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User Costs Model for Road Management Systems

A Simplified Approach for Portuguese Conditions

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Road Materials and Pavement Design

Road Pavements: Materials, design and performance
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User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Introduction

The material presented in this paper is part of a PhD research work finished in 2008 and recent new developments.

✓ Objective

Develop a Simplified Road User Cost Model to use in Portuguese road management systems.

✓ Aiming at

Simplicity; reduced data requirements; easy calibration; easy application and trustworthy results.

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Introduction

Portuguese RUC Model conceptual framework was based in simplifications of:

HDM-4 equations for **VOC**
COBA and HDM-4 approach for **AC**
JAE Model and HDM-4 equations for **VOT**

Other models studied:

NZVOC
TxDOT Manual

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Methodology

The proposed model was developed taking in to account:

- ✓ Recognized conceptual principles
- ✓ Application to trunk roads
- ✓ Impact of each component on total RUC
- ✓ Portuguese conditions
- ✓ Availability of Portuguese official data
- ✓ Four vehicle classes: PC,U, HT, HB

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Methodology

Simplified Road User Costs Model

✓ Vehicle Operating Costs (fuel, tyres, vehicle maintenance and depreciation)

✓ Accident Costs (for accident and casualty)

✓ Value of Travel Time

✓ Tolling Costs

Recent refinements were made to include the effect of working zones and pavement conditions.

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Formulation

$$RUC_{total} = RUC \times L + RUC_{M\&R} \times L_{M\&R} + RUC_{PSI} \times L_{PSI}$$

$$RUC = VOC + AC + VOT + Toll$$

$$RUC_{M\&R} = dCf + dVOT$$

$$RUC_{PSI} = VOC \times F_{VOC,PSI}$$

$$VOC = AADT \times \sum_{i=1}^{4} (VOC_i \times p_i)$$

$$VOT = AADT \times \sum_{i=1}^{4} (VOT_i \times p_i)$$

$$AC = AADT \times \left(\sum_{j=1}^{3} AC_j + \sum_{k=1}^{3} CC_k \right)$$

$$Toll = AADT \times \sum_{i=1}^{4} (ctoll_i \times p_i)$$

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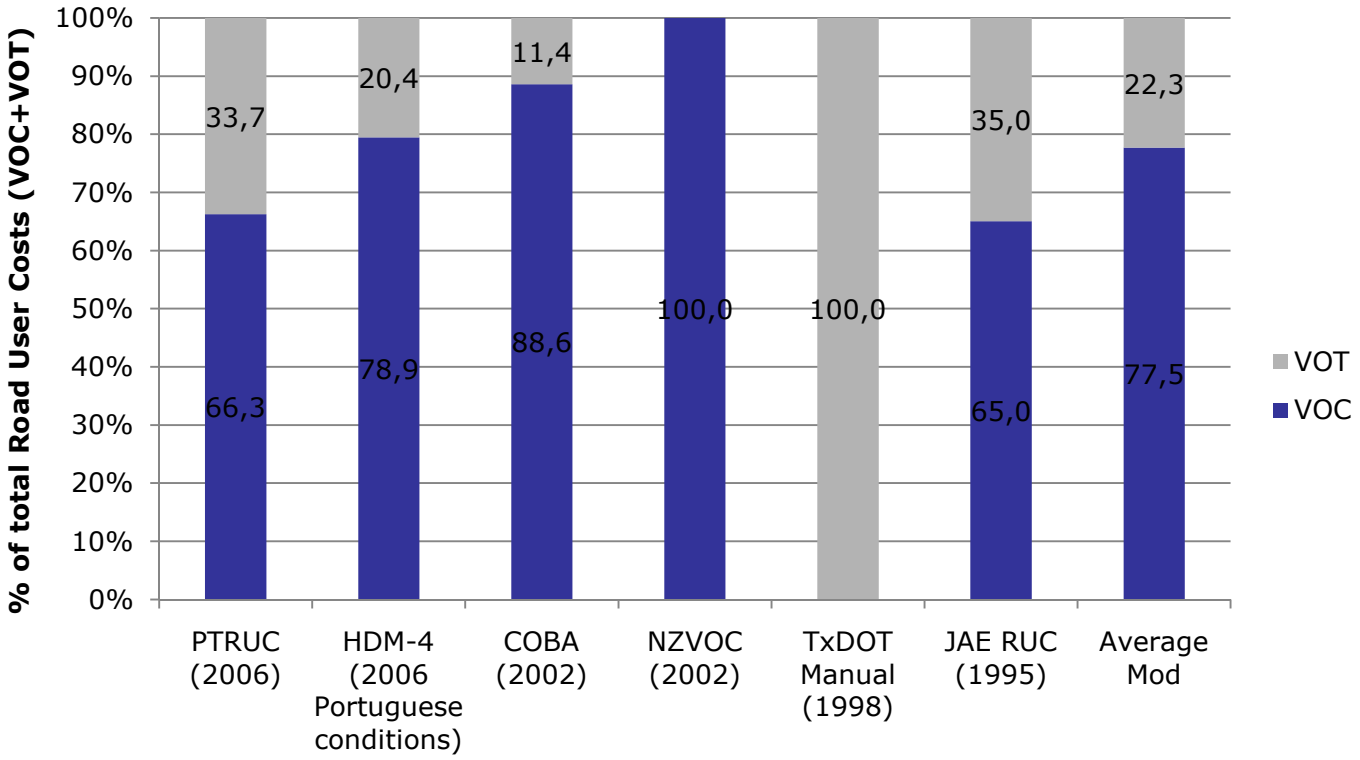
Model Validation

