

Benchmarking Transport Infrastructure Construction Costs WP.5/GE.4 – Final Report

WP.5, 33rd session

Geneva, 7 -9 September 2020

Agenda item 4 (b)



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REPUBLIC OF TURKEY
MINISTRY OF TRANSPORT
AND INFRASTRUCTURE

Benchmarking Transport Infrastructure Construction Costs WP.5/GE.4 Final Report

Dr. Leyla ÜNAL

Republic of Turkey

Ministry of Transport and Infrastructure
General Directorate of Highways

ANALYSIS OF ROAD TRANSPORT DATA

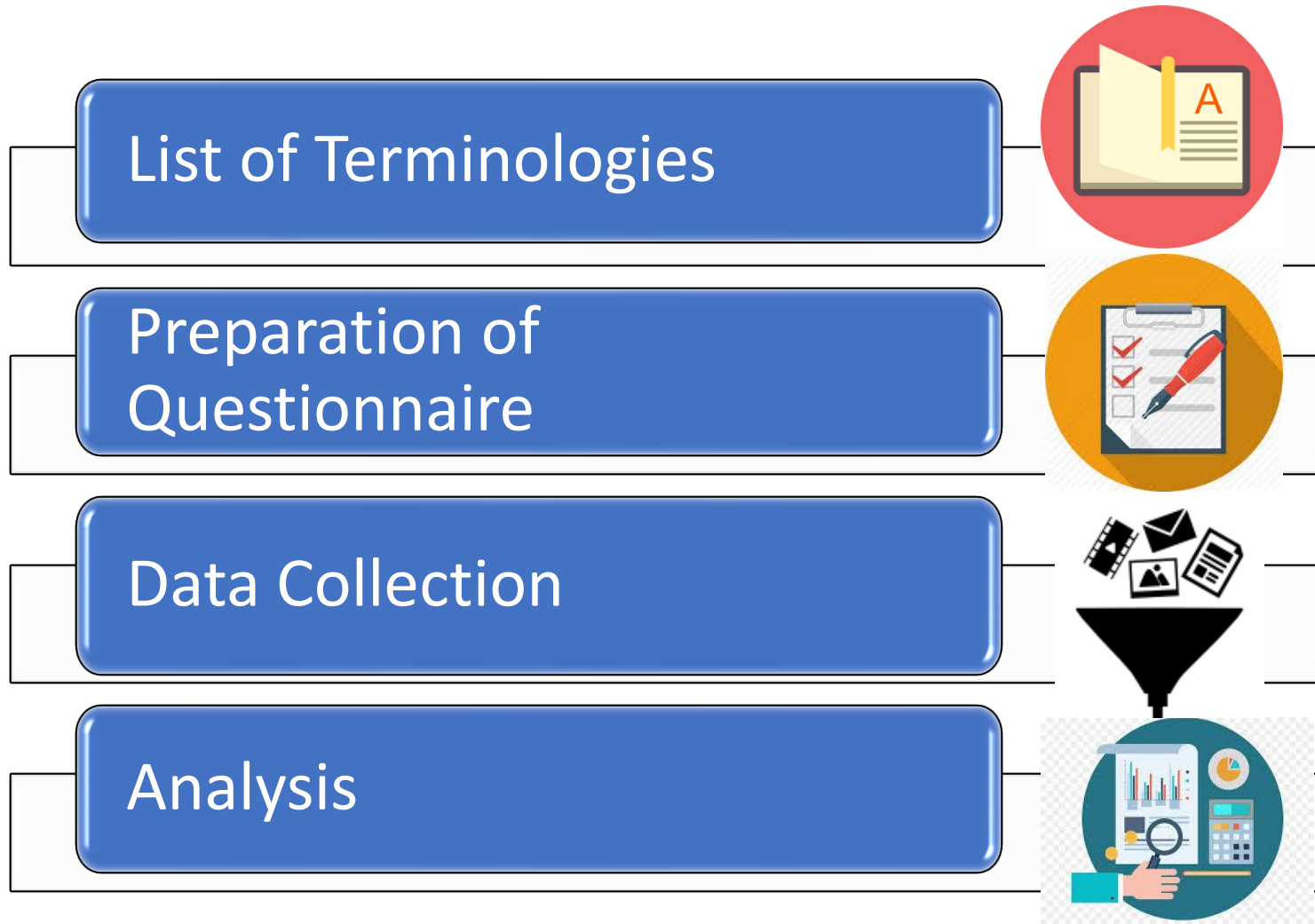


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Benchmarking Study Steps



Terminology on Road Transport Infrastructure

The Group of Experts on Benchmarking Transport Infrastructure Construction Costs produced a **set of five terminologies** and **one of them is about roads**.



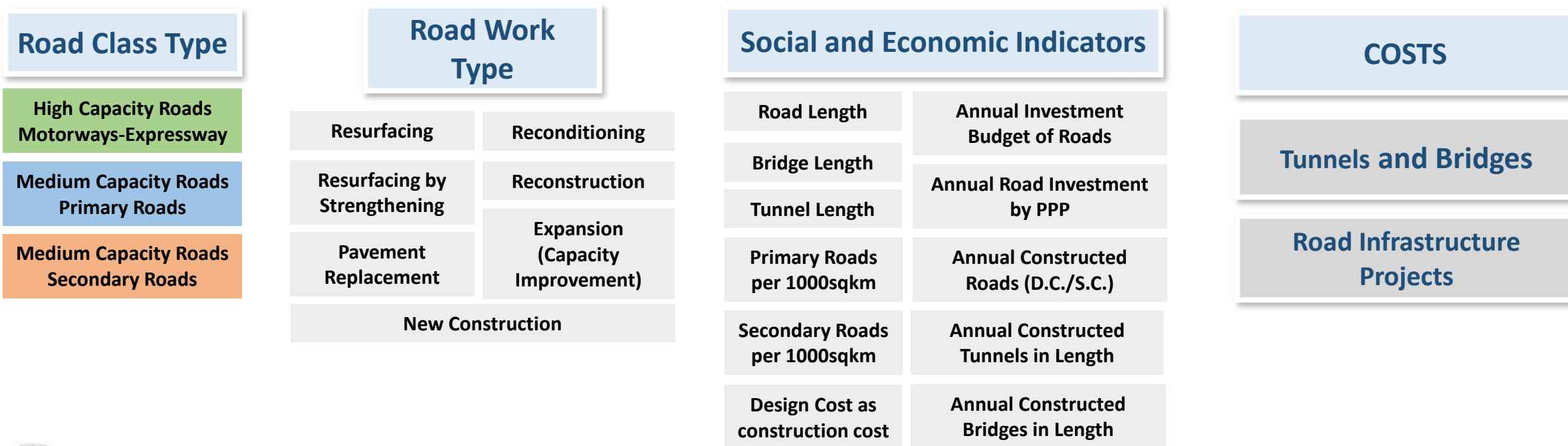
52 General terminology relevant for benchmarking of all inland transport infrastructure costs were listed

185 Revised terminology on Benchmarking Road Transport Infrastructure Construction Costs were listed

Questionnaire on Benchmarking

Road Transport Infrastructure Construction Costs

The Group of Experts on Benchmarking Transport Infrastructure Construction Costs produced a set of five questionnaires and one of them is about roads.



Benchmarking

Road Transport Infrastructure Construction Costs

HCR-Motorways-Expressway

This type of roads are High Capacity Roads such as Motorways and Expressways. These roads are full access or half access controlled (at least) double carriageway highways. Both physical and geometric capacity of this type of roads are high. The applied design speed on these roads are also higher than on other roads. They may be toll roads.

MCR-Primary Roads

This type of roads are Medium Capacity Roads such as Primary Roads. They are not access controlled. They are usually toll-free roads. They may be double or single carriageway highways. The geometric and physical capacity of this type of roads are medium. They are also main arterials and principal roads of national highways system of countries. The applied speed limits on this roads are lower than on HCR.

MCR-Secondary Roads

This type of roads are Medium Capacity Roads such as Secondary Roads. They are also not access controlled. They are toll-free roads. They may be double or single carriageway highways. The geometric and physical capacity of this type of roads are also medium but relatively lower than MCR-Primary Roads. They are important connectors of the national highways system to towns. The applied speed limits on this roads are lower than on HCR.

Benchmarking

Road Transport Infrastructure Construction Costs

Resurfacing

Placing a new surface on an existing road to increase skid resistance, to seal by aiming to preserve road from negative atmospheric conditions, to increase driver comfort, to extend pavement life, to reduce noise etc. The aim is not to increase the bearing capacity of pavement.

Resurfacing by Strengthening

Renewing of road surface with reinstalling bituminous layer by removing determined depth of pavement by milling in order to increase bearing capacity of road and to eliminate road defects.

Pavement Replacement

Renewing of the pavement either by removing the total thickness of all paving layers, existing asphalt layers from an existing roadway, and providing a new paved surface without changing capacity or geometry of the road, i.e. without changing subgrade.

Reconditioning

Reconditioning includes improvement of grades, curves, intersections or sight distances in order to improve traffic safety or changing the subgrade to widen shoulders or to correct structural problems in addition to resurfacing or pavement replacement.



Benchmarking

Road Transport Infrastructure Construction Costs

Reconstruction

Total rebuilding of both pavement and subgrade of an existing highway. Work which either changes the location of the existing subgrade shoulder points or removes all of the existing pavement and base course for at least 50% of the length of the project. In other words it is the rebuilding of an existing roads pavement and subgrade to correct road geometry, to increase road safety, to ease maintenance works and to increase preservation.

Expansion (Capacity Improvement)

Construction of additional through travel lanes in addition to reconstruction of the existing road.

New Construction

Construction of all parts of a road: structures, subgrade, pavement where no road existed before.



Benchmarking

Road Transport Infrastructure Construction Costs

Road infrastructure was defined as **High Capacity Roads (Motorways-Expressways), Medium Capacity Roads-Primary Roads and Medium Capacity Roads-Secondary Roads.**

The Group decided that for analytical purposes data infrastructure **rehabilitation projects may also be considered since they are funded from capital budget.** It was agreed to clearly define the distinction between investment and maintenance not to compare apples and peaches

The Group decided to focus its analysis on **realized costs** of construction projects for **the period 2007–2016.**

The Group also decided that overall costs should **exclude design costs, land acquisition costs, value added costs and costs of superstructures like tunnels, viaducts and bridges.**

Once the errors were removed and the costs were standardized to 2016, **all construction cost data was turned into 2016 USD prices by using GDP Deflators.**



Benchmarking

Road Transport Infrastructure Construction Costs

As agreed by the Group **terrain type is also an important parameter** in calculating construction costs. It was decided however **not to consider this parameter because of a lack of a sufficient number of projects**

The Group decided **to exclude superstructure construction costs** like tunnels, viaducts and bridges from overall road construction costs.

In order to benchmark road infrastructure construction costs, **the cost unit** was determined as **US \$ per km for single carriageway roads** and **US \$ per lanexkm for double carriageway roads** and **for tunnels US \$ per m** and **for bridges US \$ per m²**.

For road tunnels, they are classified as **single tube tunnel, twin tube tunnel, under water tunnels** and **for road bridges**, they are classified as **precasted and pre-stressed simple beam bridge, balanced cantilever bridge, cable stayed bridge, suspension bridge and pedestrian bridge**.



Benchmarking

Road Transport Infrastructure Construction Costs

The Group decided to also include **benchmarking parameters** such as **surface area, population, population density, GNP, GNP per capita, annual budget, annual operating and investment budget rates, total road network, the length of annually completed road network, length of tunnels and bridges, etc.**

Following decisions, **lead country for roads Turkey** prepared the **road questionnaires** and this questionnaire were **disseminated by the secretariat for data collection purposes.**

A set of **four open questions** was also prepared and **distributed** in order to **collect information on national benchmarking methodologies and approaches.**



Questionnaire on Benchmarking Road Transport Infrastructure Construction Costs



COSTS

**Road Infrastructure
Projects**

Asphalt Roads

Concrete Roads

**Single Carriageway
Asphalt Roads**

**Single Carriageway
Concrete Roads**

**Double Carriageway
Asphalt Roads**

**Double Carriageway
Concrete Roads**



Questionnaire on Benchmarking Road Transport Infrastructure Construction Costs

COSTS

Tunnels and Bridges

 **Tunnels**

- Single Tube Tunnels
- Twin Tube Tunnels
- Underwater Tunnels

 **Bridges**

- Precasted and Pre-stressed Simple Beam Bridges
- Balanced Cantilever Bridge
- Cable Stayed Bridge
- Suspension Bridge
- Pedestrian Bridge



Benchmarking Analysis

Approach for Data Analysis

Data Reverification

Data cleaned from any human mistakes and logical errors.

Removing the Blanks

Data brought to a readable format to make analysis more easily. For that purpose, all the projects with missing construction costs and project lengths were removed.

Standardizing the Cost Unit

Different countries gave their costs in their National Currencies. All construction costs were then converted to USD.

Data Normalization

All construction cost data was turned into 2016 USD prices using the GDP Deflators.



Benchmarking Analysis

Approach for Data Analysis

Compilation of Data

Once the data was normalized to 2016, it was combined into a single spreadsheet and analysis was carried out to determine differences between the construction costs per km across countries.

Delving into the Data

Data for the construction projects were compared with the different factors influencing the construction costs.

Data Limitations



Benchmarking Analysis on Road Transport Infrastructure Construction Costs Data

Road Class Type

High Capacity Roads
Motorways-Expressway

Medium Capacity Roads
Primary Roads

Medium Capacity Roads
Secondary Roads

Benchmarking Socio-Economic Indicators

Benchmarking Double Carriageway Asphalt Roads

Construction Cost Analysis for all Work Types

Construction Cost Analysis by Work Types

Benchmarking Single Carriageway Asphalt Roads

Construction Cost Analysis for all Work Types

Construction Cost Analysis by Work Types

Road Work Type

Resurfacing

Reconditioning

Resurfacing by
Strengthening

Reconstruction

Pavement
Replacement

Expansion
(Capacity
Improvement)

New Construction

Used Analysis Techniques

Tables

Radar Graphs

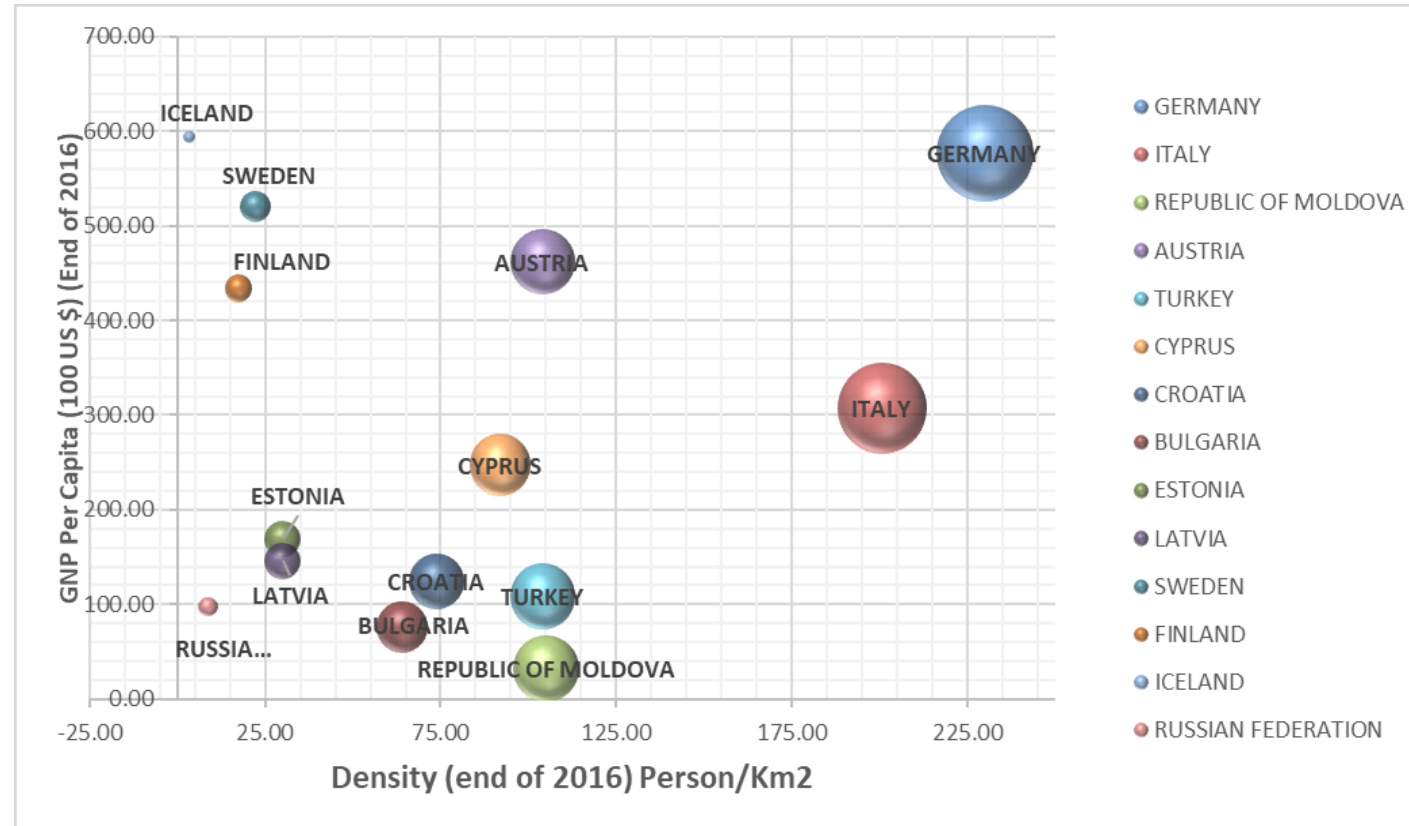
Bar Charts

Heat Maps



Benchmarking Analysis on Socio-Economic Indicators

GNP Per Capita Versus Density (End of 2016)



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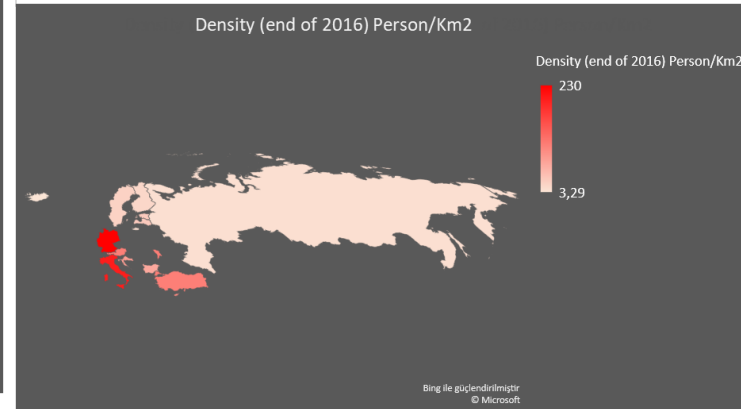
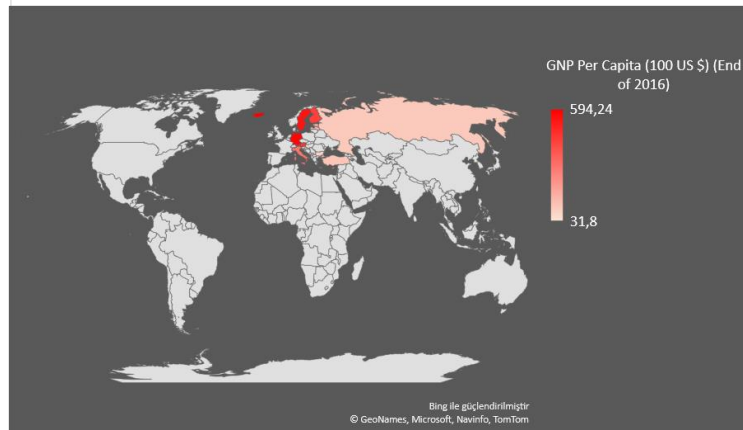
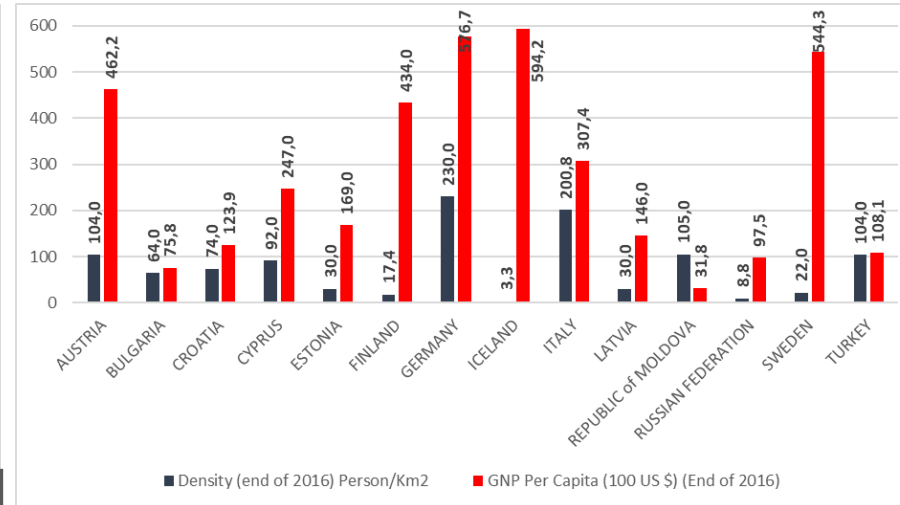
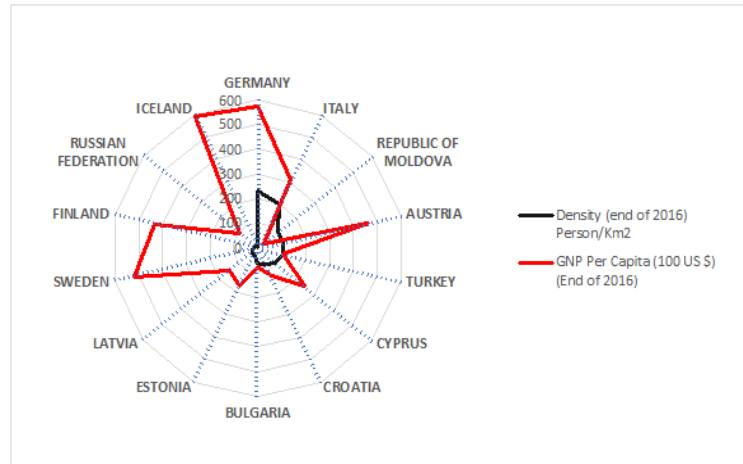


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Benchmarking Analysis on Socio-Economic Indicators

