

Sustainable Mobility for Tourists at the Dutch Coastal Islands (Waddeneilanden)

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Abstract

The European Coastal Islands around the North sea, are joined together in a project that stimulates sustainable development. Within this 'Cradle-to-Cradle Islands' project, some islands were selected as breeding grounds for potentially sustainable projects. One of these projects was the development of a device for transport: the "Vrachtfiets". A Vrachtfiets is a modular electric-assisted, two person, cargo-bicycle that enables the creation of custom made mobility solutions. The design of the Vrachtfiets includes a Product-Service System (PSS) as an integral solution to both local transport needs and transport needs to and from the island Ameland.

Currently, the majority of the tourist families take their cars to the island (by ferry), since the hassle of carrying luggage is too much to use the public transport system (local busses). For these tourists, a PSS has been designed that provides them with an alternative to transport themselves, their family and their luggage between the ferry and the holiday park without a car. This reduces the amount of cars on Ameland, saves tourists their money and creates a unique and fun experience.

Eco-Costs and the Eco-Costs/Value Ratio (EVR) have been used to assess the sustainability of the Vrachtfiets PSS. It can be concluded that approximately 90 Vrachtfiets movements can be made for each car movement in terms of Eco-Costs. EVR calculations indicate that the value based eco-efficiency is around 16 times better, compared to tourists using cars. PSS and C2C aspects were taken into account.

Keywords

Design, Sustainability, Eco-Costs/Value Ratio, C2C islands, Bicycle

1 The Cradle-to-Cradle islands project

The islands in the North Sea Region are facing many common problems: geographical isolation, a lack of local resources (energy, materials, water supply), high environmental pressure on nature and resources by tourists, and declining populations.

The Cradle-to-Cradle Islands project will focus on the development of new and sustainable energy-related technologies and strategies, in line with the Cradle-to-Cradle philosophy (Braungart, 2007), on islands around the North Sea Region. It is a collaboration of 22 different partners out of 6 countries from the North Sea area (The Netherlands, United Kingdom, Germany, Denmark, Sweden and Norway). The project runs from 1 January 2009 to the Summer of 2012.

The main aim of the Cradle-to-Cradle Island project is to accommodate tourists with systems which have a low environmental impact (lower than the current systems), combined with a high customer perceived value (so that the tourists enjoy their visit, and come back).

2 Mobility at Ameland

Ameland is one of the Dutch Coastal islands (Waddeneilanden), located at approximately 10 km distance from the Dutch shore, see Figure 1. The length is approximately 24 kilometres.



Figure 1: Ameland and the Dutch coast

One of the issues at Ameland is that the tourists (especially families) are taking their car to the island, since they don't like the hassle of carrying their luggage in public transport systems (like the bus system on the island). Once they have their own car on the island, they tend to continue to use it, e.g. for shopping (Gemeente Ameland, 2009). The Vrachtfiets is designed to provide a sustainable alternative for the car which gives comfort and fun.



Figure 2: Klein Vaarwater at Ameland

The biggest holiday park on the island is “Klein Vaarwater”, positioned between the small village of Buren and the beach. See Figure 2.

The first Vrachtfiets for tourist purposes was designed in the context of the holiday park Klein Vaarwater and its customers. In the end of November 2009 employees and tourists were interviewed. Issues were:

1. What are the activities of the tourists? How do they transport? What modules of the Vrachtfiets concept should be developed? What are the requirements and wishes of these modules?
2. What are the benefits of a Vrachtfiets system relative to the current situation and the vehicles that are being used?
3. What are the financial implications?

The results of a small tourist poll have been summarized in Table 1 and Figure 3. It can be seen that most of the tourists are very interested in using a Vrachtfiets, 70%. It can also be seen that most of the tourists bring their car along to Ameland, 73%. This combination of facts shows the high potential for the Vrachtfiets as a sustainable solution for tourists on Ameland.

