

Enhancing Efficiency and Sustainability in UK Railways: A Regional Perspective

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Summary

Post COVID-19, efficiency and sustainability has been seen as the key to unlocking a better performing, cost efficient way to run a business. The UK railway sector has evidently been working hard to keep up with the times by implementing changes being cultural, behavioural, and standards based to drive efficiency and sustainability into all things new and existing. The vast amount of assets on the railway are more than one can comprehend, and to make every single asset impenetrable from climate change is impossible so organisations need to work hard to prioritise and understand interdependencies where one solution may protect multiple assets. To support the physical solutions, theoretical and well thought out strategies need to be in place to guide organisations through the journey to efficient and sustainable practices, and it is a long-term process. The complex nature of the UK railway network requires careful consideration and well thought out strategies and action plans, which are in place and progressing at present. The progress varies between the regions, based on nature of the environment, usage, and investment as some are parts of the network are more advanced than others at present. This study outlines how the UK railway sector is driving improvement to efficiency and sustainability and approaches the many strategies with careful consideration and comparison to unravel potential areas of improvement and challenges to focus on.

Keywords: efficiency, sustainability, biodiversity, climate adaption, railway, environment, strategy

Track 12: - Innovation

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Introduction

The UK's main railway infrastructure, owned, operated, and maintained by Network Rail, spans over 20,000 miles of track, incorporating over 30,000 structures, signals, level crossings, stations, overhead line equipment, third rail, embankments, and cuttings, and much more (Network Rail, 2024). For this reason, the responsibility of managing this infrastructure has been split into five regions to make it manageable. The 5 routes are;

- Eastern
- North West & Central
- Scotland
- Southern
- Wales & Western

Within the regions, the responsibility of the infrastructure has been divided into routes where necessary dependent upon the amount of assets, and attention to the infrastructure required.

The Eastern Region is divided into 4 routes;

- Anglia
- East Coast
- East Midlands
- North & East

The North West & Central Region is divided into 3 routes;

- Central
- North West
- West Coast

Scotland is not divided into routes.

Southern is divided into 4 routes;

- Kent
- High Speed 1
- Sussex
- Wessex

Wales & Western is divided into 2 routes;

- Wales & Borders
- Western

Each region currently has a strategy for delivering the current Control Period (CP) known as CP7. Control periods are important as it acts as a five-year plan that Network Rail develop to prioritise the required maintenance, renewals, and enhancements required to maintain the functional railway and provide the best service possible to customers. The delivery plans for the control period are produced by each region and act as a guide to maintain strategic priorities specific to that region, as they all have slightly different requirements based on type of infrastructure, how frequently it is used, and how advanced they are to becoming innovative and sustainable. The delivery plans for the control period are required to align with the holistic overall strategy that Network Rail set out as an organisation. It is quite a complex strategic setup to enable the goal of providing sustainable and modern services to customers.

To inform the regional strategies, Network Rail have other strategies which aim to provide overarching aims and objectives to support what needs to be achieved as an organisation, not just individual regions. These strategies align with various governmental and even worldwide objectives, such as aiming for net zero carbon emissions, improving the social value of the infrastructure, and economic sustainability. Being a public sector company funded by the UK government; it is no surprise that strategic decisions need to align with the UK governments objectives in this field.

Sustainability is at the heart of most organisational strategies, with pressures from not only the UK Government, but also worldwide organisation's such as the United Nations, who have set out 17 sustainable development goals acting as a call for action to improve social, economic, and environmental value, tackling poverty and deprivation, and climate change. With the UK being one of the UN member states, it is important for the UK Government to be able to show commitment through the organisation's that operate within. For Network Rail, this means that many of the strategic decision making that takes place, needs to consider how they are to build a sustainable business, with sustainable operations, for a sustainable future.

