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Research Article

INCREASING COMPETITIVE ADVANTAGE OF TOMATO FARMING BASED ON COST STRUCTURE WITH BUSINESS INTELLIGENCE APPROACH IN MINAHASA, INDONESIA

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Abstract
Tomatoes are an important food for humans whose production and price must be maintained so that the commodity remains available to humans. The objectives of the study are (i) analyzing the cost structure of tomato farming in Minahasa district, Indonesia, (ii) analyzing strategies to increase the competitive advantage of tomato farmers based on the cost structure of tomato farming with a business intelligence (BI) approach in Minahasa district, Indonesia and (iii) provide recommendations for the concept of tomato farming technology based on improving the structure of tomato farming costs in Minahasa district, Indonesia. This research uses a quantitative approach with the BI method and was carried out in the tomato production center of Minahasa district, North Sulawesi. The results found that (i) the production cost structure of Apple Tomato farming, namely variable costs of Rp 53,600,054.44 / ha or 78.74 percent and fixed costs of Rp 14,475,057.00 / ha or 21.26 percent. Based on cost structure, the variable cost that can be reduced is human labor cost and the fixed cost that can be reduced is stake cost. The recommended innovations that can be applied are using tractors to replace human labor to make beds, and replacing bamboo stakes with plastic pipes. This innovation can increase the profit of tomato farming from Rp 99,122,272.83 per ha to Rp 108,456,162.83 or an increase of Rp 9333890.00 (9.42%) per ha and the BEP price from Rp 2,300 per kg to Rp 1,987.82 per kg or reduce by Rp 312.18 (13.57%) per kg.

Keywords: Business Intelligence, Competitive Advantage, Cost Structure, Minahasa, Tomato Farming

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INTRODUCTION

Indonesia is an argarian country and one of the critical sectors is the agricultural sector (Siregar et al., 2024). This agrarian sector provides jobs for rural residents, supplying food and contributing foreign exchange to the country (Liu et al., 2022; Azis & Clefoto, 2024). Therefore, increasing income in this sector needs attention. Tomatoes are one of the commodities cultivated by farmers in rural areas in this sector. North Sulawesi is one of the centers of tomato production in Eastern Indonesia (Badan Pusat Statistik Indonesia, 2024), and Minahasa Regency is a Tomato production center in North Sulawesi.Tomato production in this area is 580,670 quintals (Badan Pusat Statistik Provinsi Sulawesi Utara, 2024). This production is intended to meet the needs of the population of North Sulawesi, which is 206,190 quintals (35.41%), and to meet the needs of the surrounding areas (such as Papua, West Papua, Gorontalo, North Maluku, and Maluku) as much as 374,480 quintals (64.49%) (Sudarwan, 2019).

At the farmer level in North Sulawesi, based on observation in July 2022 to August 2023, tomato prices fluctuate from Rp 1,000 to Rp 25,000 per kg. The price mostly determined by farmers when the price highest and the buyer wher the price is lowest. When tomato prices are lowest, namely when the selling price per kg is less than the harvest cost, tomatoes should not be harvested by farmers. When tomato prices are highest, consumers must pay more than usual. That is the major marketing constrains must be solve to avoid farmers' losses (Mutayoba & Ngaruko, 2018). One way to reduce farmers' losses is to increase the competitive advantage of tomato commodities by reducing farming costs through innovation (Saptana et al., 2022). Thus, tomato farming will be more efficient in increasing farmers' income and supporting food security and independence in North Sulawesi.

One of the main problem of farmers in Minahasa is how to reduce cost production in order to increase the competitive advantage of tomato commodities (Saptana et al., 2023) (avoiding farmers from losses) on the one hand and how to provide tomato commodities remain available at prices that are affordable to consumers on the other. One way to increase competitive advantage is to know the cost structure of tomato farming. Based on the cost structure of this farming, Information on which costs can be streamlined in tomato farming is obtained so that the BEP price per kg is getting smaller (Tulungen et al., 2020). The allocation of human, fund, and natural resources will be reflected in the cost structure farmers allocate to produce tomatoes. The higher the price of tomatoes, the greater the allocation of resources. On the contrary, the lower the price of tomatoes, the smaller the resources allocated for production from tomatoes.