Being confronted with the concept of the Vrachtfiets, the employees of holiday park Klein Vaarwater were interested in Vrachtfiets in relation to their daily works:

- the cleaning employees of the holiday park
- the technical service employees of the holiday park

The combination of an electric-assisted, two person, cargo-bicycle seems to be very convenient for these kinds of jobs. Hence it was decided to design three modules for the Vrachtfiets with different functionality.

- a module for carrying goods
- a module for tourists
- a module for the cleaning employees

A prototype for the tourists module was made and together with the existing cargo module, that was used for testing the carrying of goods and cleaning utensils, these were evaluated (see Figure 4).

Table 1: Summary of the small tourist poll

#	people		luggage					transport				Interested in Vrachtfiets?				
	adults	children	suitcases	rollercases	bags	backpacks	others	feedback				yes	no	feedback		
1	2				4	2		Wanted the car on the boat but it was full. Therefore left at Holwerd and took cab on Ameland				1		Only for travelling from and to Buren, not for the rest. Something for the summer and would like to use with friends in the summer		
2	8		8		2			With two cars and left at Holwerd. On Ameland they took the bus				1		Nice, but should not be more expensive as public transport. Should also be able to rent for a longer period		
3	8	2						Two cars on the boat because of little ones				1		Nice for the summer. Then the car can stay in Holwerd.		
4	6	1						The three families and their luggage all came in one camper				0,5	0,5	Nice for the summer. Would be fun with (grand)children, not for myself		
5	2				3			Car on the boat because she found it difficult to walk because of a physical impairment				1		For people that can walk very easily it can be interesting		
6	2							With their Nissan Vanetta on the boat, full with luggage and foods - a lacy week				1		Would be interesting and the car can stay in Holwerd then		
7	10			3	8		1	Two cars on the boat, then they did not used them for the whole week				0,5	0,5	Not ideal because you actually want to hire some bicycles. Vrachtfiets would not be used during the week like the car isn't used		
8	5							Two cars on the boat					1	With lots of luggage and a person that cannot walk very well we would not use it		
9	7	2	1		10		5	Two cars on the boat, brought 2 bicycles					1	We have too much luggage, for two other persons that might not be a problem		
10	8	1	1		12			One car stayed in Holwerd and one car to Ameland because of the costs				1		Would be handy and then the other car can stay in Holwerd as well		
												7		3		
												0,7		Fraction of people that is potentially interested		
												type		amount vehicles	people transported	fraction
												car		11	47	0,73438
												camper		1	7	0,10938
												bus		1	8	0,125
												bicycle		0	0	0
												taxi		1	2	0,03125

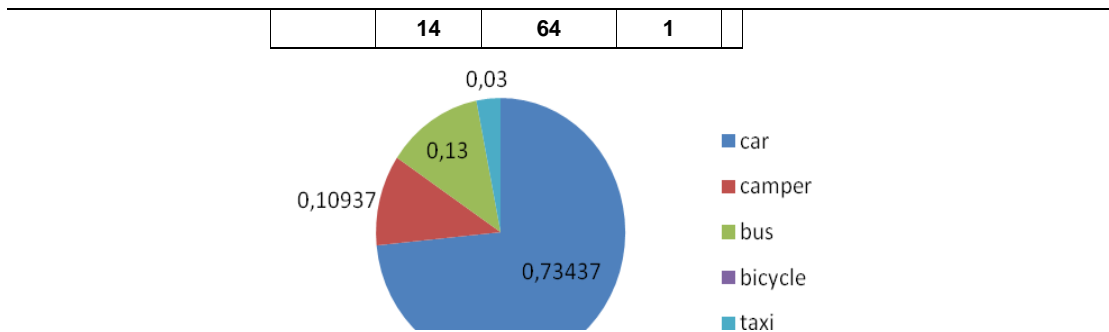


Figure 3: Fractions of tourists that use a certain kind of modality on Ameland

3 The solution

The solution is a modular cargo bicycle, that can be adapted to many different kinds of user requirements by the replacement of the cargo hold.



Figure 4: Two prototypes: the green one for carrying goods and the white one for tourists

There are two important questions regarding this solution:

1. how much is the environmental benefit of using a Vrachtfiets in relation to using a car?
2. does the Vrachtfiets generate enough customer value to make it attractive and to cover the costs?