Passenger Car VOT and VOC distribution



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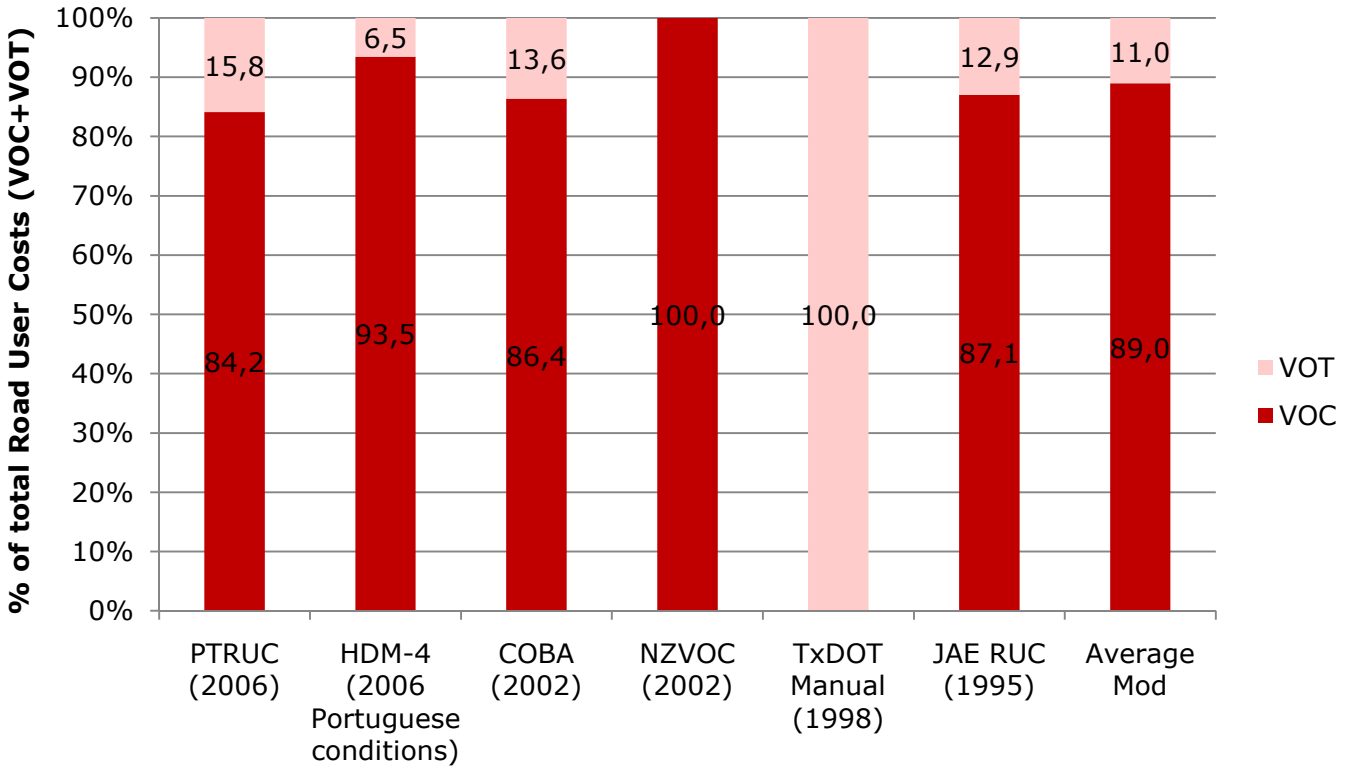
Model Validation

