

User Costs Model for Road Management Systems

A Simplified Approach for Portuguese Conditions



Bertha Santos

Luís Picado Santos

Victor Cavaleiro



**Road
Materials
and
Pavement
Design**



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Introduction

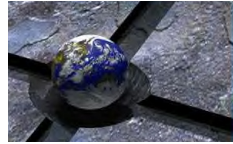
The material presented in this paper is part of a PhD research work finished in 2008 and recent new developments.

✓ 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.



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

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



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

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



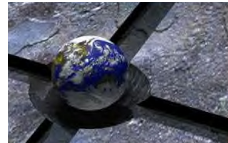
User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

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.



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Formulation

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

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

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

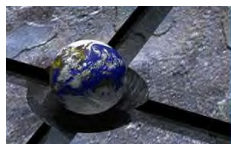
$$RUC_{PSI} = VOC \times F_{VOC,PSI}$$

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

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

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

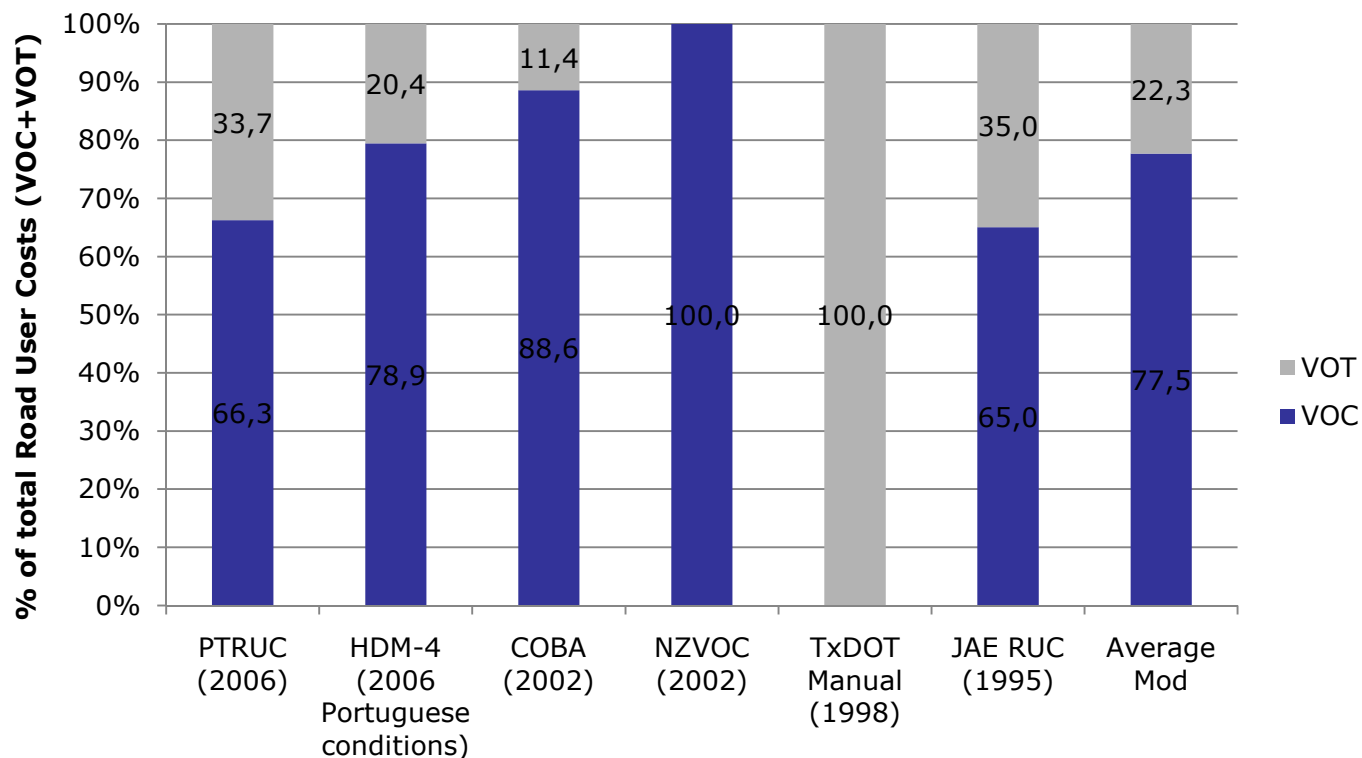
$$Toll = AADT \times \sum_{i=1}^4 (ctoll_i \times p_i)$$