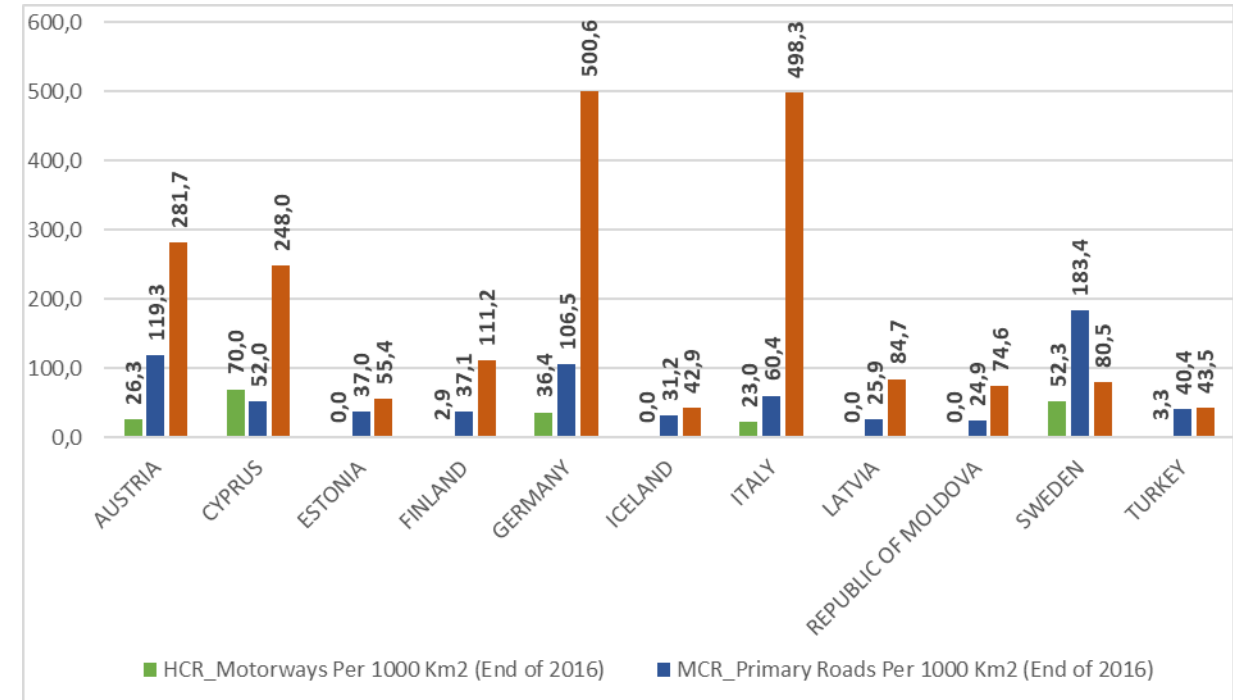
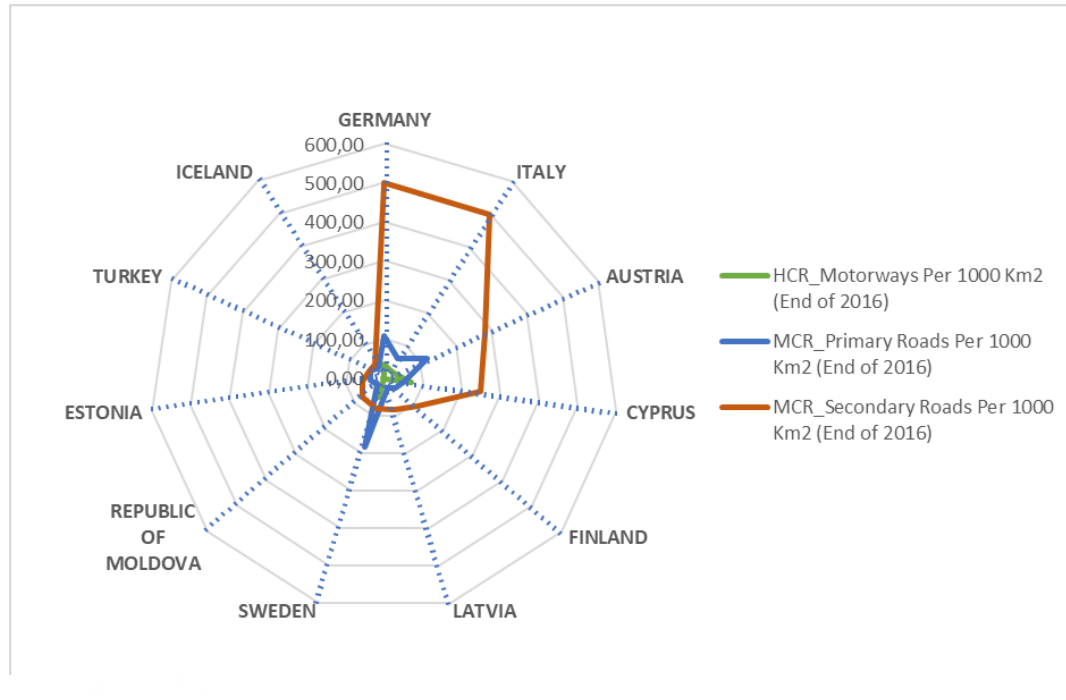
Density and GNP Per Capita (End of 2016)

- Tables
- Radar Graphs
- Bar Charts
- Heat Maps



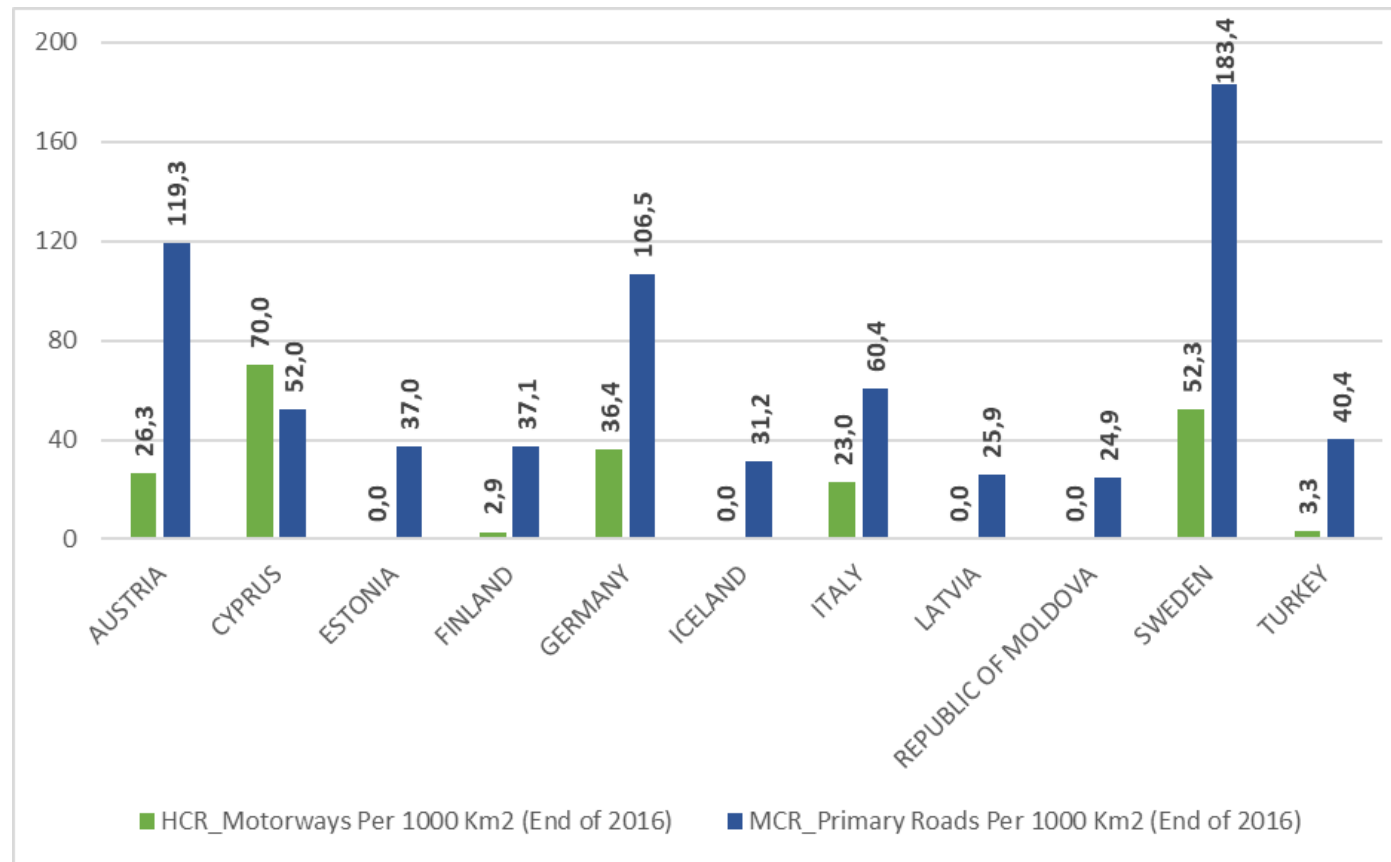
Benchmarking Analysis on Socio-Economic Indicators

HCR-Motorways, MCR-Primary Roads, MCR-Secondary Roads
Per 1000 Km² by Countries (End of 2016)



Benchmarking Analysis on Socio-Economic Indicators

MCR-Primary Roads, MCR-Secondary Roads Per 1000 Km² by Countries (End of 2016)



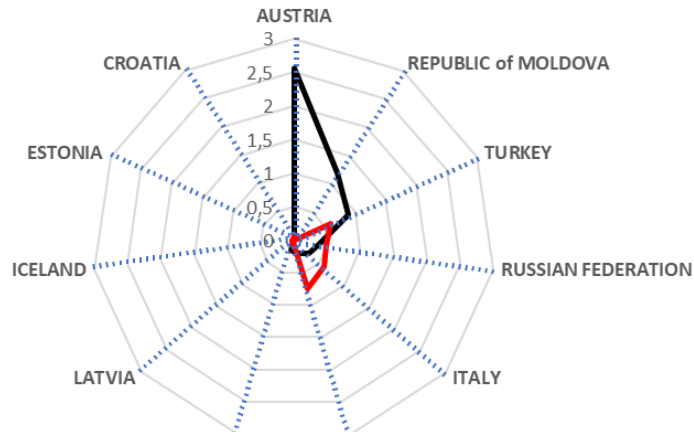
Benchmarking Analysis on Socio-Economic Indicators

Tables

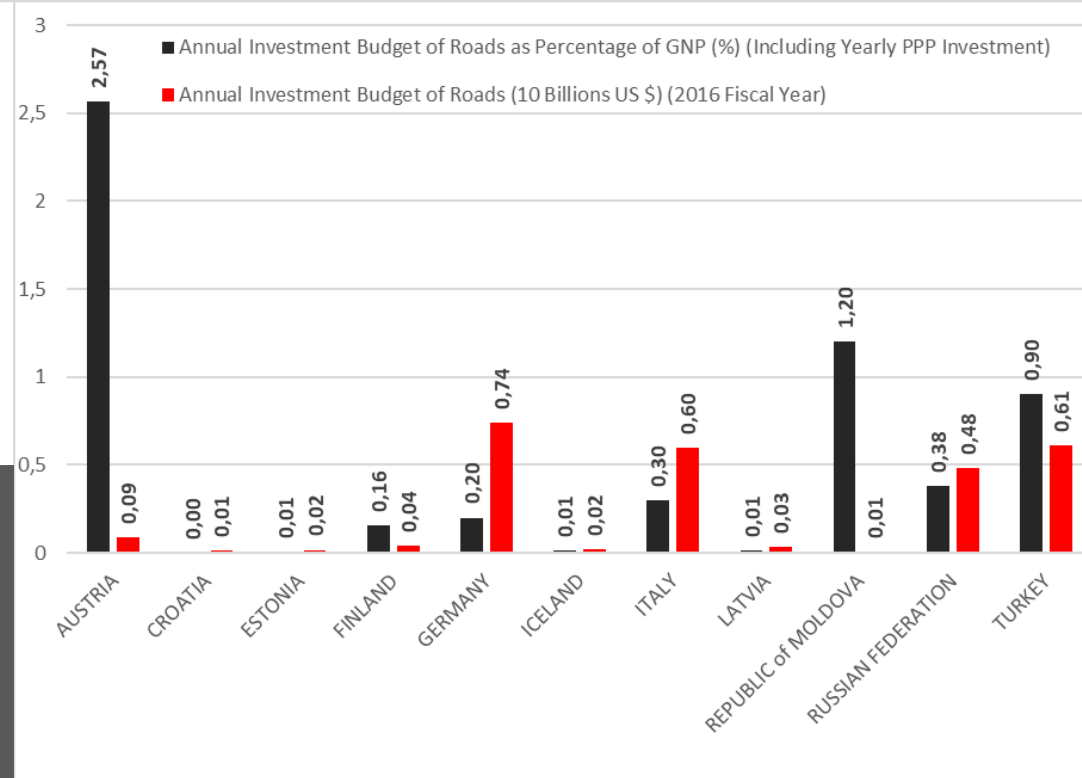
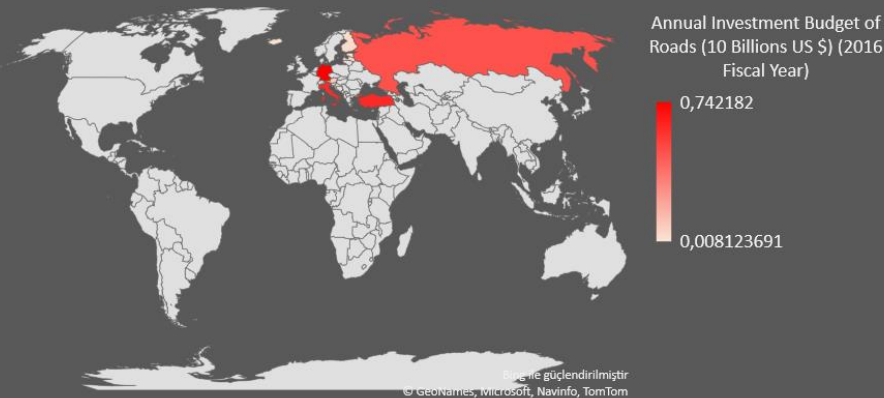
Radar Graphs

Bar Charts

Heat Maps



Annual Investment Budget of Roads (10 Billions US \$) (2016 Fiscal Year)



Annual Investment Budget of Roads by Countries (2016 Fiscal Year)

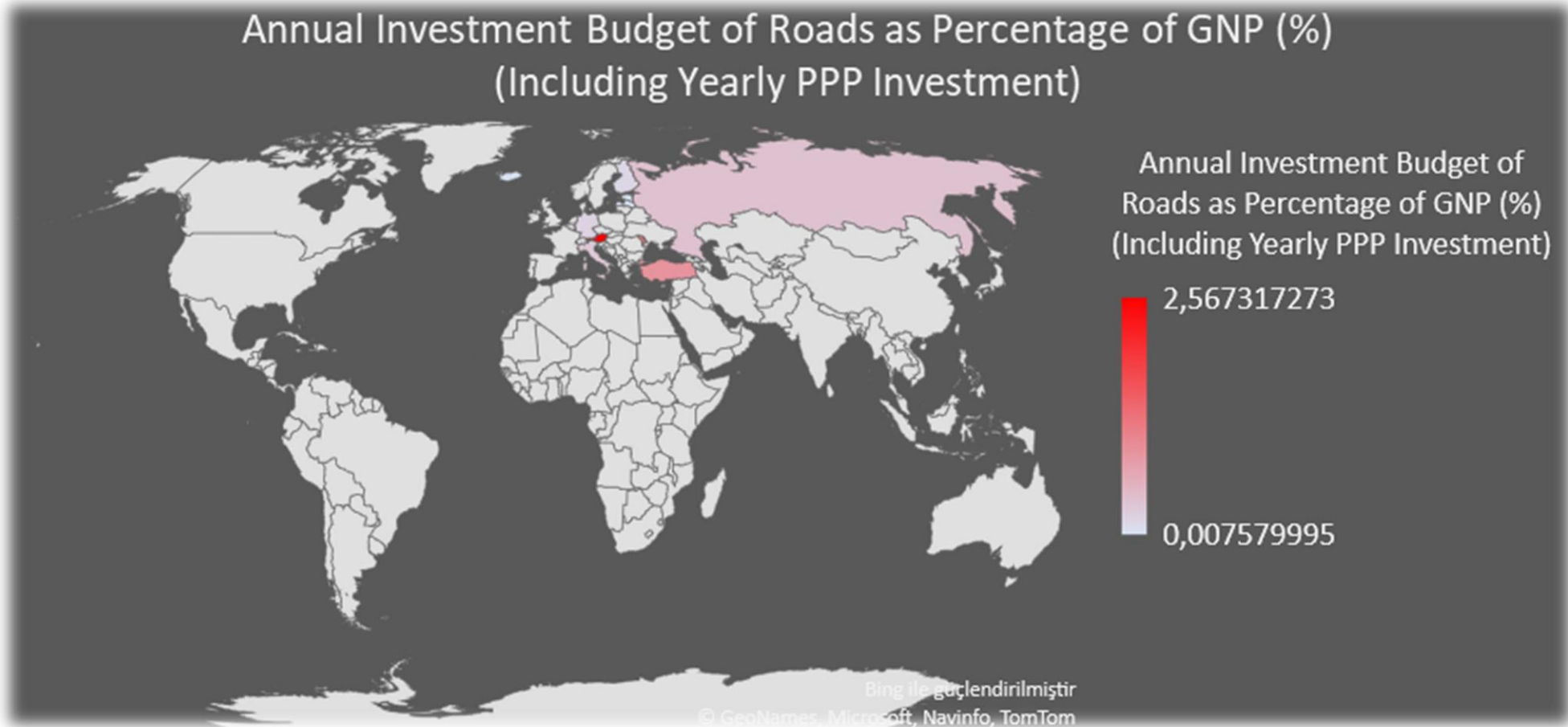


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Benchmarking Analysis on Socio-Economic Indicators



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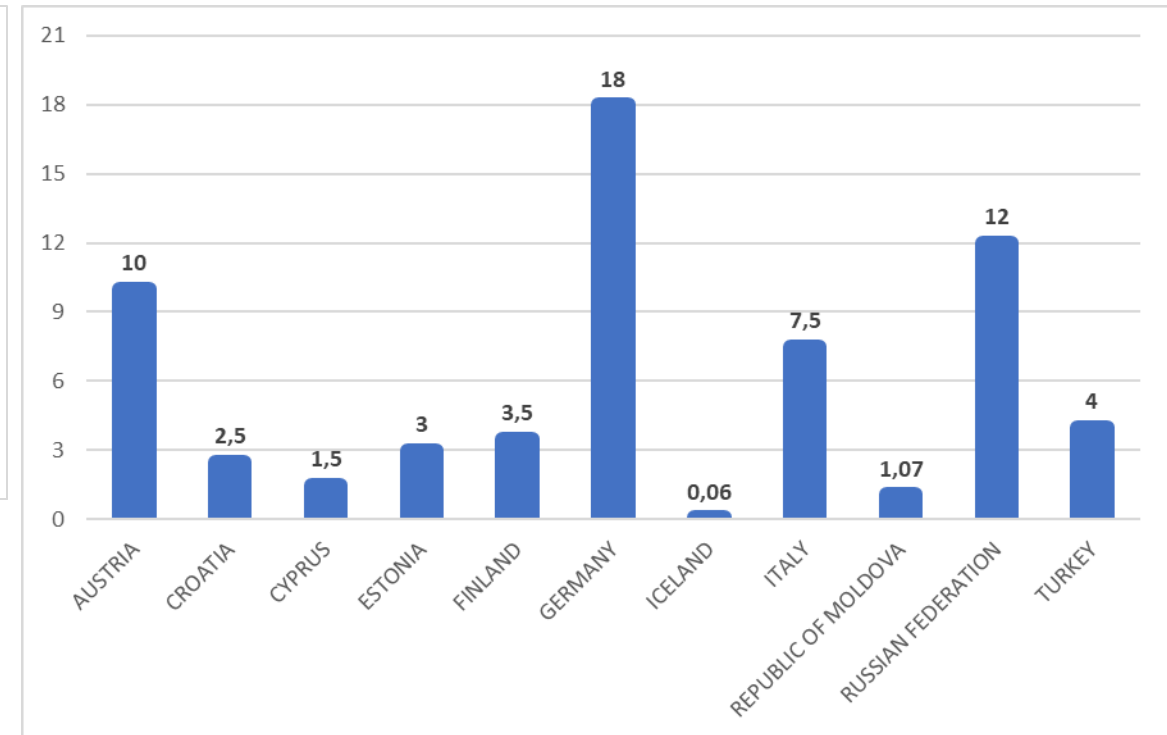
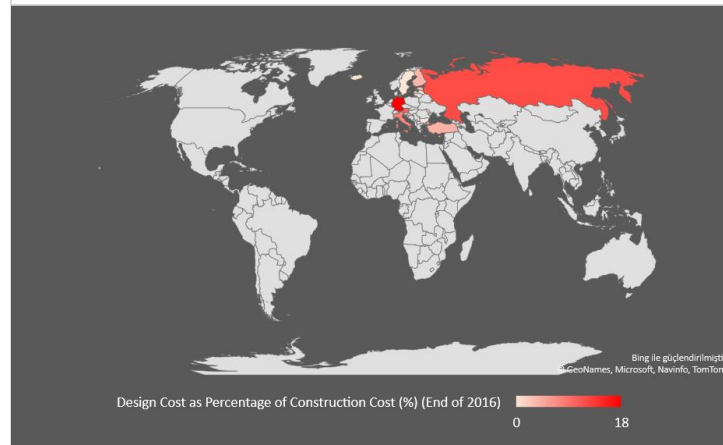
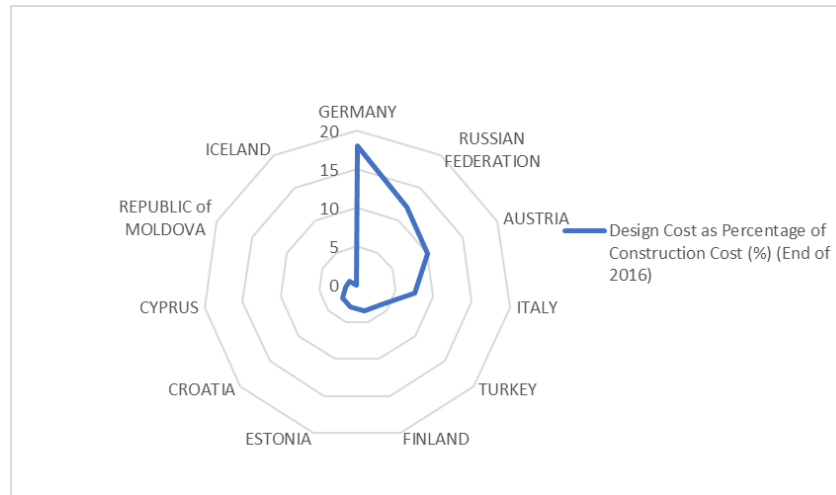
Benchmarking Analysis on Socio-Economic Indicators

Tables

Radar Graphs

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Heat Maps



Design Cost as Percentage of Construction Cost (%) by Countries (End of 2016)

