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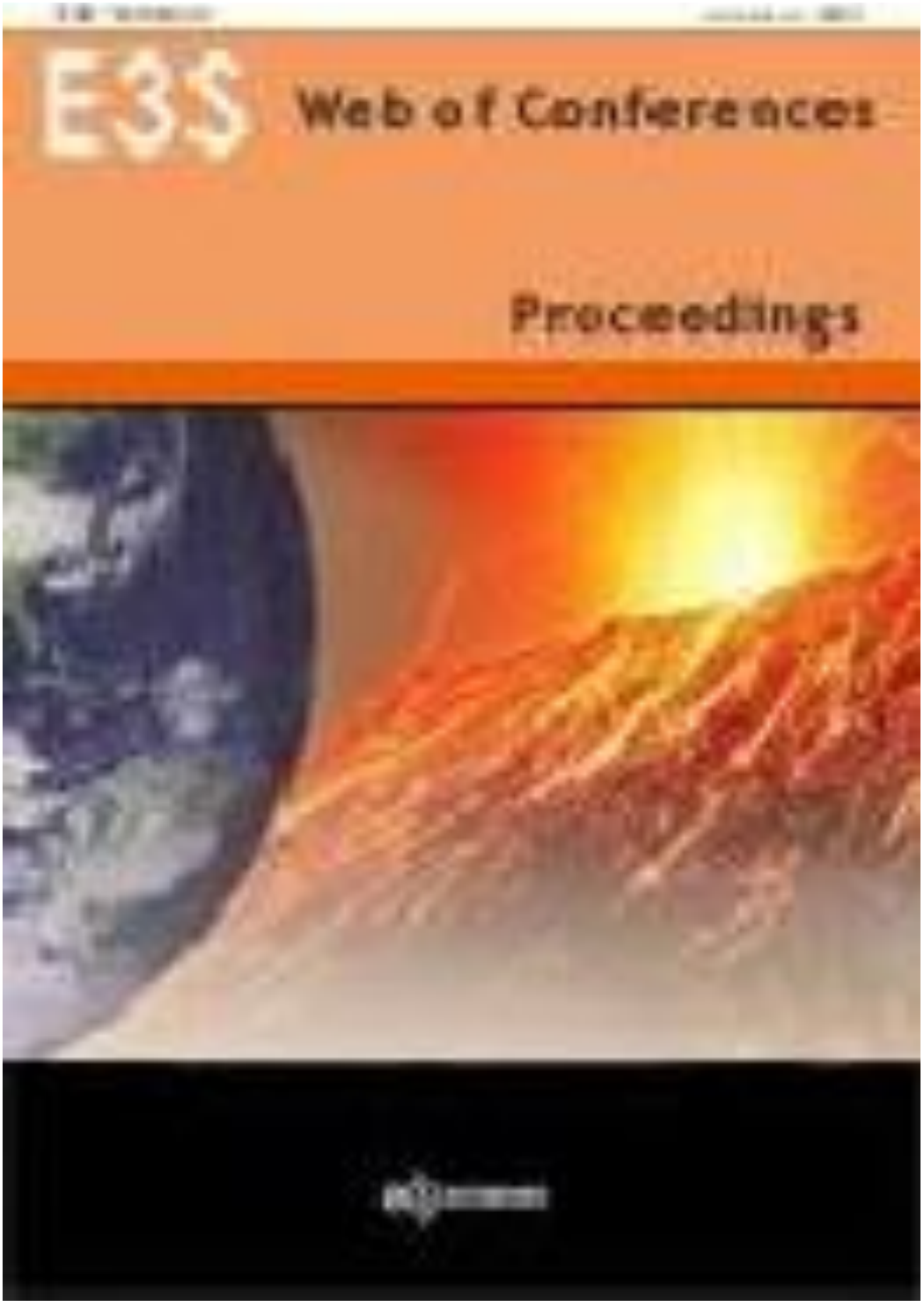
Budi Dharmawan*, Adwi Herry Koesoema Elyanto, and Ratna Satriani