Sustainability does not come easy, and with the UK railway infrastructure still sitting on Victorian time foundations, requires innovation to assist with the bespoke nature of the railway, and cater for the requirements of sustainability goals, whilst maximising the social, economic, and environmental value added. Sustainability is important to understand from a circular economy point of view, to enable a more holistic view of impact that strategic decision making has on the circular economy. Sustainability is the key because measuring how sustainable a business is, breeds continuous improvement by forcing action to be taken to achieve a sustainable operation in every field, from offsetting carbon to renewable energy, steady and stable income to economic value added throughout the supply chains and other industries, even affordable and inclusive travel options.

Innovation has become a hot topic throughout not only the UK railway industry, but throughout the entire infrastructure sector. It is the best way to become more efficient and to save money but also reduce the waste of effort and finance. Innovation can also help the UK railway infrastructure become a safer place to work and operate. Innovation is no longer a new topic and is the second necessity to becoming an efficient and sustainable industry, second to sustainability itself.

Improving efficiency and sustainability requires an understanding of how each discipline depends on another and the level of granularity that data can provide the industry with, to improve the interaction between these dependent variables and create a more efficient and sustainable operation. It makes sense that Network Rail Regions have their own strategies because the network infrastructure is at various stages of development in terms of innovation with modern technology and how sustainable their operations are, so a one size fits all does not work. It makes sense that Network Rail set objectives from a top level which filter through the regional strategies because they all need something to work towards. The challenge is the time it takes, and the finance required to makes the changes that are necessary to aligning with the overarching strategies and paving the way to achieving this and setting out the steps to get there.

Research Gap

Research surrounding the UK railway sector and the progress being made to innovate and become a sustainable and efficient industry, is quite sparse. It isn't a topic that is being researched, and this is likely since the infrastructure is bespoke and there isn't a one-size fits all solution. Network Rail have their own suite of standards to maintain, operate, and build to. Network Rail also have their own research and development department which could be a reason that research isn't often shared in the same way academic research is. Network Rail release documents for public viewing such as strategies, projects, technology and so on, but don't often share how they got there, unless in the form of a case study.

The purpose of this paper is to delve into the strategies and available research throughout the different regions, to gain a better understanding of how efficiency and sustainability is being improved on a regional and national scale, and to explore the opportunities that may be present

to accelerate the process. The following objectives have been developed to enable a structured approach towards understanding how regions are improving efficiency and sustainability, and the challenges faced, with a view to suggest improvements through process:

1. What are the strategies of each region, and how are they committing to the improvement of efficiency and sustainability?
2. What are the similarities between the goals of each region?
3. What are the challenges with improving efficiency and sustainability on both a regional and national scale?
4. How can existing strategies, or process be improved to accelerate the improvement of efficiency and sustainability?

Methodology

Due to the limited academic research resources available on the UK railway sector, it is a challenge to find current and relevant data to decipher. Railway industries worldwide are far more advanced in academic research studies than the UK. Available literature on these topics was reviewed systematically using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement to meet the objectives as mentioned in the previous section. Preliminary searches were conducted across various electronic library databases to firstly identify published research to be considered for use. The platforms identified and used for the review are: ScienceDirect, ICE Virtual Library, and University Library. Key terms used in the searches are: “railway efficiency” OR “railway sustainability” OR “railway innovation” OR “UK railway strategies” OR “railway innovation”.

Additional resources were sourced through various web-based articles and reports and anything prior to 2010 excluded due to the topic relevant to the UK railway sector was very much in it’s infancy with a lack of viable available resource. Using resources from web-based sources requires a careful approach due to the potential bias of this data.

To ensure this paper was focused on relevant material, and inclusion and exclusion criteria was adhered to as shown in Table 1.

