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Economics Aspects of Beach Cleaning Trailer

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ABSTRACT

Beach litter collection is a concern for Bang Saen beach, one of the popular tourist attractions of Thailand. In order to solve this problem, a beach cleaning trailer was designed and fabricated with emphasis on the use of local materials and local production. The design trailer prototype 3.7x1.6meters was carried out using a three dimensional solid modeling computer program. This paper explores the economics of the beach-cleaning trailer in terms of payback period, charging rate to customer, working areas. The research provided some positive results on economics aspects.

1. Introduction

Bang Saen beach is a 5-km long coastline in Chonburi province, East of Thailand. During January to October of each year, about 10 cubic meters of litter is deposited on the beach per day. In the rainy season, wind storms will blow the refuse landward, thus bringing plastic bags, young coconuts shells, etc. onto the beach. The litter comes with the water flow from the Bangpakong river to the coastal area. Saensuk municipality has addressed this problem by installing a waste-trap floating barrier 5 km away from the beach, which can prevent some waste from coming onto the

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beach (Prakobkarn et al., 2012). This barrier has been used for a long time and is now damaged. The Saensuk municipality has imported beach trash collection trailers, but the sea shore on Bang Saen has some slope and rough. It is found that the conveyor belt on the trailer has been damaged by rubbing against the trailer's side. Unfortunately, a replacement part would need to be ordered from abroad. To partially fix this problem, Saensuk municipality officials then used a loader tractor with a rake attachment to clean the litter from the coastal areas in the morning. Even though, there have been several inventions on beach cleaning apparatus (Kratzer, 1979; Gilmour, 1976; Baxter, 1992; Ohzeki et al., 2001; Arai, 2011; Higinio, 2006), our research is based on locally design and fabrication such that the beach-cleaning trailer is suitable for the difficult terrain and made with local materials.

2. Materials and Methods

2.1 Study on the amount of litter at Bang Saen beach

Data were collected from the beach to learn the composition of litter by random sampling from five sections, each 200meters long. The result in percentage is presented in Figure 1.

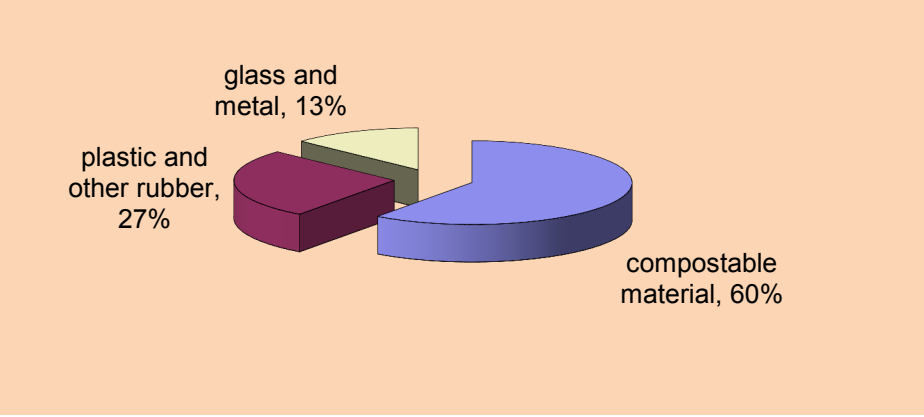
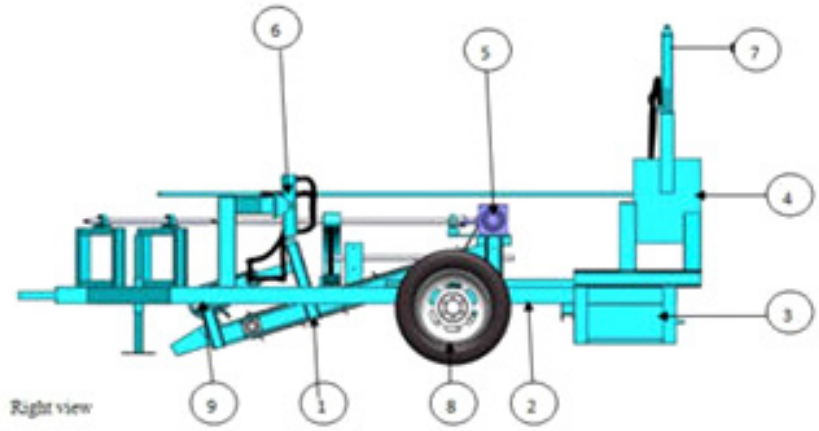