Business Intelligence (BI) is sometimes used as a synonym for competitive intelligence (CI) (Elena, 2011). CI is an approach, a method, a zet of technic used to collect, analyze, understand and disseminate intelligence (Madureira et al., 2021; Saputra et al., 2024). BI is a broad category of technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help its users make better decisions (Wixom & Watson, 2010). BI is a set of tools and techniques to use data for decision-making (Mashingaidze & Backhouse, 2017). In the era of Industry 4.0 and Society 5.0, advancements in information technology and communication are accelerating progress in various sectors, including tomato farming. The integration of Big Data and BI not only creates value but also enhances organizational performance (Elbashir et al., 2008; Liang & Liu, 2018; Syahputra & Edwards, 2024), thereby positively impacting sustainability (Cheng et al., 2023). Key factors driving the adoption of BI include its ability to streamline processes, generate actionable insights, and improve decision-making across agricultural practices (Dudija et al., 2023; Hyskaj et at., 2024).

The BI approach is a policy research method that provides recommendations as answers to research problems (Höchtl et al., 2016). The BI approach can create a competitive advantage for a commodity or company (Dou et al., 2020). The BI approach relies on information systems to find answers to problems faced by organizations (Zafary, 2020). The BI approach can be used by tomato farmers or tomato farmer organizations to solve their problems (Bimonte et al., 2021). The competitive advantage of tomato farming is the advantage of tomato commodities and the advantages of tomato farmers compared to others. The goods must be of quality at a cheaper price than competitors making tomato commodities superior. To create a competitive advantage, tomato growers must know their competitors and try to improve quality and lower prices. Innovation must be held to enhance input factors (innovation strategy) (Farida & Setiawan, 2022) so that production costs become cheaper (*cost leader)* (Mohamed & Ogada, 2019).

Innovation will affect farmers' production, marketing, management, and institutional processes. Innovation is essential to creating competitive advantages for farmers or products that must be carried out continuously to maintain or increase competitive advantage (Madureira et al., 2021)(Eshun & Tettey, 2014). Therefore, farmers must implement innovations so that farmers' products as companies still have a competitive advantage**.**

There are several other benefits tomato farmers obtain if they utilize competitive advantage strategies with the BI approach, including the cost of the production process becoming more efficient and the fact that farmers are active in agricultural innovation. Ultimately, tomato farmers (entrepreneurs) with an entrepreneurial spirit will be born. Many organizations or companies use BI to create efisiency business competition (Elbashir et al., 2008; Peters et al., 2016). BI is essential for farmers or farmer groups to maintain their performance in the industrial era 4.0 and society 5.0 (Tavera Romero et al., 2021), which is increasingly turbulent, uncertain, complex, and ambiguous (Madureira et al., 2021). The research results related to the profitability and feasibility of Tomato farming in Indonesia have been widely conducted (Saptana et al., 2023; Suwandih & Failurrahman, 2024; Tulungen et al., 2025). Still, research related to efforts to increase the competitive advantage of tomato commodities based on the cost structure of tomato farming with the BI approach has not been carried out. This is a research gap that will be answered in this research.

Based on this background, the objectives of this study are (i) analyzing the cost structure of tomato farming in Kamanga Dua village, Minahasa district, North Sulawesi, Indonesia, (ii) analyzing strategies to increase the competitive advantage of tomato farmers based on the cost structure of tomato farming with a BI approach in Kamanga Dua village, Minahasa district, North Sulawesi, Indonesia and (iii) provide recommendations for the concept of tomato farming technology based on improving the structure of tomato farming costs in Minahasa district, North Sulawesi, Indonesia.

RESEARCH METHOD

This study uses a quantitative approach with the BI research method as a policy research method (Dou et al., 2019). This method can produce development strategies for businesses and organizations(F. Tulungen et al., 2021). This research is done in tomato production centre of Minahasa, that are Langowan Barat, Tompaso Barat, and Tompaso district since July - December 2023. The population of this study was tomato farmers in the tomato production center of Minahasa Regency, namely West Langowan District, Tompaso District, and West Tompaso District. The research sample was determined by purposive random sampling of 60 farmers, namely 20 farmers in each district. The tomato farmer sample was determined intentionally with the condition of cultivating tomatoes in the period 2023. The source of the data is Farmer and documentation. The determination of data sources as samples or respondents in this study is by purposive sampling method, namely tomato farmers who plant and harvest throughout 2023 in Langowan Barat, Tompaso Barat and Tompaso district, Minahasa regency. Data collection is carried out using structured interviews. The collected data is analyzed by farm analysis.

The research instrument used a list of questions with data collection techniques carried out by means of structured interviews assisted by field observations and documentation. BI is an approach method and a set of tools used to analyze data and to create intelligence. BI is a circular process (Kahanner, 1997; Elena, 2011; Tulungen et al., 2021) (Figure 2).