Heavy Truck VOT and VOC distribution



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Sensitive Parameters of the Model

Vehicle operating speed

Fuel consumption and cost

Main parameters in determining additional RUC due to **work zones** and **pavement condition**

Additional RUC due to Work Zones

More important in trunk roads

Work Zones

Decrease of operating speed → **Increases VOT**

Additional fuel consumption → **Increases VOC**

More significant in two lanes roads with "medium" design standards

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Additional RUC due to Work Zones

$$RUC_{M\&R} = dCf + dVOT$$

$$dCf = AADT \times \sum_{i=1}^{4} (0.2 \times Cf_i \times p_i) \quad \text{for} \quad s_{M\&R_i} \leq \frac{1}{3} \times s_i \text{ and ER, EN}$$

$$dVOT = AADT \times \sum_{i=1}^{4} (VOT_{M\&R_i} \times pi) - VOT$$

$$VOT_{M\&R_i} = 1/s_{M\&R_i} \times \sum_{m=1}^{z} (TC_m \times OR_{i,m})$$

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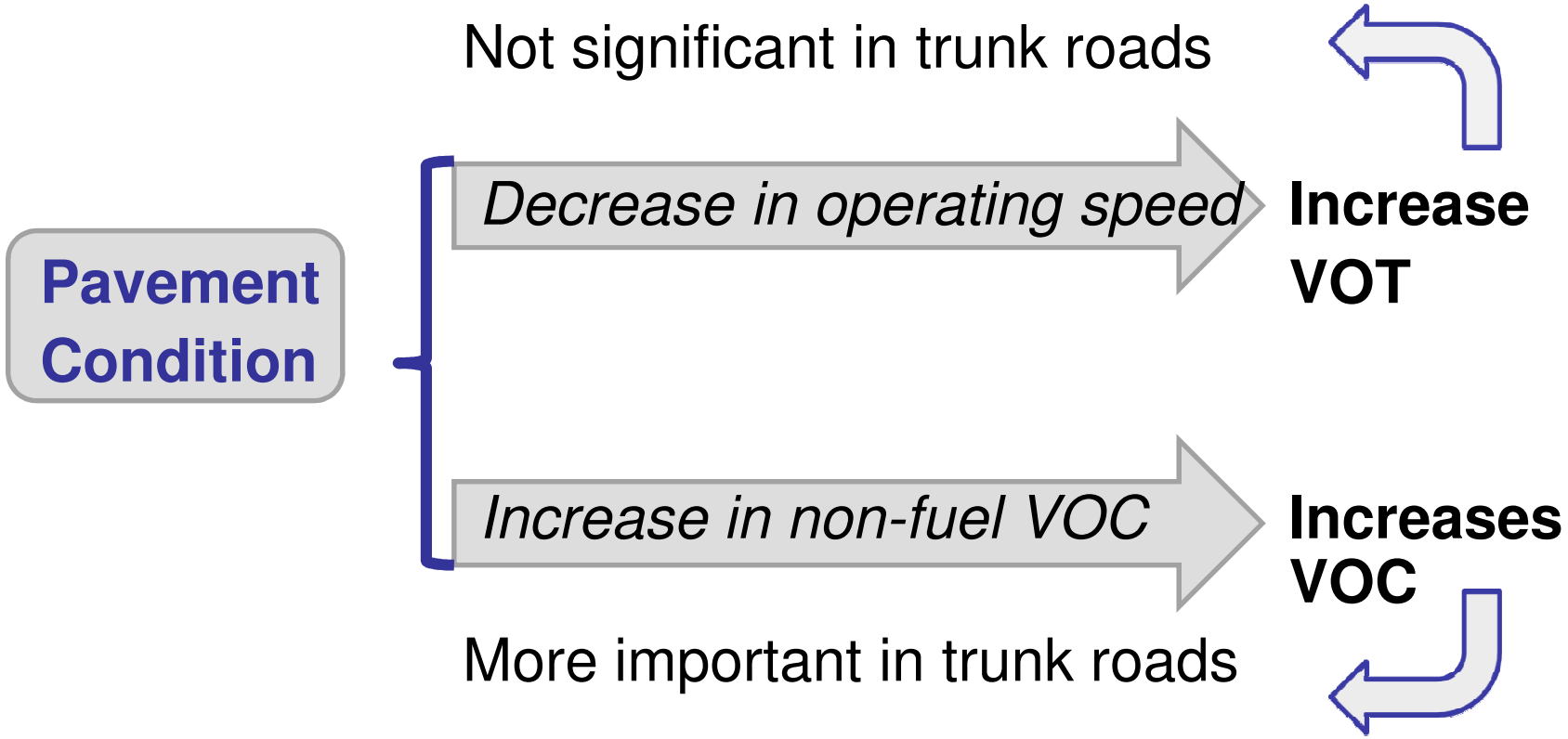
Additional RUC due to Pavement Condition



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Additional RUC due to Pavement Condition

PSI	IRI (m/km)	Correction factors for VOC
0	4,25	1,15
2,0	3,50	1,05
3,5	2,00	1,00
4,7	0,50	0,95

$$RUC_{PSI} = VOC \times F_{VOC,PSI}$$