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Model Validation

Passenger Car VOT and VOC distribution

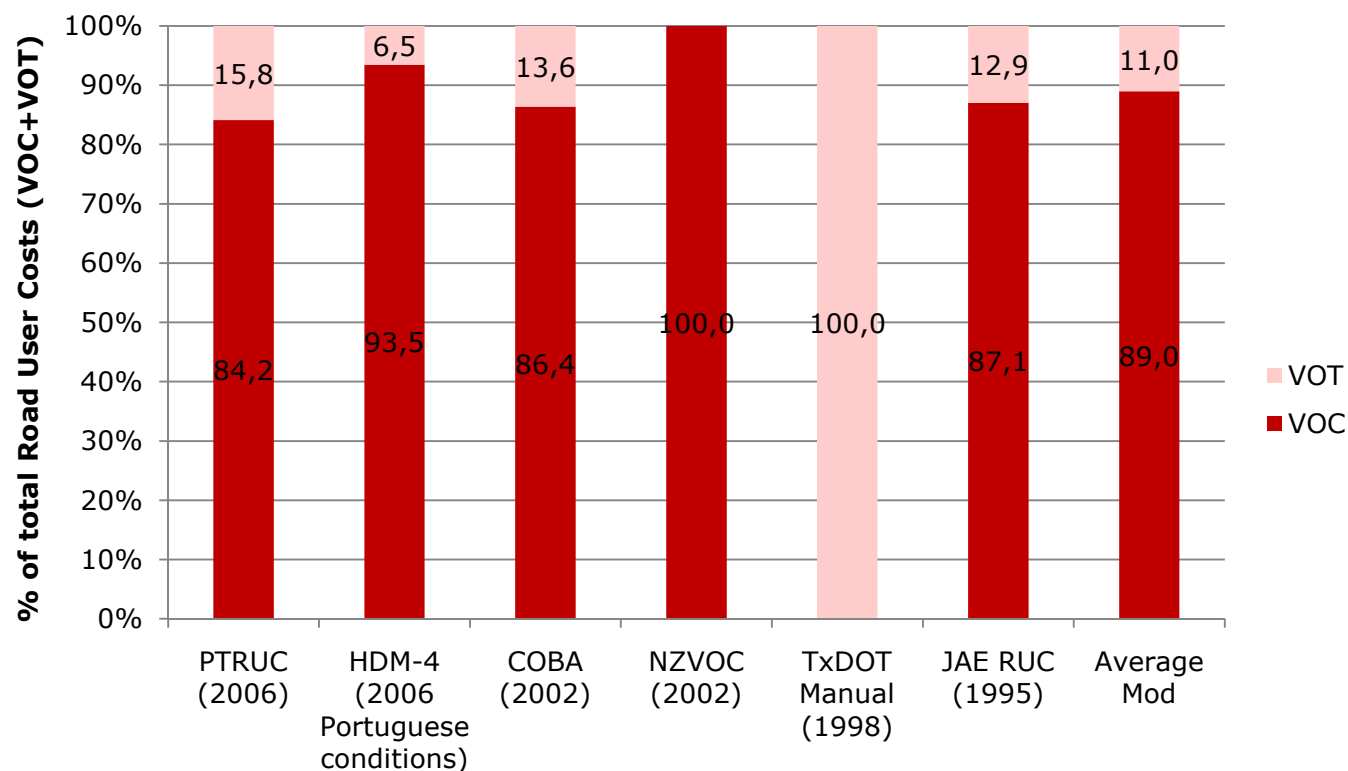


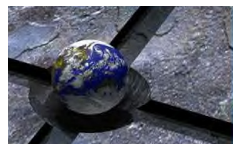


User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Model Validation

Heavy Truck VOT and VOC distribution





User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Sensitive Parameters of the Model