The first question is dealt with by an LCA on the subject, applying two types of single indicators:

- the eco-costs, a prevention based indicator in LCA (Vogtländer, 2010), see also Wikipedia <http://en.wikipedia.org/wiki/Eco-costs>
- the Carbon Footprint, a single issue indicator in LCA, based on “kg CO2 equivalent”

The system which is studied includes the boat trip and transport on Ameland, see Figure 5.

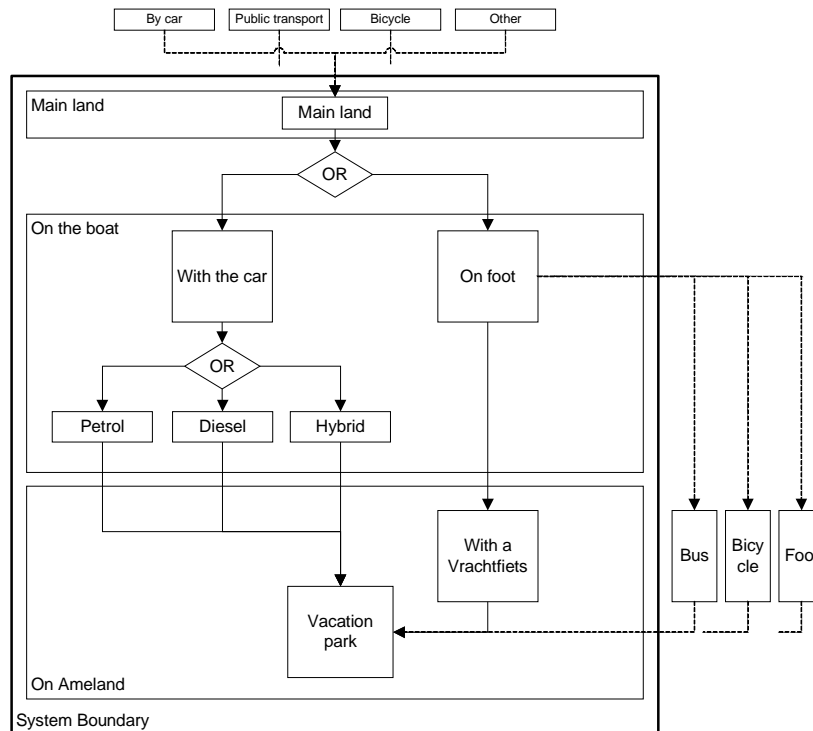


Figure 5: The transport system as studied in the LCA

People arrive at the harbour in Holwerd with OR without car. The car can either be petrol, diesel or hybrid. Vrachtfiets is competing with cars because they share the capacity to transport families and their luggage. The bus, other bicycles and walking, are excluded from the model. The bus is excluded because it does not compete with Vrachtfiets on a visitor experience level while at the same time, does not offer a door-to-door and on-demand transport solution.

It is assumed that:

- There are four people in one car
- There are four people on one VF (Vrachtfiets)
- Cars used in the model are "newer" models that likely will ride around in the present and near future
- The distance between the harbour and the park is 4 km
- The amount of people that use a car to go to Klein Vaarwater is estimated to be 73%

- The amount of people that use a Vrachtfiets is carefully estimated to be 5% of the car users

Data about cars was taken from the 'cars emissions 2007 database' from www.ecocostvalue.com. This is empirical data collected by the Delft University of Technology. Petrol, diesel and hybrid cars were taken for comparison. The models taken are relatively new and efficient. This makes the comparison valid for now and in the near future.

Table 2: CO2 emissions of modern cars

		motor cm3	power kW	fuel l/100km	CO2 g/km	Engine
Petrol	Citroen C1 1.0i ambiance	998	50	5,9	137	Otto
Diesel	Citroen C1 1.4 HDi ambiance	1398	40	4,5	120	Diesel
Hybrid	Toyota Prius 1.5 executive (Hybrid)	1497	82	5,0	119	Hybrid

Data about the barge was taken from the 'Ecocosts 2007 LCA data on products and services V2.2' from www.ecocostvalue.com. This table provides the results of calculations on Idemat and Ecoinvent LCIs by means of Simapro.