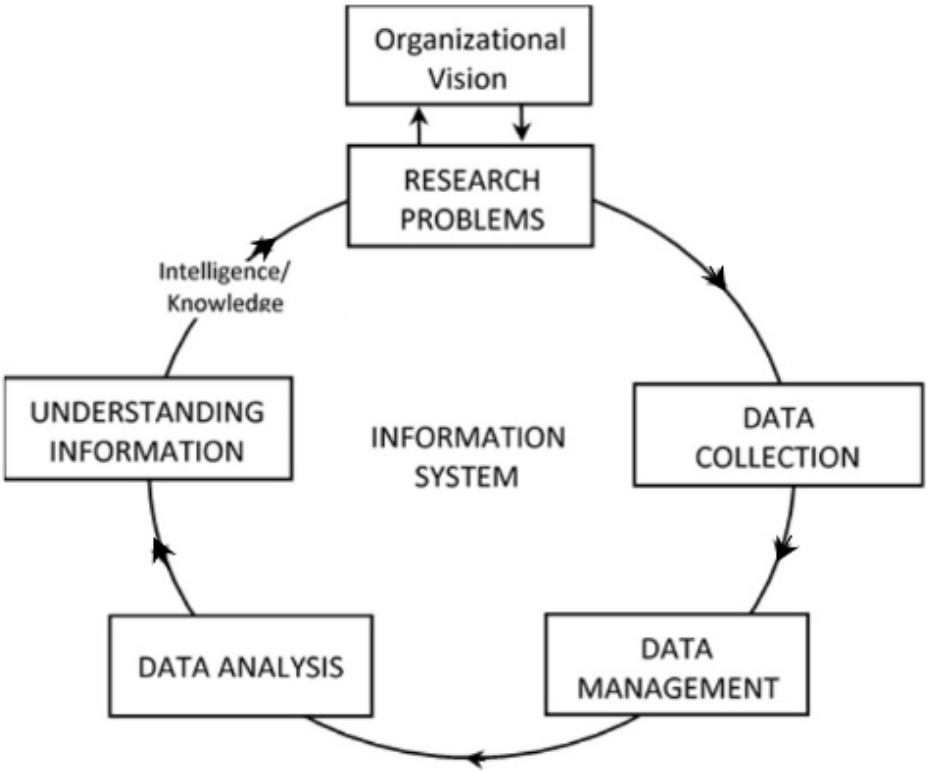

Figure 2. BI Research Methods.

The vision of farmers is tomato and tomato farmers in Minahasa production centers who have competitive advantages. To reach this vision use a BI approach. Begun to design the data collection. Data collected are farmer profile, production costs, yield production, and prices. Production costs are all costs farmers incur for a one-time tomato production process. Production costs consist of fixed costs and variable costs. Fixed costs are not directly related to the goods produced, including land rent, taxes, and equipment depreciation. Variable costs are direct costs that affect the amount of production by farmers during one production, such as labor costs, seeds, fertilizers, mulch, pesticides, tractor rental, and transportation.

Cost structure value (P) is the value of total variable costs (NTVC) times the value of total fixed costs (NTFC) divided by the value of total production costs (NTC) multiplied by 100 percent (Saraswati et al., 2021). BEP is a farming condition in which the total cost value (TC) equals total revenue (TR), equal to the total fixed cost value (FC) divided by the average price (P) minus the variable cost value (VC) (Suwandih & Failurrahman, 2024) (Pohan et al., 2023)(Abdurofi et al., 2021). The income level (Π) of tomato farming is the difference between total revenue (TR) and total cost (TC) where TR = Production (Y) x price (P) (Aula Zimah et al., 2023). The results of farm analysis are information that needs to be understood to create intelligence (Choo, 1996; Kašparová & Michalová, 2023). The cost structure analysis determines which costs can be streamlined and which have a real influence on reducing production costs and increasing profits of tomato farming. Understanding the results of this analysis uses scenario analysis. Scenario analysis assumes fixed production with particular improvements in production factors that provide maximum profit (Postma & Liebl, 2005).

RESULTS AND DISCUSSION

Tomato Farm Cost Structure

1. Variable Costs

Labor costs are the most significant cost component, amounting to 65.56% of total variable costs and 51.63% of total costs incurred in tomato farming. Family labor costs are the most considerable component of costs, followed by the cost of Production Facilities (seeds, fertilizers, mulch, and insecticides), amounting to 24.42% of total variable costs and 22.29% of total costs.

2. Fixed Costs

The cost of bamboos stake are the most significant cost component of fixed costs, amounting to 78.30% of total fixed costs and 16.65%, followed by land leases amounting to 17,275 of the total fixed costs or 3.67% of the total costs (Tabel 2).