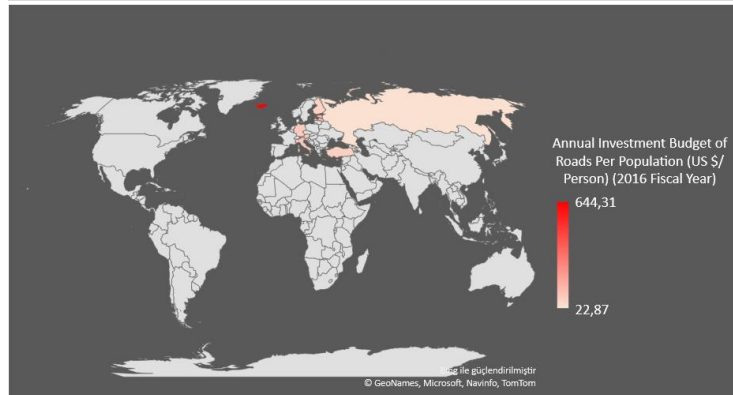
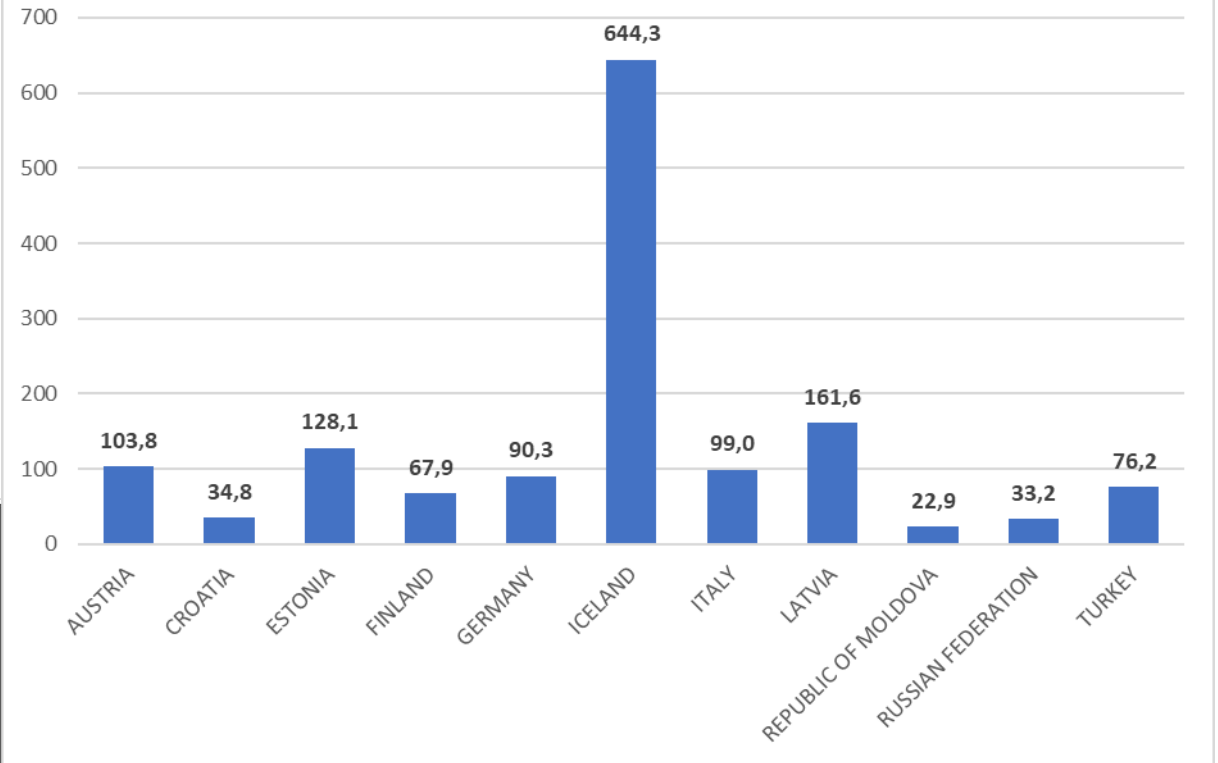
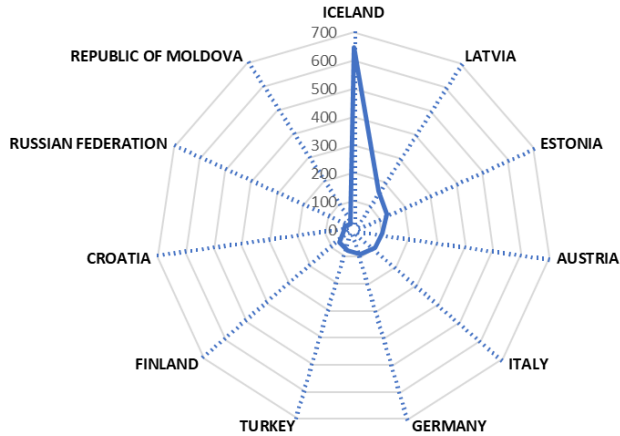
Benchmarking Analysis on Socio-Economic Indicators

Tables

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Bar Charts

Heat Maps



Annual Investment Budget of Roads Per Population (US \$/Person) (2016 Fiscal Year)

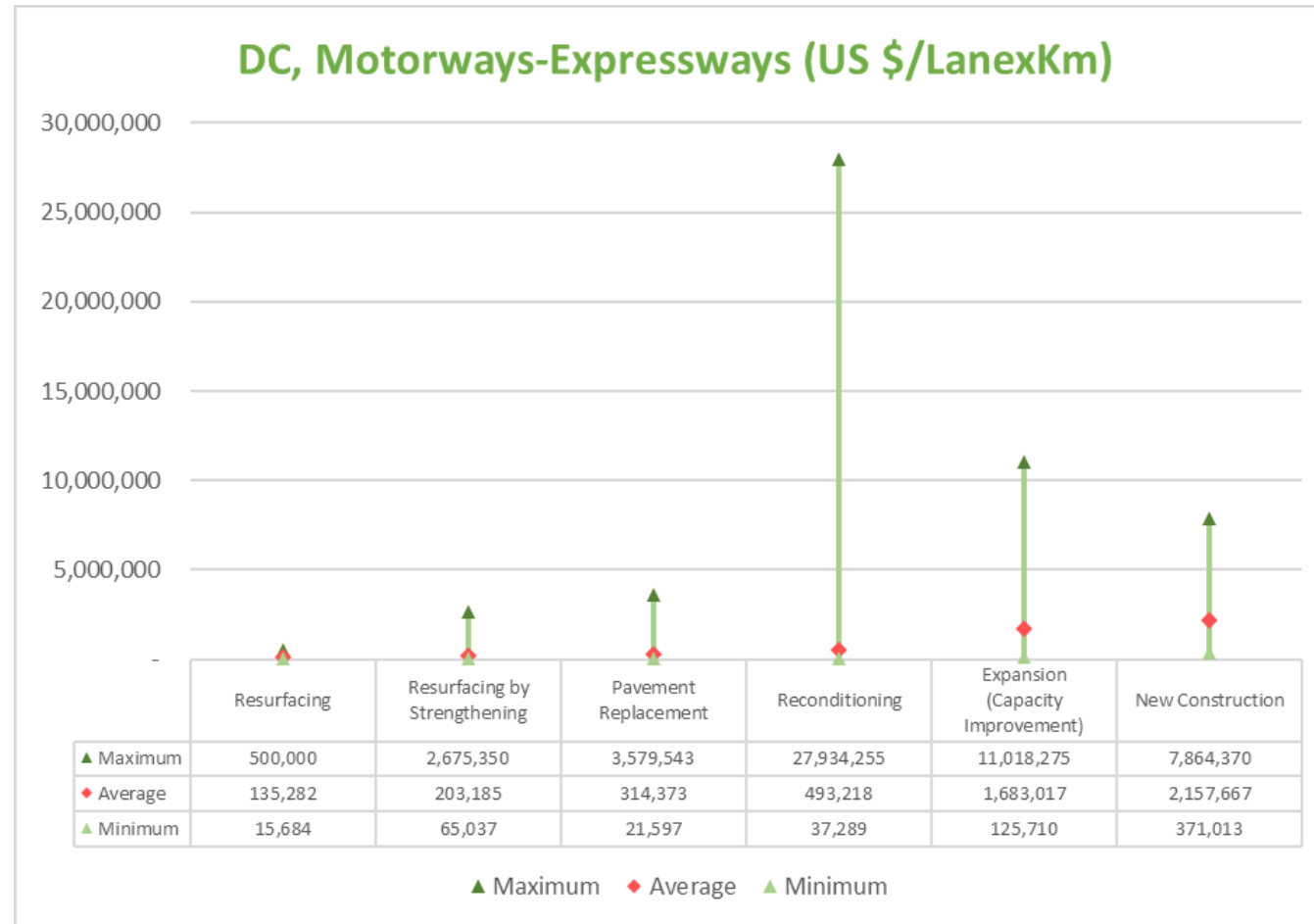


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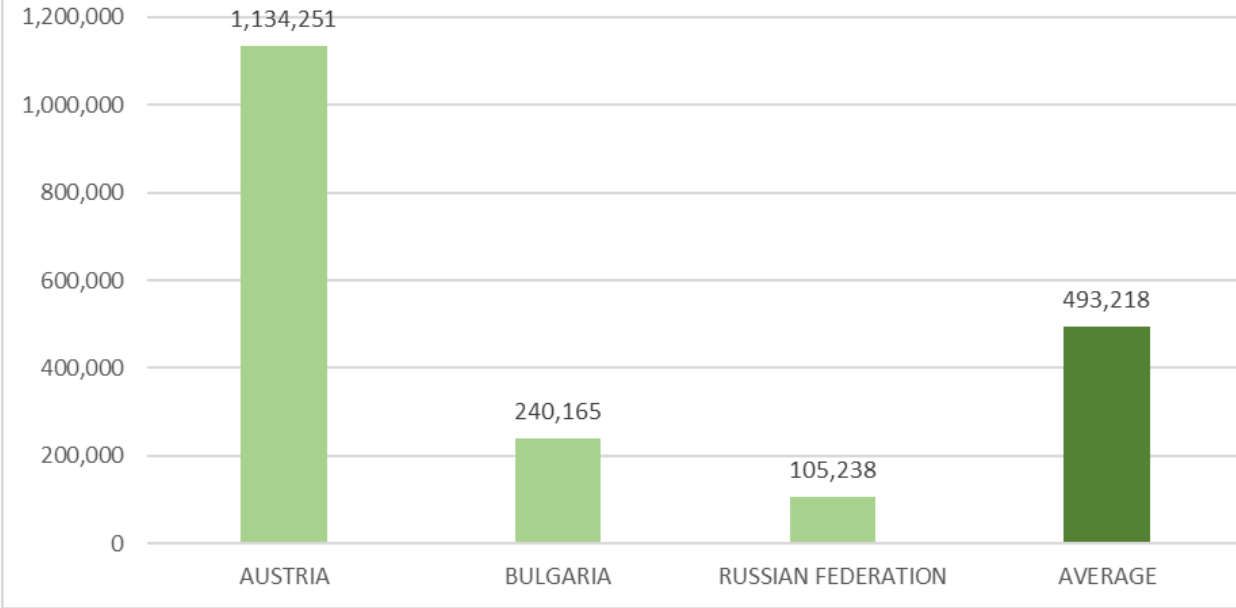
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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis For All Work Types

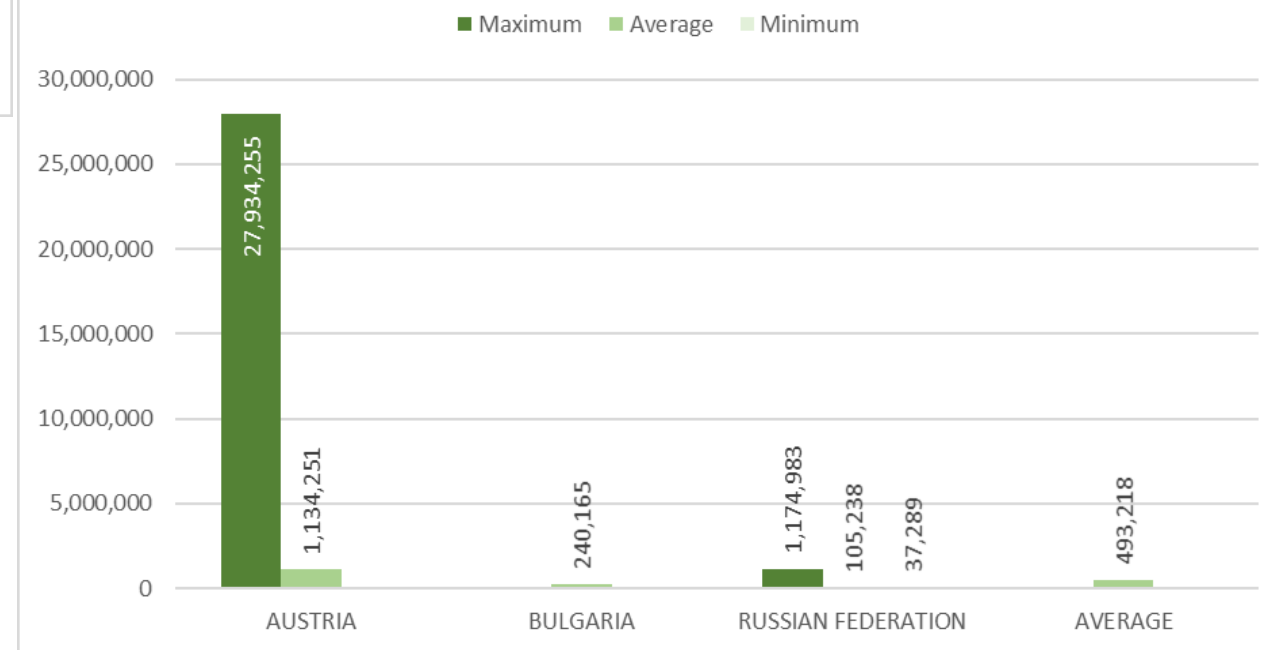


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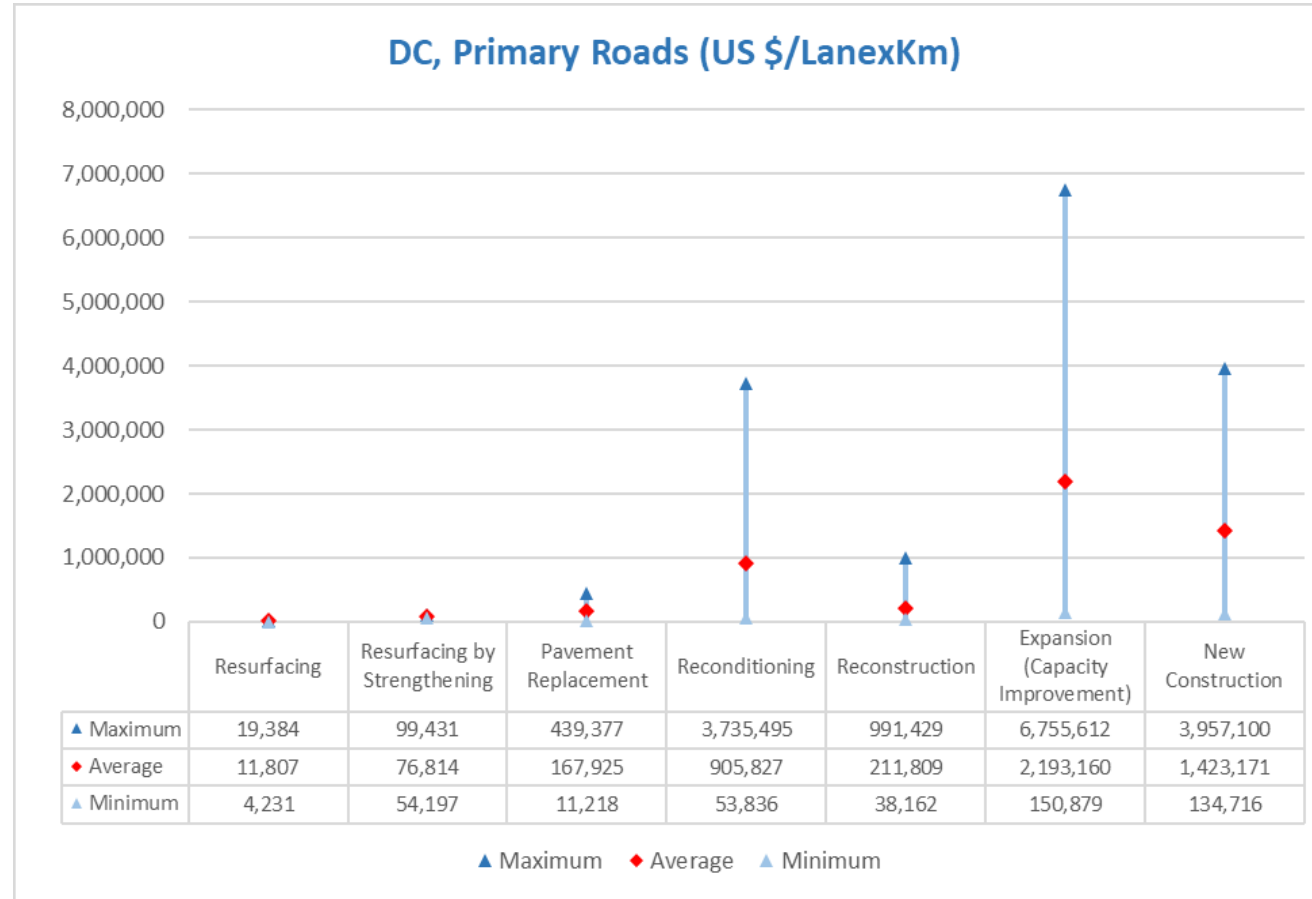
DC, Reconditioning, HCR Roads-Motorways (US \$/LanexKm)



DC, Reconditioning, HCR Roads-Motorways (US \$/LanexKm)



Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis For All Work Types

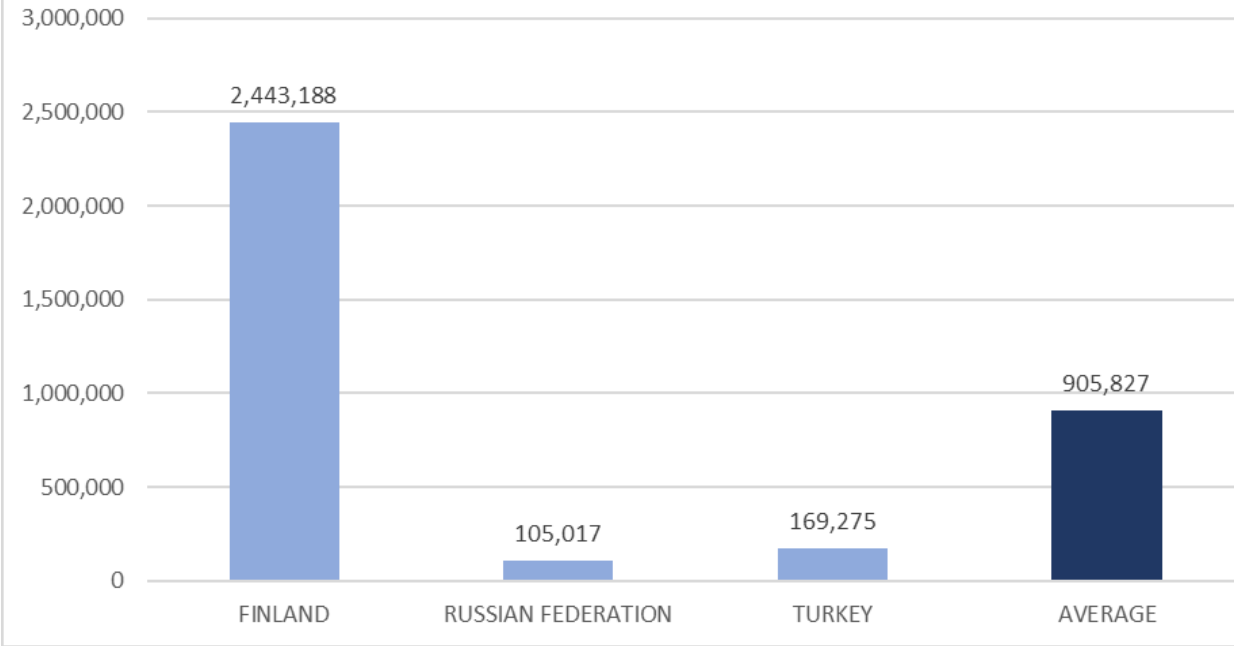


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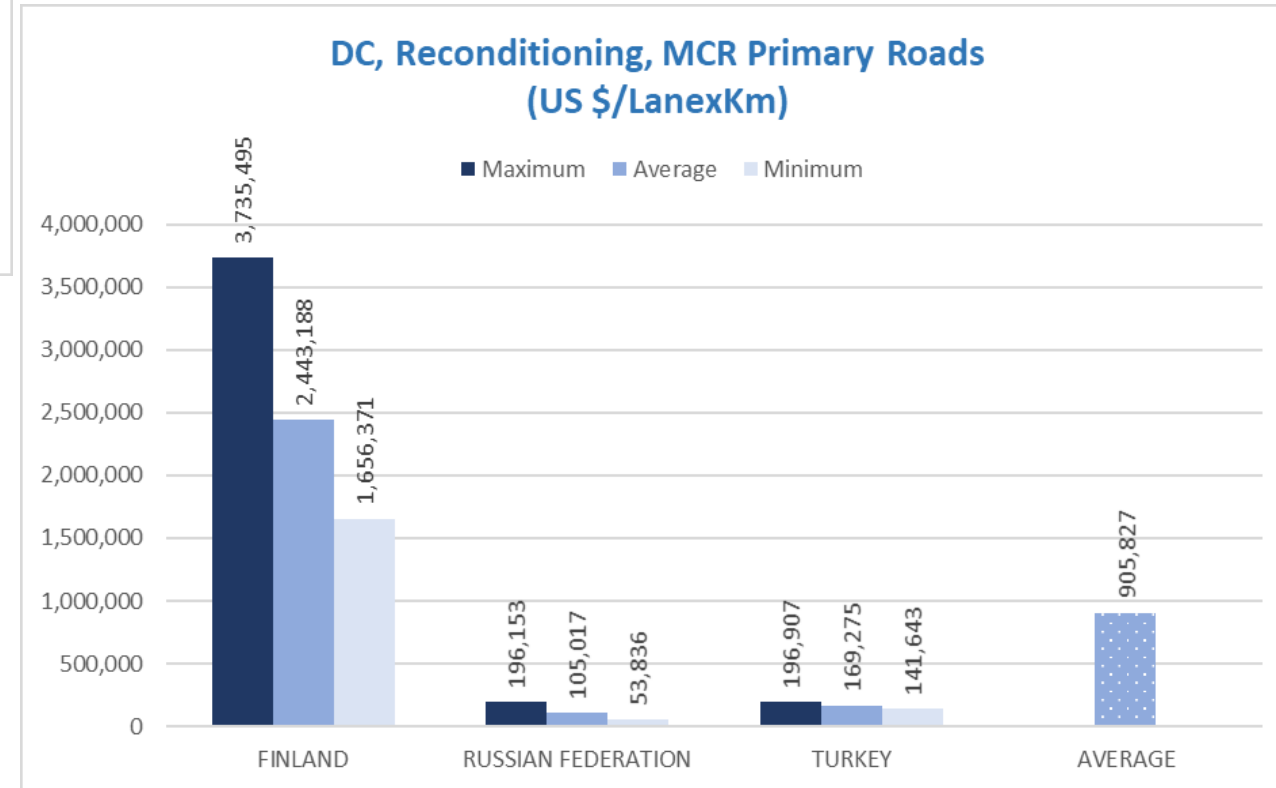


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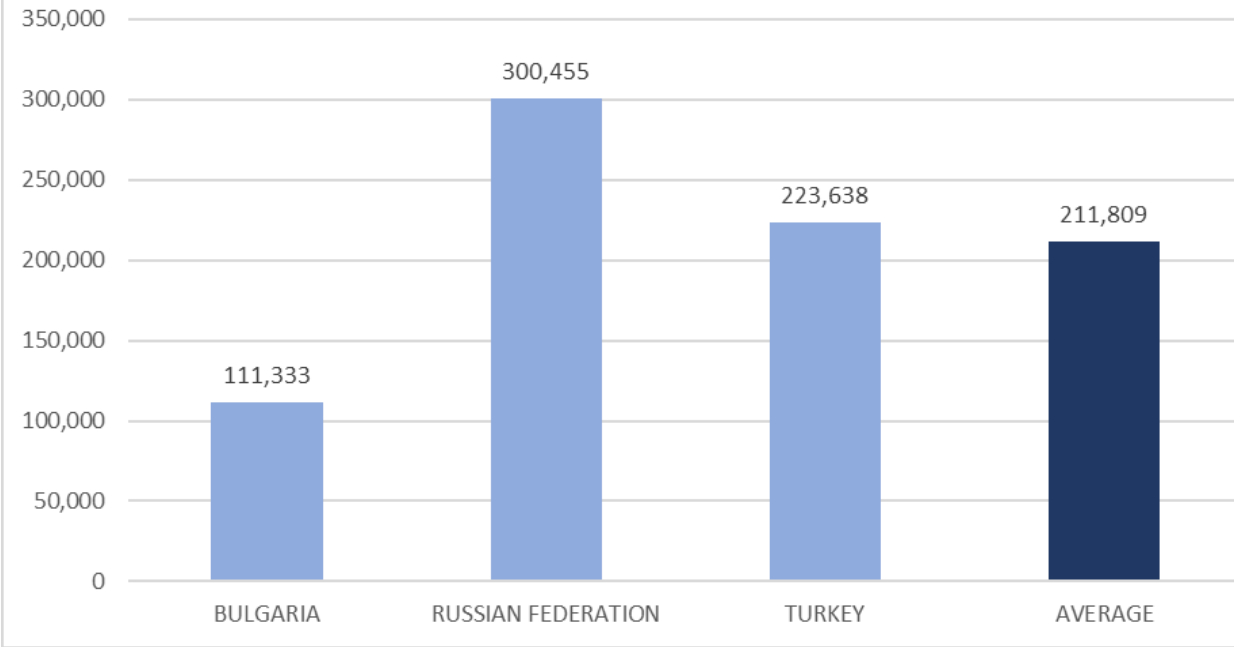
DC, Reconditioning, MCR Primary Roads (US \$/LanexKm)



