MAXIMIZING THE VALUE FOR MONEY OF ROAD PROJECTS THROUGH DIGITALIZATION

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1. Introduction

- Roads are an enabler of economic activities but road transport is, simultaneously, one of the largest contributors of CO_2
- The EU road network accounts for 5.5 million kilometers and is responsible for 75% of freight transport and nearly 90% of passenger transport

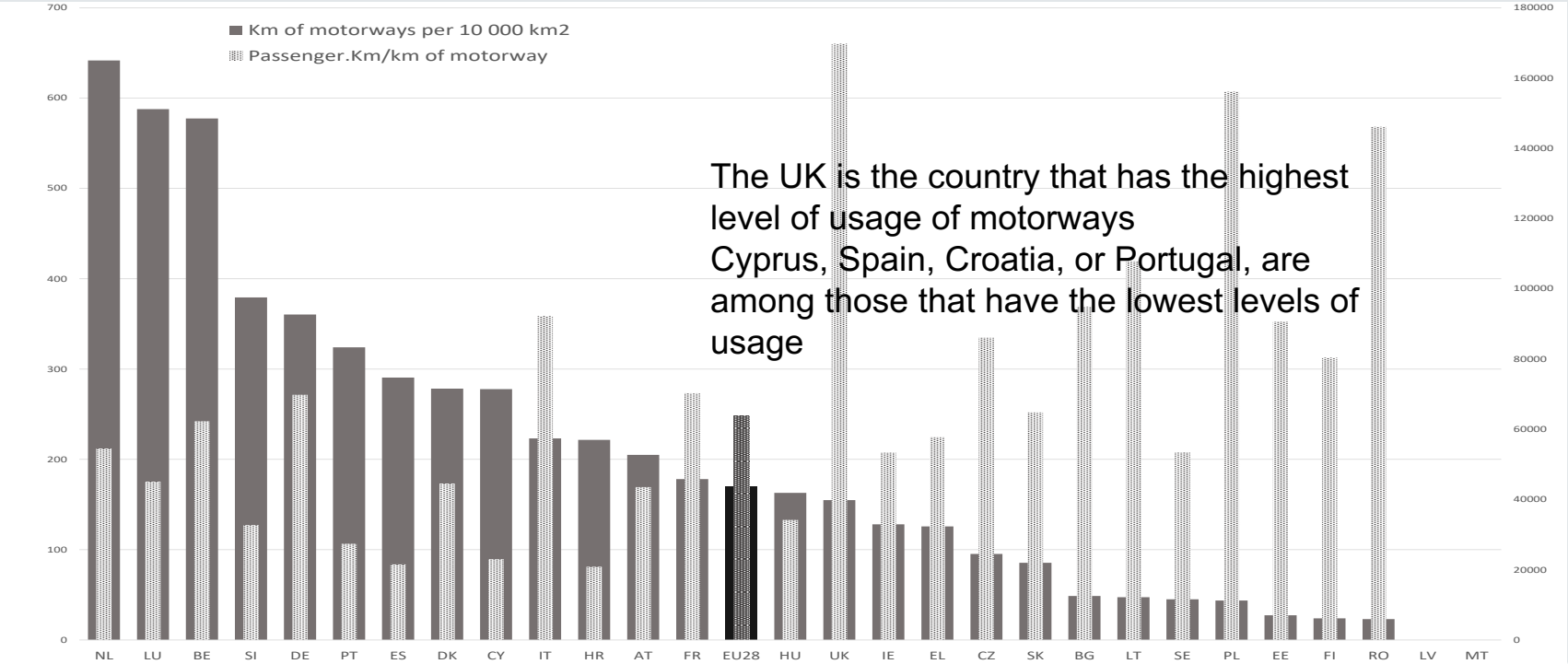
- Roads are, from a physical perspective, a relatively rigid infrastructure … but a dynamic market
- The private sector is no longer simply a service provider, but rather an active player in financing, building, and managing roads

The management of roads is moving from a service-based perspective, towards a consumer-based perspective, offering solutions to improve and optimise travels, and provide additional services, such as electric charging points, and integrated mobility solutions

The impact of digitalization may have a profound impact on the traditional business model of roads, and particularly, road PPPs

