major indicators of the quality of a Railway transportation system and of the quality of its utilization by operators. As in any system, the two parameters can not be separated. Availability should be as high as possible, yet not at any cost.

To get an order of magnitude, Life Cycle in Rolling Stock, is between thirty and forty years for an equipment, with a development and production cycle of two to three years.

Fleet availability can range anywhere from 90 to 99% depending on the type of Rolling Stock and the operational requirements. Here, it should be noted that operational availability can be defined and measured in a variety of ways, mainly dependant on the operator's objectives. For example, a Metro or tramway operator will focus on the fleet availability at rush hour time and measure daily, ''lost runs'' in a carousel of trains in operation. A freight locomotive operator has no rush hour time and will focus on global ratios of locomotive stopped or operating over longer periods of time.

In the successive phases of a Rolling Stock life, LCC and Availability are addressed and used in a variety of ways.

Initially, at design phase the manufacturer has two years to define and mature his design to reach the optimum of LCC and Availability best suited to his customer.

LCC and availability calculations are performed with models and hypothesis that should match the precision needed at a given state of development.
For instance, for early concept and architecture decisions, the models are used to compare solutions, and comparative LCC and availability values are more relevant than absolute values. Parametric models can be sufficient at this stage.
When conceptual design is close to be frozen and a service agreement might be in negotiation, more precise analytical models are necessary, along with more realistic operation hypothesis.
The difficulty of the exercise is compounded by the limited series produced by the industry. Though many efforts have been done in the recent years to standardise offering and carry over designs, ILS activities still represents a relatively high cost in the global design cost of equipment.
It is to be noted that activities related to availability prediction offer more challenges than LCC calculations due to the complexity of operation schemes, to their evolution during the life of the equipment but also to the actual performance of the maintenance organisation. This difficulty can be addressed by segregating the availability prediction of a single vehicle from the global fleet operational availability. The first feeds the second but permits greater control by the designer-manufacturer. The articulation with fleet availability is done via a ‘’behavioural” modelisation, trying to take in account the operational constraints and logistic support means.
For instance, the capacity of a maintenance shop, or the possibility to store the trains overnight, will influence the link between one vehicle availability and the operational availability of a fleet of the same vehicle.
In this situation, the better the knowledge of real life train operations and the knowledge of maintenance trade, the more realistic the availability calculation model being developed.
As for any modelisation, availability and LCC calculations are only an approximation of reality. Nevertheless the confidence one can have in these models depends greatly of the confidence one can have in its input data.

From Theory to practice, Return Of Experience and optimization

The railway Rolling Stock industry is not a mass production industry and a series of 300 somewhat similar vehicles is considered as an achievement in terms of standardization. This has several consequences including on ILS preparation. ILS represents a significant cost of a project with the budgetary limitations that this generates. ILS activities have to be started again for each new project, and following rapid technical evolutions.

In this context, the Return of Experience (REX) is the link between theory and practice. REX is implemented with a variety of objectives:

- It is used to validate our calculation models and reference data for LCC and Availability, making next project modelisation more reliable and representative;
- It is used to optimize and fine-tune ILS deliverables of a project and particularly the maintenance plan, leading to improved LCC and availability;
- Finally, REX is used in a classical manner to influence the design of equipment in our next project or next generation of Rolling Stock, as well as the preparation of its Logistic Support.

To give a few practical examples, the first maintenance steps of Citadis Tramways has evolved in the last ten years, with no train modification, from 5 000 to 15 000 km by analyzing the frequency and nature of defects effectively encountered during this first visit.

Accordingly, using Reliability Centered Maintenance (RCM) analysis, some component overhauls have evolved from systematic operation to conditioned based maintenance, increasing the average life of the component and decreasing cost of maintenance of a fleet. For example, Diesel high power units (individual sleeve and piston) are now exchanged one by one, depending on their level of vibration, rather than all at once, after a set number of operating hours.

Another practical example is the optimized scheduling of trains assignment to services, so that the fleet does not accumulate mileage in a homogeneous way. This permits the levelling of depot work load while maximizing the kilometers of each train before triggering a maintenance visit. This represents a real life optimization of both operational availability of the fleet and global maintenance cost, without any evolution of the theoretical models.

The industry has, in this field, lived through an evolution regarding the circulation of information on actual maintenance costs and equipment availability. In the past, it had always been a sensitive subject for a train operator to open to its supplier his data on maintenance costs, actual equipment performance and availability. Therefore, the data was not always available to drive improvements.

