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TECHNO-ECONOMIC EVALUATION FOR PRODUCTION DFT SYSTEM HYDROPONIC INSTALLATION

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Abstract

The purpose of this study was to analyse the techno-economic for the production of DFT hydroponic installation. The study used an analysis of materials, tools, and costs for the production of DFT hydroponic installation. The results of the study showed that the production of installation arranged vertically promises prospects to be development. The raw material was made from light steel has the advantage of being stronger and solid installation. The vertical system type has more planting holes on installation. Production of a DFT hydroponic system installation was required of Rp. 4,720,000, the production of this installation will be profitable after being produced as many as 26 pieces. The price of this installation equipment was quite expensive, but it has benefits and is capable of being used in the long term for multiple years.

Keywords: Agribusiness, DFT, Hydroponic, Techno-economic, Vegetables.

1. Introduction

Techno-economics is a solution way to make a decision, which is limited by various problems to produce the best choice from various choices. Hydroponic technology is a plant cultivation system that does not use soil and produces fresher and healthier vegetable products and has a fairly high selling value on the market [1]. In making a DFT hydroponic system installation, economic calculations are needed. Thus, the products made can be profitable and produced sustainably. This DFT hydroponic system installation is a container for plants that has been set in such a way that it can provide good growing space for plants. The provision of macro and micronutrients in this system is circulated using an intermittent water pump. The DFT hydroponic system has advantages in relatively easy plant maintenance, uniform plant yields, and better and healthier plant quality.

Research related to techno-economics has been widely conducted in various fields (Table 1). This study aims to analyse the techno-economic aspects for designing a DFT hydroponic installation of the DFT using a steel frame and vertically arranged PVC pipes. The novelty of this study was an intermittent system that was applied automatically and connected to electrical energy.

Table 1. Previous reports related to techno-economic analysis.

No.	Title	Ref.
1	A comprehensive techno-economic analysis and multi-criteria optimization of a compressed air energy storage (CAES) hybridized with solar and desalination units	[2]
2	Techno-economic analysis and Monte Carlo simulation of green hydrogen production technology through various water electrolysis technologies	[3]
3	A techno-economic analysis of solar hydrogen production by electrolysis in the north of Chile and the case of exportation from Atacama Desert to Japan	[4]
4	Integration of techno-economic analysis and life cycle assessment for sustainable process design–A review.	[5]
5	Techno-economic evaluation of biodiesel production from edible oil waste via supercritical methyl acetate transesterification	[6]
6	Techno-economic analysis for the production of LaNi5 particles	[7]
7	Evaluasi ekonomi dari produksi nanopartikel magnesium oksida melalui metode *sol-gel combustion*	[8]

2. Theory of DFT Hydroponic System

The flow of designing a hydroponic installation of the DFT system was presented in Fig. 1(A). It can be drawn that in the process of installation of the DFT system, at least consist to 6 stages are required (Fig. 1(B)): (i) It requires light steel which was be used to design the installation frame; (ii) PVC pipes (2.5 cm) with distance among the plant holes of 15 cm was be used on planting containers; (iii) Clear fibre was needed for the roof of the installation so that plants are protected from rain but still get good sunlight; (iv) The water pump machine is used to flow and circulate hydroponic nutrients from one PVC pipe to another and provide bubbles in the nutrient tank so that plants get enough dissolved oxygen in the root area; (v) This netpot is a container whose size matches the planting hole in the PVC pipe, the netpot functions as a seed container that is hung on the nutrient flow; (vi) The nutrient container is a container for storing nutrients that are circulated in each PVC pipe that is arranged vertically in the DFT hydroponic installation.