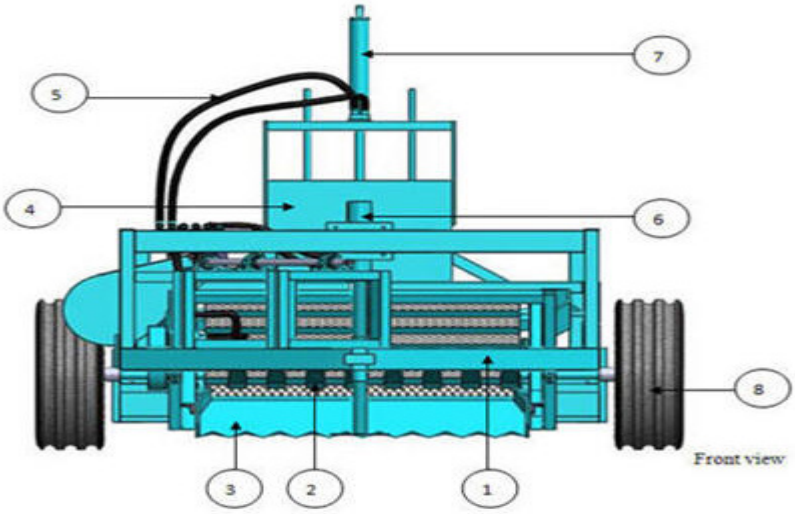
Figure 1: Type of trash.

2.2 Beach-cleaning trailer description

The beach-cleaning trailer is towed by a tractor. The major parts of the machine are: transporting and shaking system, transmission, conveyor, shaking sand tray, hydraulic system, back hydraulic system and reel of blade. The schematic diagram of the beach-cleaning trailer assembly is given in Figure 2A and 2B, while dimensions are given in Table 1.



(A)



(B)

Figure 2: Beach-cleaning trailer
A: 1. Conveyor system 2. Shaking sand tray. 3. Trash tray 4. Hydraulic pressing bucket 5. Gear box 6. Front hydraulic cylinder 7. Rear hydraulic cylinder 8.Wheel
B: 1.Frame 2.Reel 3.Blade 4.Hydraulic pressing bucket 5 Hydraulic hoses 6.Front hydraulic cylinder 7.Rear hydraulic cylinder 8.Wheel.

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Figure 3: .Beach cleaning trailer prototype 1.cam 2. Gear box 3. Front hydraulic cylinder 4. Rear hydraulic cylinder 5. Hydraulic compressing unit 6. Shaking sand tray 7. Trash tray 8. Wheel 9. Transporting system

Table 1: Machine specifications.

Machine specifications	
Overall length	3700 millimeters
Overall width	1600 millimeters
Height	1 meter
Weight	1100 kilograms
Depth of digging	1-15 centimeters

Table 2: Fix cost estimations.

Item	
Initial purchase price	US$6,451.16
Expected life of machine	6-10 years
Interest	5 % per year
Repair and maintenance (40% of purchase price)	US$2,580.64
Operators' labor	US$ 26.20 per ha
Assistance worker	US$24.19 per ha
Hours of operation	120,000 hours per year

2.3 Economics of beach-cleaning trailer

Table 2 gives fix cost estimations of life and costs for beach cleaning trailer. Operation costs were fixed costs and variable costs. Fixed costs involved depreciation, taxes, insurance, housing and interest which occur regardless of whether or not the beach-cleaning trailer was used. Variable costs were directly related to the amount of use and included fuel, labor, maintenance and repair costs (Hunt, 2002). The charge for insurance was estimated one percent of the purchase price (RNAM, 1955) and the Straight Line Method Depreciation was used in the calculation. We have found the fix cost is US$0.81 per hectare.