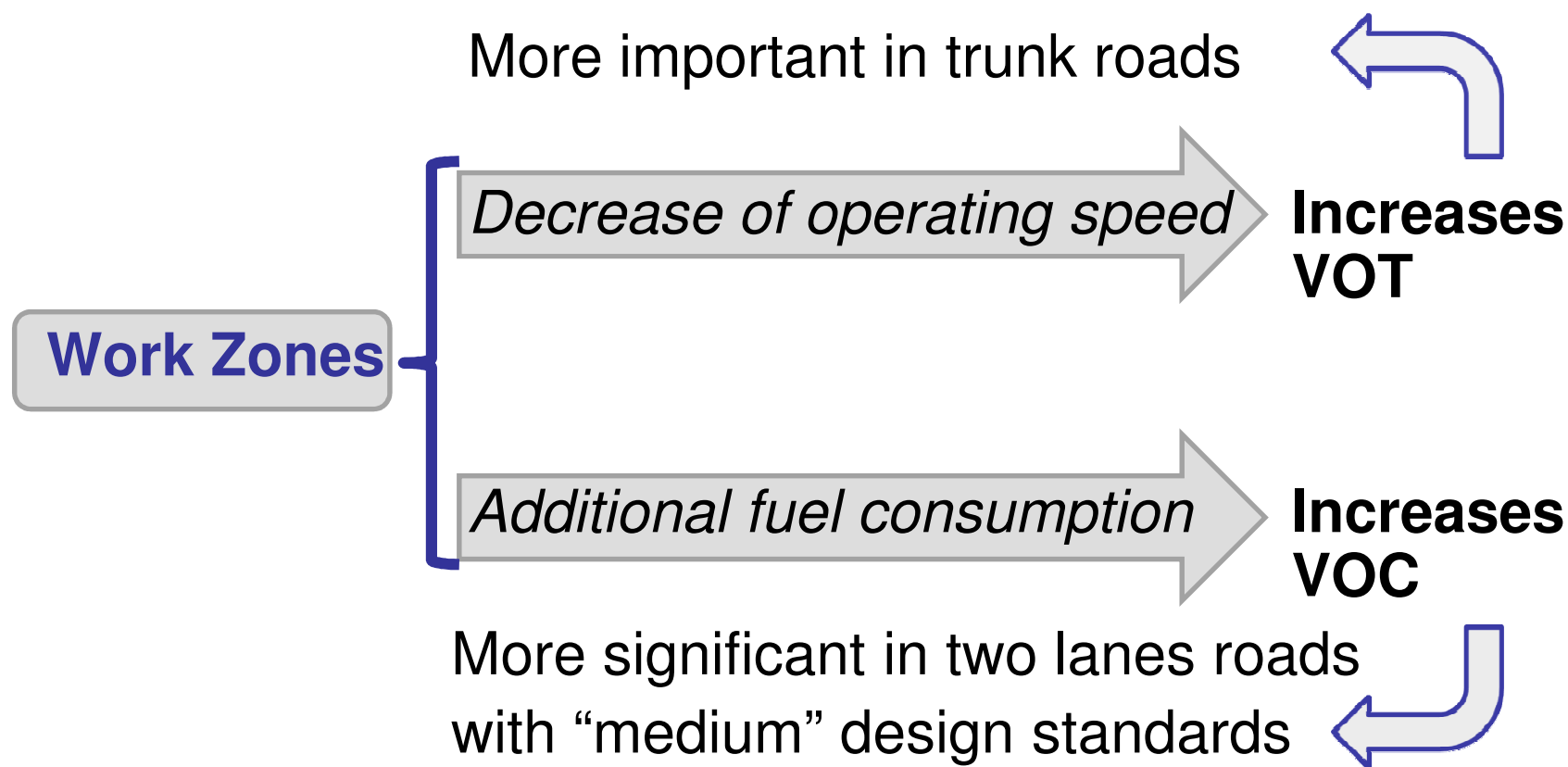
Vehicle operating speed

Fuel consumption and cost

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

User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Additional RUC due to Work Zones