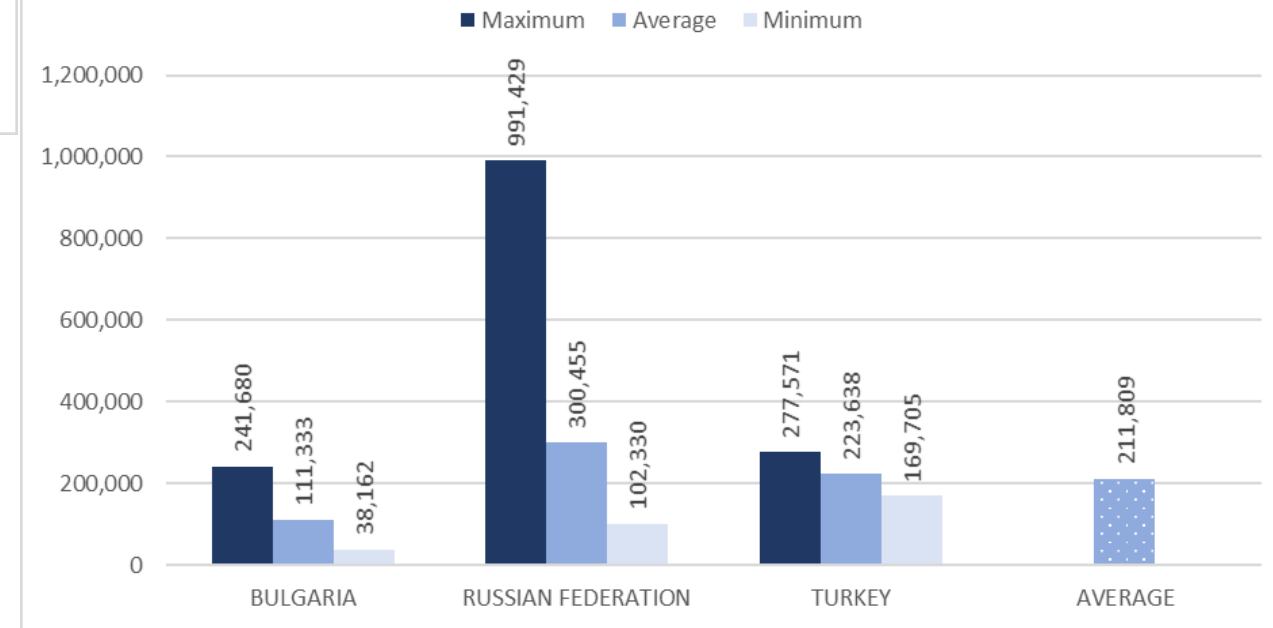
DC, Reconditioning, MCR Primary Roads (US \$/LanexKm)



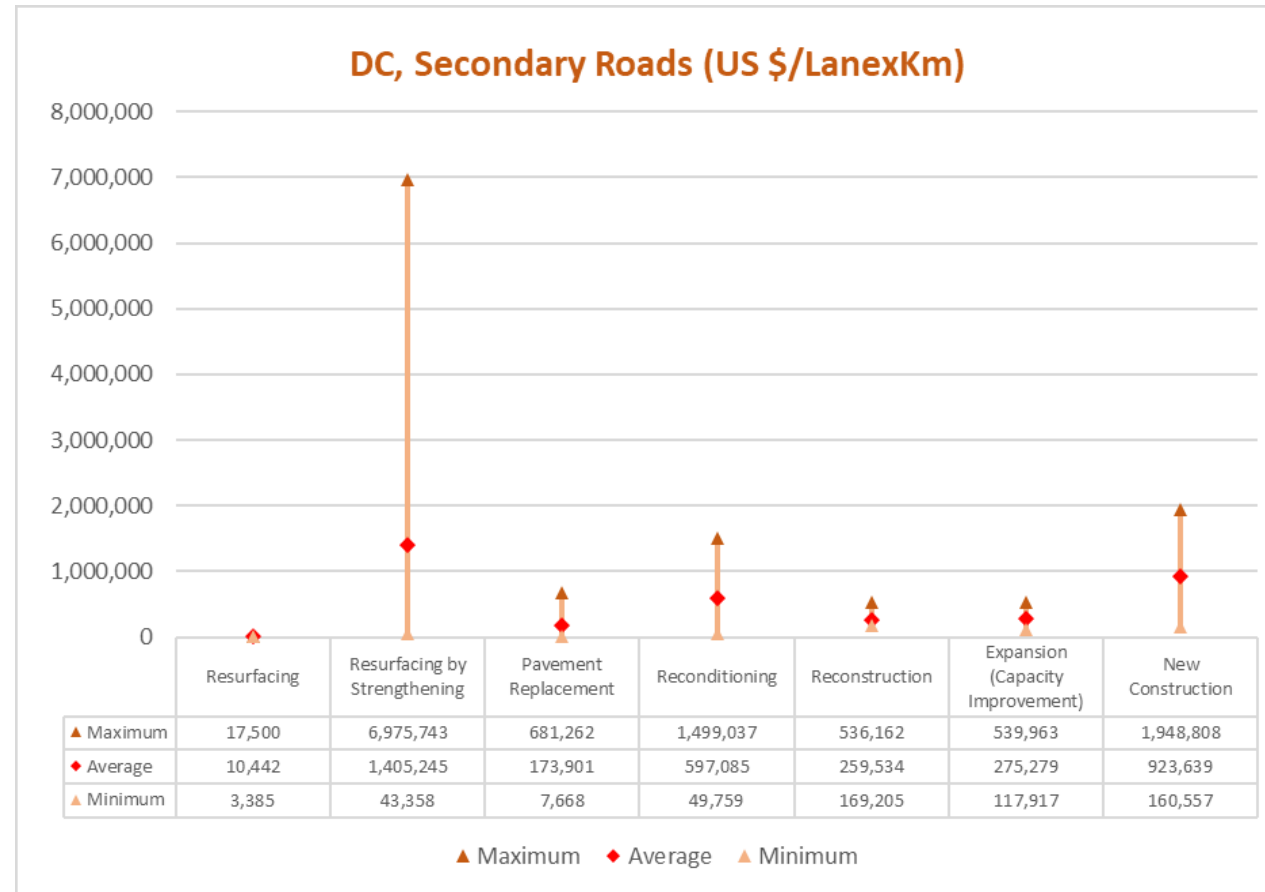
DC, Reconstruction, MCR Primary Roads (US \$/LanexKm)



DC, Reconstruction, MCR Primary Roads (US \$/LanexKm)

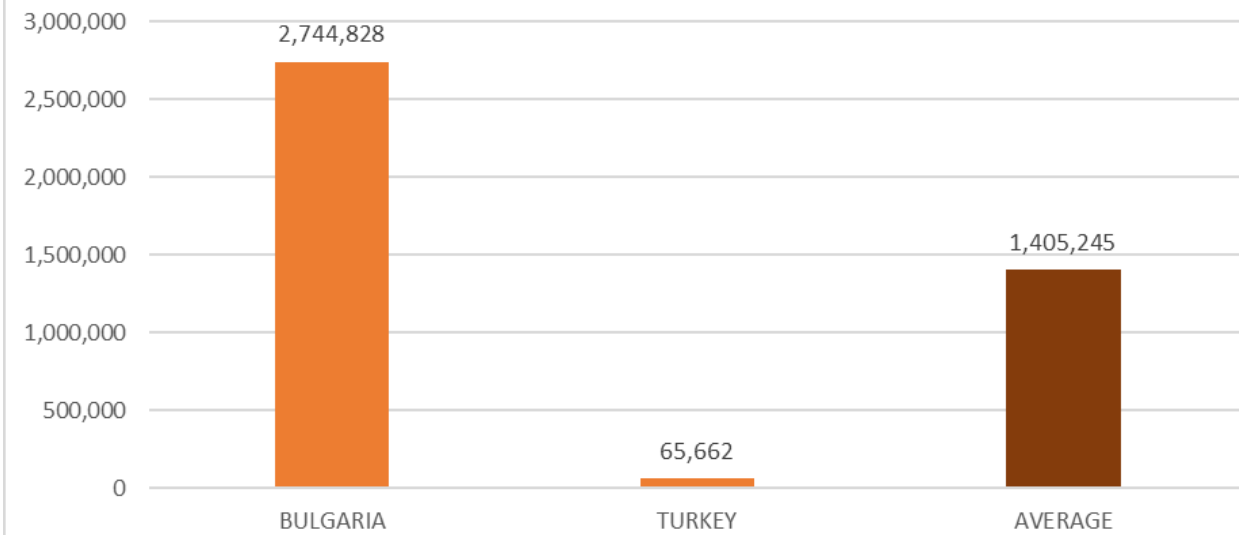


Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis For All Work Types

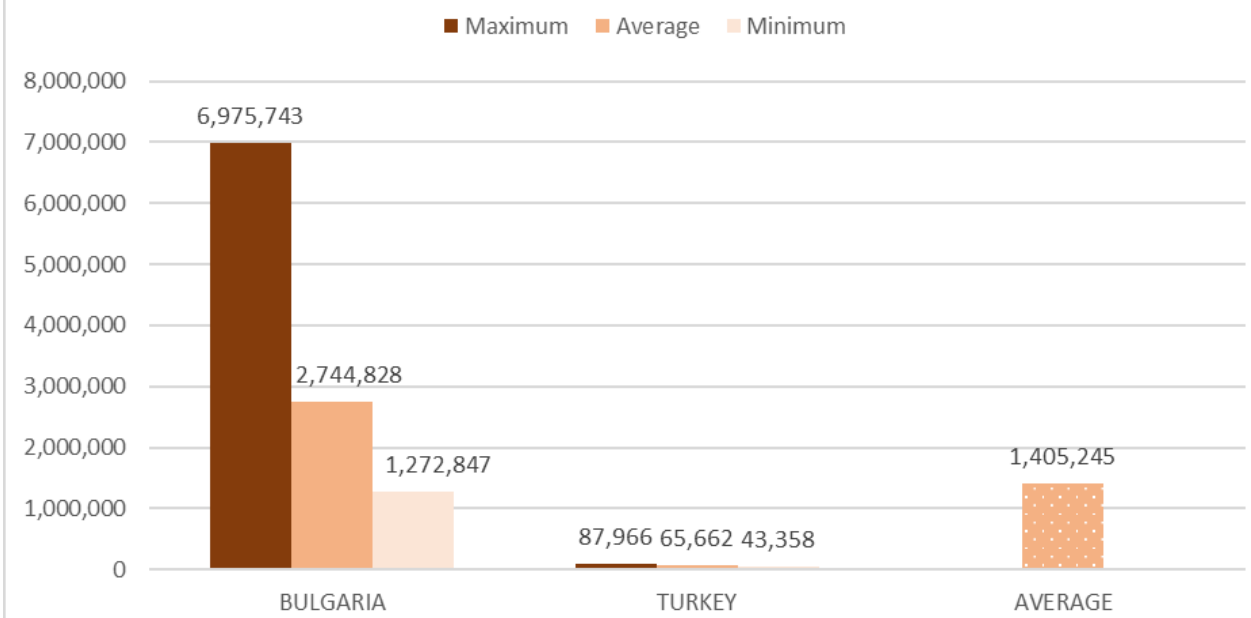


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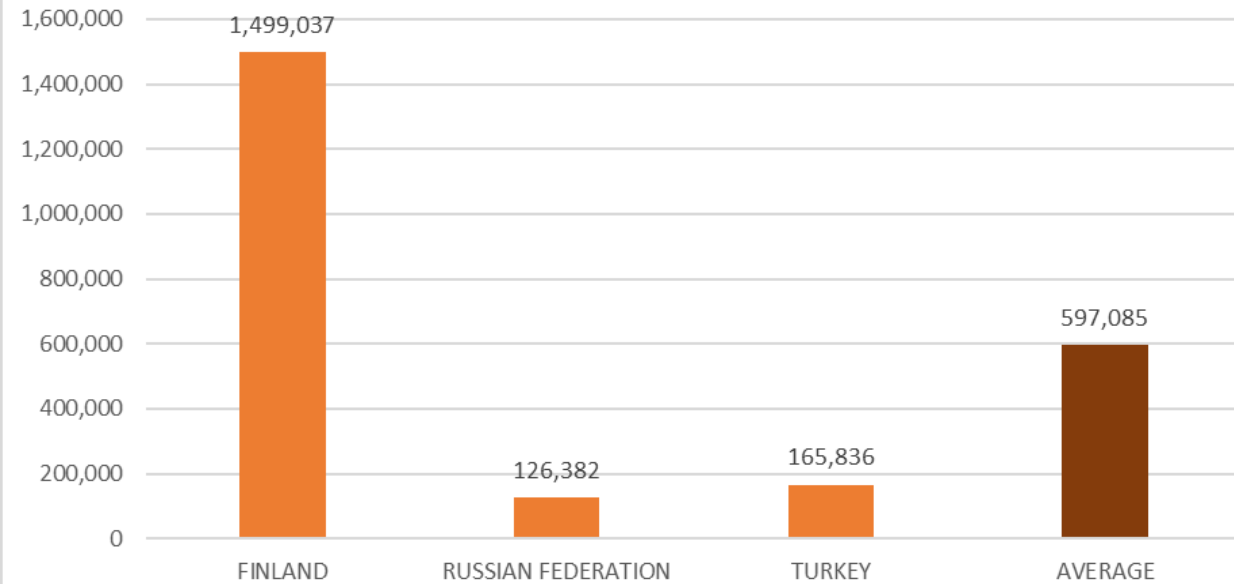
DC, Resurfacing by Strengthening, MCR Secondary Motorways Roads (US \$/LanexKm)



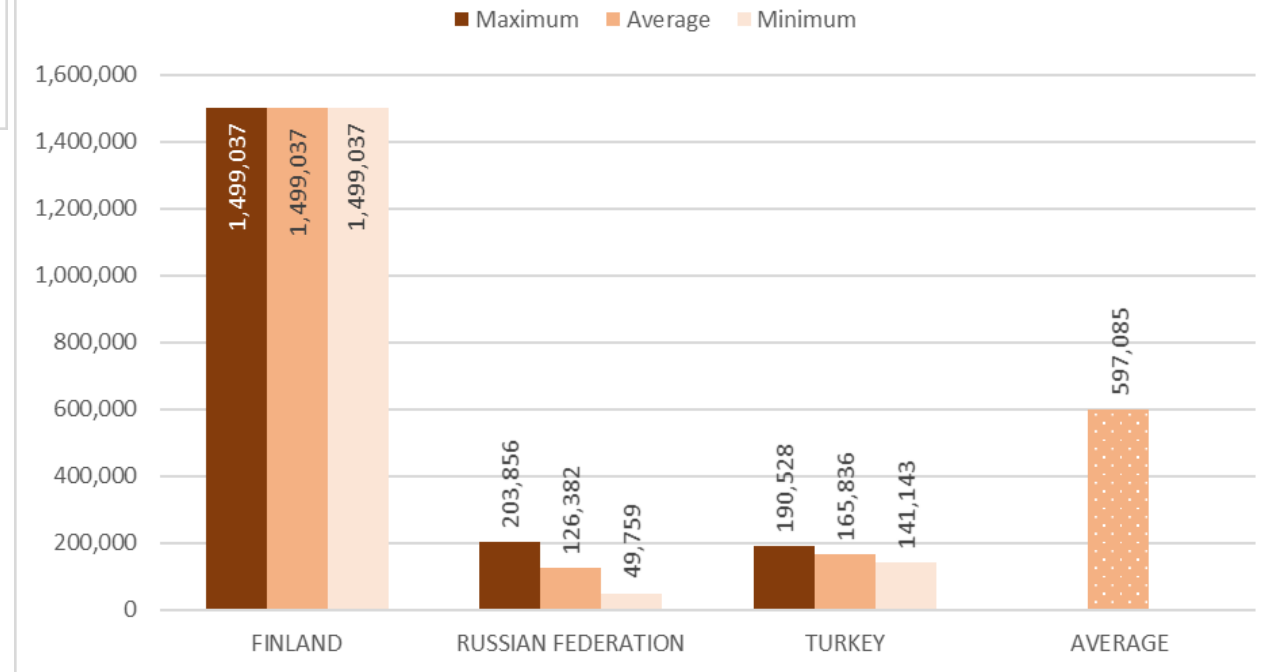
DC, Resurfacing by Strengthening, MCR Secondary Roads (US \$/LanexKm)



DC, Reconditioning, MCR Secondary Roads (US \$/LanexKm)



DC, Reconditioning, MCR Secondary Roads (US \$/LanexKm)



Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Benchmarking Double Carriageway High and Medium Classified Roads **Resurfacing Cost** (US \$/LanexKm) (2016 prices)

	Resurfacing														
	HCR_Motorways-Expressways					MCR_Primary Roads					MCR_Secondary Roads				
	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects
AUSTRIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BULGARIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CROATIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CYPRUS	240,000	210,000	180,000	65	20	-	-	-	-	-	-	-	-	-	-
ESTONIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FINLAND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ICELAND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ITALY	-	7,400	-	-	-	-	-	-	-	-	-	-	-	-	-
LATVIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REPUBLIC OF MOLDOVA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RUSSIAN FEDERATION	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SWEDEN	500,000	300,000	150,000	-	-	-	-	-	-	-	-	-	-	-	-
TURKEY	32,045	23,726	15,684	25	6	19,384	11,807	4,231	2,807	63	17,500	10,442	3,385	312	15

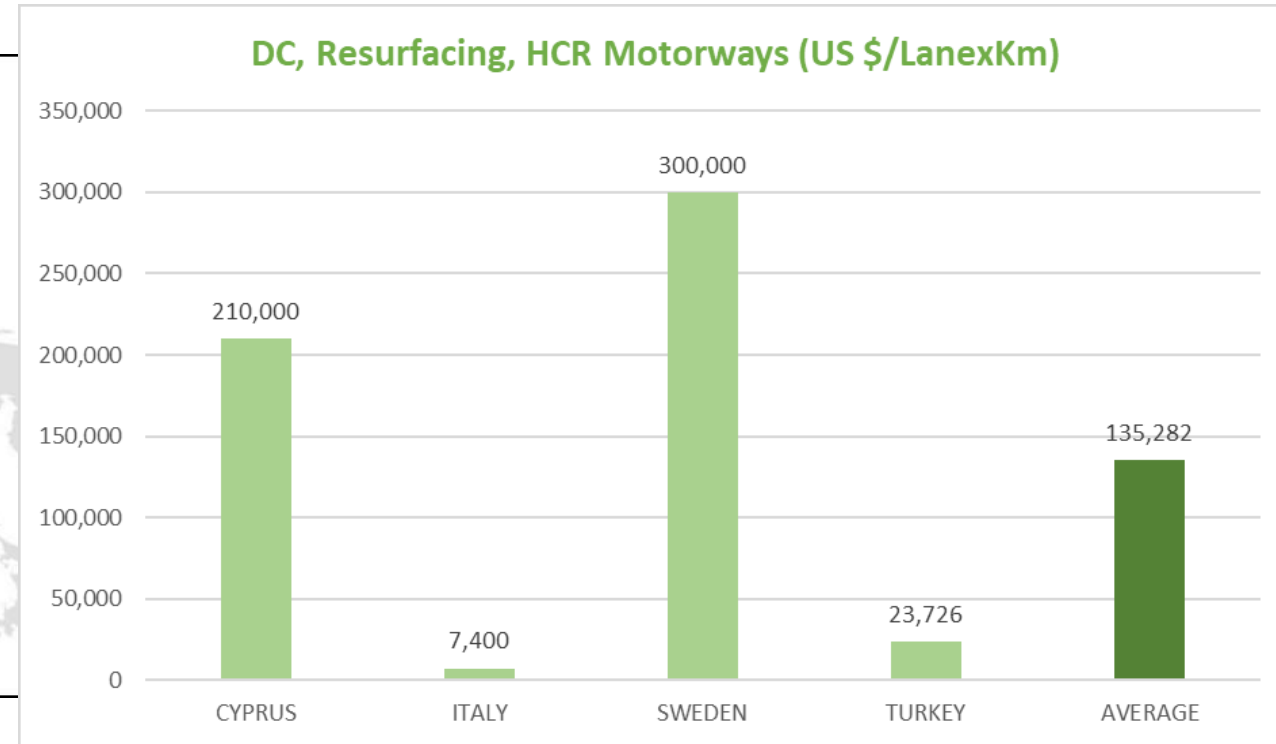


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Benchmarking Double Carriageway High Classified Roads Average **Resurfacing Costs**
(US \$/LanexKm) (2016 prices)



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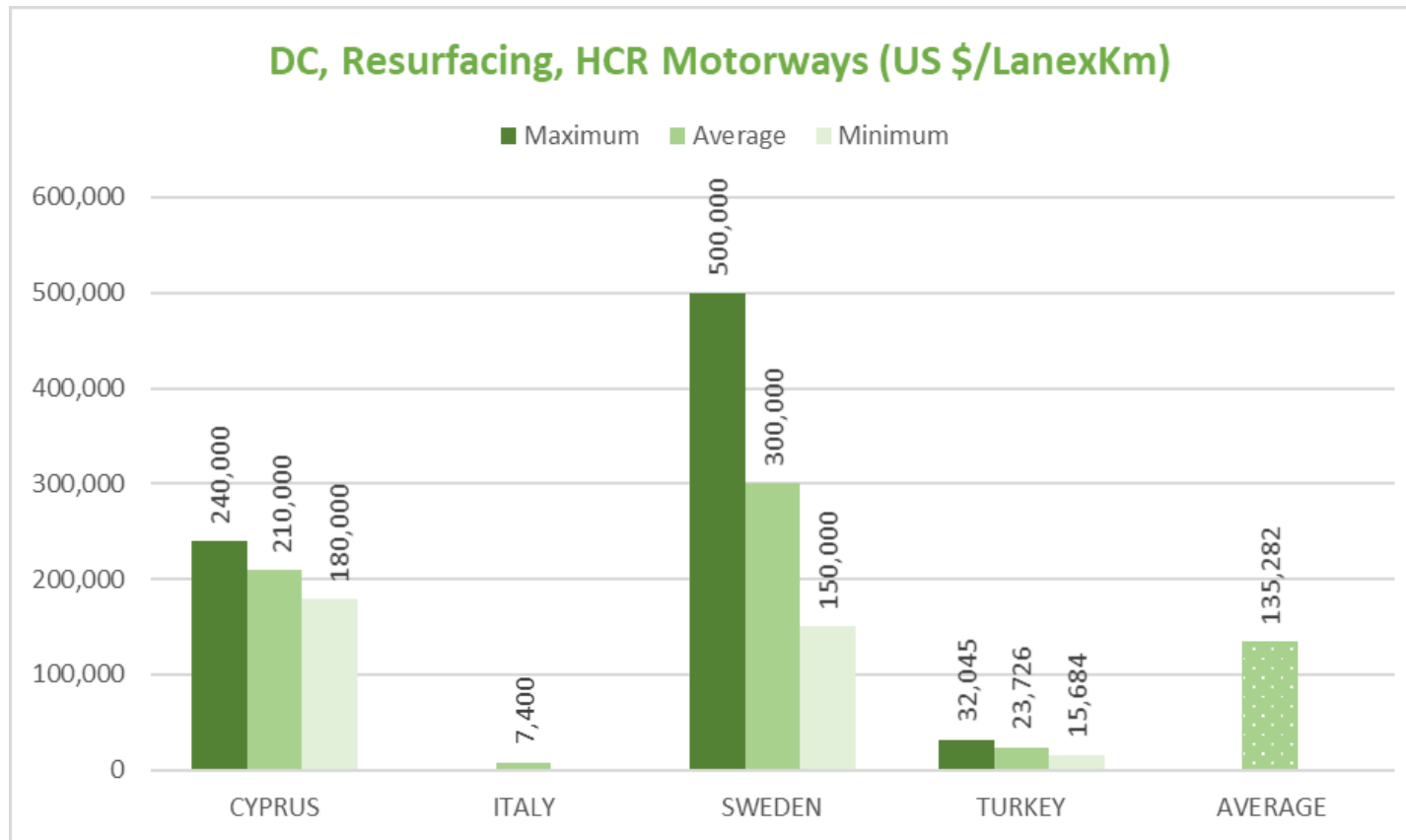