Suravej (2005) suggested the computation of Break Even Point (BEP) and Pay Back Period (PBP) as follows

$$BEP = \frac{P\left(\frac{1}{Y}+0.5I\right)+RM)}{CR-Ld-Ls-F} \quad (1)$$

$$PBP = \frac{P}{A(CR-Ld-Ls-F-O)-0.5PI+RM)} \quad (2)$$

where

BEP	=	Break even point (ha/year)
PBP	=	Payback period (year)
P	=	Initial purchase price (US$)
Y	=	Expected life of machine (year)
I	=	Interest (% per year)
RM	=	Repair and maintenance (40% of original cost)
L_S	=	Operators labor
l_d	=	Assistance Labor
F	=	Fuel (US$/ha)
O	=	Oil (US$/ha)
CR	=	Charging rate to customers for machine operations (US$/ha)
A	=	Units of work done per year (ha/year)

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Table 3: Variable costs per unit (Harris Pearson Smith1955) and (Joseph k. Campbell, 1990)

Item	Cost
Fuel: 0.1 x Horse power x Fuel price per liter (0.1 x 92 x 29.99 Baht)	US$8.90 per hour
Oil :(5% x Fuel cost per hour) (0.05 x US$ 8.90)	US$0.44 per hour
Repair and maintenance : 40% of original cost ÷annual hours of operation (0.04 x 6,451.61÷120,000)	US$0.22 per hour
Operator labor	US$2.41 per hour
Total variable costs	US$9.56 per hour
Variable cost per hectare: Total variable costs per hour divided by hectare per hour (US$9.56 ÷0.75)	US$12.74 per hectare
Total costs = Fixed costs plus total variable costs	US$0.81+ US$12.74 = US$13.55per hectare

Putting numerical figures, we get

$$\text{BEP} = \frac{6{,}451.61(1/\text{Y} + 0.5\text{I}) + 2{,}580.64}{\text{CR} - 26.20 - 24.19 - 11.88 - 0.59}$$

$$\text{BEP} = \frac{6{,}451.61\left(\frac{1}{10} + 0.5 * 0.05\right) + 2{,}580.64}{72.58 - 62.86} = 348.46\ \text{ha/year}$$

$$\text{PBP} = \frac{6{,}451.61}{(\text{CR} - 62.86)\text{A} - 2{,}838.70} = \frac{6{,}451.61}{(100 - 62.86)300 - 2{,}838.70} = 6.70\text{years}$$

The beach cleaning trailer has an estimated lifespan 6-10 years. The varied estimated life (6, 8, and 10 years) and wage were used to find BEP. If the use of the tailor is more, then payback period is less. For the 10-year payback period, the working area per year is 348.46 ha and the wage is 72.58 US $ /ha, *see* Figure 4.

