Enhanced Knowledge in Sciences and Technology Vol. 2 No. 1 (2022) 122-131

EKST

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/ekst
e-ISSN : 2773-6385

Linear Programming Approach in Fruits Production in Johor

Teh Ching Yee[1], Siti Noor Asyikin Mohd Razali[1]*

[1]Department of Mathematics and Statistics, Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/ekst.2022.02.01.014
Received 02 January 2022; Accepted 29 January 2022; Available online 1 August 2022

Abstract: Linear Programming is an optimization method mostly use in resource allocation and achieving efficiency in production planning particularly in achieving increased agriculture production of fruits. However, the supply of fruits is not enough for population and agriculture want to save money to hire the skilled workers. This study is carried out to maximize the productivity of the fruits and minimize the wages of workers. Three data set were collected through Department of Statistics Malaysia (DOSM) due to covid-19 pandemic. The first two dataset includes the types of fruits, area planted and value production while the second dataset includes number of workers and labor productivity. Previous study got used goal programming method to solve this issue but this study was using Linear Programming method to solve problem in Excel Solver and Tora software. The sensitivity analysis was also performed in this study. The result showed that the durian is the most profitable fruits and cut down the numbers of workers but increase a little bit on salary to reach optimal result. This could help the agriculture sector reached maximum profit and hired workers with optimum salary.

Keywords: Linear Programming, Agriculture, Sensitivity Analysis

1. Introduction

According to [1] the agriculture sector is critical for the nation's economic future due to tropical climate for growing exotic fruits and vegetables. Johor is the state that contributes the most to economic development in the fruit industry. Smallholders control the future of agriculture but they face challenges. They lag in productivity, structural issues and efficiency compared because they lack information on new technology [2]. Smallholders must collaborate with the government in order to maximize their agricultural productivity and benefit using the most appropriate approach for their crop.

Furthermore, agriculture preparation has become important as increased demand for agricultural commodities as a result of population growth. Proper resource use to maximize crop yield per unit area is one way to achieve high productivity [3]. Since we want to increase productivity, then the numbers

*Corresponding author: asyikin@uthm.edu.my

of workers must be increased so that they can manage to cover all the growth of crops. Since the agricultural industry has transform from traditional way to automation and power-intensive production systems [4]. We must hire professionals' workers to work with robotic devices to accomplish activities.

Linear programming is widely used as they are efficiently used in the various management processes [5][6]. This is due to the well-known advantages of using linear programming in developed world economic planning [7]. Previous study got used goal programming method to solve this issue but this study was using Linear Programming method to solve problem. So, this research only focuses on using linear programming to find the best solution to improve the productivity of fruits and lower the workers' wages in Johor.

According to [8] they find out that the linear programming is a suitable approach for finding the optimal land allocation to the major crops of study area. Farmers must depend on the assistance of technology and professional opinion to optimize productivity and minimize the costs of hiring skilled workers. According to [9] the planning factor can cause project failure, and bad planning can cause revenue allocation failure. But linear programming is in its infancy in our agricultural field. So, linear programming method can be suggested widely used in agricultural field.

2. Methodology

2.1 Data

The Malaysian Department of Statistics and the Ministry of Agriculture and Food Industry provided secondary data for this report (MAFI). The two set of data gathered include different types of fruits selected in Johor in 2014 and 2020, total land area to plant the fruits, area that produces the fruits, number of trees plant per hectare, estimated production of each tree and production value obtained from the fruits. Next, this study also focuses on how to hire skillful workers or professionals with the optimum salary. The information were types of jobs, salary of workers and farmers, number of workers and farmers, labor productivity (per hour) and salary limit of each farmer and worker.

2.2 Formulation of linear programming model to maximize productivity

Following formulation of linear programming model was first set of data for year 2014.

Step 1: Define decision variables in the problem and labeled from x_1 until x_{16} for sixteen fruits.

Step 2: Find objective function that includes a linear combination of decision variables. [10]

$$Z_{max} = 22295.85X_1 + 38353.30X_2 + 55123.25X_3 + 8650.80X_4 + 139586.77X_5 + 1317976.22X_6 + 36435.87X_7 + 36777.05X_8 + 61379.28X_9 + 17061.97X_{10} + 53125.74X_{11} + 49167.62X_{12} + 31778.72X_{13} + 387808.30X_{14} + 78725.18X_{15} + 209214.55X_{16} \quad \text{Eq.1}$$

Step 3: Formulate the problem's constraints. The constraints must be linear [11][12]. There are nineteen constraints in this set of data.