2. Overview of road projects

2.1. Network development

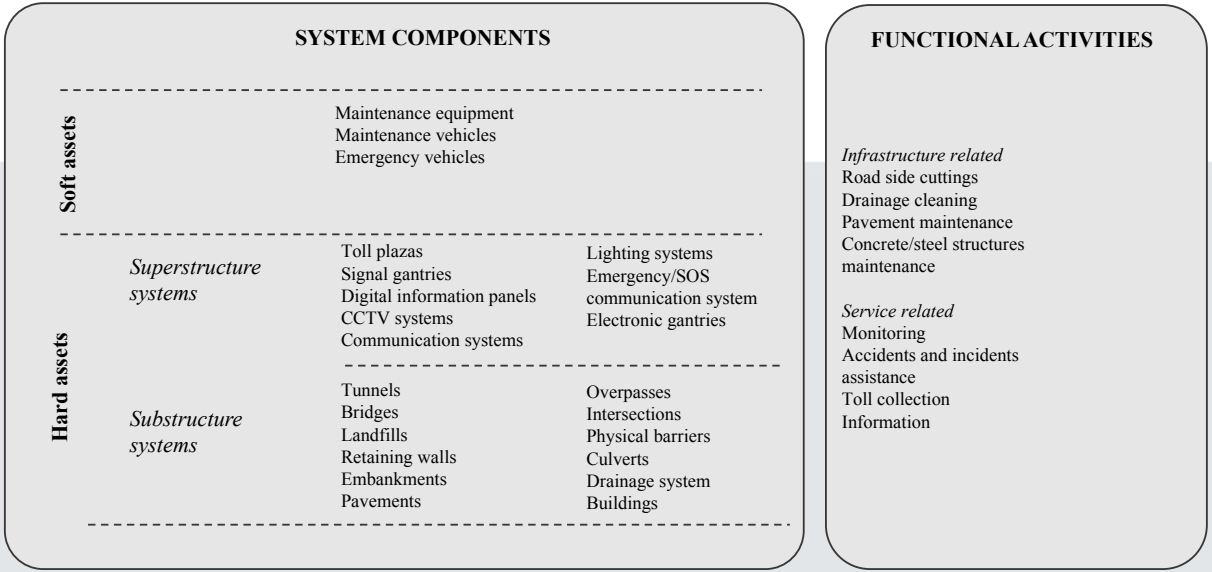


The UK is the country that has the highest level of usage of motorways
Cyprus, Spain, Croatia, or Portugal, are among those that have the lowest levels of usage

2. Overview of road projects

2.2. Road system components

Breakdown of system components and functional activities



2.3. Infrastructure and service-related innovations

“infrastructure-related”

Technological innovations are embedded in the infrastructure to support its maintenance and operation (e.g. remote sensing, electronic tolling, etc.)

“service-related”

Designed to improve how the users utilize the infrastructure/service (e.g. dynamic tools, real-time information, real-time incident detectors, etc.).

Examples of digital innovations

Infrastructure-related	Service-related
Electric charging/corridor	Traffic management
BIM and collaborative design	Automatic accident detection
IoT and intelligent monitoring	Autonomous vehicles
Smart asset management	Electronic tolling

3. Infrastructure related-digitization

3.1. Building information modelling (BIM) and collaborative design

Investment associated with the construction accounts for approximately 50% to 70% of the overall life-cycle costs of a road project over a 40-year period (Sarmento, 2010); Cost overruns typically involve an increase in investment of 20-30%

BIM (building information modelling) technology has disruptive potential: redesign of project management and patterns of collaborative design; it has a potential to decrease in costs by 15-20%

3.2. The Internet of things and intelligent monitoring

The traditional maintenance paradigm was based on the principles of preventive and corrective maintenance (mainly due to absence of data)

IoT will allow real-time data collection, changing the paradigm of infrastructure maintenance

3. Infrastructure related-digitization

3.3. Asset management

Digitalization is leading to the emergence of a new trend in infrastructure maintenance: asset condition-based maintenance; Asset condition-based maintenance makes use of real-time data and sophisticated algorithms (e.g. artificial intelligence) and/or GIS-based tools

3.4. Electronic tolling

Trend towards moving from traditional toll booth payment methods towards electronic payment

Traditional manual tolling usually involves an investment of around 1 to 4 million Euros per lane, with an annual operating cost of 370.000 Euros to 840.000 Euros per lane

For GNSS-based tolling, the CAPEX is around 200.000 to 450.000 Euros per lane with the OPEX being a fixed cost related with customer relationship services, which can add up to 3 to 6 Million Euros per year.

3.5. Electric charging/corridors

There is a growing number of electrified corridors, using either the pavement or an overhead gantry, being developed (as pilot projects) (e.g. Sweden, Germany, etc.); It can provide a significant boost in EV adoption… but it will require significant investment

Several road managers have been implementing EV charging stations along the main routes (and service areas in motorways)

4. Service related-digitization

4.1. Traffic management

Congestion is probably one of the biggest negative effects of road usage

The intelligent management of traffic signals has become a common solution, which allows to the active monitoring system of traffic patterns that optimise the real-time management of flows at intersections

4.2. Automatic accident detection

In 2016 there were 26 000 fatalities in Europe (social of 100 Billion Euros)

ACD is a relatively cheap technology, using data collected by closed-circuit television (CCTV) cameras, and allows a much quicker response

4. Service related-digitization

4.3. Autonomous vehicles

Schranck et al. (2012) estimate that for a 10% market penetration of AV, congestion on motorways will drop by 15%. For a 50% market penetration, Atiyeh (2012) estimates a reduction in congestion of 39% and an enhancement of capacity of 20% of existing road capacity

Autonomous driving will significantly increase road capacity

4.4. "Network tolling" vs. "road tolling"

Tolling has been primarily used on a financing basis for each road project
Digitization can be used to move towards a network tolling effect, based on congestion

Dynamic tolling mechanisms

which can be adjusted on a real-time basis to fully explore the benefits of network effects, is dependent on the ability to actively monitor traffic regimes and on being able to collect tolls electronically.