Table 1 - Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Date	2010 – Present	Prior to 2010
Geographic location	United Kingdom – Contribution from the United Kingdom	Not in the United Kingdom or no direct contribution from the United Kingdom
Language	English	Papers other than English
Type	Research Papers, Reports, Published Articles	Book reviews, research notes, dissertations
Publications	Peer Reviewed Articles, Organisational Reports and Publications, Government Reports, Published Textbooks, Conference Proceeding, Industry Specific Articles	Papers focusing on other infrastructure sectors besides the Railway, Discussion Forums
Participants	Organisations (Public or Private) and Researchers contributing to the analysis and information of digitising asset management in the UK specific to the Railway	Non-UK Based Organisations and Researchers
Design	Qualitative, Quantitative, Case Study, Survey, Studies that used a validated methodology	Papers and articles that are not backed by evidence or data

Focus	Is the information relevant to the UK railway sector? Does the information contribute to the study of efficiency, innovation, and/or sustainability in the UK railway sector?	Information with no relationship to the UK railway sector or efficiency, innovation, and sustainability.
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All searches were narrowed down using advanced filters to ensure the data remained relevant, along with relevance to the main topics of efficiency and sustainability in the UK railway sector.

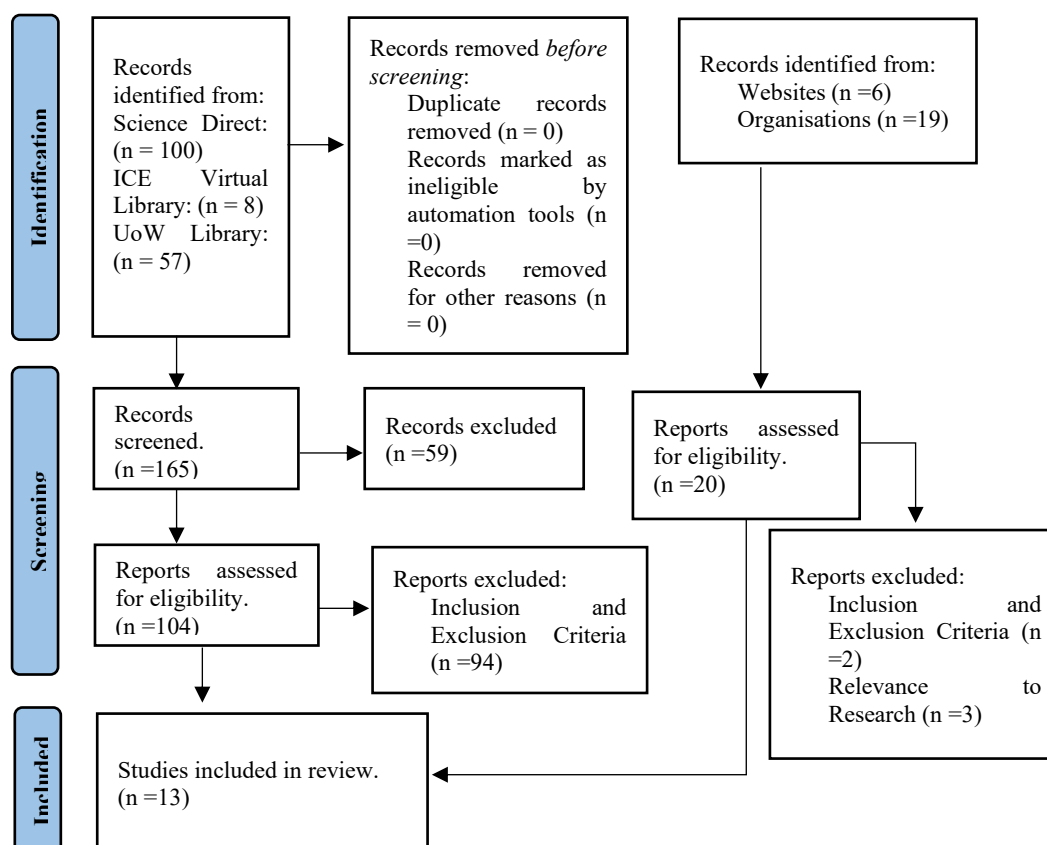


Figure 1 - PRISMA Article Screening Process

All data used in this review, has been cross-checked and reference against one another to understand the relationship between each topic and how or if there were interdependencies.