$$F_{VOC,PSI} = -0.0017 \times PSI^3 + 0.0139 \times PSI^2 - 0.0712 \times PSI + 1.15$$

$$PSI = 5 \times e^{-0.0002598 \times IRI/2} - 0.002139 \times R^2 - 0.03 \times (C + S + P)^{0.5}$$

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RUC Model Applications Results

	Scutvias (A23) Average values		Scutvias (A23) Work Zone PSI=2,0		Aenor (A7 and A11) Average values		Aenor (A7 and A11) Work Zone PSI=2,0	
Costs	**RUC (€/km/day)**	**RUC (%)**	**RUC (€/km/day)**	**RUC (%)**	**RUC (€/km/day)**	**RUC (%)**	**RUC (€/km/day)**	**RUC (%)**
VOC	2.267 €	60%	**2.379 €**	**56%**	1.352 €	53%	**1.419 €**	**49%**
AC	83 €	2%	83 €	2%	73 €	3%	73 €	3%
VOT	703 €	19%	**1.055 €**	**25%**	505 €	19%	**758 €**	**26%**
Toll	742 €	19%	742 €	17%	637 €	25%	637 €	22%
RUC	**3.795 €**	100%	**4.259 €**	**+12%**	**2.567 €**	100%	**2.887 €**	**+12%**

Conclusions

- ✓ The developed RUC Model constitutes a suitable model to Portuguese reality.
- ✓ The main improvements of the proposed model over the existing ones are the reduced amount of data, it's availability and a simple and flexible model formulation.
- ✓ The incorporation of the Additional RUC due to the explicit consideration of work zones delays and involving a explicit pavement condition indicator will allow more accurate RUC calculations to be use in asset management systems.

THANK YOU FOR YOUR ATTENTION!!!