1. Provide some insights into the UK's spending on major national infrastructure projects since 2000, and explain what the implications may be?

Nationally significant infrastructure projects (NSIPs) are large-scale infrastructure developments in the UK. They include proposals for power plants, renewable energy projects, new airports (including extensions to existing facilities), major road projects, waste water treatment works, and electricity transmission lines amongst others. These projects are the bedrock for creating growth and delivering lasting prosperity and therefore remain focal points for both public and private investment. The average annual infrastructure investment has increased to £45 billion per year compared to an average of £41 billion per year between 2005 and 2010 (see pg.6 of Ref.[1]). From 2009, the Infrastructure Planning Commission (IPC) [2] became the decision-making body for public funding of NSIPs. Recent major infrastructure projects which the IPC gave development consent to were announced in 2009 and included five wind farms, two nuclear power stations, and a biomass power plant. The first commercial venture to be awarded NSIP status was the London Paramount Entertainment Resort project in May 2014 [3], which will be described further in this section. More information for future spending on and its implications for the next 10-20 years can be found in [4]. For this section, we will briefly discuss two major projects: the £14.8 billion London Crossrail [5], which should be operational by 2018; and the £3 billion London Paramount Entertainment Resort, mentioned earlier which is currently in the design phase and estimated to open in 2021.

The first infrastructure project to be discussed is Europe's largest civil engineering project, the £14.8 billion Crossrail. This began construction in 2009 at Canary Wharf, and is now almost 75% complete (see Figure 1). The funding framework for Crossrail was put in place in October 2007, when the then Prime Minister announced that the cost will be met by Government, and the Mayor of London and London businesses. The Mayor of London, through Transport for London and the Greater London Authority, will contribute £7.1 billion. This includes a direct contribution from Transport for London of £1.9 billion. Crossrail's fare-payers will also contribute towards the debt raised during construction. Government will contribute by means of a grant from the Department for Transport of £4.7 billion during Crossrail's construction. London businesses will contribute £4.1 billion through a variety of mechanisms, including the BRS. Over 60% of Crossrail's funding will come from Londoners and London businesses. The new railway, which will be known as the Elizabeth line, will be integrated into London's existing transport network and will be operated by Transport for London. The new lines will carry an estimated 200 million passengers per year. The service aims to speed up journey times, increase central London's rail capacity by 10%, and bring an extra 1.5 million people to within 45 minutes of central London. In terms of projections, the new rail aims to bring in an extra £42 billion into the UK economy; Better links between the capital's major commercial and business districts; Plus the addition of 55,000 full time jobs and 75,000 business opportunities during the construction of the new railway. Other new stations being built include Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Whitechapel, Canary Wharf, Custom House, Woolwich, and Abbey Wood. Furthermore, 30 existing Network Rail stations in outer London, Berkshire and Essex will be upgraded and connected to the 26 miles of new tunnels under London. Along with the noted economic and social benefits some have been quick to point out the understandably large price-tag [6].