Constraint 1: $Y_1 = 707X_1 + 1741X_2 + 5598X_3 + 473X_4 + 5733X_5 + 55788X_6 + 1446X_7 + 3379X_8 + 2015X_9 + 888X_{10} + 3282X_{11} + 3037X_{12} + 453X_{13} + 22975X_{14} + 13060X_{15} + 10618X_{16} \le 155000$ Eq.2

Constraint 2: $Y_2 = 846X_1 + 1940X_2 + 7636X_3 + 538X_4 + 8535X_5 + 75370X_6 + 1734X_7 + 5425X_8 + 3077X_9 + 1082X_{10} + 5283X_{11} + 4117X_{12} + 613X_{13} + 27093X_{14} + 17777X_{15} + 11174X_{16} \le 172000$ Eq.3

Constraint 3: $Y_3 = 200X_1 + 1000X_2 + 100X_3 + 250X_4 + 150X_5 + 80X_6 + 950X_7 + 160X_8 + 250X_9 + 250X_{10} + 120X_{11} + 180X_{12} + 1200X_{13} + 1000X_{14} + 150X_{15} + 2000X_{16} \le 15000$ Eq.4

Constraint 4: $Y_4 = X_1 \le 20$ Eq. 5

Constraint 5: $Y_5 = X_2 \leq 10$ Eq. 6

Constraint 6: $Y_6 = X_3 \leq 8$ Eq. 7

Constraint 7: $Y_7 = X_4 \leq 10$ Eq. 8

Constraint 8: $Y_8 = X_5 \leq 8$ Eq. 9

Constraint 9: $Y_9 = X_6 \leq 30$ Eq. 10

Constraint 10: $Y_{10} = X_7 \leq 20$ Eq. 11

Constraint 11: $Y_{11} = X_8 \leq 18$ Eq. 12

Constraint 12: $Y_{12} = X_9 \leq 5$ Eq. 13

Constraint 13: $Y_{13} = X_{10} \leq 10$ Eq. 14

Constraint 14: $Y_{14} = X_{11} \leq 25$ Eq. 15

Constraint 15: $Y_{15} = X_{12} \leq 24$ Eq. 16

Constraint 16: $Y_{16} = X_{13} \leq 9$ Eq. 17

Constraint 17: $Y_{17} = X_{14} \leq 28$ Eq. 18

Constraint 18: $Y_{18} = X_{15} \leq 25$ Eq. 19

Constraint 19: $Y_{19} = X_{16} \leq 30$ Eq. 20

Next, below is the linear programming model for second set of data for year 2020.

Step 1: Also define decision variables in the problem and labeled from until for sixteen fruits.

Step 2: Find objective function for second set of data [13].

$$Z_{max} = 23006.99X_1 + 93693.21X_2 + 33033.65X_3 + 4214.31X_4 + 36594.8X_5 + 7338365.77X_6 + 96597.16X_7 + 41927.25X_8 + 40100.38X_9 + 27329.82X_{10} + 94011.94X_{11} + 87362X_{12} + 35963X_{13} + 570028.6X_{14} + 124894X_{15} + 184559.9X_{16} \qquad \text{Eq.21}$$

Step 3: Formulate constraints for set two data. Constraints one to three is different with set one data but from constraint four until constraint nineteen were same as set one data.

Constraint 1: $Y_1 = 481.4X_1 + 2266.93X_2 + 3987.74X_3 + 143.79X_4 + 3090.57X_5 + 51535.28X_6 + 1543.2X_7 + 2477.5X_8 + 847.5X_9 + 1168.3X_{10} + 3219.89X_{11} + 2045.08X_{12} + 608.43X_{13} + 11316.85X_{14} + 9174.45X_{15} + 8715.37X_{16} \leq 180000$ Eq.22

Constraint 2: $Y_2 = 617.95X_1 + 2623.07X_2 + 6409.27X_3 + 191.4X_4 + 4591.98X_5 + 76895.12X_6 + 1891.61X_7 + 4590.05X_8 + 1081.82X_9 + 2050.51X_{10} + 4744.38X_{11} + 3513.08X_{12} + 670.54X_{13} + 26210.15X_{14} + 15314X_{15} + 9247.36X_{16} \leq 200000$ Eq.23

