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Engineering economic analysis of meliponiculture in Malaysia considering current market price

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Abstract. Stingless bees (kelulut) keeping is now a trend in Malaysia. However, since demand for the source of colony in log is increasing, the log price is rapidly increasing. But, there is no data reported on the economic viability of meliponiculture in the current market price. Thus, the objective of this study is to clarify the economic viability of investment in meliponiculture in the current market price by engineering economic perspective. Investment in meliponiculture was analysed using Equivalent Annual Uniform Cost (EAUC), Internal Rate of Return (IRR) and Breakeven Analysis. A small start-up with 30 units of logs or hives was considered in the analysis. All raw data was acquainted from current Malaysian market price, but only revenue from honey was considered. It was found that EAUC indicated that the annual worth of the log system is 23% better than the hive system. However, IRR calculation indicated that both the log and the hive systems offer margin exceeding 55% which is a very good return in general investment. In addition, it was also found that the log system had breakeven after 8th month, whereas the hive was 13th month. Better economic value could be obtained if revenue from by-products are considered. Thus, it can be concluded that meliponiculture is still very economically viable in Malaysia market trend, and the hive systems could be a better choice if splitting colony, maintenance, safety and aesthetics points of view are considered.

1 Introduction

Bee keeping is a traditional culture in getting honey in tropical climate country. For Malaysia, it is recorded that bee keeping has established since Malacca Sultanate era (Hassan, Z., 2003). However, it is believed that bee keeping has been practiced earlier than that in Malaysia. Bee keepers preferred Apis bees than stingless bees because the honey production for stingless bee is too little, and it is well known that the stingless bees honey could not be commercialized in a large-scale (Jaafar, 2012; Ismail, 2012). However, stingless bees honey is getting high demand and has high commercial value in Malaysia because it is an alternative to the widespread adulterated honey in the country, and also because of its better health benefit than Apis honey (Ismail, 2014; Idris, 2013; Jaafar, 2011b). In addition, high commercial value of by-products from meliponiculture including propolis and bee bread, and government support through funding and research in public institutions also contribute to the grow of industrialization of meliponiculture. Bee keepers

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usually obtain a colony from Orang Asli to start the meliponiculture activity. The cost to have a log with topping or honey cassette was about RM100-150/log in 2010-2012, but now the price has increased to RM350-700/log.

Many new investors think about higher capital cost, and other challenges due to stolen logs, threats by overheat, animals and insects (Sinar Harian, 2016; Sinar Harian, 2015). There are also perception that it is currently not worthy to invest in meliponiculture under current market price. However, there is no clear data on the economic analysis of meliponiculture under current market. Thus, the objective of this study is to investigate the economic viability of investment in meliponiculture in the current market price by engineering economic perspective. Investment in meliponiculture was analyzed using Equivalent Annual Uniform Cost (EAUC), Internal Rate of Return (IRR) and Breakeven Analysis. A small start-up with 30 units of log or hive were considered in the calculation. EAUC, IRR and Breakeven Analysis was applied to determine the comparison of annual operating cost, the exact operational margin, and the breakeven time consensus depending on fixed and variable cost.

2 Material and method

The first common evaluation in engineering economic is by Equivalent Annual Uniform Cost (EAUC). It is used to determine the equal opportunity of investment suitability. The objective is to convert money into an equivalent uniform cost in a year. The main advantage of EAUC is that it could compare different investments that have different lifetime. This is because it is an equivalent annual cost over the lifetime of the project. The parameter used in the calculation is shown in Table 1. Data used are value in the current market. It should be noted that hive system includes a mounting system, and data shown for labor, maintenance, rental, revenue are annual data.

Table 1. The parameter considered in EAUC method

Type	Log	Hive
Purchasing cost (RM) Logs Fence	450 x 30 = 13,500 5,000	90 X 30 = 27,000 5,000
Site Cleaning	1,000	1,000
Annual maintenance cost (RM	1,000	5,00
Annual labour cost (RM)	9,000	9,000
Rent (RM)	3,6000	3,6000
Sale value (RM)	32,400	32,400
Life (years)	10	10

EAUC can be calculated by the following equation.

$$AW_{Log} = (AP, i, \%LT) - A_{operation} + A_{revenue} \tag{1}$$

where AWlog is Annual Worth [RM], A/P is finding Annual operation cost and revenue in terms of present value [RM], i is expected dividend/ interest/ margin of the project in decimal, LT is lifetime of the investment [year], Aoperation is per annual expenditure due to operation [RM], and Arevenue is per annual revenue [RM] after sales.