Strategic Efficiency

The 5 different regions within Network Rail; Eastern, Wales and Western, North West and Central, Scotland, Southern; each have a strategy which they call the delivery plan for control period 7. The delivery plans set out the main priorities and areas of focus for the control period which is as a standard 5 years.

Considering the improvement of efficiency and sustainability, they all have a common theme of delivering value for money and creating a resilient infrastructure, whilst aiming to be as clean and green as possible.

The common key initiatives that will be used throughout CP7 include structured business tools such as PACE (Project Acceleration in a Controlled Environment), SPEED (Swift, Pragmatic, and Efficient Enhancement Delivery), and finally MVP (Minimum Viable Product).

PACE is an operating business model that aims to streamline project lifecycle, by removing non-value-added governance at the same time as increasing the effectiveness of assurance, making it less restrictive (Network Rail, 2024). The reduction of required roles within the project due to the streamlined requirements under governance and assurance, making it easier for one person within the project to undertake a role that under previous operating governance and assurance models would usually require 2 or more people. Each stage of the project lifecycle is also overlapped, enabling a quicker and less restrictive transition from one stage to another (Woodrow, 2022). Unlike GRIP (Governance for Railway Infrastructure Projects), which was very linear, PACE is aiming to enable innovative and sustainable enhancements to the network to go through the project lifecycle reducing time and cost by up to 50%. PACE is a product of the SPEED Project which was first introduced by Network Rail after the UK government challenged the industry to half the time and cost critical infrastructure projects require to complete as part of the plan to recover from COVID-19 (Department for Transport and Heaton-Harris, 2021). Minimum Viable Product is an integral part of SPEED and subsequently PACE. Minimum Viable Product is a guiding principle requiring projects to interrogate the scope of works from the onset to understand the outcome which informs the design and manufacture and construction process on what the solution should be. By identifying MVP opportunities in early stages with Network Rail, means that the industry can begin using solutions to achieve the same outcome for a reduced cost striking a balance between compliance, tolerance, and cost savings (Network Rail, 2024).

Supply Chain Efficiency

All regions have ambitiously set out to targets to achieve 10% efficiencies on operational expenditure and 15% on capital expenditure (Network Rail, 2024) which suggests that efficiency is a critical component to the overall strategy within Network Rail. Each region is approaching the topic with similar objectives to achieve these efficiencies such as working with train operating companies to identify cheaper and less impactful windows of opportunity to gain access to the infrastructure and working with the supply chain to drive changes increasing value for money.

The supply chain has been identified as a key element of achieving efficiency throughout the delivery plans making it clear to decipher that a big portion of overall budgets are spent through the supply chain. Eastern Region is incentivising the supply chain to encourage investment into skills development and technology (Network Rail, 2024). Wales and Western Region is working on the engagement with the supply chain to reduce the duplication of work between Network Rail and Contractors in an attempt to optimise the efficiency of project delivery and utilising a flagship initiative called Intelligent Client which puts more trust into the supply chain removing duplication and enabling the supply chain to make key decisions for the benefit of the client without requiring the previous amount of paperwork, governance and assurance which is essentially SPEED (Network Rail, 2024). North West and Central Region, similar to the Eastern Region, are incentivising the supply chain to achieve time, cost, and quality objectives (Network Rail, 2024). Scotland Region pay dividend to the requirement of streamlining and optimising their business model which includes the supply chain, but don't express the importance of the supply chain in achieving efficiency like other regions do. Southern Region have recently implemented a new delivery model known as SRE (Southern Renewals Enterprise) which brings the supply chain closer to Network Rail, working closely and collaboratively to create a supply chain ecosystem, challenging the normalities in renewals and innovating to optimise outputs (Network Rail, 2024).