Constraint 3: $Y_3 = 200X_1 + 1000X_2 + 100X_3 + 250X_4 + 150X_5 + 80X_6 + 950X_7 + 160X_8 + 250X_9 + 250X_{10} + 120X_{11} + 180X_{12} + 1200X_{13} + 1000X_{14} + 150X_{15} + 2000X_{16} \leq 40000$ Eq.24

2.3 Formulation of linear programming model to minimize the wages of workers

Step 1: Since decision variables in productivity and defined A and B as representative for jobs. [10]

Step 2: Write an objective function with a linear combination of decision variables.

$$Z_{min} = 2500A + 1700B \qquad \text{Eq. 25}$$

Step 3: Formulate the constraints. The constraints also use with the symbol Y. In this set of data, there were four constraints for minimize salary of workers.

Constraint 1: $Y_1 = 3300A + 12300B \geq 13500$ Eq. 26

Constraint 2: $Y_2 = 4.8A + 4.8B \geq 4.8$ Eq. 27

Constraint 3: $Y_3 = A \leq 3000$ Eq. 28

Constraint 4: $Y_4 = B \leq 2000$ Eq. 25

2.4 Sensitivity analysis

Sensitivity analysis will determine how deterministic solution will change according to model's assumptions. Changes in the objective function coefficient, technical coefficients, and right-hand side values are examples of a problem's range of changes. Sensitivity analysis performed on adjusting the RHS constraints in order to observe output changes in this study. According to [14], the optimal partition solution is always quicker and more reliable than the optimal value approach from a computational standpoint. The formula for sensitivity analysis as shown below is to identify the key variables for the output formula and then assess the output based on different combinations of the independent variables [15].

$$Z = X^2 + Y^2 \qquad \text{Eq.26}$$

3. Results and Discussion

3.1 Proposed solution from Excel Solver and Tora software for maximize productivity of fruits production

Table 1: Solution obtained for maximizing productivity

Decision variable	Optimal solution	
X_1 (Star fruits)	20	0
X_2 (Papaya)	0	0
X_3 (Jack fruits)	0	0
X_4 (Ciku)	0	0
X_5 (Dokong)	0	0
X_6 (Durian)	2	2.6
X_7 (Guava)	0	0
X_8 (Langsat)	0	0
X_9 (Sweet lemon)	5	5
X_{10} (Grapefruit)	0	0
X_{11} (Mango)	0	0
X_{12} (Mangosteen)	0	0
X_{13} (Dragon fruit)	8	0
X_{14} (Banana)	0	0
X_{15} (Rambutan)	0	0
X_{16} (Watermelon)	0	0
Objective function (RM)	3364164.35	19086688

The value estimated objective function was RM3364164.35 for year 2014 and RM19086688 for year 2020. After the comparison between the result obtained, in 2014, it was suggested that agriculture sector should focus on X_1 (Star fruits), X_6 (Durian), X_9 (Sweet lemon) and X_{13} (Dragon fruit) because they were more profitable. While in 2020, it was suggested that agriculture focus on X_6 (Durian). This showed that durian is the most profitable fruits in these two different years.

3.2 Proposed solution from Excel Solver and Tora software for minimize the cost of hiring workers

Table 2: Solution obtained for minimizing cost of hiring workers

Decision variable	Optimal solution
A (Farmer)	0
B (Worker)	1.10
Objective function (RM)	1865.85

From the result, the salary of hiring workers could be RM1865.85 which was 1.10 percent of original salary RM1700. It was suggested that agriculture sector should maintained the salary of farmer and increased a little on the salary of workers.

3.3 Discussing the value obtained in constraints of LHS and RHS

3.3.1 Maximizing the productivity of fruits production

Table 3: The value constraints obtained for maximizing productivity of fruits in Excel Solver

	Objective value		Requirement
Constraint 1 (Area produce)	127607.01	<=	155000
Constraint 2 (Land area plant)	172000	<=	172000
Constraint 3 (Number of trees per hectare)	15000	<=	15000
Constraint 4 (Estimated production of star fruits)	20	<=	20
Constraint 5 (Estimated production of papaya)	0	<=	10
Constraint 6 (Estimated production of jack fruits)	0	<=	8
Constraint 7 (Estimated production of ciku)	0	<=	10
Constraint 8 (Estimated production of dokong)	0	<=	8
Constraint 9 (Estimated production of durian)	2	<=	30
Constraint 10 (Estimated production of guava)	0	<=	20
Constraint 11 (Estimated production of langsat)	0	<=	18
Constraint 12 (Estimated production of sweet lemon)	5	<=	5
Constraint 13 (Estimated production of grapefruit)	0	<=	10
Constraint 14 (Estimated production of mango)	0	<=	25
Constraint 15 (Estimated production of mangosteen)	0	<=	24
Constraint 16 (Estimated production of dragon fruit)	0	<=	9
Constraint 17 (Estimated production of banana)	8	<=	28
Constraint 18 (Estimated production of rambutan)	0	<=	25
Constraint 19 (Estimated production of watermelon)	0	<=	30

