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 infrastructure developments in England and Wales. 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. From 2009 the Infrastructure Planning Commission (IPC) [1] became the decision-making body for public funding of NSIPs. Recent major infrastructure projects that the IPC expects to receive as applications were announced in 2009 and included five wind farms, two nuclear power stations, and a biomass power plant. Furthermore, the first commercial venture to be awarded NSIP status was the London Paramount Entertainment Resort project in May 2014 [2]. Further information for recent proposals as of 2016 and their implications for the next 10-20 years can be found in [3]. For this section we will discuss two major projects, the £14.8 billion London Crossrail, which should be operational by 2018, and the £3 billion London Paramount Entertainment Resort, which is currently in the design phase.

The London Paramount Entertainment Resort is a proposed theme park to be built in Kent, UK. The project was announced on October 2012, and if given the green light, construction will begin in autumn of 2016 with the opening estimated for 2021. The tourist attraction financed by Kuwait's Al-Humaidi family is proposed to bring 27,000 jobs to the area according to developers. Steven Norris, the chairman for the resort, says team has so-far spent £40m on planning [4]. The resort is proposed to be built on 872 acres of largely salt marsh on the Swanscombe peninsula in North Kent. An area twice the size of the Olympic Park in East London. 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. A short distance away, is Ebbsfleet International, a High Speed 1 station. Trains run from London St Pancras (17 minutes), Paris Gare du Nord (North), Brussels-South and in the future, Amsterdam Centraal; London Resort Company holdings predict the park will add 2-3 million passengers a year to the High Speed 1 line. Furthermore, a new monorail could take passengers from Ebbsfleet International station [5] to the New Paramount resort. A further 250,000 people may travel directly to the park from central London by 'water taxis' along the River Thames; project leader Tony Sefton has said he aims for the park to have the "lowest modal mix" of car park spaces of any similar resort in the world. Changes to local infrastructure will be necessary to accommodate millions of additional visitors annually to North West Kent, though it is possible the route of a planned new Thames road crossing may be in part decided as a result of this development. Crossrail's route may be altered to run as far east as Hoo Junction, just beyond Gravesend, Kent; there are no firm plans to run trains beyond Abbey Wood in south east London. It is not known if the plans for Paramount London will create a viable case for Crossrail services to serve the park. The Hoo Peninsula was also one of the proposed Thames Estuary airport sites, although this was rejected in 2014 in favour of expansion at either Heathrow or Gatwick airports. There are also plans to create a road joining the theme park onto the A2 in Kent.

As Europe's largest civil engineering project, the £14.8 billion Crossrail [6] 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, the Mayor of London and London businesses. The Mayor of London, through Transport for London and the Greater London Authority, will contribute £7.1bn. This includes a direct contribution from Transport for London of £1.9bn and contributions raised through the Crossrail Business Rate Supplement (BRS), section 106 and the Community Infrastructure Levy. Crossrails fare-payers will 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 £4.1bn 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 fully 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 new 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 should bring in an extra £42bn 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 being upgraded and connected to the 26 miles of new tunnels under London.

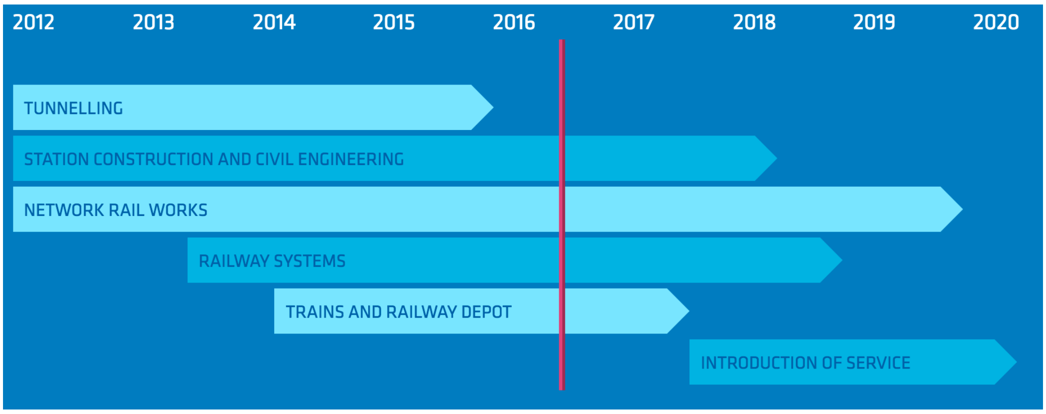

Figure 1: Timeline for the cross rail construction timeline (taken from Reference [6]).

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, fluctuates between 2000-3500 during 2002-2012. We see during 2000-2001 (the first bin) that the sample size is roughly a factor of 4 smaller than the rest of the following years. 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 for different vehicle brands yield empty values. We see for instance in the first bin, that Mercedes Benz has 0 entries for that particular year.