Infrastructure Access Efficiency

Another key element of achieving efficiency which is apparent through the regional delivery plans is the negotiation, management, and cost of access to the network through train operating companies who charge a fortune in loss of earnings known as schedule 4 costs (Network Rail, 2025). It is duly noted that since COVID-19, passengers numbers have reduced throughout the midweek, presenting an opportunity to train operating companies to enable infrastructure works to be undertaken using midweek blocks to allow work to take place meaning more work can be completed in comparison to the usual weekend and bank holiday closures which Eastern Region have taken advantage of (Network Rail, 2024). Wales and Western Region are also aiming to take advantage of midweek blockades noting that in some areas this may be the best approach to finding an optimal balance between engineering and traffic hours (Network Rail, 2024). North West and Central have implemented a Project known as SPEAR (Strategic Planning Engineering Access Reform) which aims to generate efficiencies by optimising work banks through shared access, maximising productivity through shared learning across the industry with best practice, and whole system analysis reviewing the usual access patterns to understand if changes can be made for the better (Network Rail, 2024). Scotland Region discuss the optimisation of access strategies to make them more productive (Network Rail, 2024). Southern Region also highlight access as a potential for efficiency savings through integrating programmes and early consultation with train operating companies (Network Rail, 2024).

National Efficiency Plan

As well as common themes across each strategy, Network Rail have a national efficiency plan which focuses on an industry reform through access planning, joint property strategies, workforce management, and the use of data and technology from trains and infrastructure (Network Rail, 2024). Delivering projects quicker and a reduced cost by using SPEED and effectively PACE is high on the priorities list from a national perspective, noting that the aim is to cut unnecessary red tape and be bold a purposeful in decision making, empowering the supply chain to make the right decisions to reduce time and cost of delivering enhancements to the infrastructure (Network Rail, 2024). The reduction of delays to passengers by increasing allowable access time on the infrastructure to undertake key maintenance activities is an approach being taken from a national level to drive efficiency within this strategy (Network Rail, 2024). The constant review and challenge to standards can assist in driving down costs by understanding the impact of standards changes and allowing deviation where safety is not compromised (Network Rail, 2024). Shared workspaces and the development of unused Network Rail owned land is a topic covered under the joint property strategy aiming to produce even more efficiency by work closely with local communities and even feeding in social value by working with them (Network Rail, 2024). Intelligent Infrastructure is identified within this strategy which helps the maintenance teams to monitor infrastructure remotely, plan maintenance regimes efficiently, and enable staff to do more with less, reducing cost without sacrificing on safety and enabling preventative maintenance reducing delays and costs associated (Network Rail, 2021).

Strategic Sustainability

As with everything in an organisation, there must be a clear pathway to achieving goals for there to be success. Network Rail have a strategy to improve sustainability which aligns with the UK Governments ambition of having net zero carbon emissions by 2050. The Environmental Sustainability Strategy (2020) sets out a road map to achieve key milestones up to 2034, which is a good way to manage the longevity of the ambition and enables Network Rail to review and update milestones based on progress rather than keeping the same strategy

for 30 years. Greener trains, greener assets, climate change adaption, biodiversity, and circular economy have been picked out as the key themes to map out a way to improving sustainability.

Greener Trains

Network Rail do not have direct influence on the trains the train operating companies use, so rely heavily on backing from the Department for Transport, HM Treasury, and other funders to make the key decision to electrify lines (Network Rail, 2020). The ambition is to electrify the network to a point where there are no diesel-only trains by 2050, which seems a tall order when at current the latest statistics released show that 39% of the infrastructure is electrified with 19% of the rolling stock across the network being diesel only (Office of Rail and Road, 2024). Only 7% of the infrastructure in Wales is electrified (Office of Rail and Road, 2024), and there is a plan to commence decarbonisation but less so through electrifying the infrastructure, the focus is more so on fleet, property, and offsetting carbon emissions through alternative sources (Network Rail, 2024). Scotland have 33% of the infrastructure electrified (Office of Rail and Road, 2024), and as part of the delivery plan, they are continuing their commitment to find efficiencies through enhancement projects to realise opportunities to electrify routes within the region which includes incorporation into maintenance regimes to consider electrical clearance further reducing cost of renewal and enhancement work (Network Rail, 2024). The majority of the Southern Region is already electrified using conductor rail 650-750v direct current, so the focus or more applied towards making the electrified railway more resilient to climate change (Network Rail, 2024). Eastern Region have been running major enhancement projects across the Midland Mainline and East Coast Mainline, two of the major routes within the region, providing cleaner and more resilient electrification within the region (Network Rail, 2024). On the topic of electrification, Network Rails ambition is to provide decarbonised passenger rail in Scotland by 2035, and in England and Wales by 2040 (Network Rail 2020).