This indicated that in year 2014, we needed 172000 hectares of land to plant the fruits trees with number of 15000 fruits trees to require the 133326.61 hectare of area to produce the fruits. Therefore, we had optimized by making use of every hectare area of land available to retain high output.

Table 4: The value constraints obtained for maximizing productivity of fruits in Excel Solver

	Objective value		Requirement
Constraint 1 (Area produce)	134040.4	<=	180000
Constraint 2 (Land area plant)	200000	<=	200000
Constraint 3 (Number of trees per hectare)	208.08	<=	40000
Constraint 4 (Estimated production of star fruits)	0	<=	20
Constraint 5 (Estimated production of papaya)	0	<=	10
Constraint 6 (Estimated production of jack fruits)	0	<=	8
Constraint 7 (Estimated production of ciku)	0	<=	10

Constraint 8 (Estimated production of dokong)	0	<=	8
Constraint 9 (Estimated production of durian)	2.6	<=	30
Constraint 10 (Estimated production of guava)	0	<=	20
Constraint 11 (Estimated production of langsat)	0	<=	18
Constraint 12 (Estimated production of sweet lemon)	0	<=	5
Constraint 13 (Estimated production of grapefruit)	0	<=	10
Constraint 14 (Estimated production of mango)	0	<=	25
Constraint 15 (Estimated production of mangosteen)	0	<=	24
Constraint 16 (Estimated production of dragon fruit)	0	<=	9
Constraint 17 (Estimated production of banana)	0	<=	28
Constraint 18 (Estimated production of rambutan)	0	<=	25
Constraint 19 (Estimated production of watermelon)	0	<=	30

This indicated that in year 2020, we needed 200000 hectares of land to plant the fruits trees with number of 208 fruits trees to require the 134040.4 hectare of area to produce the fruits. Therefore, we had optimized by making use of every hectare area of land available to retain high output.

3.3.2 Minimizing the cost to hiring workers

Table 5: The value constraints obtained for minimizing the cost of hiring workers

	Objective value		Requirement
Constraint 1 (The number of workers)	13500	>=	13500
Constraint 2 (Labor productivity per hour)	5.27	>=	4.8
Constraint 3 (Salary limit for each farmer)	0	<=	3000
Constraint 4 (Salary limit for each worker)	1.10	<=	2000

So overall stated that to minimize the salary of workers and farmers, we only needed 13500 farmers and workers and each of them with the labour productivity of 5.27 per hour, so that we could save up the money not to hire extra workers and obtained the optimized output.

3.4 Sensitivity analysis

Table 6: Sensitivity report for decision variables (Maximizing productivity)

Name	Final value	Reduced cost	Objective coefficient	Allowable increase	Allowable decrease
X_{1}	20	0	22295.85	infinite	4006.93
X_{2}	0	-13089.09	38353.34	13089.09	infinite
X_{3}	0	-80019.26	55123.25	80019.26	infinite
X_{4}	0	-5134.62	8650.81	5134.62	infinite
X_{5}	0	-12129.70	139586.77	12129.70	infinite
X_{6}	1.79	0	1317976.22	82612.96	108031.06
X_{7}	0	-10524.50	36435.87	10524.50	infinite
X_{8}	0	-60795.02	36777.05	60795.02	infinite
X_{9}	5	0	61379.28	infinite	3234.81
X_{10}	0	-6222.04	17061.97	6222.04	infinite
X_{11}	0	-41262.57	53125.74	41262.57	infinite
X_{12}	0	-25907.44	49167.62	25907.44	infinite
X_{13}	8.01	0	31778.72	15724.09	12723.73
X_{14}	0	-103005.67	387808.3	103005.67	infinite
X_{15}	0	-234436.75	78725.18	234436.75	infinite
X_{16}	0	-21091.90	209214.55	21091.90	infinite

We only take the sensitivity report for year 2014, the current solution value for X_{1} (star fruits) is 20 ton and the current objective coefficient (profit) is RM22295.85. The allowance increase and decrease mean that the decision to produce 20 ton of X_1 remains optimal even if the profit per unit on X_1 is not actually RM22295.85 (but lies in the range).