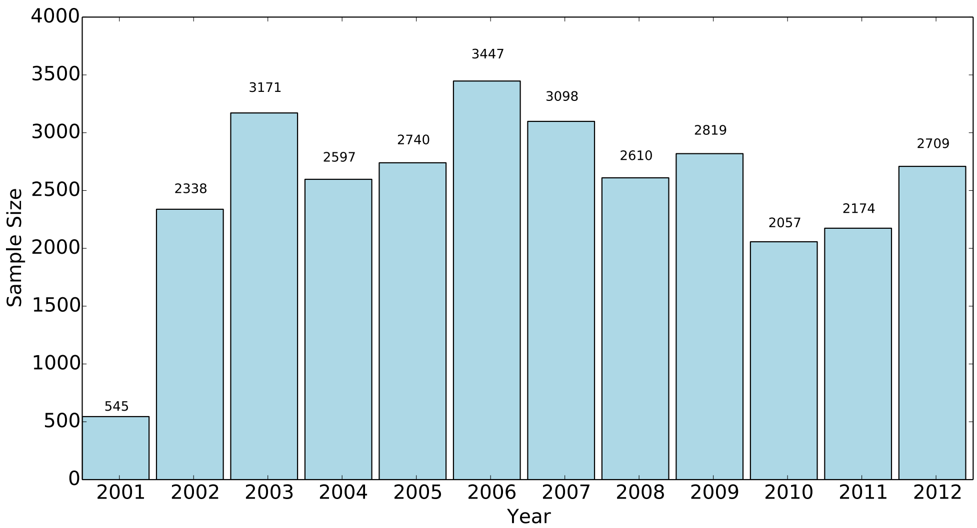

Figure 2: Shown above is the sample size per year taken between the years 2000-2012 for all road-going vehicles.

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 conditional score for all road-going vehicles per year from 2000-2012. 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 values for all road-going vehicles remain reasonably constant (within ± 6%). We see that the highest overall score attained (averaging over all vehicles) was during 2001-2002 (52). The lowest was attained during 2010-2011 (44). Lastly, we note a small overall downward trend of around 6% from 2002 to 2012 (which will be discussed briefly in Section 2.4). Given the uncertainties however, this trend is not a statistically significant.

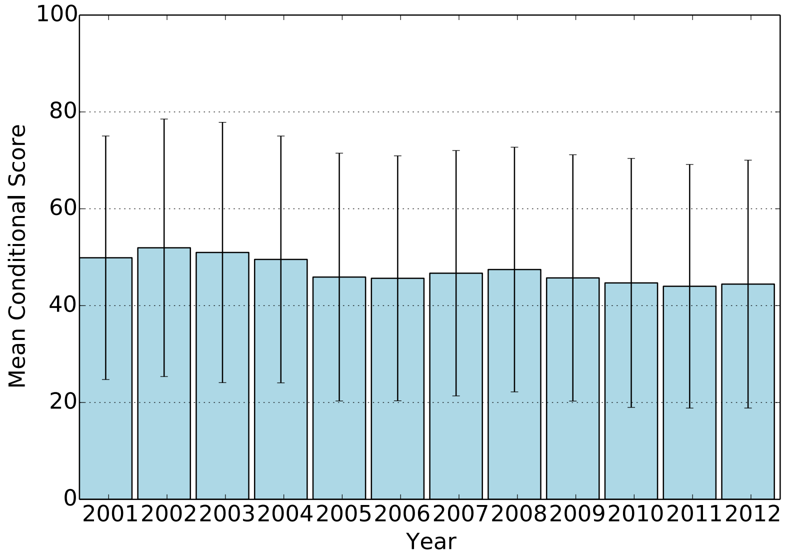

Figure 3: Shown above are the mean conditional scores per year taken from years 2000-2012 for all road vehicles. The error bars represent one standard deviation of the conditional scores taken. The uncertainties are calculated to be between 50-60%.

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 score 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 to 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 RMS of the conditional scores for personnel vehicles (30%) is significantly lower in comparison to heavy and light goods vehicles (60%).

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 (as noted 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 high (mean across all years is 57). Conversely we see that Iveco (light green) tends 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 2009, and as low as 43 in 2010.

In terms of improvements to the sampling methodology, one could obtain more information about heavy and light goods vehicles in order to spot trends or correlations. Such information could include the actual weight of the vehicle. Since currently (according to the DVLA) a large goods vehicle is classified as having a gross weight of more than 3.5 tonnes, with a light goods vehicle classified as less than 3.5 tonnes. Further to this, one could obtain more information about the light goods vehicle sample by specifying if road tractors and curtain sided vehicles are included in the sample. One could also envision adding a medium goods vehicle category, choosing specific weight categories given by the DVLA. In terms of personnel vehicles, one could better clarify the term in order to understand the type of vehicle which is being graded (whether military or commercial, or otherwise). Lastly, it would be beneficial to standardise the sample size per year (for example 3000). The range from the data is between 500-3500, which could lead to fluctuations particularly in Figure 5 which requires more data than other Figures in this report.