Then, Internal Rate Return (IRR) was calculated to evaluate the relevance of the investment. IRR indicates the exact rate of return that is received on an investment. IRR is also defined as the investment rate that makes the Present Worth of all expenditures is equal to the Present Worth of all income, i.e., the Net Present Value (NPV) equals zero. To calculate the IRR, the NPV of all values are calculated as a function of the interest rate, and then interest rate that makes the NPV is equal to zero is calculated. IRR can be calculated by the following equation;

$$PW_{Loss} = PW_{Gain} \tag{2}$$

$$PW_{Loss} = A_{operation}(P/A, i, LT) - A_{revenue}(P/A, i, LT) \tag{3}$$

where *PW* is Present Worth [RM], $A_{operation}$ is per annual expenditure due to operation in negative value [RM], and $A_{revenue}$ is per annual revenue [RM] after sales, *P/A* is finding Present worth of money, *P* with given Annual operation and revenue cost [RM], *i* is expected dividend/ interest/ margin of the project, *LT* is lifetime of the investment [year].

Table 2. Schedule for breakeven analysis

Cost	Type	Log [RM]	Hive [RM]
Fixed	Logs	450 x 30 = 13,500	90 X 30 = 27,000
Fixed	Fence	5,000	5,000
Fixed	Site Cleaning	1,000	1,000
Fixed	Annual maintenance cost One-Off	1,000	5,00
Fixed	Annual labour cost (RM) RM 750.00 Monthly	9,000	9,000
Fixed	Rent (RM) RM 300.00 Monthly	3,6000	3,6000
Revenue	Sale value [RM / kg]	300	300
Variable Cost	Bottle [RM/ 100 ml]	2	2
Variable Cost	Harvesting and Bottling (RM 100/ 9 kg which produce 90 bottle of 100 ml capacity) 100 /9 = RM 11.11/ kg	11.11	11.11

Finally breakeven calculation was carried out to determine the payback period of the investment. Payback period is the period of time required for the revenue from an investment to equal the cost of the investment. The breakeven calculation based on given schedule shown in Table 2. It should be noted that more detail parameters were considered as compared to Table 1.
Payback Period in month PBP_{month} could be obtained by the following equation;

$$PBP_{month} = \frac{m_{BE}}{m_{month}} \quad (4)$$

Where m_{BE} of honey needed to achieve breakeven [kg], m_{month} is estimated mass of honey produced monthly [kg], and it is equal to [9 kg/month] for 30 logs or hives. m_{BE} could be calculated by Equation (5), and to achieve breakeven, the Total contribution $T.Cont$ must be equal to Fixed Cost (FC) as shown in equation (6).

$$m_{BE} = \frac{T.Cont}{Cont_{perkg}} \quad (5)$$

$$T.Cont = FC \quad (6)$$

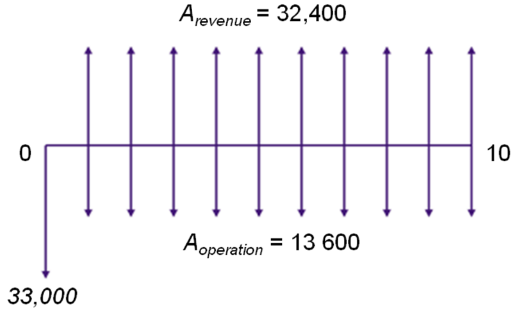
where $T.Cont$ is in [RM], and $Cont_{perkg}$ is Contribution per-kg [RM/kg] is calculated by difference between revenue total variable cost per-kg shown in Equation (7).

$$Cont_{perkg} = REV_{perkg} - TVC_{perkg} \quad (7)$$

where Rev_{perkg} is revenue per-kg obtained from sales of honey [RM/kg], and TVC_{perkg} is total variable cost per-kg of bottling and operational cost [RM/kg]. It should be noted that it takes time for colony to produce honey after honey cassette is placed to the log, or after colony is transferred to hive system. Thus, expected 1st batch of the honey production is after four month with 0.3 [kg-honey/log/month] produced.

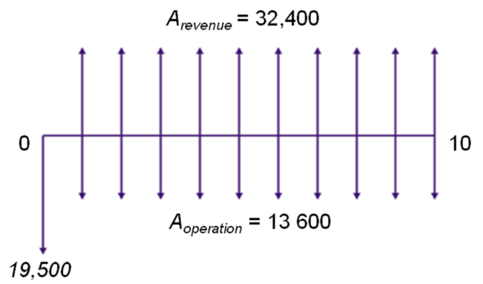
3 Result

3.1 Equivalent annual uniform cost



AW_{log} = -33,000 (A/P, 20%,10) -13,600 + 32,400
AW_{log} = -33,000 (0.2385) -13,600 + 32,400
AW_{log} = 10,929.50