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Benchmarking Double Carriageway High Classified Roads **Resurfacing Costs** (US \$/LanexKm) (2016 prices)



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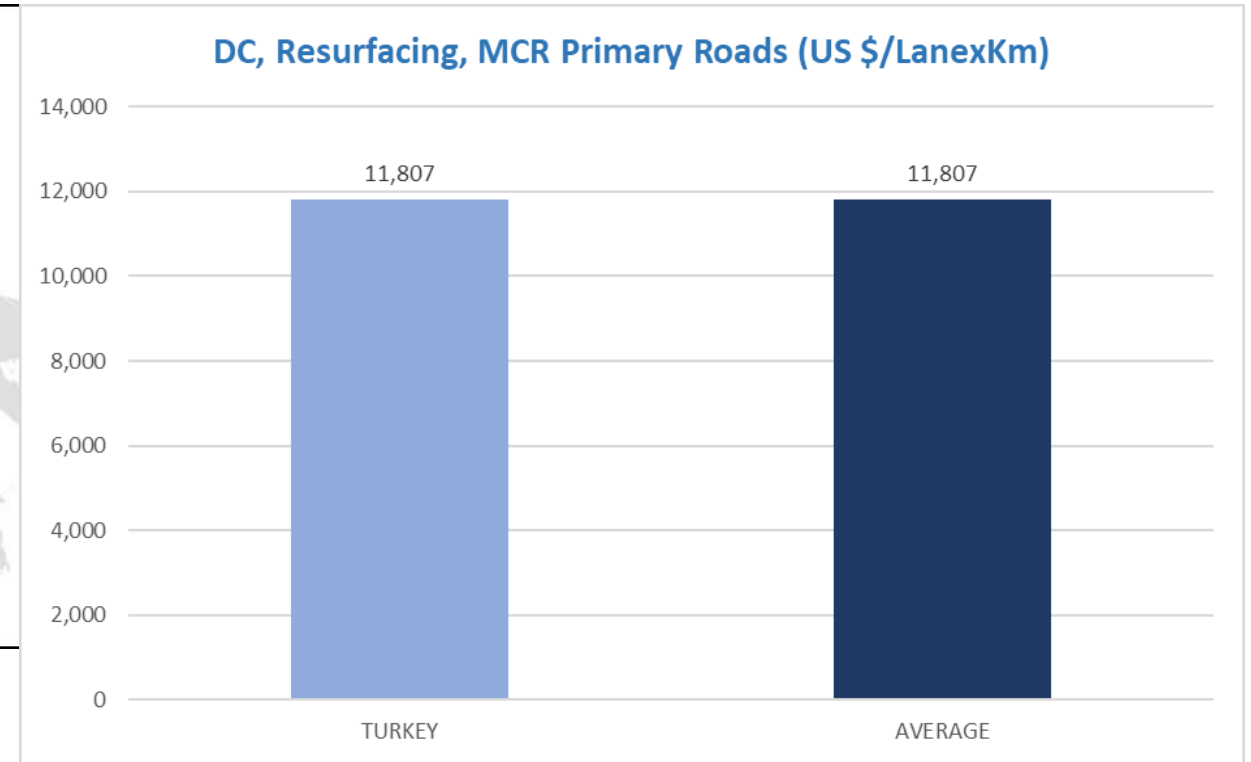


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Primary Roads Average
Resurfacing Costs by Countries (US \$/LanexKm) (2016 prices)



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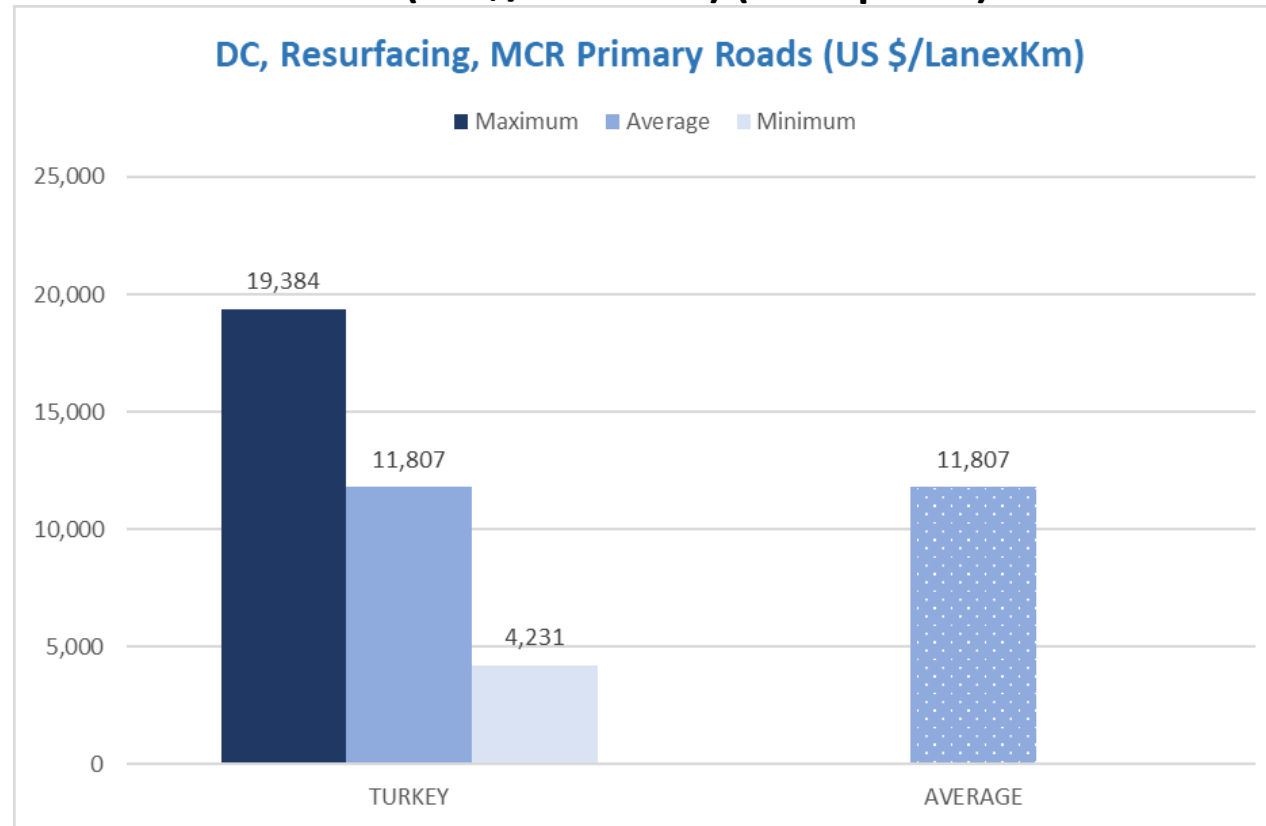


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Primary Roads **Resurfacing Costs** by Countries
(US \$/LanexKm) (2016 prices)



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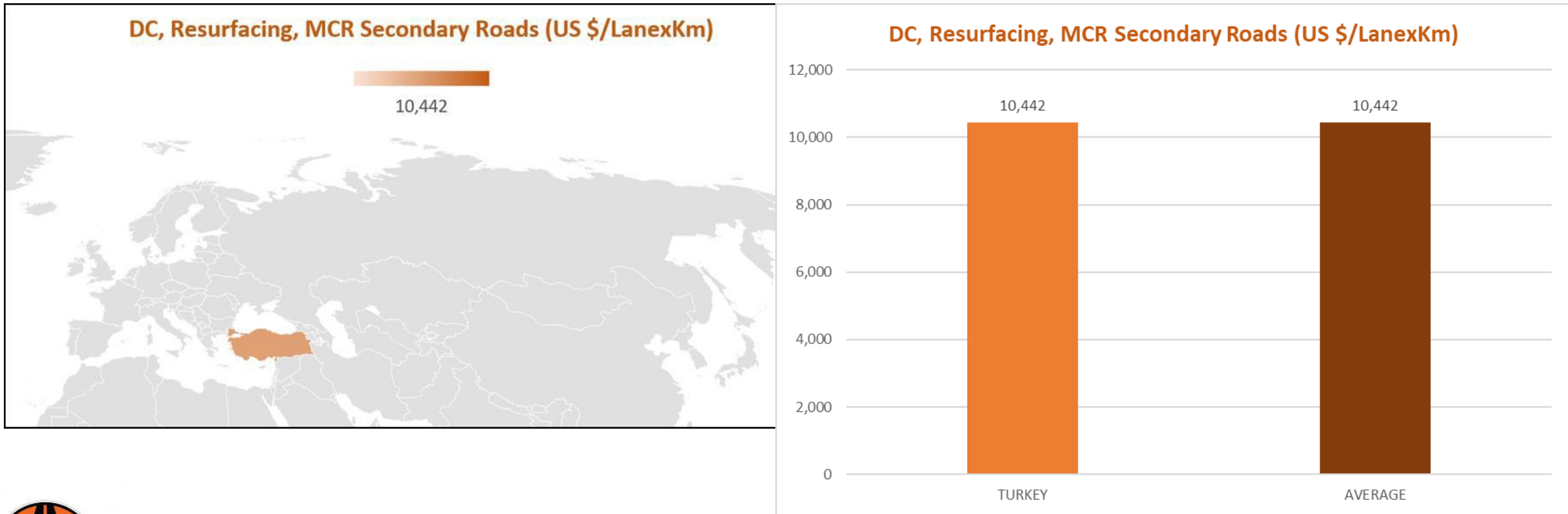


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Secondary Roads Average **Resurfacing Costs** by Countries
(US \$/LanexKm) (2016 prices)

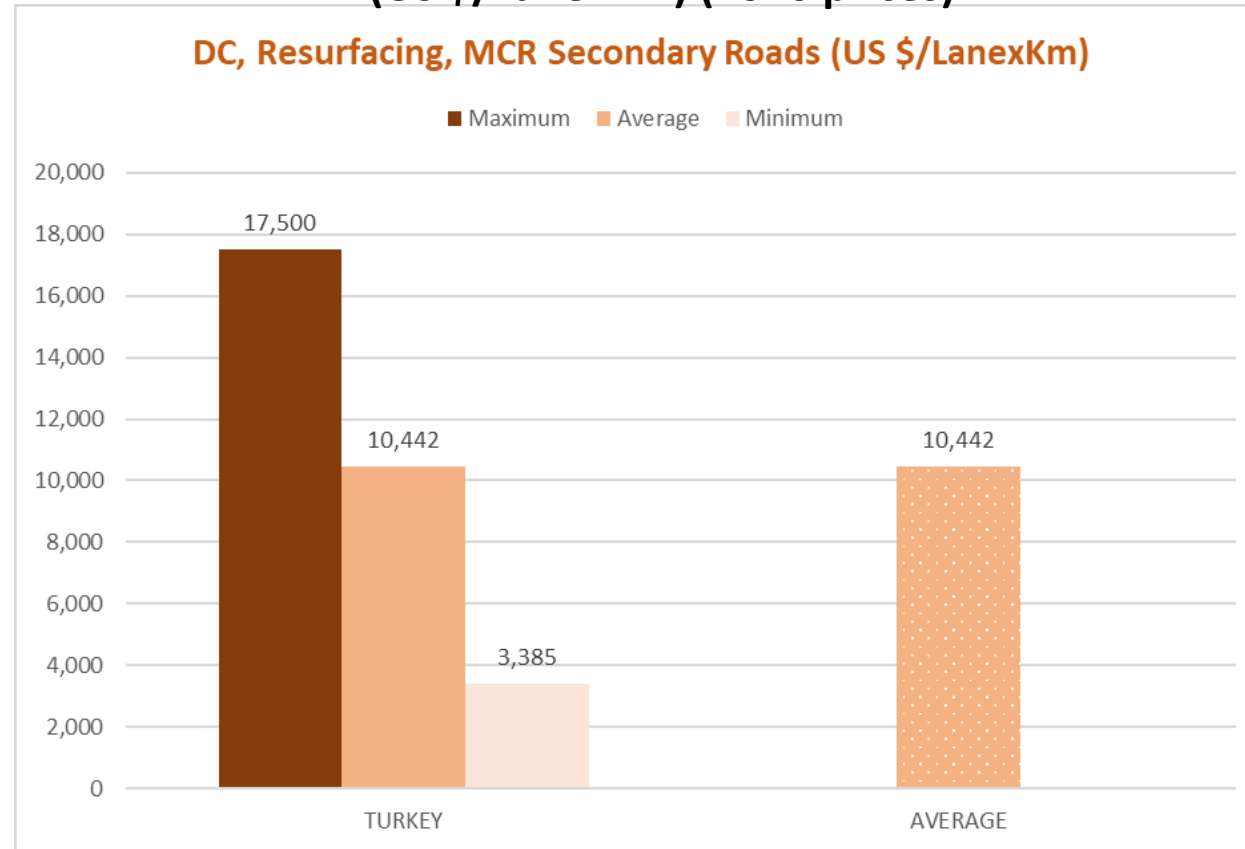


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Secondary Roads **Resurfacing Costs** by Countries
(US \$/LanexKm) (2016 prices)



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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Benchmarking Double Carriageway High and Medium Classified Roads **New Construction Costs** (US \$/LanexKm)
(2016 prices)

	New Construction														
	HCR_Motorways-Expressways					MCR_Primary Roads					MCR_Secondary Roads				
	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects
AUSTRIA	7.864.370	2.683.414	-	112	16	-	-	-	-	-	-	-	-	-	-
BULGARIA	2.771.119	1.869.746	1.066.128	275	5	-	-	-	-	-	-	1.948.808	-	3	1
CROATIA	5.554.700	2.842.500	1.719.200	150	9	3.957.100	2.739.000	1.520.800	19	2	-	-	-	-	-
CYPRUS	-	3.750.000	-	20	2	-	-	-	-	-	-	-	-	-	-
ESTONIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FINLAND	3.440.588	1.934.901	429.214	23	2	1.785.751	1.785.751	1.785.751	19	1	-	-	-	-	-
ICELAND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ITALY	-	650.000	-	-	-	-	-	-	-	-	-	-	-	-	-
LATVIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REPUBLIC OF MOLDOVA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RUSSIAN FEDERATION	2.225.891	846.862	701.277	74	6	991.429	523.355	134.716	37	8	530.187	530.187	530.187	0	1
SWEDEN	6.000.000	4.000.000	3.000.000	-	-	-	-	-	-	-	-	-	-	-	-
TURKEY	1.696.339	841.578	371.013	613	11	1.310.338	644.577	216.472	180	6	443.721	291.922	160.557	30	3

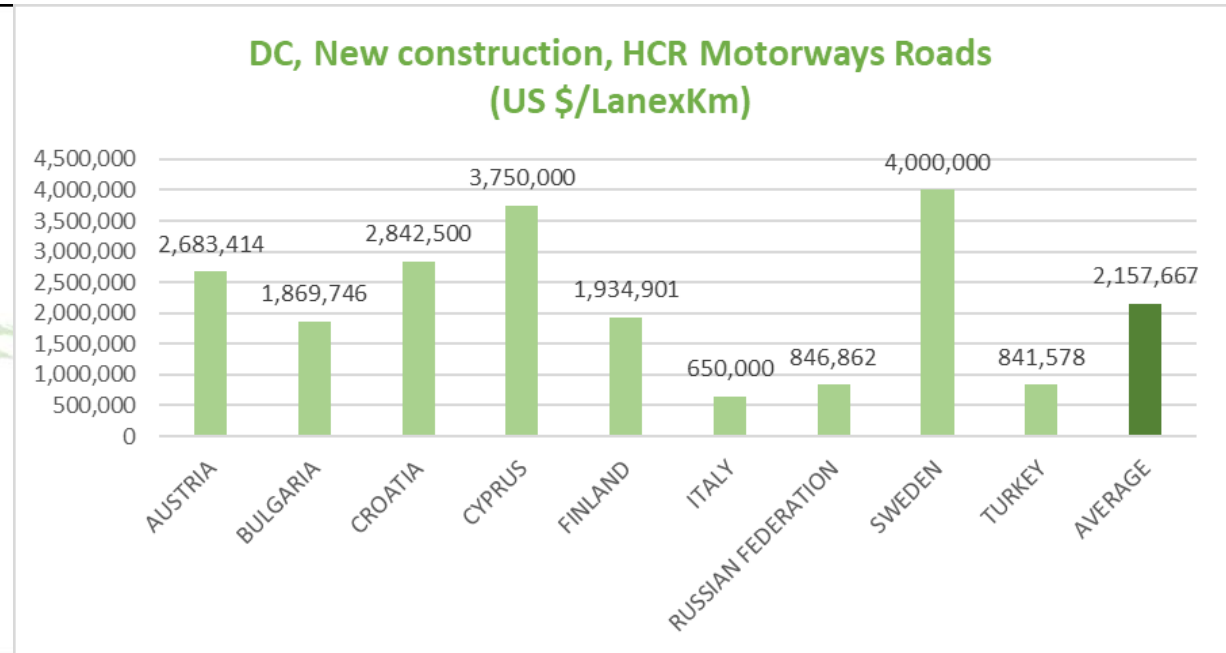


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Benchmarking Double Carriageway High Classified Roads Average **New Construction Costs**
(US \$/LanexKm) (2016 prices)

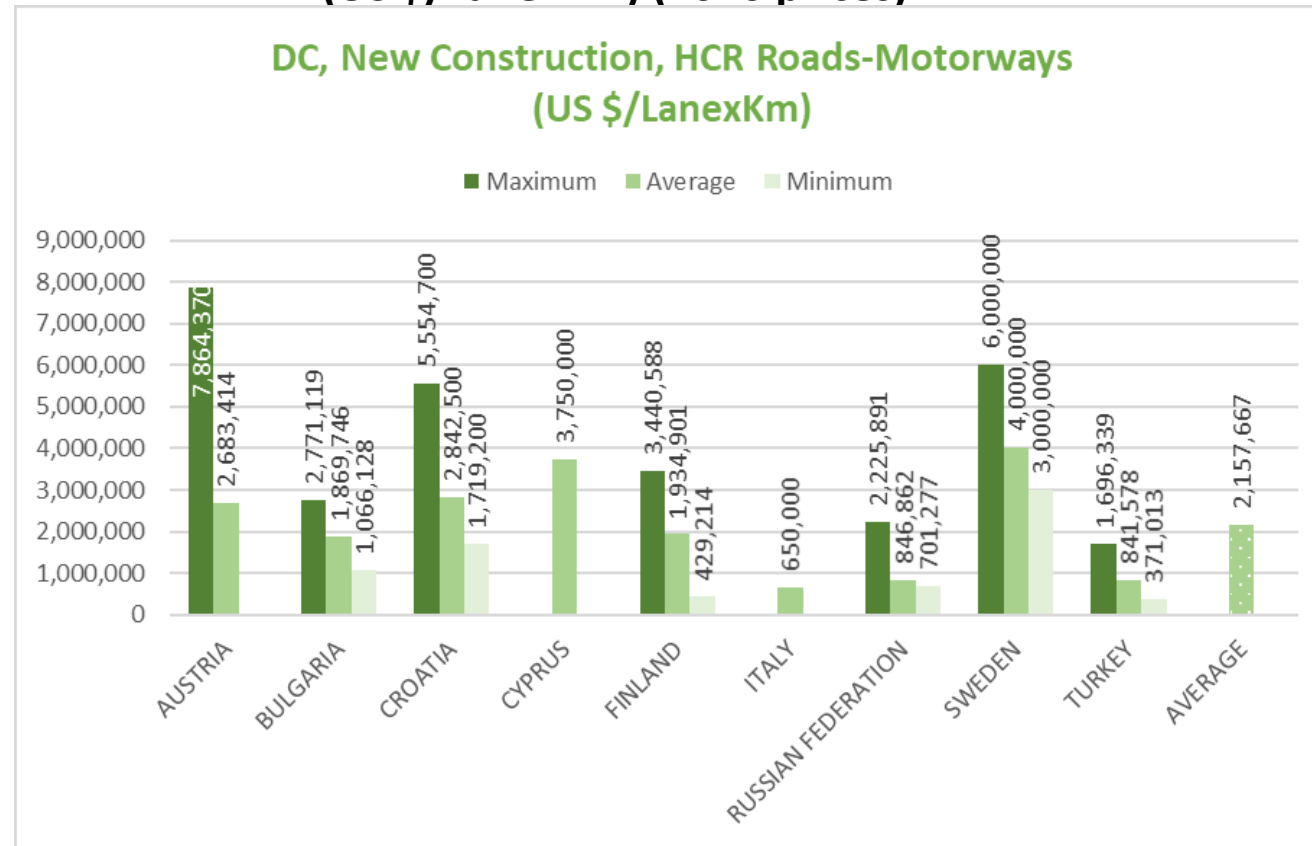


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Benchmarking Double Carriageway High Classified Roads **New Construction Costs**
(US \$/LanexKm) (2016 prices)



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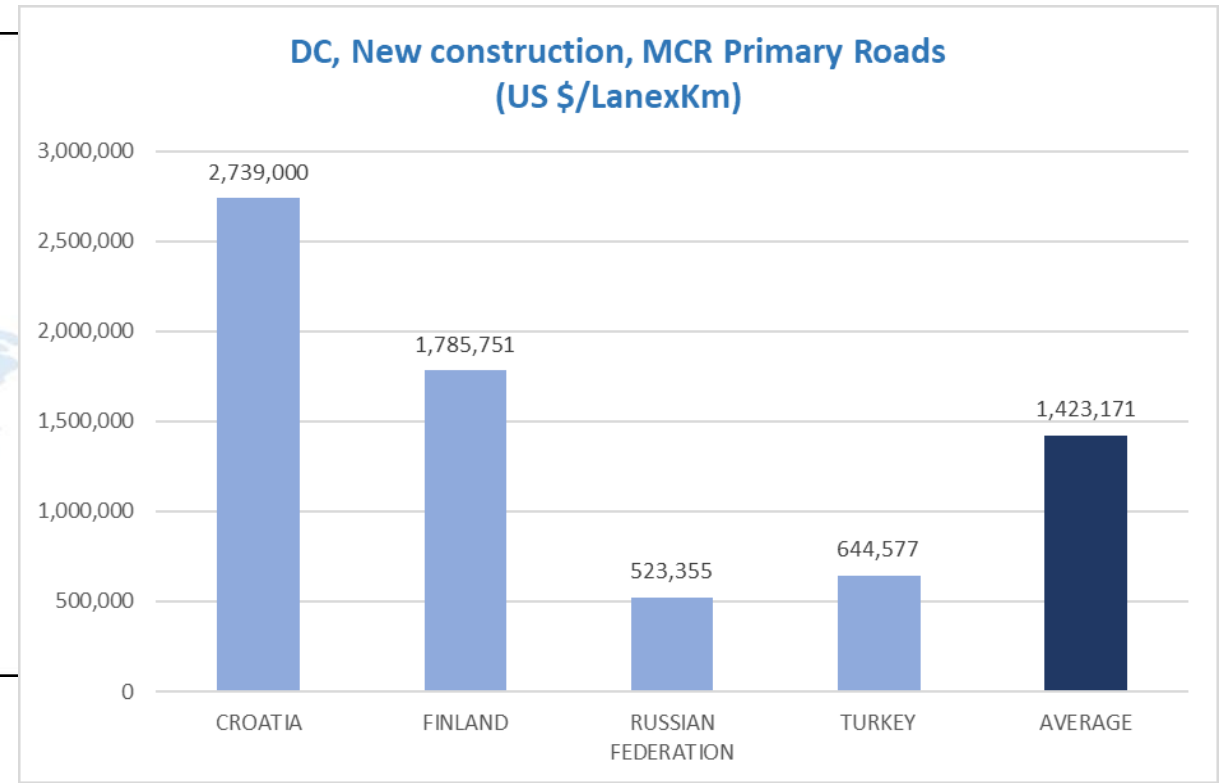


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Primary Roads Average **New Construction Costs** by Countries
(US \$/LanexKm) (2016 prices)