Greener Assets

Greener assets involve making key decisions around renewal and enhancement work to reduce the whole life carbon and air pollution emissions which not only feeds into the main sustainability strategy but also increases social value throughout the nation (Network Rail, 2020). The use of renewable energy is an opportunity that can be realised with some thought along with considering embodied carbon emissions which comes from the extraction of raw materials used on the railway, so the strategy aims to cover an in-depth assessment and change of practice with how the railway industry designs, build, and operates (Network Rail, 2020). Wales and Western Region are making a commitment to invest in the development of green infrastructure which helps to offset carbon emissions, as well as consider the circular economy and whole life carbon of assets by changing the culture of wasting old assets in attempt to reuse as much as possible to reduce carbon emissions (Network Rail, 2024). Improving data accuracy and granularity of indirect carbon emissions is a key objective for the Scotland Region, which can help with understanding how to achieve improvement in the five key areas identified in their delivery plan which consists of; being climate ready through increasing the climate resilience of assets, aiming for net zero carbon by considering the circular economy of assets and encouraging decarbonisation across the region, delivering nature positive initiatives to improve biodiversity which includes the implementation of a lineside vegetation management strategy, reduction of environmental incidents through the monitoring of air and noise pollution to inform improvement plans, which will all then increase the social value impact (Network Rail, 2024). Southern Region have five core programmes aimed at improving sustainability which are linked to the reduction of carbon consumption, protection of nature, increasing climate resilience and social value whilst maintain high standards of progression by following the basic principles of sustainability such as transitioning to renewable energy, enhancing

biodiversity through protection of wildlife and habitats, using a variety of strategic employment programmes and green skills development to support socio-economic growth and maintaining ISO 14001 certification for environment management systems (Network Rail, 2024). The Eastern Region aim to reduce carbon emissions by a further 20% during this control period with interesting initiatives such as empowering employees to identify ways of cutting carbon emissions in their own workplace and having the funding readily available helping to drive a cultural change and way of thinking, and aim to have no net loss of biodiversity by 2024 actually achieving net gain on biodiversity by 2035, whilst instilling an holistic approach to sustainability by driving a circular economy approach to decision making with maintenance, renewals and enhancements (Network Rail, 2024). North West and Central also have a similar approach to greener assets with stress placed on carbon emission reduction through fleet electrification and renewable energy consumption, increasing net gain in biodiversity through habitat management plans and investing in ecological expertise (Network Rail, 2024).

Climate Change Adaption

North West and Central Region understand climate change is an issue and is also getting worse, so preparing is key to improve resilience and becoming sustainable, by renewing priority assets and protecting them using various technology such as digital lineside inspections, slope monitoring, and environmental surveillance, whilst investing in people to develop competence in this area of interest (Network Rail, 2024). Wales and Western have similar plans to improve climate resilience with the identification and prioritisation of high-risk areas, establishing long term pathways to achieve a climate resilient network, which in collaboration with Network Rail's weather risk task force can help to drive targeted pro-active response and action (Network Rail, 2024). Scotland Region is commonly known to experience some of the most extreme weather events across the network, and in their delivery plan is heavily focused in investing in climate resilience as well as understand the science and adaption capabilities to help strengthen decision making processes (Network Rail, 2024). The Southern Region talk of climate adaption and continue to commit to their climate adaption plan which insist the use of strong partnerships to build a resilient network (Network Rail, 2024). Like other regions, Eastern plan on harnessing data to optimise climate resilience, and have already identified approximately £500m worth of works that can increase the benefit of climate resilience (Network Rail, 2024).

