Case Studies on Transport Policy 3 (2015) 431–448

Contents lists available at ScienceDirect

Case Studies on Transport Policy

journal homepage: www.elsevier.com/locate/cstp

Application of the analytic hierarchy process to identify the most suitable manufacturer of rail vehicles for High Speed 2

Shobhan Dhir[a], Marin Varbanov Marinov[b,*], David Worsley[b]

[a] Mechanical and Systems Engineering School, University of Newcastle, Newcastle upon Tyne, United Kingdom
[b] NewRail, Newcastle University, United Kingdom

ARTICLE INFO

Article history:
Received 3 June 2014
Received in revised form 9 July 2015
Accepted 19 August 2015
Available online 25 September 2015

Keywords:
Rolling stock
Manufacturer
Analytic hierarchy process
Comparisons

ABSTRACT

The objective of this paper is to use an appropriate strategic decision-making method to identify the most suitable manufacturer of rail vehicles for the UK infrastructure project High Speed 2. This comprises identifying the potential alternatives, considering the use of methodologies such as cost-benefit analysis and multi-criteria analysis, and applying a particular form of multi-criteria analysis, namely the Analytic Hierarchy Process. This allows for effective comparison of the four primary rolling stock manufacturers: Bombardier, Siemens, Hitachi and Alstom. The process involves conducting pairwise comparisons with respect to designated criteria. Eigenvectors are calculated in order to normalise the results of the pairwise comparisons, and matrix algebra is used to combine the Eigenvectors for individual criteria in to an overall result, thereby indicating a recommended manufacturer.

1. Introduction

High Speed 2 (HS2) is the current proposal to implement a high speed railway in the UK. It is split in to two phases and is estimated for full completion by 2033 (HS2 Ltd., 2014b). The manufacturer for the high speed rail vehicles has not yet been chosen; however, the current investment budget for rolling stock stands at £9.2bn, comprising a base estimate of £7.5bn with £1.7bn of contingency (HS2 Ltd., 2014a). This amounts to approximately one fifth of the entire expected project cost, a very significant component; the decision as to which manufacturer will receive the investment and deliver the high speed vehicles is therefore of high importance.

Due to the substantial amount of resources to be invested in this project, decisions for how to best use them must be made in an appropriate and justified manner. However, there have been several discrepancies within the project's current decision-making and appraisal methodology. There have been historic cases where decisions have been forced by biased assumptions and questionable demand forecasting (Aizlewood and Wellings, 2011). This has resulted in setbacks which could have been avoided. It is therefore crucial that initial decisions are made using an appropriate and defensible methodology. The aim of this investigation is to identify a decision-making approach which can be adapted and applied to large strategic decisions for HS2. Once identified, this process will be implemented in order to reach a justifiable decision.

Upon identifying the method, the contribution of this study is a complete analysis for a critical strategic decision that has yet to be made, namely identifying the most suitable manufacturer of rail vehicles for High Speed 2. This is to be achieved by the use of a mathematically-justified strategic decision-making method known as the Analytic Hierarchy Process (Saaty, 1999). A conclusion will be presented regarding which rail manufacturer would be most suitable to manufacture and deliver the high speed trains for HS2. The reasons behind this recommendation will be explained and the validity of the model will be evaluated. Potential future applications of the model and this form of analysis will be considered.

1.1. Objective

The objective of this investigation is to identify the most suitable manufacturer of the high speed trains for HS2 using an appropriate strategic decision-making method.

1.2. Methodology

This project involves a four-step approach: firstly, formulating the strategic objective of identifying the most suitable manufacturer and considering what exactly is meant by 'the most suitable manufacturer'; secondly, identifying the most appropriate method to employ through critical analysis of the alternatives; thirdly,

* Corresponding author.
E-mail address: marin.marinov@ncl.ac.uk (M.V. Marinov).

http://dx.doi.org/10.1016/j.cstp.2015.08.004
2213-624X/

designing the decision-making model and applying it to the problem; finally, recommending the most suitable manufacturer, evaluating the results, and considering the method's potential future application.

2. Brief overview of HS2

Due to the complexity of the HS2 project, it is important to understand the fundamentals of the proposal.

2.1. The route

The current proposed route for HS2 is split in to two phases. Phase 1 runs from London to Birmingham and is around 140 miles long. Phase 2 incorporates two lines: a Western leg, about 95 miles long, from Birmingham to Manchester, and an Eastern leg, about 116 miles long, from Birmingham to Leeds (HS2 Ltd., 2014a). These routes are shown in Fig. 1.