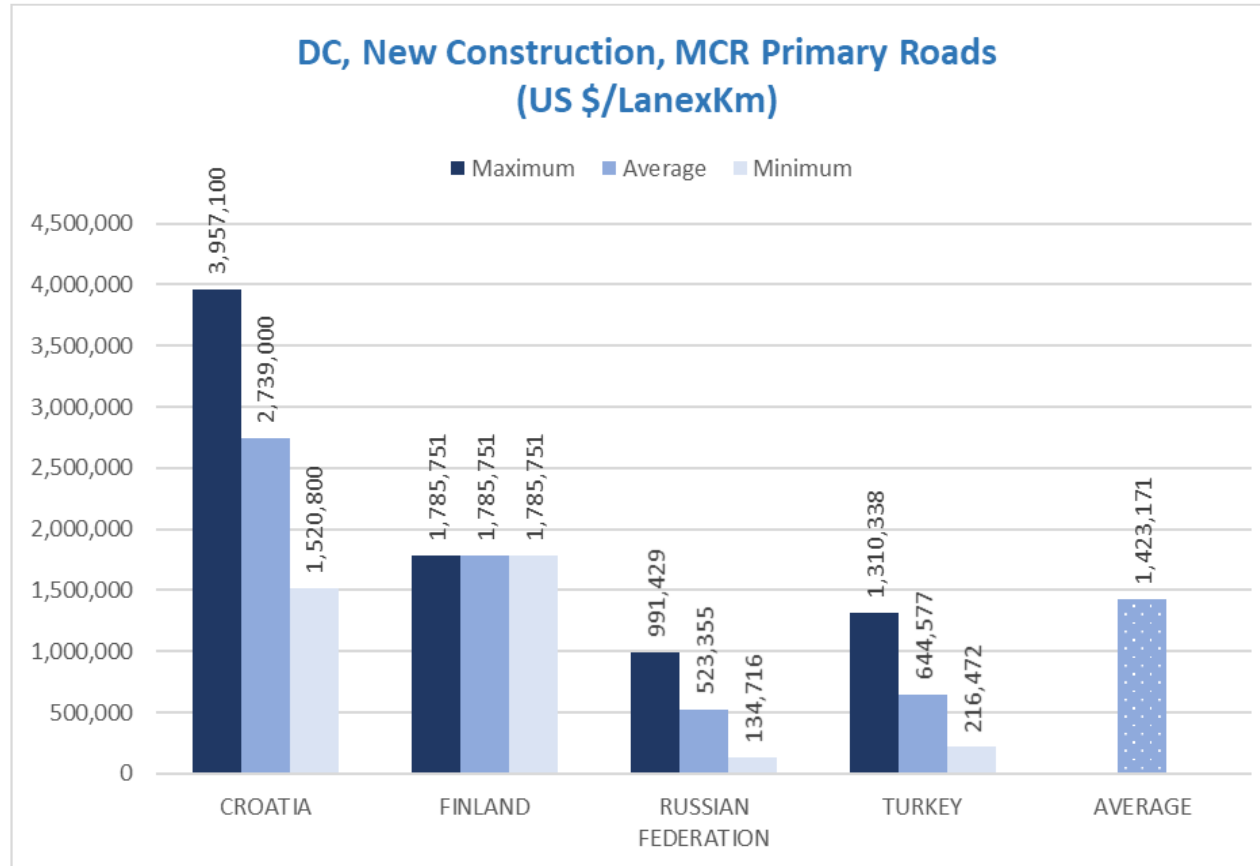


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Primary Roads **New Construction Costs** by Countries (US \$/LanexKm) (2016 prices)



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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types

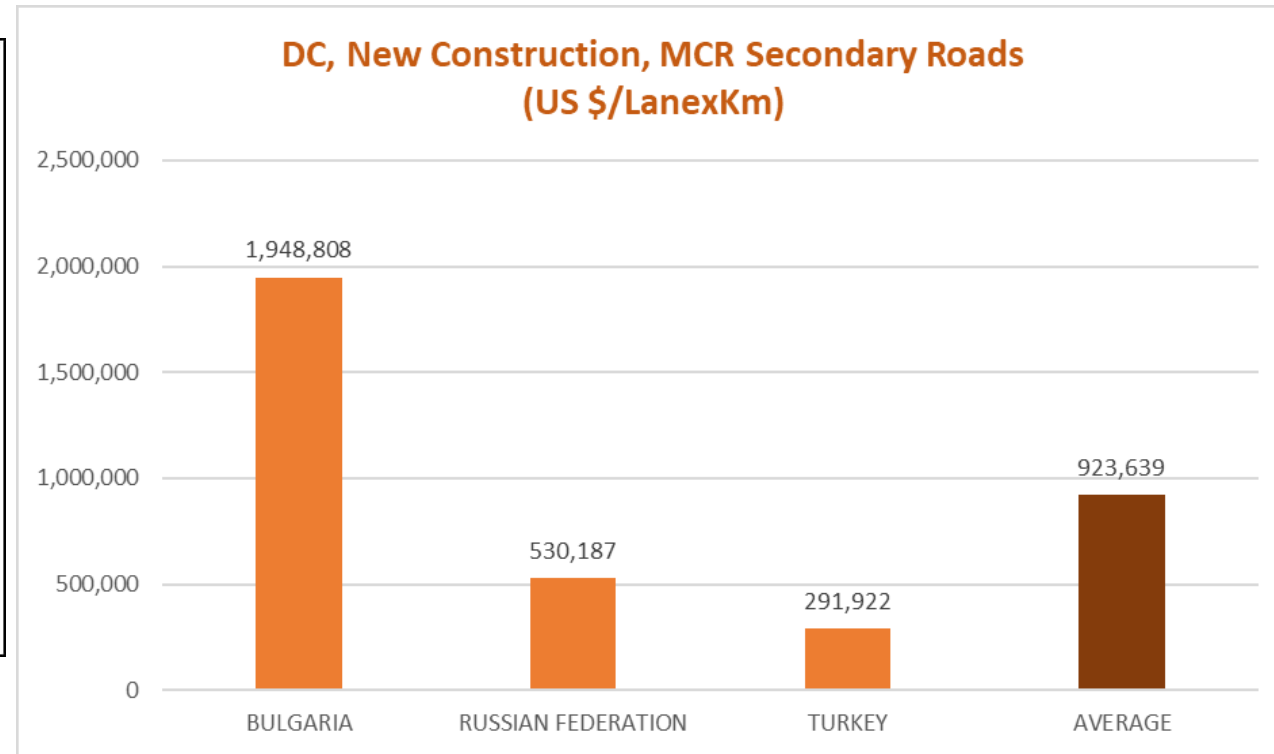


Double Carriageway Medium Classified Secondary Roads Average **New Construction Costs** by Countries
(US \$/LanexKm) (2016 prices)

DC, New Construction, MCR Secondary Roads (US \$/LanexKm)



DC, New Construction, MCR Secondary Roads (US \$/LanexKm)



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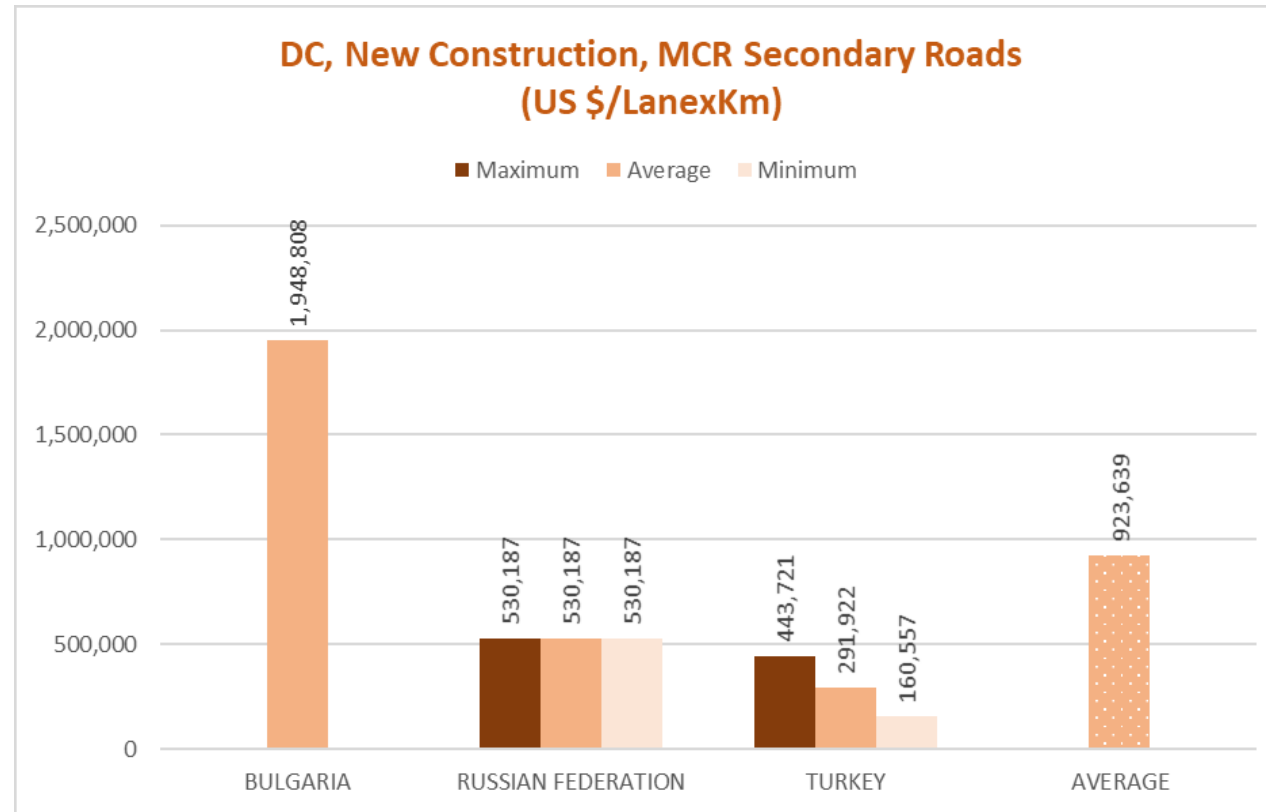


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Benchmarking Double Carriageway Asphalt Roads Construction Costs Analysis By Work Types



Double Carriageway Medium Classified Secondary Roads **New Construction Costs** by Countries
(US \$/LanexKm) (2016 prices)



TRANSPORT

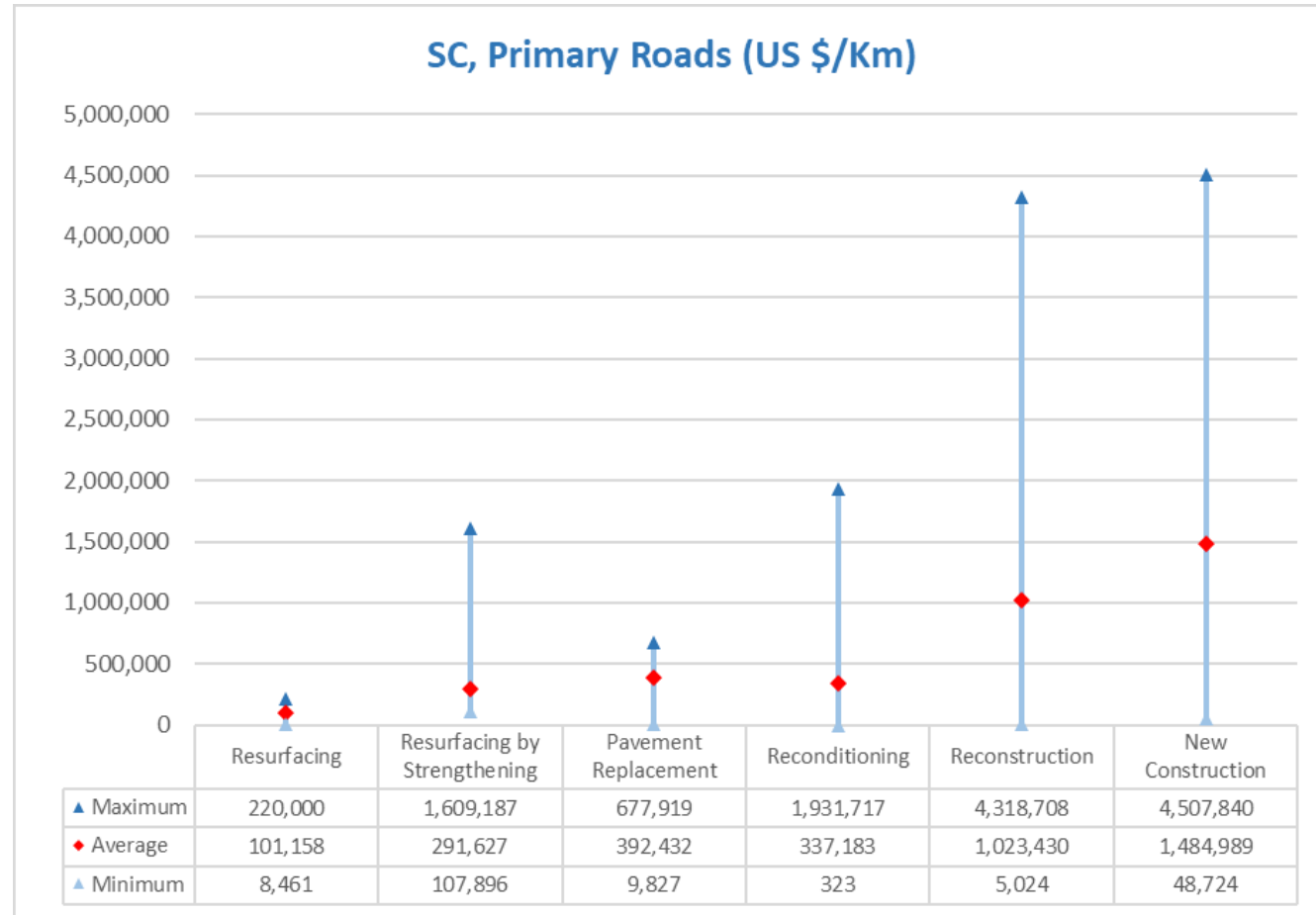


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Benchmarking Single Carriageway Asphalt



Roads Construction Cost Analysis For All Work Types



TRANSPORT

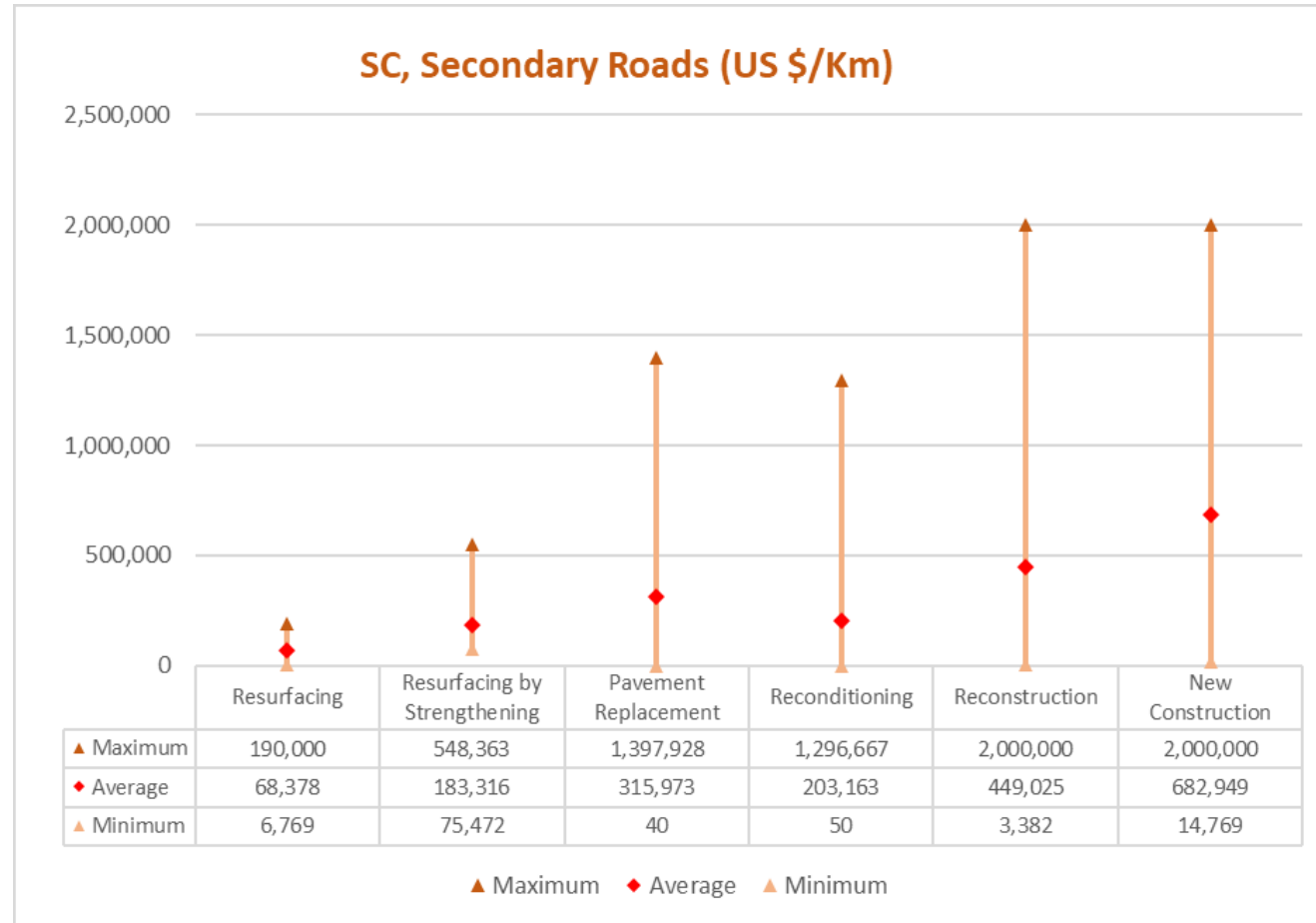


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Benchmarking Single Carriageway Asphalt



Roads Construction Cost Analysis For All Work Types



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Benchmarking Single Carriageway Asphalt



Roads Construction Cost Analysis by Work Types

Benchmarking Single Carriageway High and Medium Classified Roads **New Construction Costs** (US \$/Km) (2016 prices)

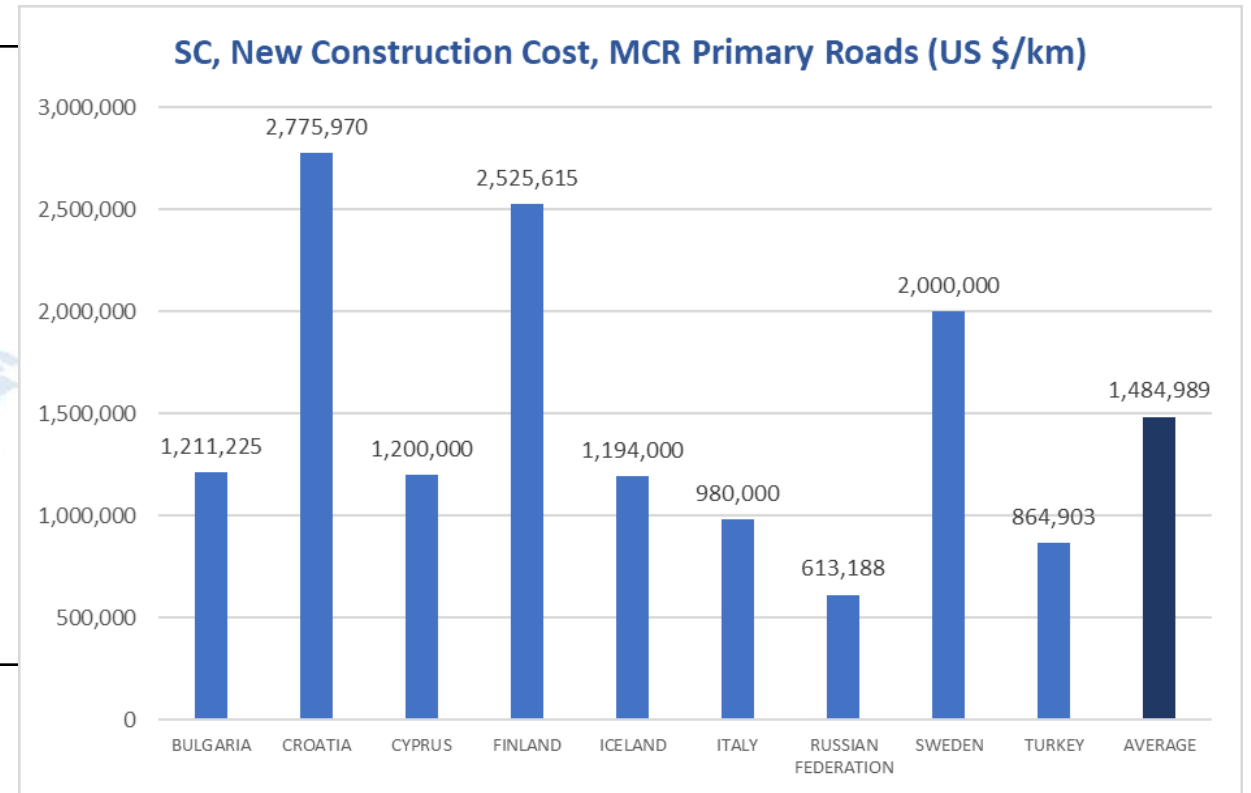
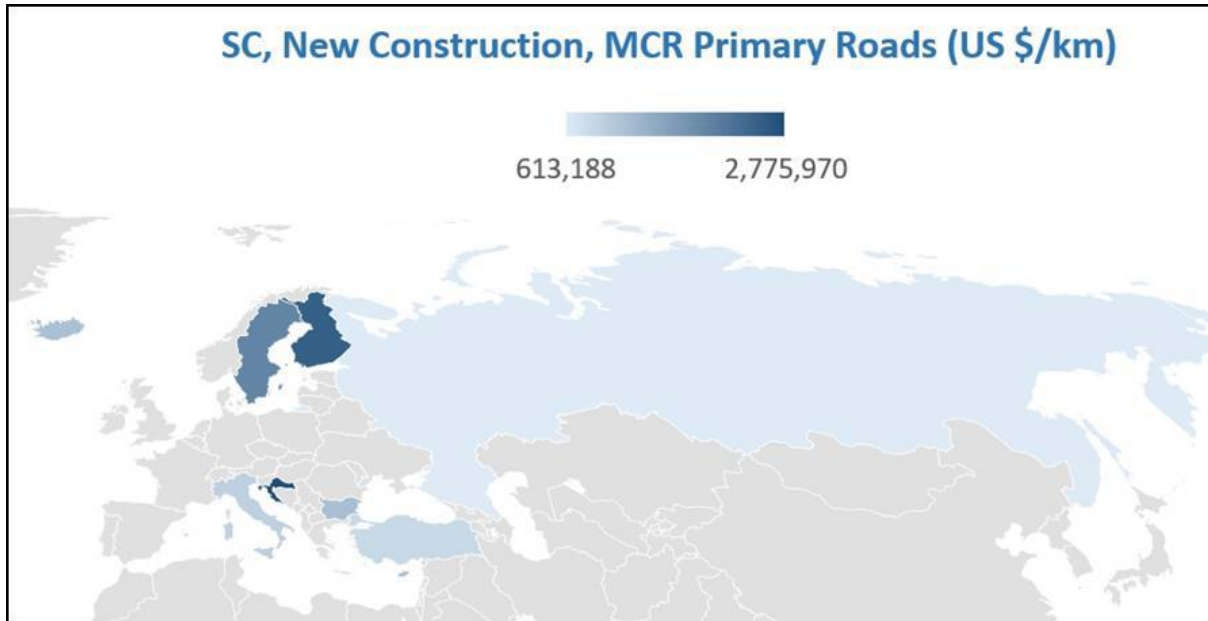
	New Construction									
	MCR_Primary Roads					MCR_Secondary Roads				
	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects	Maximum	Average	Minimum	Length of Regarded Projects (Km)	Number of Projects
AUSTRIA	-	-	-	-	-	-	-	-	-	-
BULGARIA	-	1,211,225	-	7	1	-	-	-	-	-
CROATIA	4,507,840	2,775,970	994,903	12	8	-	-	-	-	-
CYPRUS	-	1,200,000	-	20	4	-	1,000,000	-	3	1
ESTONIA	-	-	-	-	-	-	-	-	-	-
FINLAND	3,760,569	2,525,615	1,290,661	21	2	821,552	821,552	821,552	3	1
ICELAND	2,250,000	1,194,000	893,000	14	3	-	-	-	-	-
ITALY	-	980,000	-	-	-	-	268,000	-	-	-
LATVIA	-	-	-	-	-	-	-	-	-	-
REPUBLIC OF MOLDOVA	-	-	-	-	-	-	-	-	-	-
RUSSIAN FEDERATION	1,144,512	613,188	48,724	157	20	855,919	192,578	14,769	818	214
SWEDEN	3,000,000	2,000,000	1,000,000	-	-	2,000,000	1,300,000	1,000,000	-	-
TURKEY	1,314,653	864,903	475,697	40	6	737,087	515,563	294,040	45	5