User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

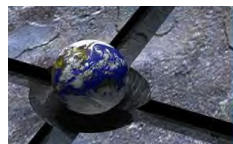
Additional RUC due to Work Zones

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

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

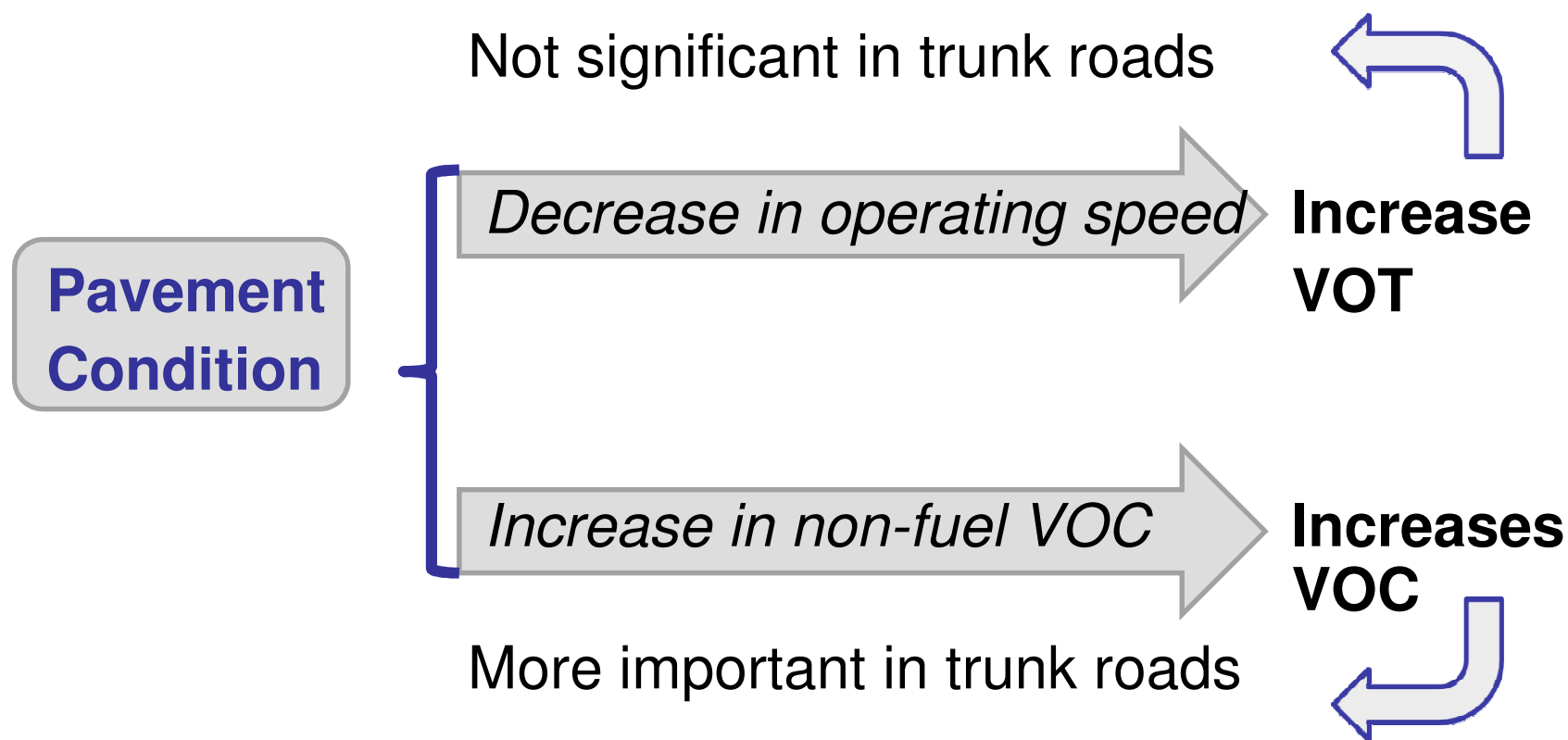
$$dVOT = AADT \times \sum_{i=1}^4 (VOT_{M\&R_i} \times p_i) - VOT$$

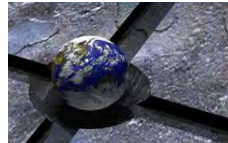
$$VOT_{M\&R_i} = 1/s_{M\&R_i} \times \sum_{m=1}^2 (TC_m \times OR_{i,m})$$



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

Additional RUC due to Pavement Condition





User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

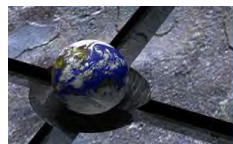
Additional RUC due to Pavement Condition

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

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

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

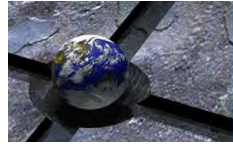
$$PSI = 5 \times e^{-0.0002598 \times IRI/2} - 0.002139 \times R^2 - 0.03 \times (C + S + P)^{0.5}$$



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

RUC Model Applications Results

Costs	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	
	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%



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

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, its 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.



User Costs Model for Road Management Systems - A Simplified Approach for Portuguese Conditions

**THANK YOU FOR YOUR
ATTENTION!!!**