The entry of train manufacturers into the maintenance business and the emergence of new operators focused on train operation, has made detailed reliable data available to train manufacturers and forced a new type of relation between owners and manufacturers.

The major Rolling Stock manufacturers are all, at varying speed and degrees, evolving toward service providers. LCC and availability have become key drivers for both the award of Rolling Stock contracts and the competition to be the service provider. The award, two years ago, of the first private very high speed train in Italy, was based on the global cost of ownership and accompanied by a 30 years maintenance contract. The fleet guaranteed availability was a key input to the operator's business plan.

In the same manner, we are driving an evolution of our relationships to our main equipments suppliers (brakes, air conditioning, doors…). While demanding more availability and improved cost of ownership from them, it is our interest to make available to them the pertinent REX we can gather from our own experience as full maintenance service providers. As we were before, they are in large part unaware of the actual usage and performance of their equipments in service. This situation naturally leads to co-engineering and ILS integration.

These evolutions go with their share of difficulties.

Internally, the company culture and organization has to adapt a changing context.

The mode of management of products and projects is evolving towards a systemic approach, braking the silos of various ''metiers". The new management practices and organization are aiming to reach an optimum in LCC and availability which have become performance criterias equal in importance, to technical performances such as speed, mass, capacity.

In this context, the organization, the processing and validation of REX data requires efforts and resources. The changes are progressive and the perceived value of accurate data is slowly improving. The virtuous cycle takes time to show its virtues.

Contratual Implications.

The changes in market and the renewed interest put on ILS have in turn generated evolution in the contractual relations between parties regarding ILS deliverables, LCC and availability commitments.

Many years ago in the Railway industry, Logistic Support was often prepared by the operator himself and this after delivery of the first vehicles. Of course there was no question of ‘’Integration’’ of Logistic Support and the level of optimisation was limited.

In the early 90’s Logistic Support elements and LCC progressively became standard deliverables of Rolling Stock contracts. First the LCC was indicative and without commitments and therefore treated by manufacturers on a “fire and forget” basis, due to both lack of contractual consequences on the accuracy of the information and a lack of Return of Experience. At that time the operators were not forthcoming with operating data and the manufacturers were not involved in the optimisation of the design and ILS studies of their equipment.

In the late 90’s demands became stronger on the quality of ILS in general and on the accuracy of LCC and availability in particular. Verification phases and financial incentives were introduced in the contracts. Nevertheless a lot still had to be clarified. The verification period of the LCC and availability commitments was limited to the duration of warranty, which only represents a short window on the equipment life of thirty to forty years. Discrepancies observed between LCC calculations and maintenance costs was the occasion of endless discussions where the share of responsibilities and the impact of actual operating conditions could be interpreted to anybody’s advantage. Contractualisation remained difficult and prevented proper context for optimisation. Optimisation efforts and costs remained on the manufacturer’s side with benefits in the long run on the operator side.

As a consequence of the effort on deregulation, especially in Europe, new entrants with no historical background in the railway operation business and no interest in maintenance, triggered a new type of relation between manufacturers and operators. These new entrants want to focus on operation and see maintenance as a service to be provided to them. They need strong commitments on LCC and availability, these being key inputs to their business models. As a consequence, many new build contracts are now assorted with a long term maintenance service option. LCC and availability calculations are now backed by a service commitment associated with a bonus and penalty regime. Yet ILS deliverables maintain their importance since the operator does not want to be restricted to his Rolling Stock supplier maintenance option. Good ILS package is necessary to be able to sub-contract maintenance to other providers’ that the manufacturer.

This new context has launched a virtuous cycle, where LCC and availability calculations are based on strong REX input and backed by human and technical resources matching the financial risks and opportunities linked to these predictions.

Perspectives and Conclusion

Life Cycle Costing and Availability predictions are out-puts of models, which by essence are only an approximation of reality. Nevertheless, under the pressure from the market, these young models are acquiring a maturity they did not have. This improvement is the result of increased management attention, as well as extensive REX. This REX is facilitated by the fact that most Railway manufacturers have now entered the field of long term maintenance services. Further improvements will come by the introduction of cooperative development in the industry. The key first tear suppliers to the rolling stock manufacturers are also hungry for REX that can help them improve both their equipment and their LCC calculations. This REX they can now access via the manufacturer/maintainer.
Nevertheless, 30 to 40 years of life of a rail vehicle remains a long time to make accurate predictions. Innovations in the maintenance tools and practices themselves make it likely that the current LCC and availability predictions, though more accurate than ever, will also be proven wrong in the long run. Hopefully reality will be better than our most optimistic predictions.