5. Impacts of digitization in road projects

Technology	Road system applicable	Level of maturity	Level of technological complexity	Main barriers to entry	Expected mass adoption timeline	Potential to impact existing road infrastructure	Potential to impact revenues and/or road capacity
BIM/collaborative construction planning	Hard assets/substructure systems	Medium	Low	Institutional and regulatory	Medium term	High	
IoT / intelligent monitoring	Hard Assets /super and substructure systems	Medium	High	Economic and technological	Long-term	Very high	
Asset management	Hard Assets /super and substructure systems	High	Medium		Medium term	Very high	
Electric charging	Hard Assets /superstructure systems	Low	Medium	Technological, regulatory and economic	Long-term	Medium	
Electronic tolling	Hard Assets /superstructure systems	High	Medium	Institutional	Short term	Very high	Very high
Traffic management/congestion pricing	Users	High	Medium	Technical and institutional	Medium term	Very high	High
Automatic accident detection	Users	High	Low	Economic	Short term	Low	Low
Autonomous vehicles	Users	Low	High	Economic, regulatory and legal	Long-term	Low	Very high

5. Impacts of digitization in road projects

Technology	Potential impact	Source
BIM/collaborative construction planning	Reduction of 27-38% in Capex	Mckinsey (2017)
IoT / intelligent monitoring		
Asset management		
Electric charging	Not available	----------
Electronic tolling	Reduction of 50% on toll collection costs (Opex)	Steer Davies Gleave (2015)
Traffic management/congestion pricing	Up to 20% on revenues	Li et al (2017)
Automatic accident detection	Reduction of 25% on assistance costs (Opex)	Fernandes et al. (2016)
Autonomous vehicles	Up to 20% capacity increases	Schranck et al. (2012)

6. The Portuguese case

Brisa has 30 years of experience in managing highways, twenty of which have adopted its solutions, from tolls to roadside. Brisa created a specific company for its innovation lab, called A-to-Be.

Technology	Brisa (A-to-Be)	Short description	Benefits
IoT / intelligent monitoring	A-to-Be® VideoWall™	Control and act on complex operational theatres.	▪ Improve maintenance periods over 8 years. ▪ Ability to replace defective LCD without service disruption. ▪ Provide the operator with the choice of using open-architecture and supplier-neutral for video codecs. ▪ Resilience in failure, with easy recovery to prior condition.
Asset management	A-to-Be® Audit™	Performance measuring for road operators that need to verify road-side equipment and systems.	▪ Maximize revenues collection. ▪ Optimize human intervention in enforcement process. ▪ Uphold service level agreements. ▪ Monitor and enforce KPIs for suppliers and subcontractors.
	A-to-Be® Monitoring™	Improves companies' planning and the execution of preventive and corrective maintenance.	▪ Preventive and predictive maintenance. ▪ Implementing business rules. ▪ Monitoring equipment and applications ▪ Integrate stock management.
Electronic tolling	A-to-Be® ManualTolling™	Integration with current legacy systems and smooth technological evolution, for cashier or remote-user operation in self-service environments.	▪ Operational costs with manual tolling lanes decrease by using remote cashiers, without compromising customer service. ▪ Capacity to commute the operating mode of lanes between manual, all-electronic, and remote cashier. ▪ The assignment of lanes per remote cashier is dynamic and flexible, being easily defined by the back-office. ▪ A fully auditable and traceable solution which allows the operator to see the performance of cashiers.
	A-to-Be® ElectronicTolling™	Paying without stopping.	▪ Reduce carbon-emission operation. ▪ Lower operational and transaction costs. ▪ Coexistence of video and radio-frequency account users. ▪ Multiple equipment vendors plug´n´play.
	A-to-Be® RUC™	Tolling, dematerialised. Satellite-based and mobile solutions	▪ Satellite-based and mobile (smartphone) solutions. ▪ Road-side enforcement.
Traffic management/ congestion pricing	A-to-Be® Congestion Pricing™	Claiming streets for cities that aspire to create better experiences for citizens, walkers, and bike riders	▪ Reduced traffic flow ▪ Reduced urban furniture implementation. ▪ Integrate mobility plans for accessing inner city streets. ▪ Improved urban air quality.
	A-to-Be® Access Control™	Mobility is about getting to places. Managing who accesses, which is now easier.	▪ Improved security for accessing gated perimeters. ▪ Unique identification systems for vehicles. ▪ Seamless user experience with other mobility services (tolling, public transport, parking) and ▪ Commuting services (fueling, drive-through).

7. Conclusions

- There are enormous challenges ahead regarding digitalization in the road sector.
- Roads hold the largest share of passengers and cargo movement, associated with road transport being simultaneously the largest contributor to CO_2 emissions, are all putting pressure on governments to enact public policies that accelerate digitalization in the road sector.
- Digitalization has the potential to significantly reduce CAPEX and OPEX, and also to increase revenues and capacity
- There relevant barriers to the mass adoption of digitalization: regulatory, legal, economic and technological

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