Biodiversity

Biodiversity is a common commitment from not only Network Rail at a national level, but throughout each region.

Eastern Region is working closely with the Wildlife Trust to help develop action plans in conjunction with local stakeholders to align works with Nature Recovery Frameworks, which will support the ambition of 10% net gain biodiversity by 2035 with a key milestone of 4.8% by 2029 (Network Rail, 2024). Scotland Region have a lineside vegetation management strategy which will be used to assist in achieving biodiversity goals by 2029, by incorporating not just vegetation management but also ecological surveys and data collection and biodiverse enhancements such as habitat protection (Network Rail, 2024). Wales and Western Region commit to improving biodiversity to a 4% net gain but attribute it to green infrastructure as part of the greener asset initiative (Network Rail, 2024). The natural environment programme implemented by Southern Region focuses on enhancing biodiversity through protecting wildlife and habitats lineside creating dedicated railway nature sites, producing habitat management plans and integrating into the land management strategy, promoting nature connectivity along the railway (Network Rail, 2024). North West and Central are planning to incorporate biodiversity gain through design of renewals and enhancements requiring habitat

management plans and consideration to be made wherever works are happening for the purpose of protecting wildlife through design of assets, and working closely with the ORR (Office of Rail and Road) to establish appropriate change control to inform monitoring against regulatory baselines (Network Rail, 2024).

Relationship with Sustainable Development Goals

As part of Network Rail's commitment to improve sustainability through the Environmental Strategy (2020), the links to the UN Sustainable Development Goals are clear and represented within the strategy highlighting the importance of being able to achieve objectives set on a global scale. Each of the core themes which form roadmaps within the strategy, identify alignment to the sustainable development goals.

Greener trains, greener assets, and climate change adaption has been linked with affordable and clean energy, industry innovation and infrastructure, sustainable cities, and climate action, evidently expressing that investing in providing greener transportation can have a positive impact on a larger scale than just the railway.

Biodiversity has been identified to link with life below water and life on land, portraying an important requirement to protect the wildlife that we can and can't see, and that consideration may be beyond what an everyday railway worker may think.

Circular economy which is wrapped up in nearly all key themes within the strategy, identify links with sustainable development goals the same as the rest of the roadmaps, with the addition of clean water and sanitation, decent work and economic growth, and responsible consumption and production, meaning it is likely the most impactful of all the roadmaps themes due to the reach of potential benefits it can bring to the table. By having a circular economy Network Rail can have an indispensable asset base which could have multiple uses within its lifecycle and beyond.

Conclusions and Recommendations

It is evident that Network Rail are suitably striving for improvements in efficiency and sustainability with purpose, by providing the organization with strategies to guide through the process. The regional strategies are set out in a way that emphasises on safety, train service delivery, customers and communities, sustainable growth, efficiency, and people, and it is an holistic approach being similarly set out within each regional delivery plan. The regional strategies align with the national strategies such as National Efficiency Plan (2024), Environmental Sustainability Strategy (2020), and various other national strategies that aim to improve biodiversity, social value, and digital innovation.

The main areas of focus for efficiency were found to be identified within the supply chain which will support the ambition to achieve 10% efficiencies in operational expenditure and 15% in capital expenditure. There are multiple opportunities and initiatives available to find efficiency in operational expenditure, such as the role out of SPEED and subsequently PACE and MVP. These provide the organization with leaner ways of working and reduced duplication of roles and unnecessary spending on certain roles. Also on products that are normally used and instead choosing a cheaper product with the same outcome. The capital expenditure however may be more difficult when trying to improve efficiency and sustainability, because it requires investment into infrastructure and assets, which is where MVP becomes a cross over expenditure from operational expenditure, to find solutions with the same outcome for a better price.

