Causation and modelling of railway civil engineering costs

Introducers

S. J. Barber, MICE, MCIT, N. H. Jones and M. Shenton, PhD

Reporter *D. M. Wolfendale, MICE*

The Introducers explained that Britain was pre-eminent in Europe in its understanding of cost causation. To ensure optimal use of its infrastructure they said it is important that British Rail (BR) accurately attributes costs between businesses where assets are used by more than one business. This requirement is particularly relevant to trainload freight (TLF) because this business uses 17 500 miles of BR's 20 300 miles but only directly owns and manages 2000. (Civil engineering costs are 28% of overall costs for TLF.) The relative lack of direct managerial control focuses attention on the ability to allocate with accuracy.

They put forward the following as reasons for the importance of modelling costs.

- (a) *Choices of rolling stock* Modelling accepts the interrelationship between track and rolling stock and can demonstrate the benefits to be gained from track-friendly wagons. It could also determine the implications of high axle load wagon types over the existing maximum of 25 t. After analysis, which included modelling, it was decided not to procure further two-axle pedestal suspension wagons.
- (b) *Route strategy* Key routes can be identified and traffic allocated to them and costs, both for individual businesses and the corporate body, may be minimized.
- (c) *Judging profitability* When considering taking up new business the track costs may be estimated. This feature of being able to estimate accurately a key element of the costing structure is considered to be of great benefit.

The two criteria the Introducers put forward as essential characteristics of any model were

- (a) it should be seen to be accurate and realistic by business managers and civil engineers and
- (b) it should be based on good data and be kept up to date.

Analysis of the sources of track costs and how they are affected by traffic starts with splitting expenditure into three categories

- (a) that which is independent of traffic (fencing, drainage, etc.)—5%
- (b) that which is related to traffic but which is dependent on experience or arbitrary decision (e.g. inspection)—3%

- (c) that which arises due to the damage caused to the track structure caused by loads applied by the traffic—92%.

The latter category may be further divided approximately equally into costs of renewal and day-to-day costs.

It was explained that in a deterministic model the loads generated by traffic are used to predict damage, and each component's maintenance and renewal is determined. When mechanisms of failure are less well understood, statistical relationships between costs and traffic loading are used. Often a combination of both methods is used.

Dynamic loads applied by vehicles cover a wide range of frequencies from static axle loading through loads applied by vehicle motion to very high frequencies caused by the interaction of wheelset and track. Each of these loads has a different effect on the components of the track. For example, high frequency forces largely cause damage to the rail, whereas static axle load has a great influence on the deterioration of the ballast and formation. Fatigue is a predominant factor and the number of load applications at a given magnitude is very relevant. Thus it is not only gross tonnage that must be taken into account but also speed, suspension design and unsprung mass of wheelsets. Additional factors such as the damage caused to ballast by spillage from wagons and by the breakdown of ballast particles caused by track maintenance machines also feature.

Whereas the prediction of work causing day-to-day maintenance costs is relatively simple, the modelling of renewal costs is complicated and informed opinion can play a large part due to lack of data.

Modelling of mechanical behaviour only gives part of the cost equation; requirements must be translated into costs and this is achieved by using average work unit costs. Simplification of such factors as possession patterns, travelling, weather, etc. are necessary. Costs due to condition, such as the effect of the quality of the geometry on the ride in vehicles and hence revenue, must be estimated. Maintenance of vehicles and costs of delays due to failures in the permanent way (and in extreme cases the cost of derailments) also form part of the model.

*S. J. Barber,
Policy Unit,
British Railways
Board*

*N. H. Jones,
British Rail,
Trainload Freight*

*M. Shenton, BR
Research*

*D. M. Wolfendale,
British Rail
(Network
SouthEast)*

Thus modelling techniques provide a method which gives the costs on a track section for any given traffic. There are several ways by which these costs may be attributed to a train or particular traffic flow. The way in which such attributions take place is fundamentally related to the accountancy treatment selected. The engineering cost model is independent of accounting treatment and can provide input for any subsequent calculations.

The executive decision on cost allocation adopted by British Rail is that the route owner pays for the base costs of the facilities required and other users pay the incremental costs of adding extra facilities and for the damage caused by their traffic.

British Rail has developed a computer program known as MARPAS (maintenance and renewal planning aid system) to assist in making decisions on traffic strategies, planning of renewal and maintenance and cost apportionment to business users of a route. The program provides input to the trading rules within which the rail businesses trade internally. A PC-based MINI-MARPAS is used for apportionment, route strategies and new vehicle evaluation.

MARPAS is undergoing trials and is tied into track databases. In addition MARPAS offers a method for detailing planning of when and where work should be carried out.

Modelling techniques can help future business management by enabling it to

- (a) model the situation as it exists and use the resultant tool to assess alternative strategies and
- (b) model an ideal and use the tool to assess performance of the organization.

A number of areas for development and application of models can be identified.

Modelling techniques could allow easy 'what if' assessments of maintenance and renewal regimes in terms of trade-offs between possession patterns and traffic values. This would require more development of the model's understanding of the relationship between work content and resource requirement (so simple 'average BR' values were not automatically used).

In some instances models determine asset condition from records of work input as a second-order effect. If asset condition is available as numeric primary data then asset management regimes could be based on a better reflection of the real world.

A further enhancement might help short- and medium-term decision making, and modelling effects of leads and lags which cause confusion in the relationship between engineering costs, business requirements and traffic patterns.

Another suggested area the Introducers mentioned is in the field of overheads, as it is not

fully appreciated how these substantial costs respond to change in business remit. A forward agenda such as that outlined in their presentation requires understanding from two viewpoints. Engineers need to recognize

- (a) the validity of business input in asset management and
- (b) that after safety needs are met, asset condition is an area for debate (engineers can assist by helping to develop more numerate measures of condition).

Information systems which provide raw data will need to be improved and positive incentives must be given to staff and managers to use such systems.

Business planners need to understand costs. The ability to take informed decisions based on systems such as MARPAS must be recognized as having a value in its own right and the question must be asked whether businesses can afford *not* to make appropriately informed choices.

The discussion that followed the presentation was wide-ranging, but the trial area in Nottingham was particularly highlighted.

It was pointed out that the model predicts higher inspection costs than are currently being charged, but it was suggested that data input irregularities were probably the cause. One speaker mentioned that predictions of re-railing requirements had resulted in an indication that re-railing programmes would need enhancing if rail breakages were not to increase. Also, attention was drawn to the fact that predictions of machine maintenance (tamping) produced results which were similar to the plan produced by the permanent way maintenance engineer (PWME) manually.

When asked whether the system could work for heavier axle loads than at present in use, Dr Shenton explained that the system, when tried out on Union Pacific in North America had been accurate in predicting tamping requirements and estimated ballast life.

The questions concerning whether or not actual costs were in line with those estimated were answered in the affirmative with maintenance and renewals costs being very similar to those predicted. A reconciliation exercise was being undertaken.

Questions were asked concerning finances and whether the railway business sectors were willing to underwrite the required data collection. A qualified 'yes' was the answer given and that the benefits achieved were greater than the costs of the modelling exercise.

A figure of £400 million was given for British Rail's annual track costs and the system hardware costs put at £1.5 million. Costs of gathering data had not been estimated but were also considerable. Development costs had not been significant when judged against the implementation costs.