Fig. 1. EAUC for log system



AW_{log} = -19,500 (A/P, 20%,10) -13,600 + 32,400
AW_{log} = -19,500 (0.2385) -13,600 + 32,400
AW_{log} = 14,149.25

Fig. 2. EAUC for Hive system

Results of EAUC for log system and hive system is shown in Fig. 1 and Fig. 2, respectively. It shows that uniform revenue and variable operational cost is same because same production and operation was estimated for both systems. Since initial cost of log type is 40% cheaper, log system has 22.7% higher EAUC value than hive system for 10 years of lifecycle considered. However, the calculation never discusses the ease of maintenance and operation, splitting colony benefit of hive.

3.2 Internal rate of return

Results of IRR for log and hive systems is shown in Table 3 and Table 4, respectively. It was found that IRR for the log system is more than 69%, whereas IRR for the hive system is 58.4%. This indicates that both investments shows very high return and worth to invest. Even the lower IRR of hive system is actually very good for investment, although higher initial investment is required. Thus, both investment opportunity are very promising even in the current market price. If production of propolis, bee bread, and by-products are considered, even higher return is expected from the investment.

$$PW_{Loss} = PW_{Gain}$$

$$19{,}500 = 13{,}600(P/A\,, i, 10) + 32{,}400(P/A\,, i, 10)$$

$$19{,}500 + 13{,}600(P/A\,, i, 10) + 32{,}400(P/A\,, i, 10) = 0$$

Table 3. IRR and NPV for log system

When i [%]	P/A (10)	NPV
i =20%	4.192	-59309.6
i= 60%	1.652	-11557.6

Then,

$$\frac{i - 20}{60 - 20} = \frac{0 - (-59309.6)}{-11557.56 - 59309.6}$$

$$i_{log} = 69.7\%$$

$$PW_{Loss} = PW_{Gain}$$

$$33{,}300 = 13{,}600(P/A, i, 10) + 32{,}400(P/A, i, 10)$$

$$33{,}300 + 13{,}600(P/A, i, 10) + 32{,}400(P/A, i, 10) = 0$$

Table 4. IRR and NPV for hive system

When i [%]	**P/A (10)**	**NPV**
i =20%	4.192	-45809.6
i= 60%	1.652	1942.6

Then,

$$\frac{i - 20}{60 - 20} = \frac{0 - (-45809.6)}{1942.6 - (-45809.6}$$

$$i_{hive} = 58.4\%$$

3.3 Breakeven and payback period

Finally is the results of breakeven and payback period. Fig. 3 shows the breakeven of log and hive systems. As shown in Fig. 3, both systems starts to produce honey in 4th month of the life cycle. Since estimated production is same at 9kg/month, payback period for log system is at 8.35 months, whereas for hive system is 13.56 months. Although hive system has longer period, but it is still can get payback within 14 months which is considered as a short payback period for an investment. Thus, meliponiculture is in general it is too good as an investment with high IRR and short payback period. If bee bread, propolis and by-products are considered, the payback period could be even shorter. Both systems is therefore economically viable enough to be invested in Malaysia even in the current market price.

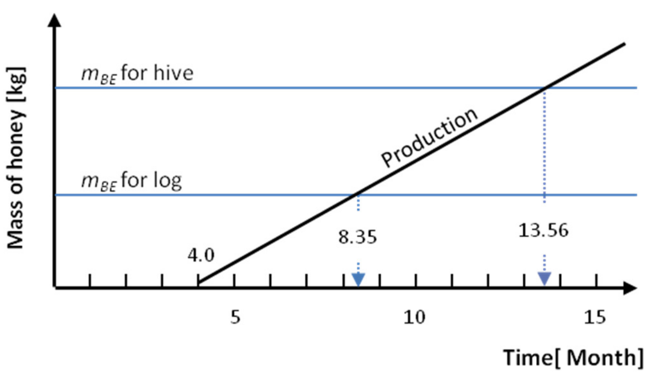


Fig. 2. Breakeven comparison of both system

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4 Conclusion

Investment in meliponiculture by log system and hive system with only honey sales as revenue was analyzed by engineering economic analysis. It was found that hive system has 40% higher capital cost, and log system has 22.7% higher EAUC. IRR of log system is 70%, whereas hive system is 58%, which is both has high return. Breakeven analysis shows that log system has 8.35 months of payback period, whereas hive system has 13.3 months of payback period. Although log system shows better results, if easiness of maintenance, colony splitting, and risks are considered, hive system could be a better choice. Both investment is economically viable in the current market price, and if sales of bee bread, propolis and by-products are considered, even better economic results could be obtained.

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