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#### INTERNATIONAL CONFERENCE SUSTAINABLE SOLID WASTE MANAGEMENT

### ATLANTIS HOTEL Heraklion, Crete Island, Greece nvestigating the influence of eliminary processing of waste of Technology tires on collection and transportation costs and vehicle emissions

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# And for electric vehicles... time for end of life of tires



Global demand for car and light commercial vehicle tires is about 1,63 billion units. In the European Union, more than 3.93 million tons of waste tires are produced annually.



## Reverse supply chain of waste tires

So, how can we handle with large amou waste tires? By the efficient reverse supply chain!



## Primary sources of end of life tires



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## Destination of end of life tires





## Loading and transportation

But what abo Ioading and transportation waste tires?

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# Loading and transportation of end of life tires



## Reverse supply chain of waste tires



## Scenarios for ELT collection















## Methods of loading and payload volume of a truck

Method of loading or preprocessing ELT	Payload capacity for truck and trailer [m <sup>3</sup> ]	Payloa d mass [t]	Average number of ELT Full load (truck and trailer)	Volume of payload ratio and potential increase of ELT [%]
loosely	68	9.1	1150-1250	100%
cutting	68	11.9	1550-1650	135%
baling	68	16.6	2100-2200	180%
packing (doubling)	68	15.9	2070-2170	170%



## Collection of ELT in Poland

### And for the case study of ELT collections in Poland...







# Cost of the ELT collection and transportation

can simplify it  $v_v + C_l + C_p$ 

As the manager of ELT collection company I would like to know the costs.



# Input parameters and results of costs

	Input parameters									
	Scenario*	Payload Mass [tons]	Number of routes	Vehicles' distance for o route [km]						
	A0	9.1	11		900					
	BC	11.9	8		1138					
	BB	16.6	6	1360						
	<b>B1</b> →2	15.9	6	<b>6 1360</b>						
	<b>C0</b>	9.1	11		667					
	<b>C1→2</b>	15.9	6		718					
cen	arið is for t	he reference v	alue 100 toh	sof ELT	321					
	C0 4526	110	2	2	132					

## Vehicles' exhaust emissions

### And what about vehicles' exhaust emissions?



# Vehicles' exhaust emissions for scenarios



How can I find the best solution or the best scenario for the ELT collection?



#### Et ingrefenen bertanking Dig METHON HOFE Everichment m**et**i ws for applying many tenset deel generations of a Growand fonitarian gavallars of readthil ever istrate, white prover the assigned problem. The issessed certifices competentitie leaf levelportanectere critteria stragle, footbacks evaluation, atotheasanpairimeer the esy aluation promedure invelves a pairwing subjective comproposate detailing variables is Piotr Nowakoaskulated.

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Qualitative description of the relation of A entity to					
B entity					
A is the same as B	1				
A is slightly preferred	3				
A is strongly preferred	5				
A is very strongly preferred	7				
A is extremely preferred	9				

#### Assessment for the upper level

	Criteria for highly developed society (HDEV)							
A	В	Assessment	Value	Justification				
EI	тс	A is the same as B	1	Managers are aware of the issue of environment protection				
EI	мн	A is slightly preferred	2	A little more of additional man-hours is acceptable for effective environment protection				
МН	TC A is the same as 1			Managers often prefer limiting the contribution of human labor, but man-hours are simply a cost				
Criteria for developing society (DEVC)								
Α	B	Assessment	Value	Justification				
EI	тс	B is preferred	1/5	Despite the environmental awareness managers are under the pressure of financial results				
EI	мн	B is slightly preferred	1/3	Other criteria except costs seem to be less important; however, they are satisfied if possible. Additionally, human labor is a cost, thus it is a bit more important				
MH	TC	B is slightly preferred	1/3	Man-hours aresimply a cost, but whenever it is possible the costs are decreased, even causing an increase in workload				

### **Assessment for the lower level (only EI)**

A	В	Assessm	nent	Valu e	Justification						
РМ	CO <sub>2</sub>	A is sligl preferr	htly ed	3	Althoug recently	h the awa common,	areness the sho	of greer ort term	nhous impa	e eff ct of	ect is smog
NO <sub>x</sub>	CO <sub>2</sub>	A is sligl preferr	htly ed	3	generat importa	ing comp nt to the h	oonents uman he	seems alth	to	be	more
	bsol	l <b>uite weig</b> B	hts of	<mark>cộn</mark>	siderec	factors	hents ha	<b>oth var</b>	iant	<b>'s</b> If imp	act
					HDEV	DEVC	-				
			CO <sub>2</sub>		0.058	0.014					
			NOx		0.176	0.043					
			PM		0.176	0.043					
			ТС		0.330	0.640					
			МН		0.260	0.260					



## Final results for both variants

	HDEV							
	b	inary funct	ion	linear function				
Scenario	Φ+	Φ-	Φ	Φ+	Φ-	Φ		
Α	0.16	0.85	-0.69	0.08	0.37	-0.29		
BC	0.19	0.80	-0.61	0.04	0.35	-0.31		
BB	0.50	0.43	0.07	0.15	0.20	-0.05		
<mark>B1→2</mark>	0.48	0.43	0.05	0.14	0.19	-0.05		
<mark>C0</mark>	0.64	0.36	0.28	0.25	0.18	0.07		
<mark>C1→2</mark>	0.95	0.05	0.90	0.65	0.02	0.63		
			DE	<b>VC</b>				
	b	inary funct	ion	l	inear funct	ion		
Scenario	Φ+	Φ-	Φ	$\phi_+$ $\phi$ $\phi$				
Α	0.16	0.85	-0.69	0.08	0.32	-0.24		
BC	0.16	0.84	-0.68	0.01	0.38	-0.37		
BB	0.50	0.49	0.01	0.12	0.22	-0.10		
<mark>B1→2</mark>	0.42	0.56	-0.14	0.09	0.24	-0.15		
<b>C0</b>	0.80	0.20	0.60	0.29	0.12	0.17		
<mark>C1→2</mark>	0.95	0.05	0.90	0.70	0.01	0.69		





## Conclusions

- We investigated the influence of preprocessing of waste tires to compact them for transportation purposes including cutting, packing tires and bailing.
- The results show the preprocessing is desired for the reduction of total costs of collection and transportation. The most profitable method is the collection by large payload heavy vehicle with preprocessing tires in the collection points.
- We investigated the possibility of using packing (doubling) machine for the ELT as the cheapest alternative for the necessary equipment, although other packing methods are also possible.
- The evaluation of costs. labor time, and ELT collection vehicles'

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## Thank you for your attention Σας ευχαριστώ για την προσοχή σας





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