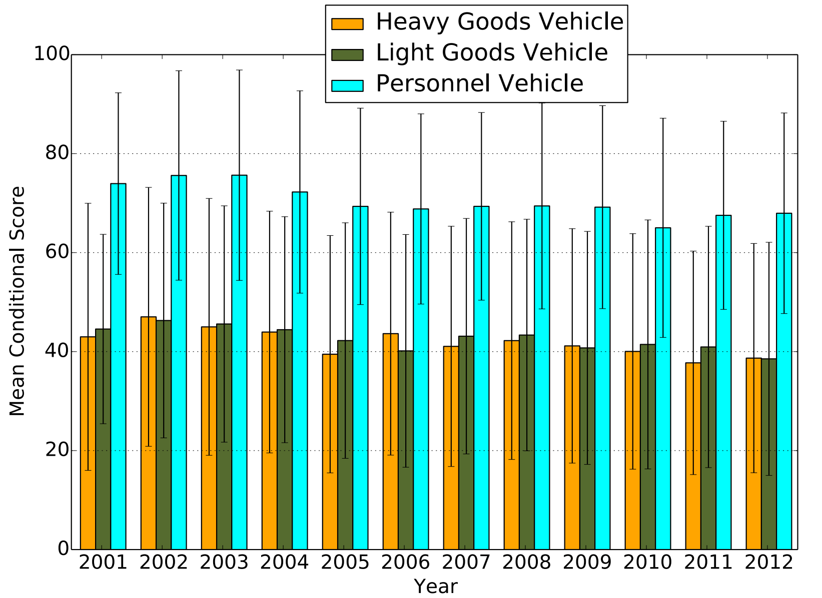

Figure 4: Shown above are the mean conditional scores per year taken from years 2000-2012 for all road vehicles. The error bars represent one standard deviation of the conditional scores taken. The errors are calculated to be roughly ±60% for heavy goods vehicles, ±60% for light goods vehicles, and ±30% 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 toward a lower score. In fact, if we look at Figure 2, we see a small downward trend from 50% to 44% during 2001-2012. 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 conduct between 2000-3500 inspections per year. This is 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 are 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 seems to be an exception, with all subsequent years having a large enough sample per vehicle manufacturer and type (roughly 300 and 1000 per year respectively).

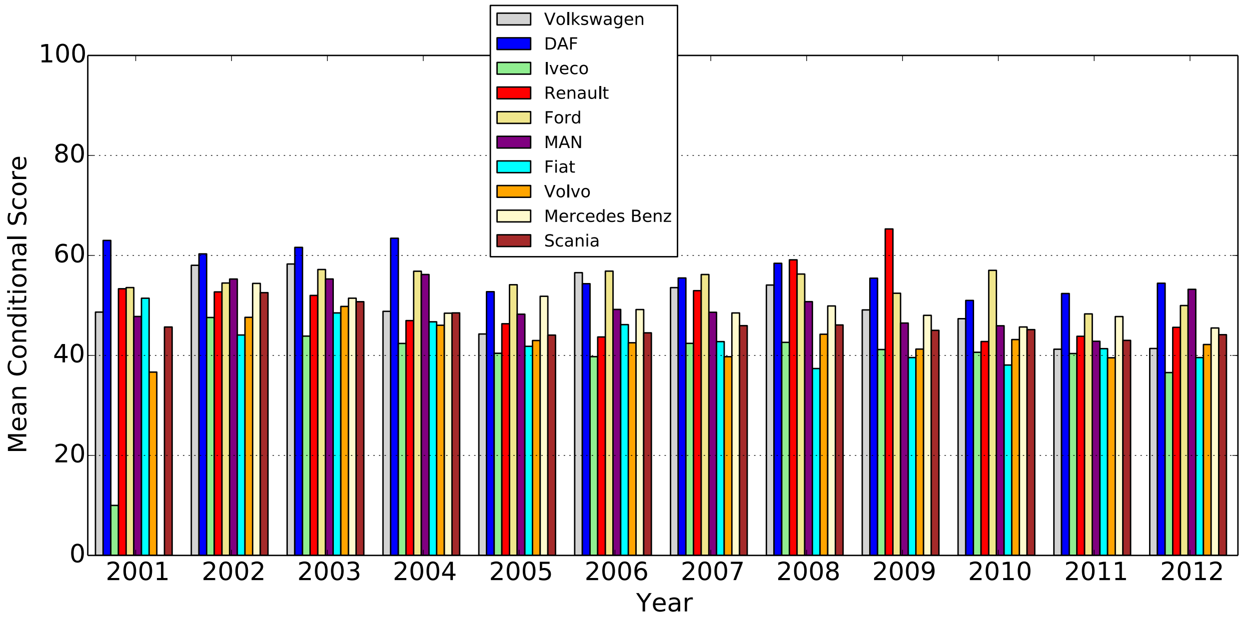

Figure 5: Shown above are the mean conditional scores per year taken from years 2000-2012 for all road vehicles split into different brands. The standard deviations are calculated to be roughly 30-60% depending on the brand in question.

3. References

[1] https://infrastructure.planninginspectorate.gov.uk/

[2] http://www.londonparamount.info/

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/520086/2904569_nidp_deliveryplan.pdf

[4] http://www.kentonline.co.uk/kent-business/county-news/weve-spent-40m-already--42534/

[5] http://www.planningresource.co.uk/article/1294526/project-cleared-fast-track-decision

[6] http://www.crossrail.co.uk/route/