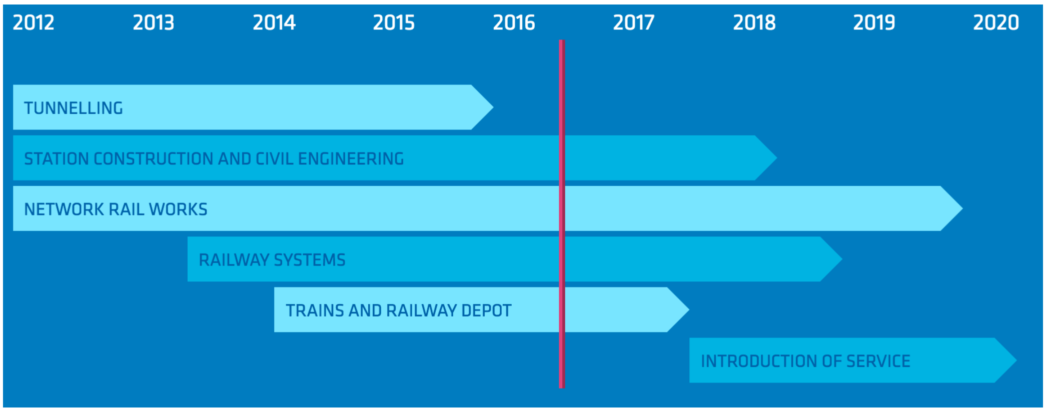

Figure 1: Timeline for the cross rail construction timeline (taken from Reference [6]).

The second infrastructure project to be discussed is the London Paramount Entertainment Resort, and is a proposed theme park to be built in Kent, UK. The project was announced on October 2012, and if given the green light will begin construction in 2016, with the opening estimated for 2021. The project unlike Crossrail will be privately financed (by Kuwait's Al-Humaidi family). Steven Norris, the chairman for the resort, says team has so-far spent £40m on planning [7]. The project is proposed to be built on 872 acres of largely salt marsh on the Swanscombe peninsula in North Kent, and is proposed to bring 27,000 jobs to the local area, and 15-18 million tourists annually according to developers. It will feature Europe's largest indoor water park, theatres, live music venues, cinemas, restaurants, event space, and hotels. The closest station to the proposed site is Swanscombe, which is serviced by Southeastern services and intersects at London Charing Cross. Additionally, a short distance away, is Ebbsfleet International (a High Speed 1 station), which has connections to London St Pancras (17 minutes); Paris Gare du Nord; Brussels-South; and in the future, Amsterdam Centraal. Developers predict that the park will add 2-3 million passengers a year to the High Speed 1 line. A further 250,000 people may travel directly to the park from central London by water taxis along the Thames. With a project such as this, changes to local infrastructure will be necessary to accommodate millions of additional visitors annually to North West Kent. Crossrail's route may be altered to run as far east as Hoo Junction, just beyond Gravesend, Kent.

In terms of possible hurdles for the project, there are the current tenants and landowners who own roads and sizeable chunks of land around Northfleet Industrial Estate. In order for the project to proceed, these landowners must relocate elsewhere. Currently there is no objection to relocate, but compensation is estimated to be in the region of £500 million. Furthermore, Paul Kelly, the chief executive of the British Association of Leisure Parks, objected to the 15 million tourists a year quoted by developers as a "remarkable figure", given the UK's existing theme park industry. He also raised concerns on the effect of moving a large workforce away from existing local businesses, describing the endeavour as "trying to squeeze into a pot which is already full".

2. Quantitative Task

2.1 How does the sample size vary from year-to-year? Are there any years that the DfBL should exclude from this analysis?

The sample size shown in Figure 1, is between 2000-3500 during 2002-12. We see during 2000-01 (first bin) that the sample size is roughly a factor of 4 smaller than the rest of the following years. Therefore, one should probably exclude this year due to insufficient statistics. Further implications can be seen in Figure 5, where when splitting into 10 sub-samples yields empty values for that year (Mercedes Benz).