Table 7: Sensitivity report for condition

Condition	Final value	Shadow price	Constraint RHS	Status	Allowable increase	Allowable decrease
C1	127606.56	0	155000	Not Binding	infinite	27393.4380
C2	172000	17.47	172000	Binding	37008.2724	134709.889
C3	15000	17.55	15000	Binding	23980.0470	9601.7248
C4	20	4006.93	20	Binding	48.2251	20
C5	0	0	10	Not Binding	infinite	10
C6	0	0	8	Not Binding	infinite	8
C7	0	0	10	Not Binding	infinite	10
C8	0	0	8	Not Binding	infinite	8
C9	1.7883	0	30	Not Binding	infinite	28.2117
C10	0	0	20	Not Binding	infinite	20
C11	0	0	18	Not Binding	infinite	18
C12	5	3234.80	5	Binding	38.9154	5
C13	0	0	10	Not Binding	infinite	10
C14	0	0	25	Not Binding	infinite	25
C15	0	0	24	Not Binding	infinite	24
C16	0	0	9	Not Binding	infinite	0
C17	8.0058	0	28	Not Binding	infinite	19.9942
C18	0	0	25	Not Binding	infinite	25
C19	0	0	30	Not Binding	infinite	30

Result showed one hectare of the land area plant of C2 was used, the profit will be increased by RM17.47. This is true if the hectare is up to more 37008.27 while profit will decrease by RM17.47 if less than 134709.89 hectare. The infinite in allowable increase represented the allowable increase id infinite for most of the non-binding constraint. C2, C3, C4 and C12 are the binding constraints as there is no surplus.

Table 8: Sensitivity report for decision variables (Minimizing the salary of hired workers and farmers)

Name	Final value	Reduced cost	Objective coefficient	Allowable increase	Allowable decrease
A	0	2043.9024	2500	infinite	2043.9024
B	1.0976	infinite	1700	7618.1818	1700

From Table 8, the current solution value for A is 0 and the current objective coefficient (salary) is RM 2500. The allowable increase and decrease lied between infinite and 2043.90. While the current solution value for B is 1.10 and current objective coefficient is RM1700. The allowable increase and decrease lied between 7618.18 and 1700.

Table 9: Sensitivity report for conditions

Name	Final value	Shadow price	Constraint RHS	status	Allowable increase	Allowable decrease
C1	13500	0.1382	13500	Binding	24586500	1200
C2	5.2683	0	4.8	Not Binding	0.4683	infinite
C3	0	0	3000	Not Binding	infinite	3000
C4	1.0976	0	2000	Not Binding	infinite	1998.9024

This sensitivity report showed that if one worker was used, the profit will be increased by RM0.14. This is true if upper limit for number of workers was up to more 24586500 while profit will decrease by RM0.14 if less than 1200 workers.

3.4.1 Decrease non-binding constraints for maximizing productivity

Table 10: Comparison of optimal solution

Decision variable	Optimal solution (original)	Optimal solution (changed constraints)
X_1	20	0
X_2	0	0
X_3	0	0
X_4	0	0
X_5	0	0
X_6	2	188
X_7	0	0
X_8	0	0
X_9	5	0
X_{10}	0	0
X_{11}	0	0
X_{12}	0	0
X_{13}	8	0
X_{14}	0	0
X_{15}	0	0
X_{16}	0	0
Objective function (RM)	3364164.35	247120541.25

The quantity of non-binding constraints was decreased in analysis. The original objective function is RM3364153.35 while optimal solution after changed right-hand non-binding constraints is RM247120541.25. The profit of optimal solution using changed RHS constraints was higher. Hence, it is recommended that agriculture can less focus on estimation production of fruits.

3.4.2 Increase binding constraints for maximizing productivity

. **Table 11: Comparison of optimal solution**

Decision variable	Optimal solution (original)	Optimal solution (changed constraints)
X_1	20	0
X_2	0	0
X_3	0	0
X_4	0	0
X_5	0	0
X_6	2	487
X_7	0	0
X_8	0	0
X_9	5	0
X_{10}	0	0
X_{11}	0	0
X_{12}	0	0
X_{13}	8	0
X_{14}	0	0
X_{15}	0	0
X_{16}	0	0
Objective function (RM)	3364164.35	642183913.20

The original objective function is RM3364153.35 while optimal solution after changed right-hand binding constraints is RM642183913.20. The profit of optimal solution using changed RHS constraints was higher. Hence, it is recommended that the agriculture can decrease the land area plant and number of fruit trees per hectare so that fruit production can be increase.