Table 2. Structure of tomato farming cost per ha in Minahasa regency, 2023.

No	Cost type	Average Total (IDR)	Percentage	Percentage
I	Variable Costs		(VC+FC)	VC/TC; FC/TC
1	Labor Cost			
	In the Family	7,093,126.67	13.23	10.42
	Outside the Family	28,050,386.90	52.33	41.21
2	Cost of Production Facilities			
	Seeds	2,330,011.65	4.35	3.42
	Furadan	166,667.50	0.31	0.24
	Mulsa	5,000,025.00	9.33	7.34
	First fertilizer	2,100,010.50	3.92	3.08
	Followup fertilizer	1,615,700.00	3.01	2.37
	Pesticide	3,644,018.22	6.80	5.35
	Rope	333,335.00	0.62	0.49
3	Other Cost			
	Tractor/Plow Rental	1,266,673.00	2.36	1.86
	Transport	2,000,100.00	3.73	2.94
	Total Variable Cost	**53,600,054.44**	**100.00**	**78.74**
II	Fixed Costs			
1	Land Rental	2,500,000.00	17.27	3.67
2	Stake	11,333,390.00	78.30	16.65
3	Tax	98.667,00	0.68	0.14
4	Tool Depreciation	543,000.00	3.75	0.80
	Total Fixed cost	**14,475,057.00**	**100.00**	**21.26**
	Total Cost	**68,075,111.44**		100.00

Source: Research Results (processed)

The average total cost of apple tomato farming is IDR 68,075,111.44 per hectare, which includes total variable costs (VC) of IDR 53,600,054.00 (78.74%) and total fixed costs (FC) of IDR 14,475,057.00 (21.26%). It can be concluded that the average total cost of production is Rp 68,075,111.44 per ha. It started from labor costs, production facilities costs, land rent, taxes, and other costs needed in farming tomatoes.

Revenue and Profit

Revenue results from farmers' tomato sales obtained from the multiplication between total tomato production (kg) multiplied by the selling price of tomatoes at the farmer level.

The results of interviews with 60 farmers who planted apple tomatoes in 2023 obtained an average production of 305,62.4 kg/ha, the highest production of 37,000 kg/ha, and the lowest production of 21,155.00 kg/kg. The average selling price is 5,700 per kg with an average income of Rp167,197,384.27/ha (Table 3). So, the profit of Tomato farmers in Minahasa regency is Rp167.197.384,27 - Rp 68.075.111,44 = Rp 99.122.272,83. Judging from the average production, the average production in Minahasa regency of 29,550.51 kg per ha is still smaller than the average tomato production in Ciamis Regency of 33,215 kg per ha (Apriadi et al., 2017). That means there is still an opportunity to increase the average tomato production in Minahasa Regency, North Sulawesi.

Table 3. Average production, price, and income of tomato farming in Minahasa regency, 2023

Description	Production/ha (Kg)	Price/kg (IDR)	Income/ha (IDR)
Average	29,550.51	5,700.00	167,197,384.27
Maximum	37,000.19	10,000.00	309,001,545.00
Minimum	21,155.00	2,000.00	56,666,950.00

Source: Research Results (processed)

Based on the cost structure, it can be shown that the variable cost of labor outside the family is the most significant cost component, amounting to 52.33% of the Total Variable Cost (TVC) or 41.20% of the Total Fixed Cost (TFC). In fixed costs, stake costs are the most significant component of fixed costs (FC), amounting to 78.30% of total fixed costs (TFC) or 16.65% of total costs (TC) of tomato farming. These two cost components are the critical factors success of tomato farmers, meaning that if they can innovate to reduce these costs, they will be able to increase the competitive advantage of apple tomatoes in Minahasa regency (Pandremmenou et al., 2013).

Variable Costs

Tillage, fertilizing, pruning, and tying tomatoes are labor from outside the family that must be financed. The labor costs to be paid are 52.33% of the total variable costs. Of these, 45 men's working days (equivalent to 9 million rupiah) for making beds. If the manufacture of beds is assisted by a tractor, the cost of making the beds can be reduced by 20 men's working days (equivalent to 4 million rupiah). Thus, the cost of making beds can be reduced by as much as 33.3% from before using the tractor. Business profit, if the variable cost of making beds is replaced with a tractor, will be from IDR 99,122,272.83 to IDR 102,122,272.83, and BEP price from IDR 2,303.69 to IDR 2,202.17

Fixed Costs

Stake purchases are the most significant cost component of fixed costs. The purchase of this stake can be reduced by replacing stake from bamboo with stake from plastic pipes. If tomato farmers replace stake from bamboo with plastic pipes, it will be able to reduce the cost of stake up to half of the cost of stake. Currently, stake from bamboo can only be used for a year or only for 2 (two) times production. Using stake from a plastic pipe can save costs from an average of Rp 755.56 per stake to an average of Rp 333.33 per stake. In other words, the improvement of stake technology can increase the competitive advantage of apple tomato farming (Djiu et al., 2024), namely BEP price from Rp 2,303.69 to Rp 2089.35 or reduced Rp 215.03 (9.33%) and tomato farming profit from Rp 99,122,272.83 to 105,456,162.83 or an increase of Rp 6,333,889.7 (6.39%).