Fig. 1 also shows the stations through which the HS2 line will pass and its connectivity to the existing rail network. The planned route will provide improved connectivity to all areas of the North, including Newcastle, Glasgow and Edinburgh, and may provide the basis for construction of further high speed lines in the future.

2.2. High speed trains

The specific design requirements for the rolling stock have been outlined. The trains shall operate at speeds of 200–225 mph, with the potential capability to operate at 250 mph (faster than any current operating speeds in Europe). They are to be 400 m long

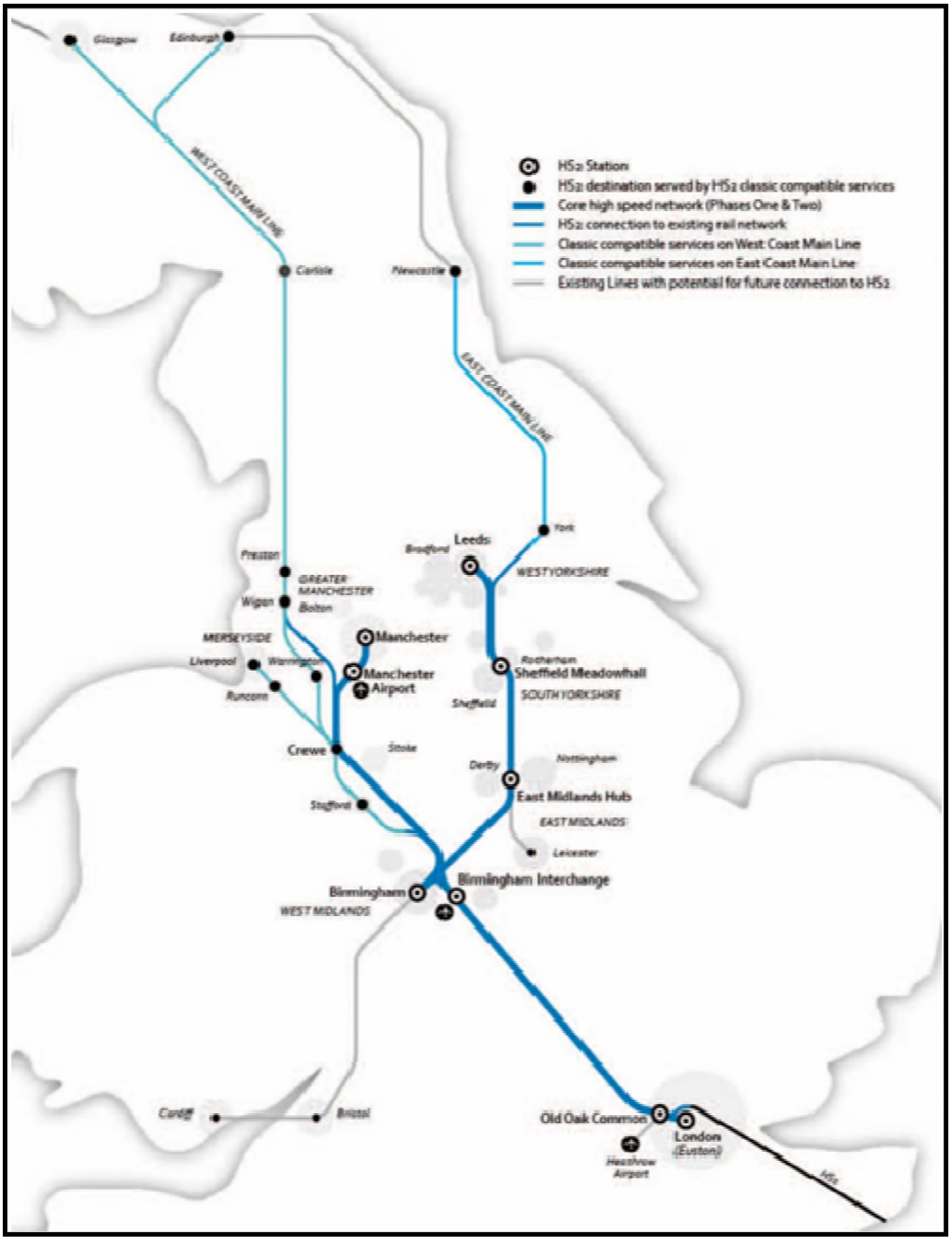

Fig. 1. HS2 proposed route (Cross, 2013).