3.4.3 Decreasing non-binding constraints for minimizing salary of workers

Table 12: Comparison of optimal solution

Decision variable	Optimal solution (original)	Optimal solution (changed constraints)
A	0	0
B	1.10	1.10
Objective function (RM)	1865.85	1865.85

The original objective function and after changed right-hand non-binding constraints are RM1865.85. The profit of optimal solution using changed RHS constraints was same. Hence, it is recommended that the agriculture can decrease salary of the worker or farmer to help agriculture sector to save the cost.

3.4.4 Increase binding constraints for minimizing salary of workers

Table 13: Comparison of optimal solution

Decision variable	Optimal solution (original)	Optimal solution (changed constraints)
A	0	0
B	1.10	8.13
Objective function (RM)	1865.85	13821.14

The original objective function is RM1865.85 while optimal solution after changed right-hand binding constraints is RM13821.14. The profit of optimal solution was higher. Hence, it is recommended that the agriculture can increase the number of workers and increase the labor productivity at the same time.

4. Conclusion

Land allocation to provide enough productivity in fruits is the issue that happened in our country. Since the technologies are developing in this era, so the number of farmers and workers in agriculture sector is important to save the hiring cost. The study was carried out a study to solve land allocation problem with maximizing productivity of fruits and minimizing the cost of hiring workers by using Linear Programming method. Linear Programming has been proven to improving the land allocation management and adjusting the cost of hiring workers with achieved the maximum productivity and profit of the agriculture sector in Johor.

Acknowledgement

The authors would also like to thank the Faculty of Applied Science and Tehcnology, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] A. Zainuddin. “Daim: The future of Malaysia is in agriculture”, Economy. 2020.

[2] F. M. Arshad. “My Say: Smallholders still crucial to agricultural sector.” The Edge Markets, 5 February 2016.

[3] N. A. Sofi, A. Ahmed, M. Ahmad, and B. A. Bhat, “Decision making in agriculture: A linear programming approach.” *Int. J. Contemp. Math. Sci*., 13(2), 160-169, 2015.

[4] V. Marinoudi, C.G. Sorensen, S. Pearson, and D. Bochtis, “Robotics and labour in agriculture” A context consideration. Biosystems Engineering, 184, 111-121, 2019.

[5] G. Vico, and R. Bodiroga, “Tools for planning in agriculture–Linear programming approach”, 2017

[6] N. H. Mohamad, and F. Said, “A mathematical programming approach to crop mix problem.” *Afr. J. Agric. Res*., 6(1), 191-197, 2011

[7] S. R. Jeffrey, R. R. Gibson, and M. D. Faminow, “Nearly optimal linear programming as a guide to agricultural planning.” Agricultural Economics, 8(1), 1-19, 1992.

[8] M. O. Wankhade, and H. S. Lunge, “Allocation of agricultural land to the major crops of saline track by linear programming approach: a case study.” *Int J Sci Technol Res*., 1(9), 21-25, 2012.

[9] I. Attarzadeh, and S. H. Ow, “Project management practices: the criteria for success or failure.” *CIBIMA*, 1(28), pp. 234-241, 2008.

[10] G. B.Dantzig, and M. N Thapa, “Linear programming 1: introduction. Springer Science & Business Media”, 2006.

[11] K. Reynisdottir, “Linear Optimization Model that Maximizes the Value of Pork Products (Issue January).” Reykjavík University: Master's Research Thesis, 2012.

[12] S. I. Gass, “Linear programming: methods and applications.” Courier Corporation, 2003.

[13] F. C.Statistic, “Statistik tanaman buah-buahan”, 2015.

[14] B. Jansen, J. J. De Jong, C. Roos, and T. Terlaky, “Sensitivity analysis in linear programming: just be careful!”, *Eur. J. Oper. Res.*, 101(1), 15-28, 1997.

[15] J. Pek, and R. C. MacCallum, “Sensitivity analysis in structural equation models: Cases and their influence”. Multivar. Behav. Res., 46(2), 202-228, 2011.