Furthermore, if innovation is carried out both on variable costs (the use of tractors for making beds) and replacing stake from bamboo with plastic pipe, the profit of tomato farming from Rp 99,122,272.83 per ha to Rp 108,456,162.83 per ha and BEP prices from Rp 2,300 per kg to Rp 1,987.82 per kg (Table 4). Hal ini sejalan dengan temuan di

Table 4. Farm cost structure after the innovation of making beds and changing stake.

No.	Kind of Cost	Mean Total IDR/ha	Prosentase	Prosentase
I	Variable Costs			
1	Labor Cost			
	In the Family	7,093,126.67	14.02	12.08
	Outside the Family	25,050,386.90	49.51	42.65
2	Cost of Production Facilities			
	Seeds	2,330,011.65	4.60	3.97
	Furadan	166,667.50	0.33	0.28
	Mulsa	5,000,025.00	9.88	8.51
	First fertilizer	2,100,010.50	4.15	3.58
	Followup fertilizer	1,615,700.00	3.19	2.75
	Pesticide	3,644,018.22	7.20	6.20
	Rope	333,335.00	0.66	0.57

No.	Kind of Cost	Mean Total IDR/ha	Prosentase	Prosentase
3	Other cost			
	Tractor/Plow Rental	1,266,673.00	2.50	2.16
	Transport	2,000,100.00	3.95	3,40
	Total Variable Cost	50,600,054.44	100.00	86.14
II	Fixed Costs			
1	Land Rental	2,500,000.00	30.71	4.26
2	Stake	4,999,500.00	61.41	8.51
3	Tax	98,667.00	1.21	0.17
4	Tool Depreciation	543,000.00	6.67	0.92
	Total Fixed Cost	8,141,167.00	100.00	1.86
	Total Cost	58,741,221.44		100.00

Based on the cost structure, it can be shown that the total variable is around 86% dominating the cost of tomato farming, while fixed costs are only around 14%, this finding is inversely proportional to tomato farming with full technology (Peña et al., 2022). This means that tomato farming in Minahasa needs to be more directed at the use of technology that can replace human labor which is more than half (> 50%) of the total variable cost of tomato farming. This finding is greater than the total labor costs in tomato farming in neighboring countries (Samshunnahar et al., 2016).

The use of mechanization for soil cultivation and replacing tom ato poles with pipes has been able to increase efficiency and can further increase competitive advantage, but it is necessary to think about how to reduce the use of chemical fertilizers and pesticides with fertilization and control of pests and diseases that are more environmentally friendly (Esengun et al., 2007). Tomato farmers are recommended to use tractors in making beds to reduce the labor costs of making beds up to 33.3 percent per ha. In addition, it is necessary to replace the stake of bamboo with a plastic pipe to reduce the cost of stake per ha by up to 50%.

CONCLUSION

The cost structure of tomato farming production is divided into two types, namely variable costs and fixed costs. The total variable costs that farmers must incur are IDR 53,600,054.44 / ha or 78.74 percent more significant than the total fixed costs incurred by farmers, which is IDR 14,475,057.00 / ha or 21.26 percent of the total cost of IDR 68,075,111.44 with a total profit of tomato farmers of IDR 99154272.83 per hectare. BEP Price Rp 2,303.69 per kilo gram and BEP Production 34,037.56 kg per hectare. The innovation of using tractors to replace human labor in making beds at variable costs and replacing stake from bamboo with a plastic pipe at fixed variables can increase the profit of tomato farming from Rp 99,122,272.83 per ha to Rp 108,456,162.83 or an increase of Rp 9333890.00 (9.42%) per ha and the price of BEP from Rp 2,300 per kg to Rp 1,987.82 per kg or reduced by Rp 312.18 (13.57%) per kg.

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AUTHOR CONTRIBUTIONS

Conceptualization and Methodology; Franky Reintje Tulungen, Jety Deisye Lempas. Software and Writing – Original Draft Preparation; Jemly Lengkong, Joy M. Oping, Heibert Lintong.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

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