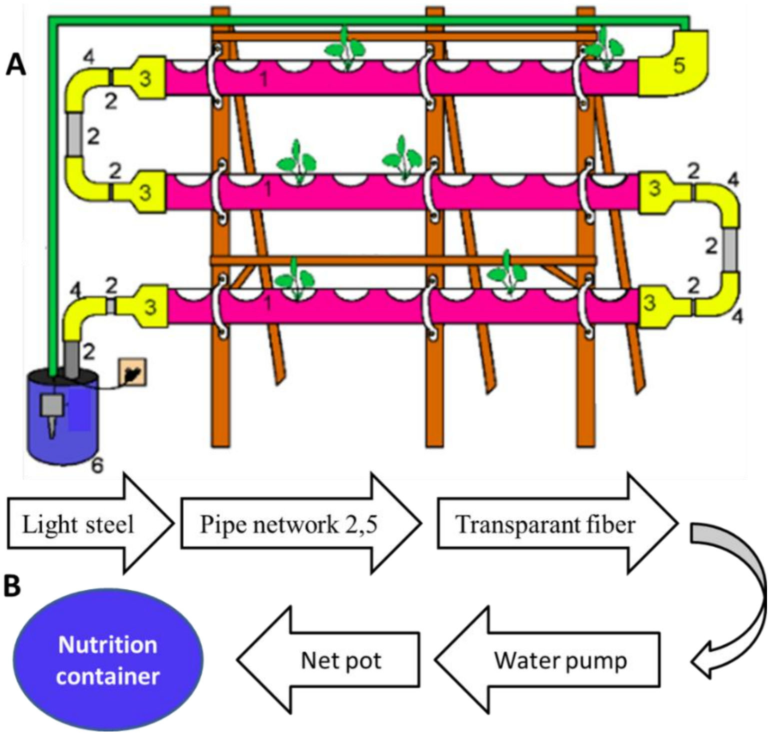

Fig. 1. Flowchart for designing a DFT hydroponic system installation.

3. Method

This study was carried out in several steps, namely basic design of the tool, assembly, or manufacture of the tool, testing the design results, observation, and data analysis. The method was used to analyse the materials and tools for designing hydroponic installations of the DFT system based on the average commercial price for products available on online shopping websites to ensure the latest price of materials. All data was calculated using simple mathematical analysis using Excel. The economic evaluation parameters used: CNPV, GPM, PBP, BEP, BEC, IRR, ROI, and PI. Then, when evaluating the feasibility, various conditions are tested, including changes in raw materials, sales capacity, labour conditions, interest rates, and others [9, 10].

4. Results and Discussion

The equipment and raw materials needed to design a DFT hydroponic system installation, the total manufacturing cost, and factors for estimating production were presented in Tables 2-5. This equipment has a relatively long service life.

Table 2. Equipment calculation.

	Equipment	Price (Rp)	Unit	Total (Rp)
a	Light steel	100,000	12	1,200,000.00
b	Pipe network	95,000	8	760,000.00
c	Transparent fibre	45,000	8	360,000.00
d	Net pot	1,500	200	300,000.00
e	Planting container	25,000	4	100,000.00
f	Socket cover	15,000	16	240,000.00
g	Drilling machine	1,500,000	1	1,500,000.00
Total				4,720,000.00

Table 3. Raw material calculation.

	Raw material	Small-scale production needs (kg/jam)	Price	Total
a	Seed media	1	50,000.00	50,000.00
b	Nutrient reservoir	1	300,000.00	300,000.00
c	hydroponic nutrients	1	100,000.00	100,000.00
d	Vegetable seeds	1	75,000.00	75,000.00
Total				525,000.00

Table 4. Total manufacturing cost.

No.	Item	Price
1	Raw Materials	135,000,000.00
2	Utilities	5,400,000.00
3	Loan Interest	-
4	Operating Labor	180,000,000.00
5	Labor-related cost	
	a. Payroll overhead	54,000,000.00
	b. Supervisory, misc. labour	45,000,000.00
	c. Laboratory charges	21,600,000.00
6	Capital-related cost	
	a. maintenance	10,800,000.00
	b. Operating supplies	1,620,000.00
	c. Environmental	708,000.00
	d. Depreciation	5,492,124.00
	e. Local taxes, insurance	2,196,849.60
	f. Plant overhead cost	54,921,240.00
7	Sales-related cost	
	a. Packaging	22,500,000.00
	b. Administration	45,000,000.00
	c. Distribution and marketing	45,000,000.00
	d. Research and development	22,500,000.00
	e. Patents and royalties	22,500,000.00
	Total Product Cost (TPC)	674,238,213.60

Table 5. Factors for estimating production.