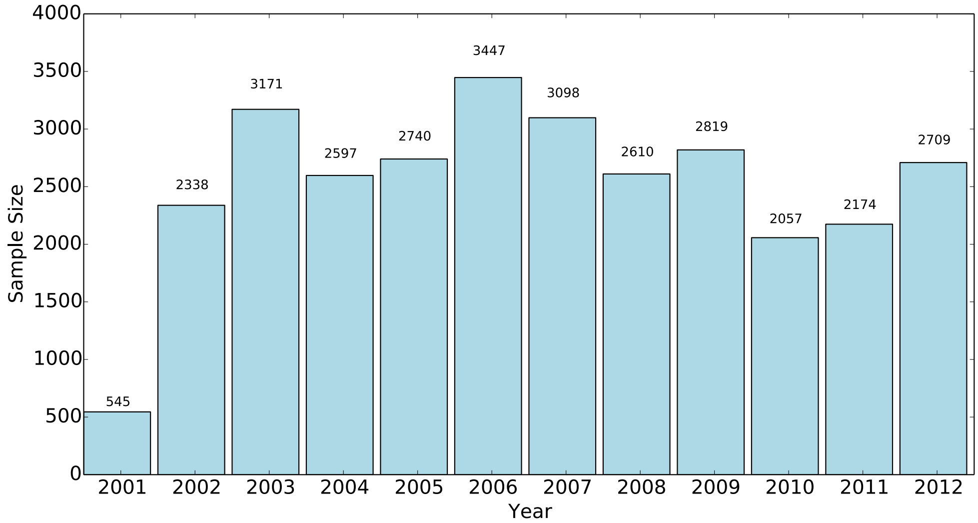

Figure 2: Shown above is the sample size per year taken between the years 2000-12 for all road-going vehicles.

2.2 Assuming that the data is a representative sample of the population; does the condition of road-going vehicles appear to be changing over time? If so, is it deteriorating or improving?

In Figure 3, we plot the mean average of all the conditional scores for all road-going vehicles per year from 2000-12. We also overlay the standard deviation to assess the spread of scores as an uncertainty. We see that over the period assessed, the mean conditional scores for all road-going vehicles remain reasonably constant to within ± 6%. The highest mean conditional score attained was found during 2001-02 (52), with the lowest attained during 2010-11 (44). Lastly, we note a small overall downward trend of around 6% from 2002-12 (which will be discussed briefly in Section 2.4). Given the uncertainties however, this trend is not statistically significant.

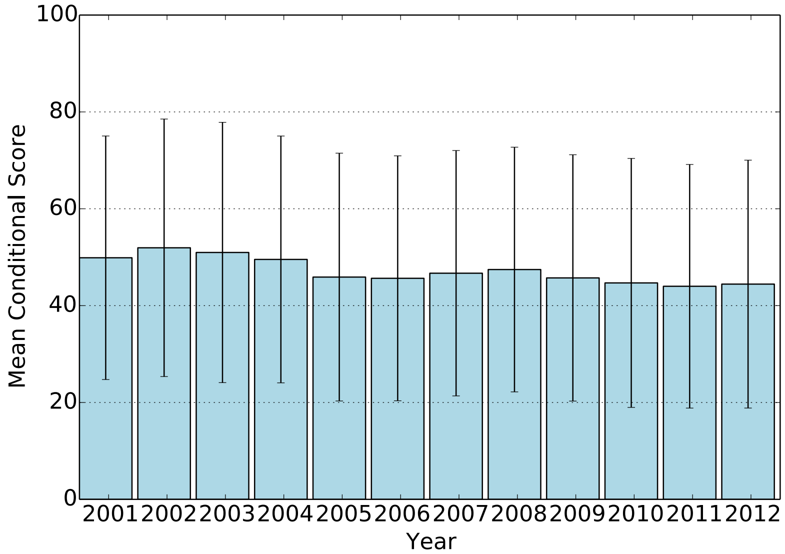

Figure 3: Shown above are the mean conditional scores per year taken from years 2000-12 for all road vehicles. The error bars represent one standard deviation of the conditional scores taken. The uncertainties are calculated to be between 50-60%.

2.3 Are there any particular vehicle types or manufacturers that the DfBL should pay special attention to? Would you suggest any changes to the sampling methodology to obtain better information for these types?