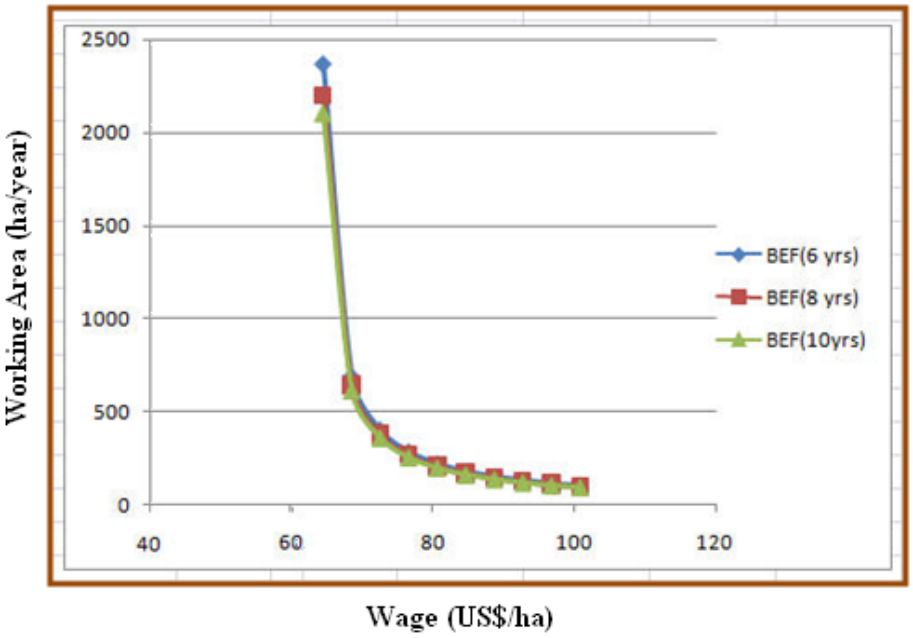

Figure 4: Plots of working area per year and wage with varying lifespan.

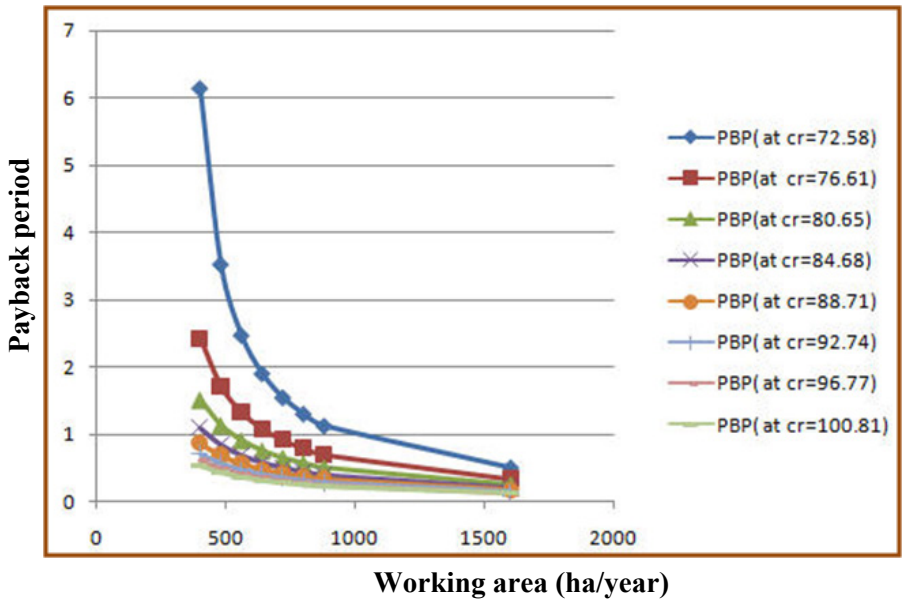

Figure 5: Plots of working area and payback period (years) using varying wages.

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3. Results and Discussion

Our beach cleaning trailer can operate at a maximum speed of about 6 kilometer per hour and the collecting capacity is 120 kilograms per hour under continuous operation. The engine speed is about 1600 rpm and the corresponding fuel consumption is 9.52 liters per hour. From Figure 5, the plots show similar trend that the payback period decreases when working area increase. When machine charging rate goes higher, the payback period also drops.

For a given 10-year payback period, with minimum charging rate to customers for machine operations US$72.58/ha, minimum working area is 358.39 hectare, *see* Figure 5. For normal usages, machine life span is about 15 years. As the beach cleaning machine exposed to salty conditions, machine life span is thus reduced. However, we expect that the machine life lasts longer than the 10-year payback period.

Every year during January to October, litter is problematic due to high volume and inwards wind blowing litters to the Bang Saen beach. Scavengers cannot pick all the litters in time. Our beach cleaning machine can greatly help to alleviate litter problem.

4. Conclusions

The design trailer prototype has been developed and fabricated with emphasis on the use of local materials and local production. The machine has been tested at Bang Saen beach in Thailand. We have explored the economics of the beach-cleaning trailer in terms of payback period, charging rate to customer, working areas. The research provided some positive results on economics aspects. We hope to further design and develop the fully mechanized beach cleaning trailer.

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