Component	Parameter	Cost
Fixed Cost	Loan Interest	
	Capital Related Cost	75,738,213.60
	Fixed cost + Depresses	
	Depreciation	5,492,124.00
	Fixed Cost less depreciation	
	Total Fixed Cost	81,230,337.60
Variable Cost	Raw material	135,000,000.00
	Utilities	5,400,000.00
	Operating Labor (OL)	180,000,000.00
	Labor Related Cost	120,600,000.00
	Sales Related Cost	157,500,000.00
	Total Variable Cost	598,500,000.00
% Profit Estimated	Sales	2,250,000,000.00
	Manufacturing Cost	674,238,213.60
	Investment	58,868,040.00
	Profit	0.70
	Profit to Sales	26.77
BEP	Unit	300
	Fixed Cost	81,230,337.60
	Variable cost	598,500,000.00
	Variable cost	0.00
	Sales	2,250,000,000.00
	Sales	0.00
	BEP	14.75573798
	Percent Profit on Sales	0.700338572
	Return on Investment	28.69130024
	Pay Out Time	0.034732714

Cumulative net present value (CNPV) is a value that predicts the condition of a production project in the form of a production function in years. The CPNV value was obtained from the net present value (NPV) at a certain time. NPV is a value that states the expenditure and income of a business. Briefly, CNPV was obtained by adding the NPV value from the beginning of the project to the end of factory operations. The CNPV analysis to obtain minimum capacity requirements was shown in Fig. 2. CNPV predicted in detail when the production carried out begins to be profitable. The results of the study indicate that capacity plays an important role in the profitability of a project. A decrease in capacity has a direct effect on final CNPV [4].

The minimum capacity to maintain the production of the DFT system hydroponic installation must be more than 26%. Production of installations with a capacity of less than 26% will not be profitable. Figure 2 shows the relationship between CNPV/TIC and production time. The y-axis is CNPV/TIC, and the x-axis is lifetime (years). It shows a decrease in income in years 1 to 3, which is due to the large initial capital costs for the purchase of equipment needed to design a DFT hydroponic system installation. In the 4th year, the curve shows an increase in income, this condition is the Payback Period (PBP). Profits can cover the initial capital that has been spent, and profits continue to increase thereafter until the 20th year. Thus, the production of DFT hydroponic system installations can be considered a profitable project because this project requires a relatively short time to recover investment costs, since PBP is only about 4 years. This project is ideal to be run in industrial production to be able to support modern agriculture on limited land. Detailed information for calculating techno-economic analysis is explained elsewhere [11]. This study adds new information about techno-economic analysis, as reported elsewhere [12-16].

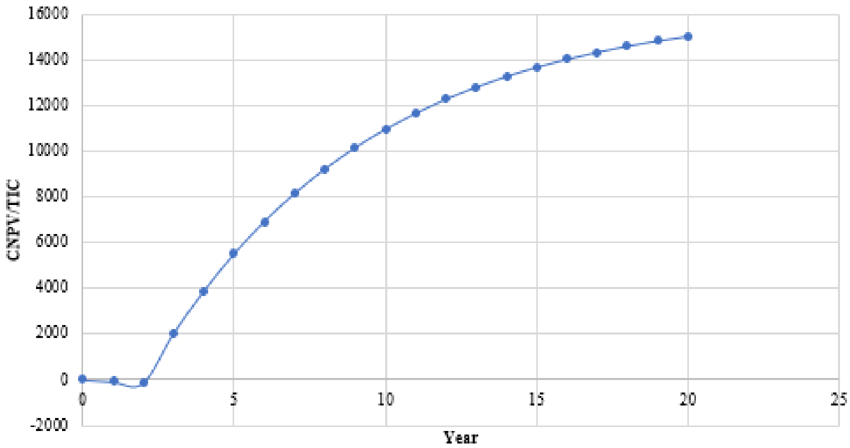

Figure 2. CNPV curve in various production years.

5. Conclusion

The production of a DFT hydroponic system installation arranged vertically was prospective to be developed. The frame material made from light steel has the advantage of being stronger and sturdier. The vertical system used related to this installation has more planting holes. To produce one DFT hydroponic system installation, the equipment costs of Rp. 4,720,000 was required; the production of this installation will be profitable after being produced as many as 26 pieces. The price of this installation equipment is quite expensive, but it has benefits and uses in the long term.

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