Table 3: CO2 emissions and eco-costs of a barge

	Eco-costs		kg CO2 equiv.	
Idemat2008 Barge	€ 0,016892	/tkm	0,0463	/tkm

The total amount of Carbon Footprint and Eco-Costs for the total system have been calculated. Table 4 represents the emissions for each type of vehicle.

Table 4: CO2 emissions and eco-costs of the Vrachtfiets

	g CO2 equiv.		Eco-costs	
Eco costs of charging battery	59,14	grams CO2	€ 0,029167	/per battery
Eco costs of one Vrachtfiets round trip	14,79	grams CO2	€ 0,007292	/per trip
Eco costs of one Vrachtfiets round trip per person	3,70	grams CO2	€ 0,001823	/per trip/person

Table 5: CO2 emissions and eco-costs of the ferry

	g CO2 equiv.		Eco-costs	
car back and forth to Ameland on ferry	832,8	/ car	€ 0,3041	/ car

Table 6: CO2 emissions and eco-costs for cars at Ameland

	Petrol	Diesel	Hybrid		Petrol	Diesel	Hybrid
Eco-costs at Ameland per car	1096	960	952	grams CO2	€ 0,40	€ 0,36	€ 0,34
Eco-costs at Ameland per person	274	240	238	grams CO2	€ 0,10	€ 0,09	€ 0,08

Table 7: CO2 emissions and eco-costs per round trip

	Petrol	Diesel	Hybrid	VF		Petrol	Diesel	Hybrid	VF
Eco-costs per round trip (round-trip)	1929	1793	1785	14,79	grams CO2	€ 0,70	€ 0,66	€ 0,64	€ 0,0072

Eco-costs per round trip per person	482	448	446	3,70	grams CO2	€ 0,18	€ 0,17	€ 0,16	€ 0,0018
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It can be concluded that 120 - 130 Vrachtfiets movements can be made for each car movement in terms of carbon Footprint and 88 – 96 Vrachtfiets movements in terms of Eco-Costs.

The second question is: does the Vrachtfiets have enough customer value to make it attractive and to cover the costs?

To answer this question, user tests were organized on Ameland, see Figure 6. Multiple groups of tourists were asked to transport themselves, the children and their luggage using Vrachtfiets. The general reaction of the people is one of immediate enthusiasm and willingness to try the Vrachtfiets. Four out of five tourists, claim that they would use it when it would be available. One of five has some doubts. The amount of money tourists would be willing to spend is around €10-€15 per round trip. All tourists indicate that the reason for car usage are their luggage and kids. They seem to agree on the fact that a Vrachtfiets should be reserved on beforehand (by them) to ensure availability when they arrive. Only then would they dare to leave their cars behind.

Tourists indicated the following benefits:

It is an alternative for bringing their car to Ameland. Thereby it is greener, less expensive, much space is available and children like it.

Tourists indicated the following areas for improvements:

It does not provide cover from the rain; it is limited in luggage space and this space cannot be locked; the lock on the door should be on the outside, away from the reach of children.



Figure 6: User tests at Ameland

4 Analyses on system sustainability

In general, innovative sustainable designs (like the Vrachtfiets) must fulfil a double obligation:

- the new design must have a lower eco-burden (otherwise it is not sustainable)
- the new design must have a better perceived customer value (otherwise customers will not buy it)

At the Delft University of Technology we call this “eco-efficient value creation” (Vogtländer, Mestre, 2009).

In LCA benchmarking, the two systems which are to be compared, must have the same functionality and quality (= the same “functional unit”). It remains to be seen if the Vrachtfiets and the car have the same “functional unit”, since the systems are quite different. In such cases, the two systems should be compared in terms of “value based eco-efficiency”. The EVR (Eco-costs / Value Ratio) is such a measure of eco-efficiency (Vogtländer, 2010). It is claimed that the EVR is the only scientific way to compare two systems with a different functionality and quality, since it is an indicator of the delinking of economy and ecology (the real issue in sustainability). See Wikipedia http://en.wikipedia.org/wiki/Eco-costs_value_ratio.