Another key area identified for efficiency potential, is through actual access to the infrastructure. It seems regressive that network rail has to pay to access their own infrastructure, but this is because the train operating companies pay a fee to Network Rail to essentially lease the infrastructure to run their trains, so any disruptive access Network Rail require, the train operating companies are paid compensation for potential loss of earnings. So to minimize the financial impact of the disruptive access requirements, Network Rail through strategizing and developing innovative systems, are looking to combine access footprints to optimize the work that can be completed. Midweek blockade opportunities are identified as a possible way to achieve efficiency, considering a lot of passengers since COVID-19 have remained in a predominant work from home regime, shown through passenger figures.

The key initiatives for sustainability cover topics such as providing greener trains, greener assets, climate change adaption, and biodiversity. Greener trains and greener assets will enable Network Rail to reduce carbon emissions by using renewable and clean energy further contributing to the global goal of reducing the impact of climate change. However, climate change is still a challenge and it cannot be undone, and rightly so Network Rail have identified the continued need to become climate resilient and ensure assets are renewed and installed with the specification to be resilient to the most extreme weather events like we are experiencing in the present day.

The natural environment surrounding the railway infrastructure in the UK, contributes to healthy regeneration and reproduction of wildlife and is also home to some of the most incredible scenery in the world. Network Rail's commitment to biodiversity net gain (BNG) supports the overall global ecosystem, and to increase biodiversity will positively impact the not only environmental value, but also social value through the ecosystem.

All the initiatives and strategies are good, and really echo the effort that is being put into the railway sector to improve and support local and global initiatives however, there seems to be a lot to consider and some of it is down to legislation. To instill behavioural and cultural change, and adapt peoples way of thinking, they must be educated on the details rather than be told to adhere to this or work with guidance from a strategy. The workforce have got to understand the importance which can only be gained through education rather than enforcement. Mandatory awareness courses and e-learning modules could be a good way of educating remotely, and the use of corporate social responsibility days could also be used to benefit the workforce through education.

A lot of the delivery plans and strategies are very much the same, with mainly just figures, projects, and certain applications setting them apart, which begs the question as to whether the suitability of the regional delivery plans are just duplication of an overarching strategy. They do however express the commitment of the Regions to achieving overall national strategies. It is apparent that dividing responsibility through breaking down the UK railway infrastructure into regions and even further into routes, although being easier to manage it sometimes acts as the cause of duplication of time and money being spent on innovation, reversing the effect it could have in improving efficiency and sustainability on a national scale.

There is mention of national forums and knowledge sharing but there is no strategy to support this and mandate national forums. The challenge of supply chain outreach could be considered as part of this, as some SME's (Small to Medium Enterprises) are locally contracting with the regional area and have some really good innovational and sustainable solutions, which could be shared nationwide with backing from Network Rail.

The lack of academic support and research to the UK railway sector in terms of strategies is missed in the industry. Throughout this research, a lot of resources were found but were not

relevant the bespoke nature of the UK railway. With academic support and research, organizations like Network Rail could learn new and innovative ways to implement strategies at an accelerated pace. India has the largest green railway in the world, Network Rail could potentially learn from their implementation. Germany is one of the most eco-friendly countries in the world yet harbor the sixth largest rail network in the world so there may be lessons to learn from them. Japan is home to the most efficient railway system in the world and have one of the largest networks in the world which again Network Rail could learn from. Network Rail without the backing of academic support and research are an operational business and likely do not have the time that students may have for research in the detail that is required to shape strategic business decisions for the better so this is an area which should be drawn on in future. It is not to say that there is no research being undertaken, there is much academic support through engineering and innovation technology applications.

In summary, progress is being made, and each day the industry is learning and developing for the improvement of efficiency and sustainability. The requirement to share knowledge not only nationally, but globally, and not only within the industry, but throughout other industries advancing with similar strategies. The bespoke nature of the railway should not crowd the potential standardised applications of sustainable innovation, and strategies to improve efficiency.

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