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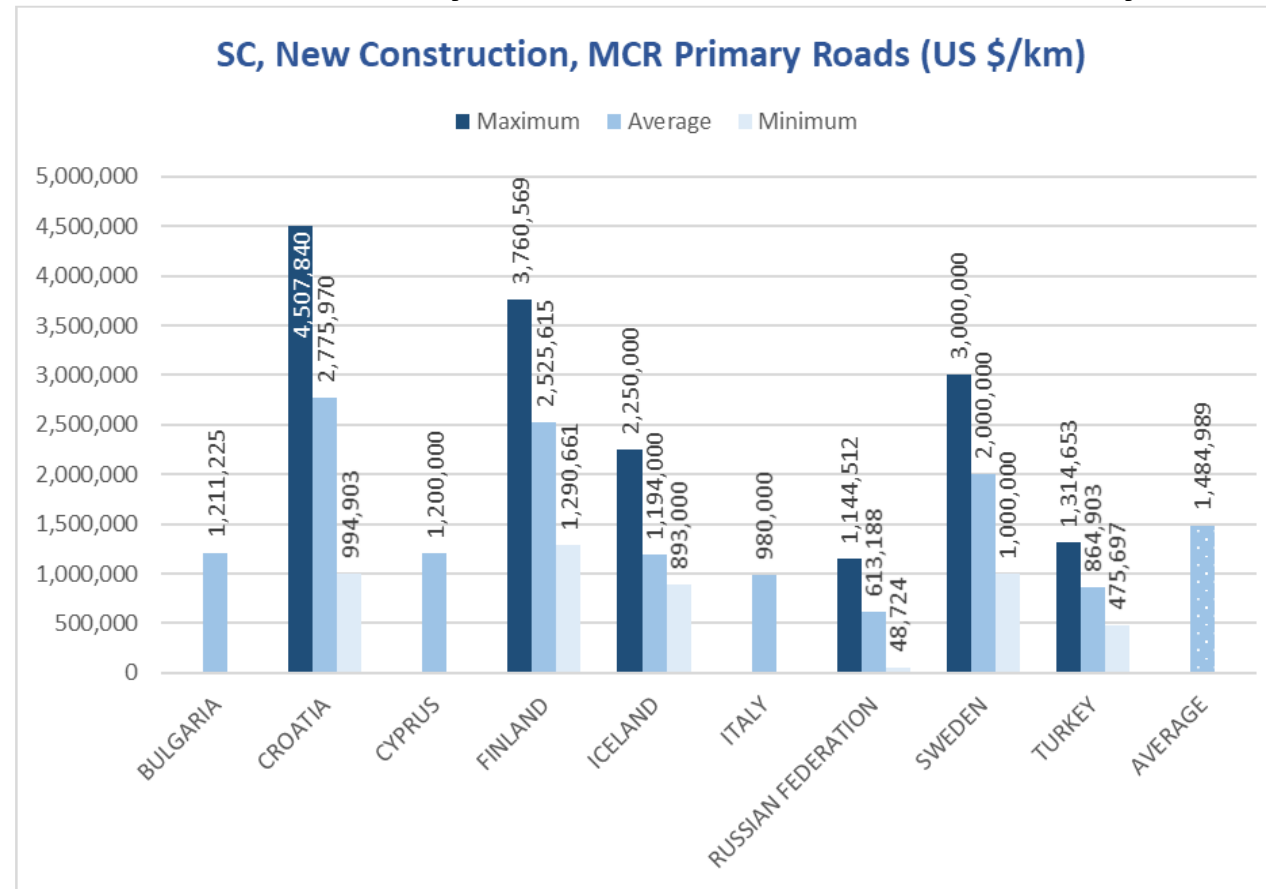
Benchmarking Single Carriageway Asphalt Roads Construction Cost Analysis by Work Types

Single Carriageway Medium Classified Primary Roads Average **New Construction Costs** by Countries (US \$/Km) (2016 prices)



Benchmarking Single Carriageway Asphalt Roads Construction Cost Analysis by Work Types

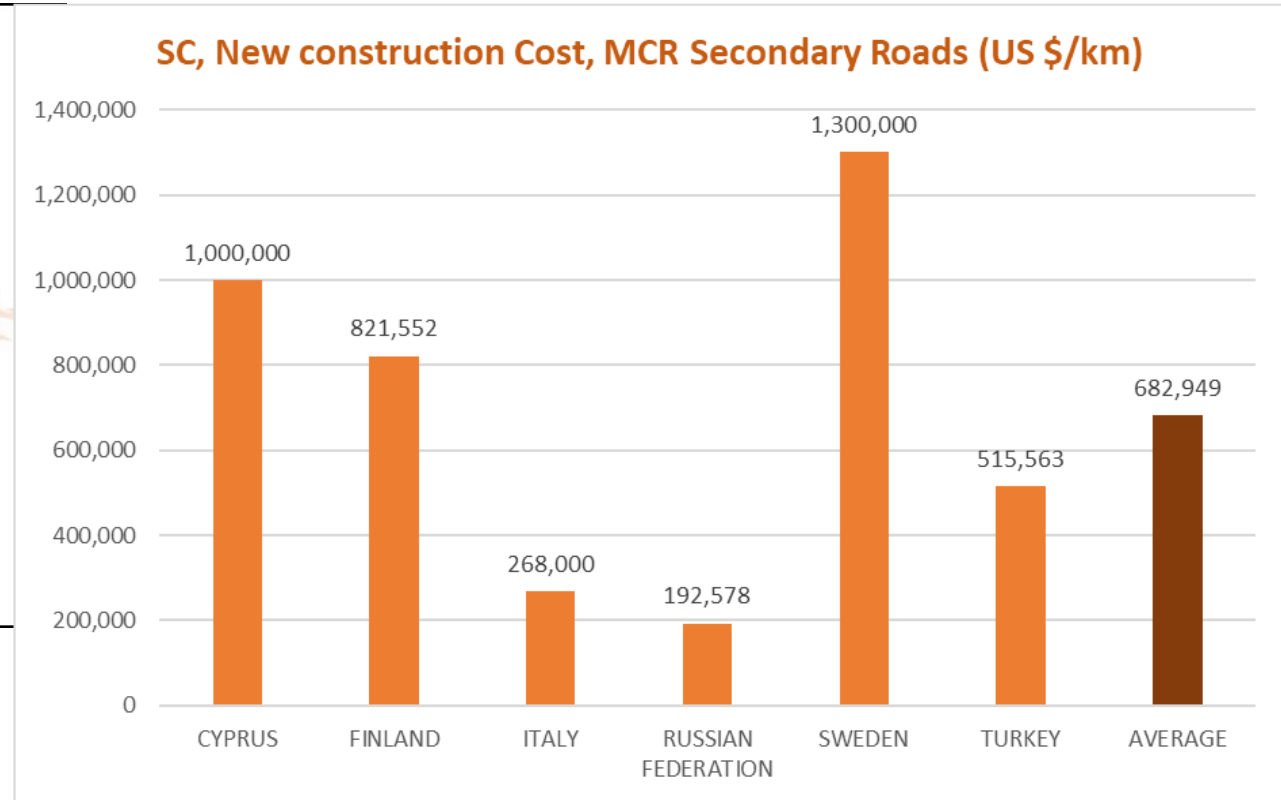
Single Carriageway Medium Classified Primary Roads **New Construction Costs** by Countries (US \$/Km) (2016 prices)



Benchmarking Single Carriageway Asphalt Roads Construction Cost Analysis by Work Types



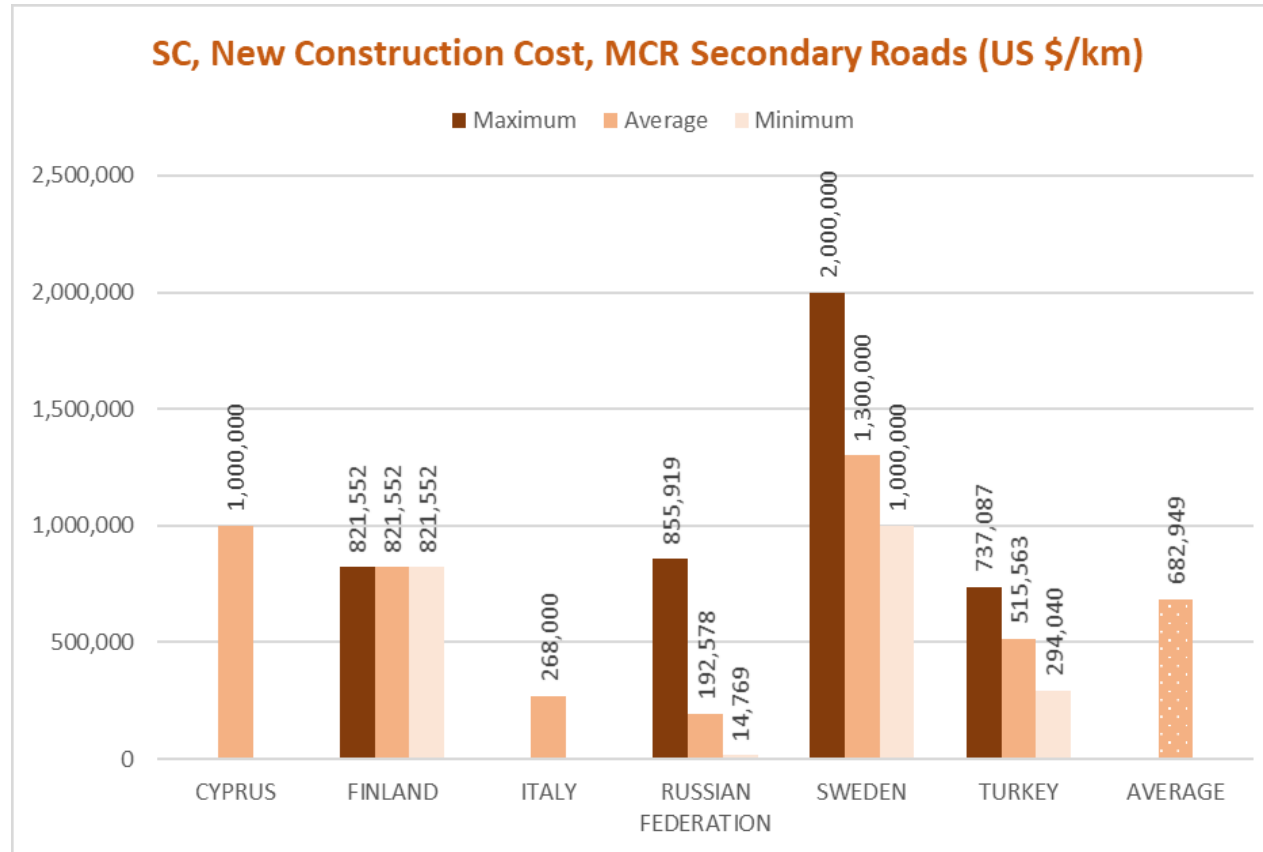
Single Carriageway Medium Classified Secondary Roads Average **New Construction Costs** by Countries (US \$/Km) (2016 prices)



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Benchmarking Single Carriageway Asphalt Roads Construction Cost Analysis by Work Types

Single Carriageway Medium Classified Secondary Roads **New Construction Costs** by Countries (US \$/Km) (2016 prices)



Benchmarking Analysis

DETAILS ARE GIVEN IN
ECE/TRANS/WP.5/2020/8

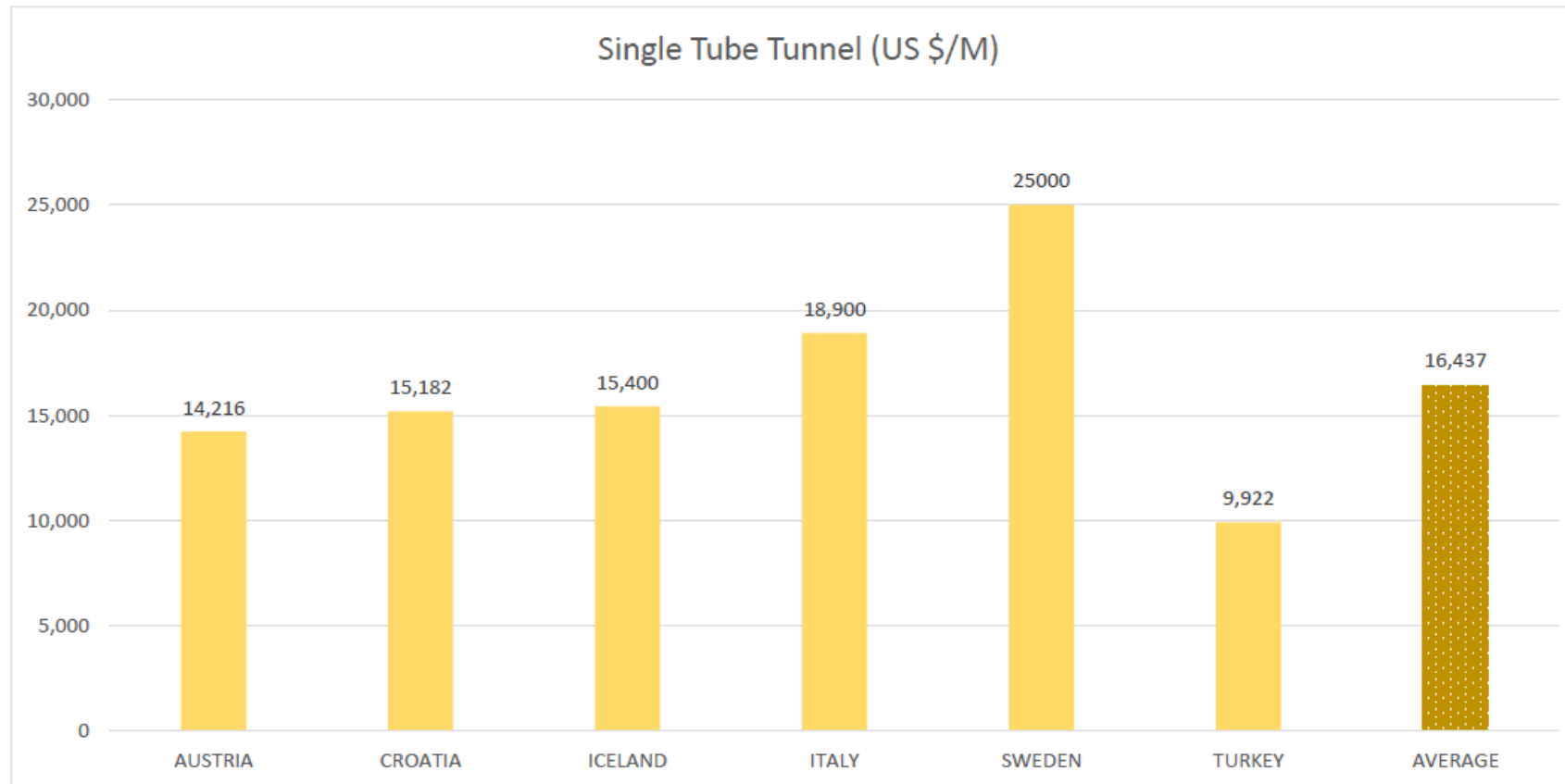


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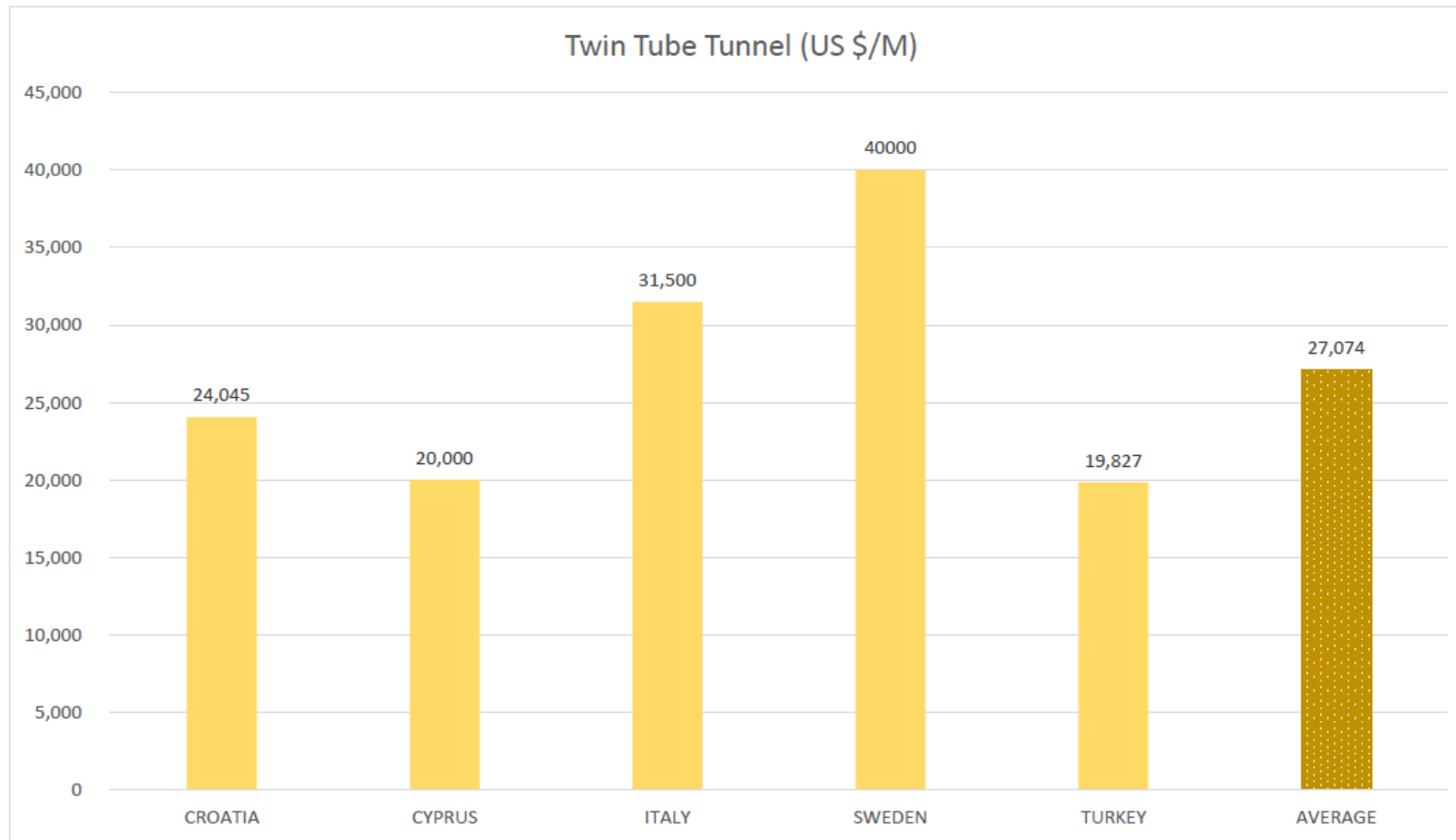


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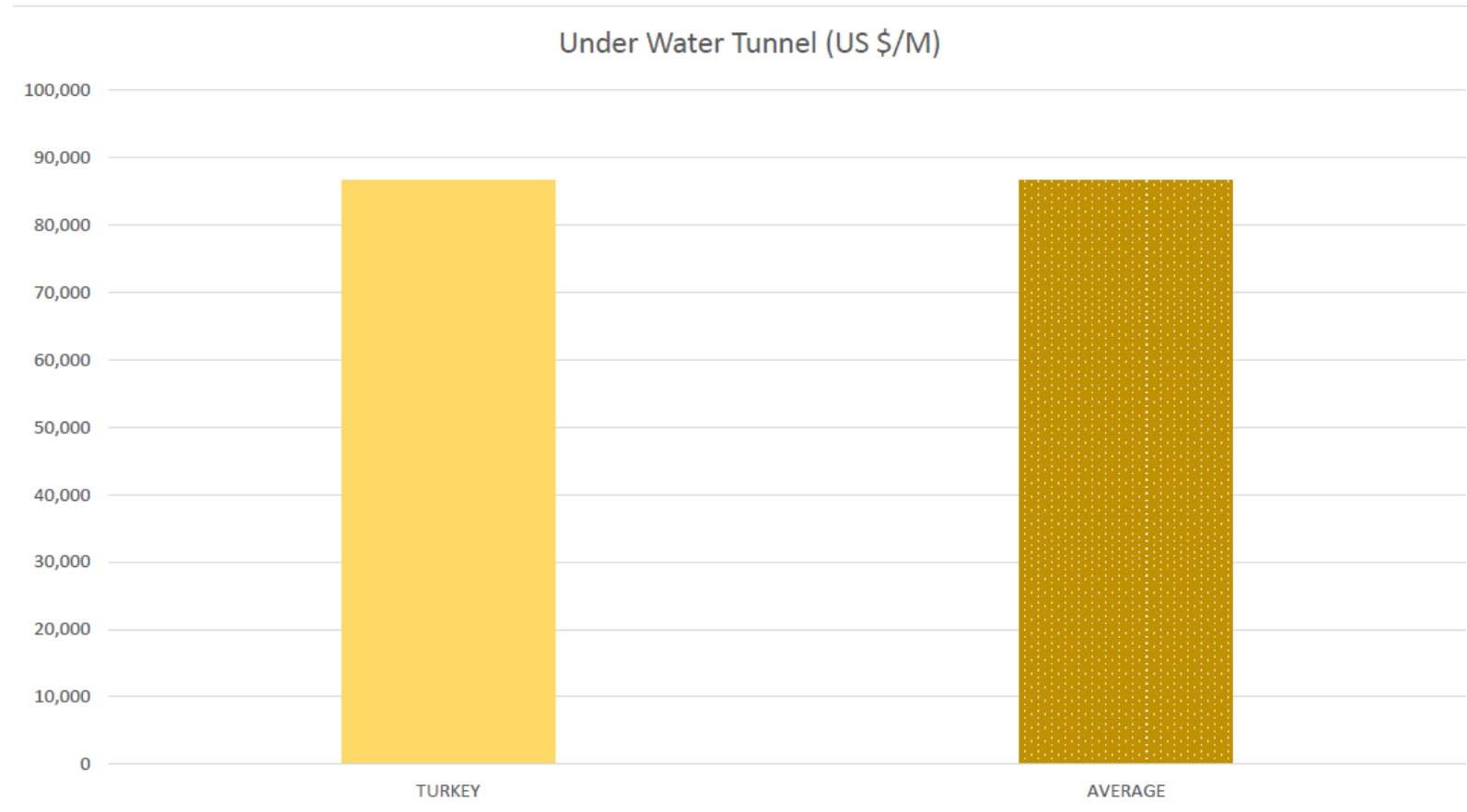
Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