The eco-costs have been calculated in the previous chapter. The value expresses the value perceived by a customer. Perceived customer value is something like “*the use and fun*” that is expected by the customer. The perceived customer value can be derived by marketing research. In this case the tourist poll is used as a feedback for perceived customer value. This was around €15, per round trip for the Vrachtfiets. As the perceived customer value for using a car on Ameland, the ferry price is taken. Table 8 and Figure 7 display the EVR for cars and Vrachtfiets.

Table 8: The EVR of cars and Vrachtfiets

vehicle	petrol	diesel	hybrid	Vrachtfiets
eco-costs [€]	€ 0,70	€ 0,66	€ 0,64	€ 0,01
perceived customer value [€]	€ 84,30	€ 84,30	€ 84,30	€ 15,00
EVR	0,008360189	0,007866616	0,00763024	0,000486109
Times, relative to Vrachtfiets	17	16	16	1

Figure 7 displays the EVR graphically. The EVR of all alternatives are relatively low. The EVR of the cars are low because of the high price they pay for the ferry. The low EVR of Vrachtfiets is explained by that fact that Vrachtfiets has very low eco-costs.

Vrachtfiets could improve its EVR by using electricity from renewable (local) resources. Solar energy could be used to power the internal battery and reduce EVR and at the same time inspire people. Another way to improve the EVR of the Vrachtfiets is to try to enhance the customer perceived quality even further, which is done by improving the next prototypes.

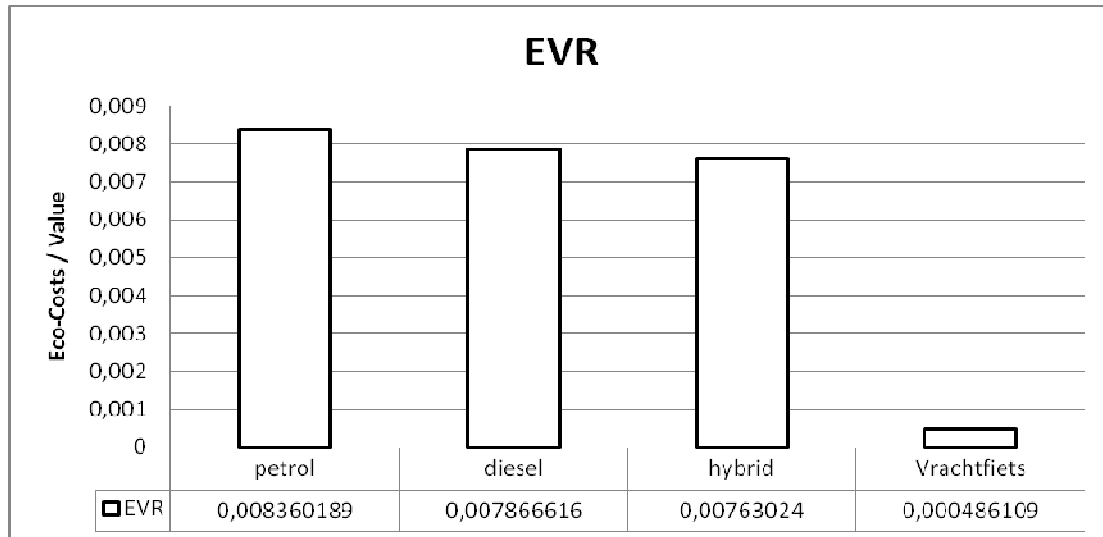


Figure 7: The EVR of cars and Vrachtfiets

5 Discussion and conclusions

The following conclusions may be drawn:

1. the Vrachtfiets seems to have a good market position in the tourist industry
2. the sustainable development of tourism at the Dutch Coastal Islands can be supported by a Vrachtfiets system
3. the Vrachtfiets seems to have other applications than transport of tourists: it seems to be a good solution to support service functions as well (as a transport device for cleaning staff, maintenance staff, etc.)

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