In Figure 4, we plot the mean conditional scores for all road-going vehicles per year from 2000-2012, split into three categories (heavy goods vehicles, light goods vehicles, personnel vehicles). We also overlay the standard deviation for each category to assess the spread as an uncertainty. We see that personnel vehicles consistently score higher than heavy and light goods vehicles. This observation can somewhat be expected since given the definition of 'personnel' (i.e. used in an organisation or engaged in an organised undertaking such as military service), one would expect such vehicles to be maintained at a higher standard with respect to their counterparts. We also see that there is no significant difference per year in-terms of conditional scores between heavy and light goods vehicles. Furthermore, the standard deviation of scores for personnel vehicles (30%) is significantly lower in comparison to heavy and light goods vehicles (60% each).

In Figure 5, we plot the mean conditional score for all road-going vehicles per year from 2000-2012, split into the ten most common manufacturers (seen in the plot legend). From this plot, one can see significant differences in-terms of conditional scores between certain manufacturers. For example, we see that DAF vehicles (blue) tend to score consistency higher (mean across all years is 57). Conversely, we see that Iveco vehicles (light green) tend to score consistently low (mean across all years is 39). The greatest spread of scores is seen in Renault vehicles, which reached as high at 63 in 2008-09, and as low as 43 in 2009-10.

In terms of improvements to the sampling methodology, one could try to obtain more information about heavy and light goods vehicles for future years in order to better clarify trends or spot correlations. Such information could include the actual weight of the vehicle. Currently (according to the DVLA) a large goods vehicle is classified as having a gross weight of more than 3.5 tonnes. A light goods vehicle is classified as less than 3.5 tonnes. With information about the weight one could also envision adding a medium goods vehicle category (choosing ranges recommended by the DVLA). Further to this, one could obtain more information about the light goods vehicle sample by specifying if for instance road tractors and curtain sided vehicles are included in the sample. In terms of personnel vehicles, one could better clarify the definition of the term in order to understand the type of vehicle which is being graded (whether military, commercial, or otherwise). Lastly, it would be beneficial to standardise the inspections per year to within ±100. The range from the data during 2000-12 is between 500-3500, which is too wide a window.

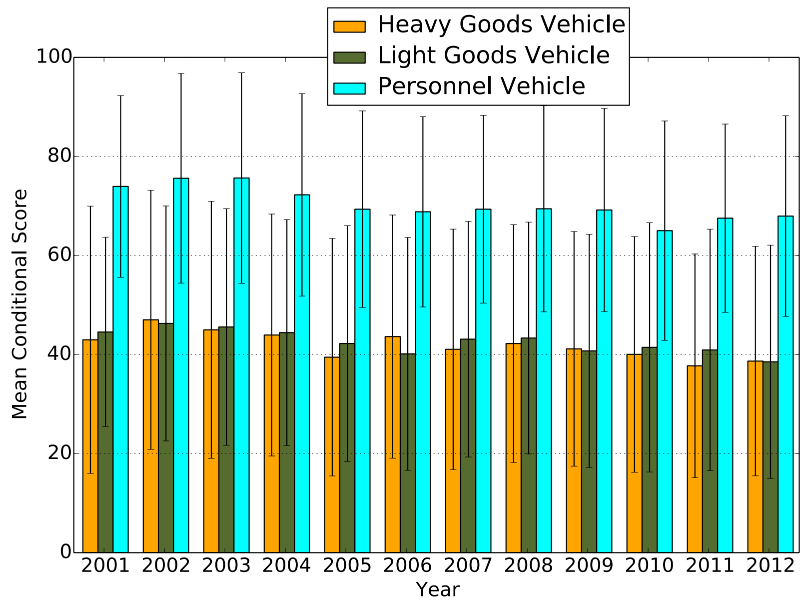

Figure 4: Shown above are the mean conditional scores per year taken from years 2000-12 for all road vehicles. The error bars represent one standard deviation of the conditional scores taken. The errors are calculated to be roughly ±60% for heavy goods vehicles, ±60% for light goods vehicles, and ±30% for personnel vehicles.

2.4 Since 2000 the vehicle inspectors have slowly improved the algorithm that they use to determine which vehicles to inspect more frequently, so that they are getting better at inspecting vehicles in poor condition more often. What effect could this have on the results?