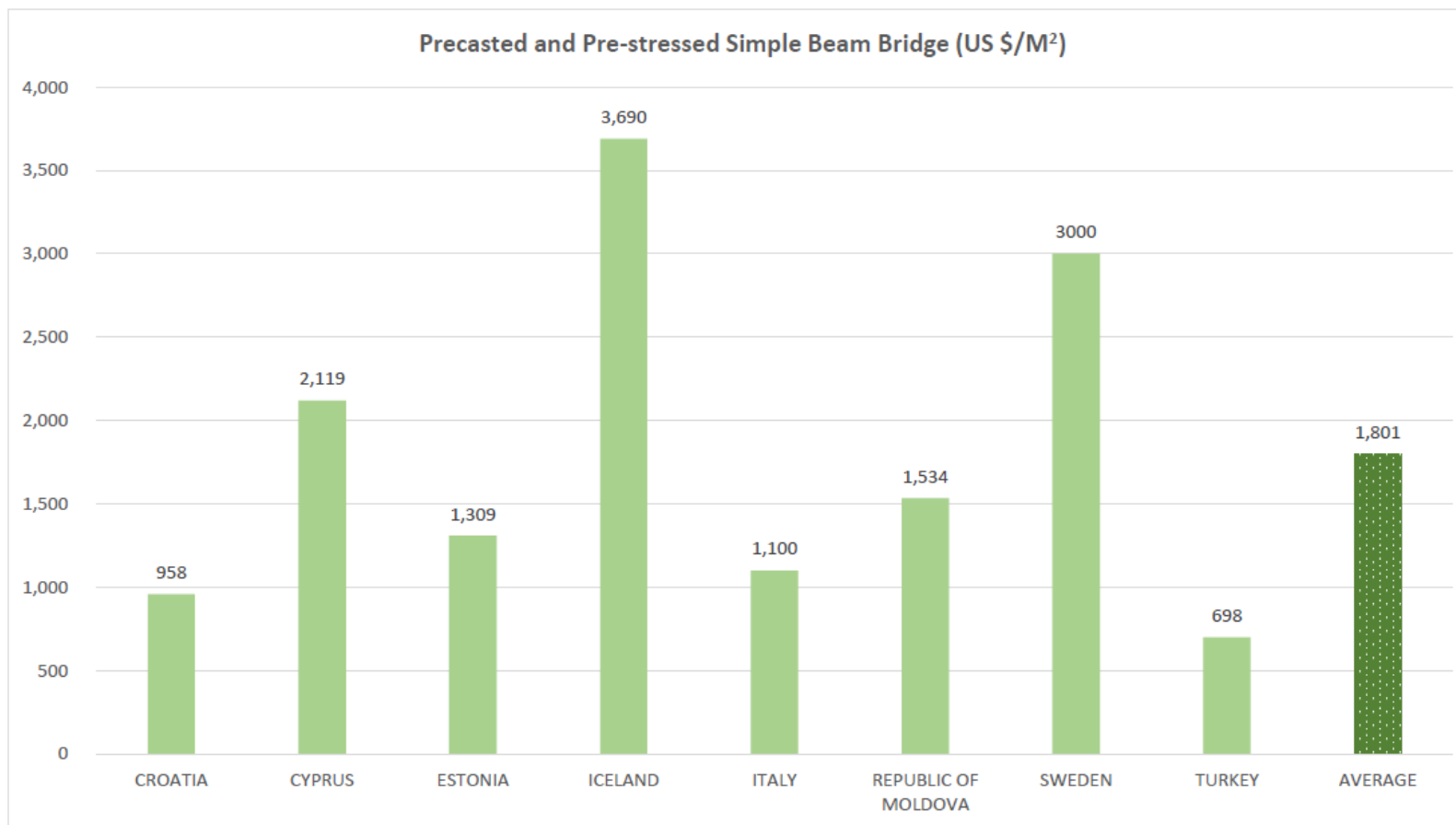
Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



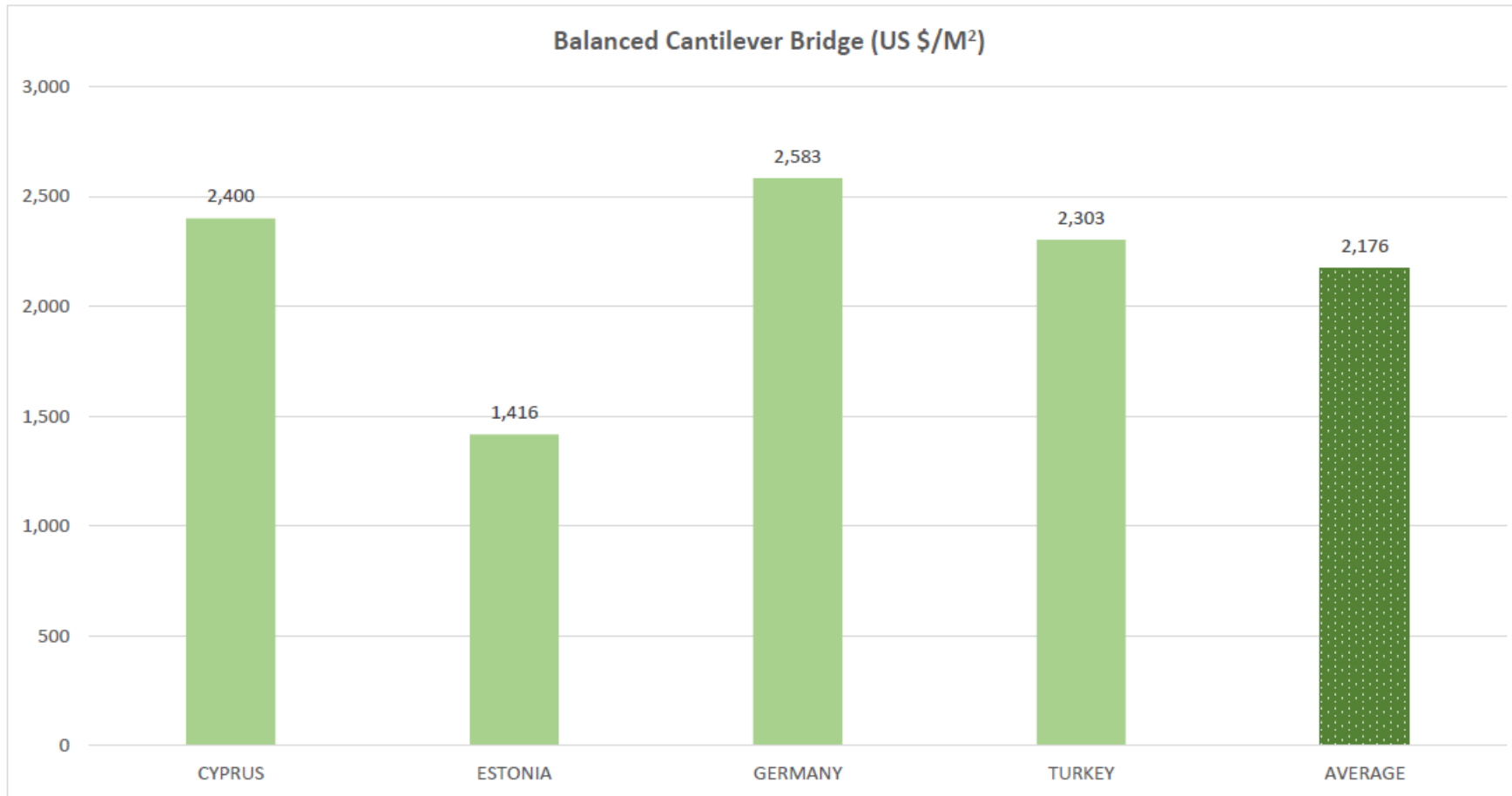
Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



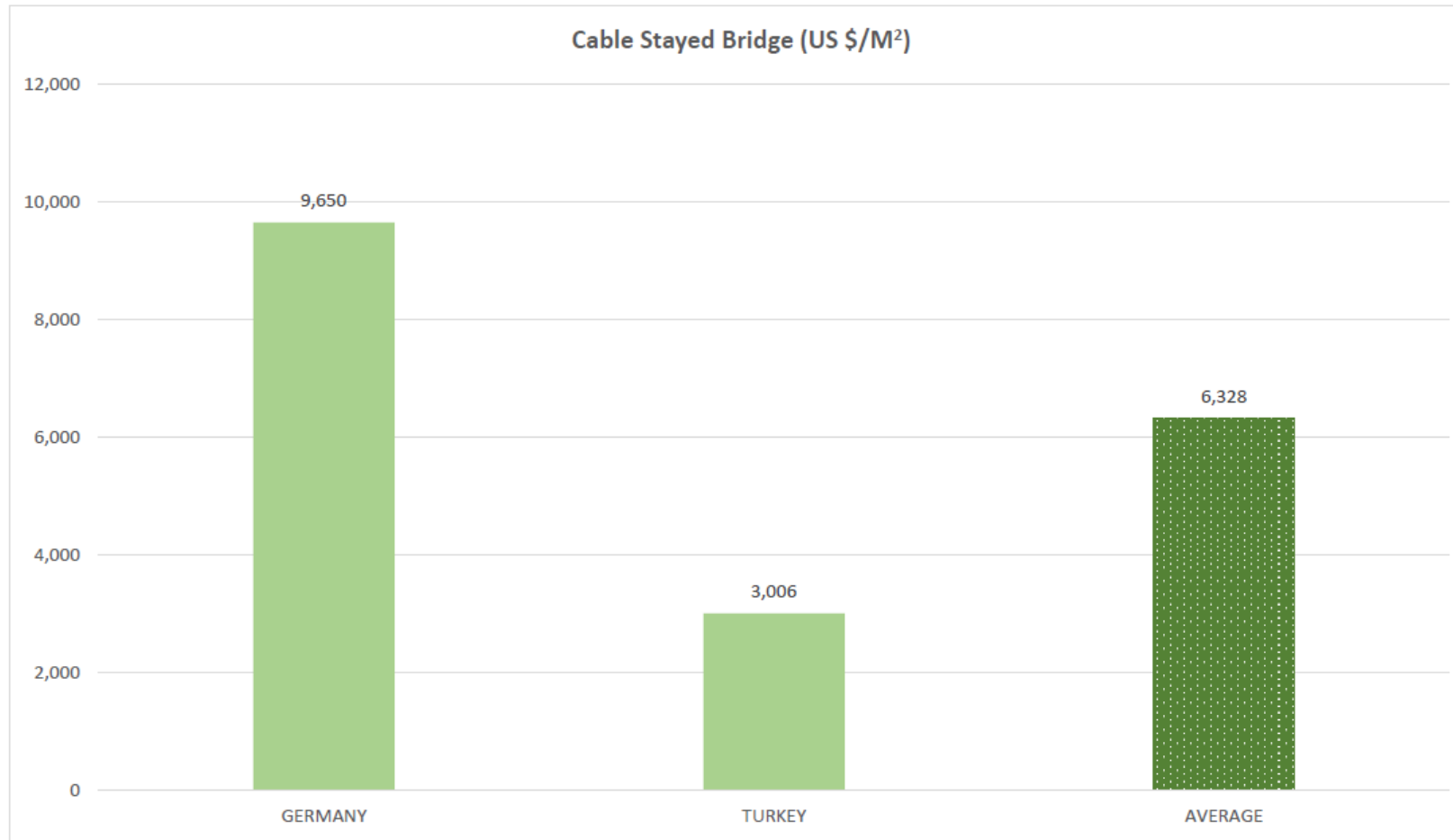
Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



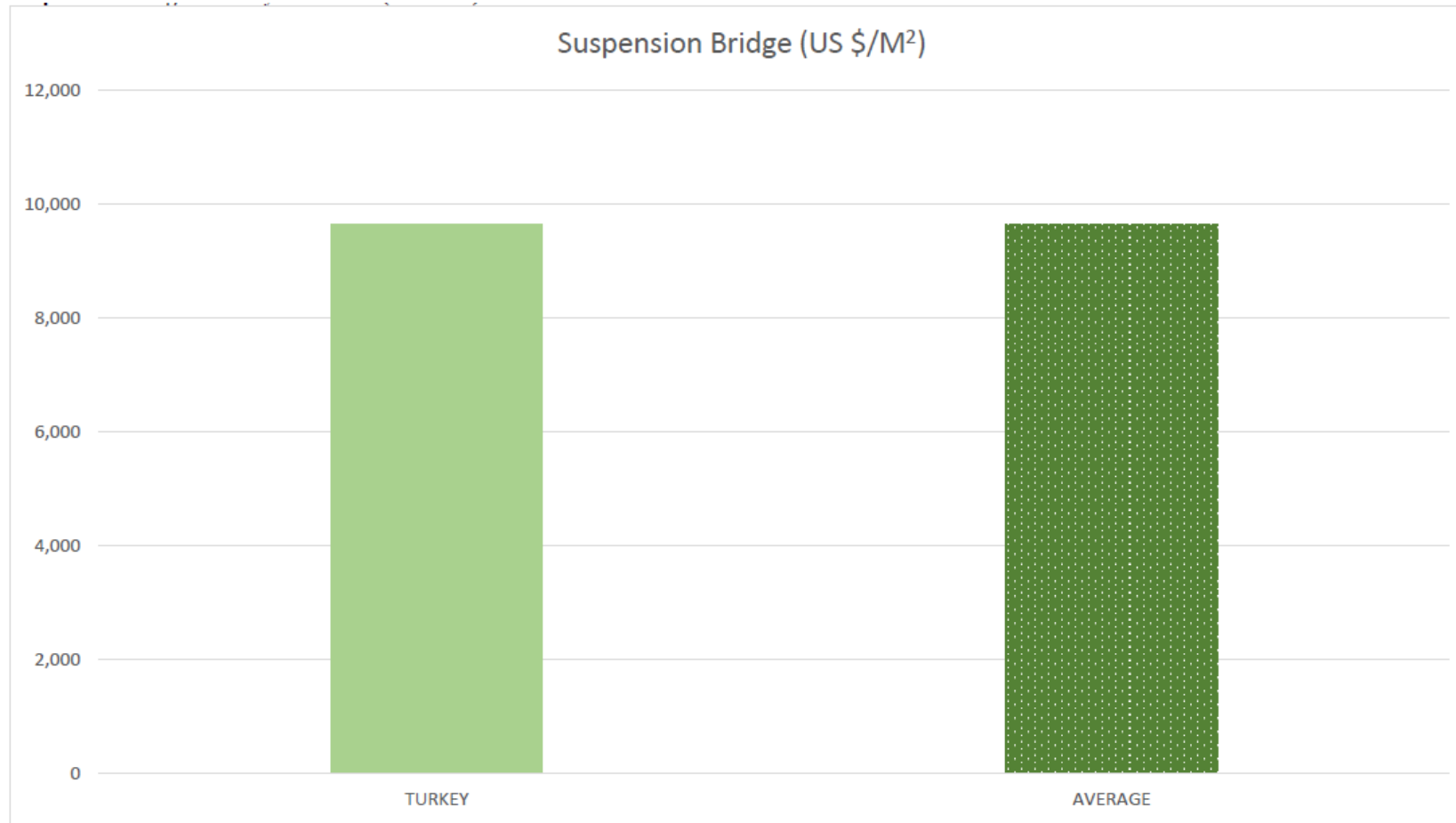
Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



Benchmarking Analysis on Road Tunnels and Bridges Construction Costs



Findings, Conclusions and Recommendations

- Even though transport infrastructure costs include costs for construction, maintenance and operation, only construction (and rehabilitation) costs were considered under this group of study.
- Identifying the parameters that affect the costs of a project is critically important.
- Superstructures such as tunnels and viaducts tend to have a major impact on the overall cost level of a project.
- The **lead country for roads, Turkey**, suggested that for analytical purposes, costs should be designated through **descriptive analysis** instead of regression analysis because cost data does not follow normal distribution.



Challenges



- ECE member States were reluctant to share their data for benchmarking purposes.
- Even though benchmarking is used in the public sector starting from the 1990s it is a relatively new tool for public sector in the field of infrastructure development.
- The biggest challenge is **Creating Sense of Mutual Understanding**.
- **Identifying the parameters** that affect the costs of a project is **critically important**.



Challenges



- **Each country has its own standards** to construct infrastructure and collect and structure cost data.
- For benchmarking of different countries or organizations, it is always to be expected that data may not be directly comparable.
- Another challenge faced by the Group was the limited data availability. 14 countries namely Austria, Bulgaria, Croatia, Cyprus, Estonia, Finland, Germany, Iceland, Italy, Latvia, Republic of Moldova, Sweden, Russian Federation and Turkey shared their road infrastructure construction cost data.
- In some cases data was **missing** or may have been **misrepresented** or **inaccurate** which complicated the actual data analysis. For instance, some countries may not have excluded some cost as superstructures such as tunnels, bridges.



Findings



Single Carriageway Roads

- ✓ The average of **single carriageway primary roads new construction cost** from 9ECE member States (Bulgaria, Croatia, Cyprus, Finland, Iceland, Italy, Russian Federation, Sweden and Turkey) is **1,484,989 US \$ per km**.
- ✓ The highest one 4.5 Million US \$ per km observed in Croatia, and the lowest one is 475,697 US \$ per km observed in Turkey. The highest one is 9 times higher than the lowest one.
- ✓ The average of **single carriageway of secondary roads new construction cost** from 6ECE member States (Cyprus, Finland, Italy, Russian Federation, Sweden and Turkey) is **682,949 US \$ per km**.
- ✓ The highest one is 2 million US \$ per km observed in Sweden, the lowest one is 14,769 US \$ per km observed in the Russian Federation. The highest one is 135 times higher than the lowest one.
- ✓ Regarding all road work types, it is also observed that the **lowest cost for primary roads is 323 US \$ per km for reconditioning** and the **highest one is 4,507,840 US \$ per km for new construction**.
- ✓ Regarding all work types, it is also observed that **the lowest cost for secondary roads is as 40 US \$ per km for pavement replacement** and **the highest one is 2 million US \$ per km for new construction**.

Findings



Single Carriageway Roads

- ✓ **Average construction cost of primary single carriageway roads by work types gradually increases** as for resurfacing 101,158 US \$ per km, resurfacing by strengthening 291,627 US \$ per km, pavement replacement 392,432 US \$ per km, reconditioning 337,432 US \$ per km, reconstruction 1,023,430 US \$ per km and new construction 1,484,989 US \$ per km.
 - ✓ There is only **one unexpected result which is reconditioning costs.**
- ✓ **Average construction cost of secondary single carriageway roads by work types gradually increases** as for resurfacing 68,378 US \$ per km, resurfacing by strengthening 183,316 US \$ per km, pavement replacement 315,973 US \$ per km, reconditioning 203,163 US \$ per km, reconstruction 449,025 US \$ per km and new construction 682,949 US \$ per km.
 - ✓ There is only **one confusing result which is reconditioning cost.**



Findings



Double Carriageway Roads

- ✓ **The average of double carriageway motorways new construction cost** from nine-member countries (Austria, Bulgaria, Croatia, Cyprus, Finland, Italy, Russian Federation, Sweden and Turkey) is **2,157,667 US \$ per lane x km**.
 - ✓ The highest one is 7.8 Million US \$ per lane x km observed in Austria, the lowest one is 371,013 US \$ per lane x km observed in Turkey. The highest one is 21 times higher than the lowest one.
- ✓ **The average of double carriageway primary roads new construction cost** from four-member countries (Croatia, Finland, Russian Federation, and Turkey) is **1,423,171 US \$ per lane x km**.
 - ✓ The highest one is 3.96 Million US \$ per lane x km observed in Croatia, the lowest one is 134,716 US \$ per lane x km observed in Russian Federation. The highest one is 29 times higher than the lowest one
- ✓ **The average of double carriageway of secondary roads new construction cost** from three-member countries (Bulgaria, Russian Federation and Turkey) is **923,639 US \$ per lane x km**.

Findings



Double Carriageway Roads

- ✓ Regarding all work types, it is also observed that **the lowest cost for motorways is as 15,684 US \$ per lane x km for resurfacing and the highest one is 11,018,275 US \$ per lane x km for expansion (capacity improvement).**
- ✓ Regarding all work types, it is also observed that **the lowest cost for double carriageway primary roads is as 4,231 US \$ per lane x km for resurfacing and the highest one is 6,755,612 US \$ per lane x km for expansion (capacity improvement).**
- ✓ Regarding all work types, it is also observed that **the lowest cost for double carriageway secondary roads is as 3,385 US \$ per lane x km for resurfacing and the highest one is 1,948,808 US \$ per lane x km for new construction.**



Findings



Double Carriageway Roads

- ✓ **Average construction cost of motorways by work types gradually increases** as for resurfacing 135,282 US \$ per lane x km, resurfacing by strengthening 203,185 US \$ per lane x km, pavement replacement 314,373 US \$ per lane x km, reconditioning 493,218 US \$ per lane x km, expansion 1,683,017 US \$ per lane x km and new construction 2,157,667 US \$ per lane x km.
- ✓ **Average construction cost of primary double carriageway roads by work types gradually increases** as for resurfacing 11,807 US \$ per lane x km, resurfacing by strengthening 76,814 US \$ per lane x km, pavement replacement 167,925 US \$ per lane x km, reconditioning 905,827 US \$ per lane x km, reconstruction 211,809 US \$ per lane x km and new construction 1,423,171 US \$ per lane x km. There is only one confusing result which is for reconstruction.
- ✓ **Average construction cost of secondary double carriageway roads by work types gradually increases** as for resurfacing 10,442 US \$ per lane x km, resurfacing by strengthening 1,405,245 US \$ per lane x km, pavement replacement 173,901 US \$ per lane x km, reconditioning 597,085 US \$ per lane x km, reconstruction 259,279 US \$ per lane x km and new construction 923,639 US \$ per lane x km. There are two confusing result one is for resurfacing by strengthening the other one is for reconditioning



Findings



Superstructures Bridges and Tunnels

Superstructures costs were analyzed as bridges and tunnels construction cost. Bridges cost unit is US \$ per m², tunnels cost unit is US \$ per m.

For single tube tunnels six countries (Austria, Croatia, Iceland, Italy, Sweden, and Turkey), for twin tube tunnels five countries (Croatia, Cyprus, Italy, Sweden and Turkey) for underwater tunnels one country (Turkey) provided data.

- ✓ The average cost of **single tube tunnel** is **16,437 US \$ per m**.
- ✓ The average cost of **twin tube tunnel** is **27,024US \$ per m**.



Findings



Superstructures Bridges and Tunnels

Bridges costs were analyzed as precasted and pre-stressed simple beam, balanced cantilever bridge, cable stayed bridge, suspension bridge and pedestrian bridge.

Eight countries namely Croatia, Cyprus, Estonia, Iceland, Italy, Republic of Moldova, Sweden and Turkey provided data for **Precasted And Pre-stressed Simple Beam Construction Costs**.

- ✓ The average of eight countries is **1,801 US \$ per m²**.

Four countries namely Cyprus, Estonia, Germany and Turkey provided data for **Balanced Cantilever Bridge Construction Costs**.

- ✓ The average of four countries is **2,176 US \$ per m²**.

Two countries namely Germany and Turkey provided data for **Cable Stayed Bridge Construction Costs**.

- ✓ The average of two countries is **6,328 US \$ per m²**.

- ✓ Only one country, Turkey provided data for **Suspension Bridge Construction Costs** which was at **9,644 3,006 US \$ per m²**.



Conclusions



- ✓ It can be concluded that some construction costs of road infrastructures are not comparable across ECE member States.
- ✓ Results shows that mutual understanding has not been fully achieved.
- ✓ Data and results need to be further calibrated.
- ✓ Regarding other benchmarking parameters such as GNP per capita and population density a correlation between actual cost and the size of economies and of countries was not established.
- ✓ Due to limited data availability boxplot analysis could not be applied.



Recommendations



- ✓ The present study has however proven its value and therefore recommended to continue by the data collection efforts of the Group.
- ✓ In doing so, efforts need to be made to make sure that there is a better understanding among ECE member States wishing to submit additional data regarding the exact requirements.
- ✓ Better and more data would allow an even better analysis and results.
- ✓ A possible follow-up study may focus on maintenance and operation cost of transport infrastructures. This type of data is easier to find and access.



Presented by
Dr. Leyla ÜNAL
Delegate from Republic of Turkey
Ministry of Transport and Infrastructure
General Directorate of Highways

WP.5, 33rd session
Geneva, 7 -9 September 2020
Agenda item 4 (b)



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