This would bias the yearly trend towards a lower score. In fact, if we look at Figure 2, we see a small downward trend from 52% to 44% during 2001-12. As mentioned in Section 2.2, this trend is not significant when considering the uncertainties, but still noteworthy given the information about algorithmic improvements in terms of vehicle sampling.

2.5 Is DfBL conducting a sufficient number of inspections a year? Explain and justify your answer.

In Figure 1, we see that the DfBL from 2001 onward conducts between 2000-3500 inspections per year. This seems sufficient when looking at quantities relating to the total road going vehicles such as Figure 2 and 3. When splitting into three vehicle sub-categories such as in Figure 4, there is still sufficient statistics for a reasonable assessment. However, for Figure 5 when splitting into ten subgroups we see 0 entries for the

Mercedes Benz bin during 2000-2001. In any case, this year is an exception with an abnormally low sample size, with all subsequent years having a large enough sample per vehicle manufacturer and type (roughly 300 and 1000 per year respectively).

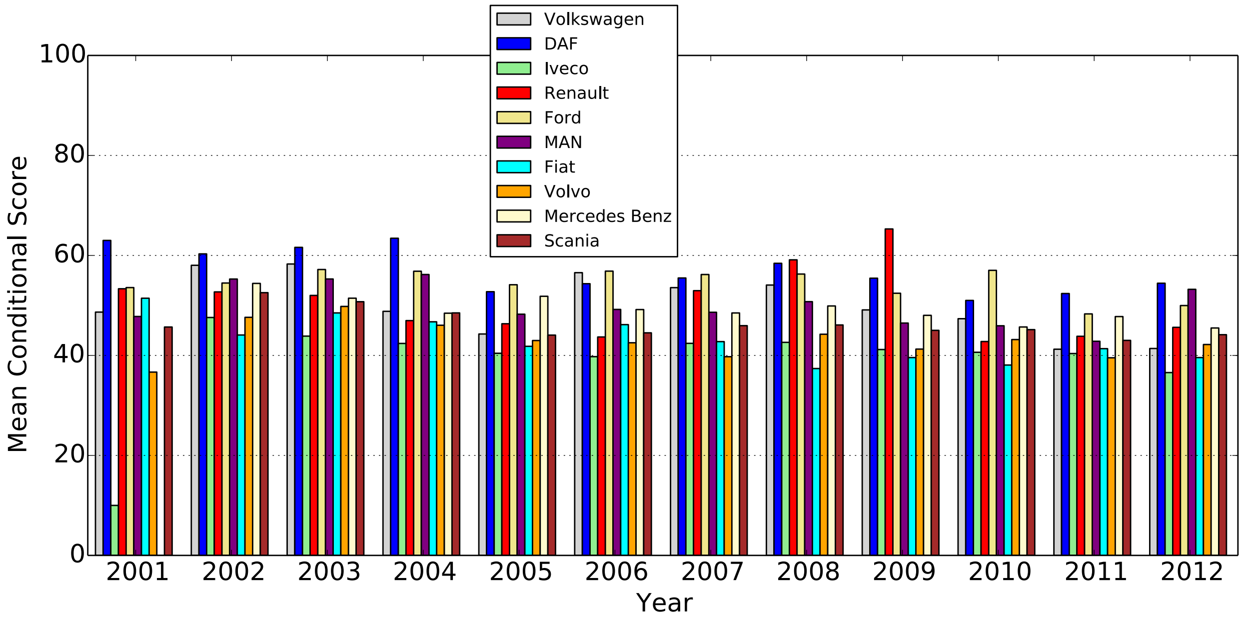

Figure 5: Shown above are the mean conditional scores per year taken from years 2000-12 for all road vehicles split into different brands. The standard deviations are calculated to be roughly 30-60% depending on the brand in question.

3. References

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209279/PU1524_IUK_new_template.pdf

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