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# New product development in micro, small, and medium-sized enterprise-based agriculture products: a valuation technology approach

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**Abstract.** The innovation from university can assist Micro, Small, and Medium-sized Enterprises (MSMEs) in growing their business. However, because the technology has not been tested, MSMEs are still hesitant to adopt it. As a result, the objective of the research is value the innovation produced by the researcher at university that can add value to MSME products and business development. We employ a technology valuation application as a decision-making tool for valuing and predicting license prices for innovative technology to be commercialized. The use of mangosteen rind powder as a natural preservative on the physicochemical characteristics of coconut sugar had a risk factor of 0.4277, with a technology class of moderate risk, and was located in the technological life cycle's growth area and the product life cycle's diffusion area. The technology license price was IDR 302,042,177 and the diffusion of new technical consumer features was a growing field of innovation. As a result, to attract late adopters, it was necessary to project a positive image of technology beneficial to their health. The study's relevance is based on the patient-oriented technology valuation system, which can anticipate the price of new technology that has the potential to be commercialized.

## 1 Introduction

Product innovation as we know it now is a result of individual or collective ingenuity. The ability to create inventions that one owns, communicate what one thinks, and recognize new opportunities that aren't in the product or that may be referred to as fresh discoveries is what is meant by the definition of creativity. There are three different sorts of creativity: 1) producing new things or new goods; 2) fusing together previously known information with new information, and 3) altering an already existing object [1].

Product innovation is essential for the growth of MSMEs, and by dividing products into the three categories above, it is believed that business actors will be more innovative in how they conduct their operations [2]. MSMEs, which include both small enterprises and big businesses, is expanding quickly in Indonesia right now. Due to MSMEs' increased importance on Indonesian soil and ability to support the lower class economy while reducing unemployment, competition between MSMEs and large businesses has now become

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inevitable [3]. There are many MSMEs that are interested right now, and it is anticipated that fiercer competition would encourage business actors to be more innovative with new product developments. Business people may also take part in MSMEs-focused social events or exhibitions, which would force them to consider what innovations they want to produce. Due to the fierce competition between MSMEs and large business owners, business people in this region are forced to be innovative by implementing fresh ideas into their operations [4].

Coconut sugar MSMEs are among the top MSMEs in Banyumas District, Central Java. A food item derived from coconut sap is coconut sugar. The process of treating coconut mangoes (spatha) that haven't opened by a specific age results in the production of coconut sap, a pleasant liquid [5]. Water, sucrose, reducing sugar, other organic substances, and inorganic substances make up nira. The sap is excellent for microbial growth since it contains all the necessary nutrients. The sap suffers harm from microbial development.

Sodium metabisulfite, sometimes known as sulfite or sugar drug, is the synthetic solvent employed by producers of coconut sugar (Na2SO2O5). If the amount of sulfites in the food does not go over the established limit, it is actually acceptable. The Ministry of Health of the Republic of Indonesia states that 2 g/kg of material weight is the upper limit for the usage of Na-metabisulfite that may be used in food processing [6]. However, the population that cultivates coconut sugar takes these components over the safe limit, endangering health.

When sulfites are used in excess, it can have a negative impact on health, especially when renal problems develop as a result of residue buildup. Additionally, according to [7] sulfites can be fatal to humans and specifically harm asthmatics' respiratory systems. The use of synthetic solvents must be replaced with natural solvents in order to minimize the risks associated with the overuse of sulfite.

Lime mixed with mangosteen rind or jackfruit wood was the natural solvent that was once commonly used by the people. Due to their antibacterial characteristics, which can prevent the growth of microorganisms, jackfruit wood and mangosteen rind can both be used as solvent sap. The public has long been aware of the use of mangosteen rind as a substitute for coconut juice, but the ratio of its usage is still not specified, and because it is only semi-liquid, it is not stable. Therefore, it is anticipated that the technology for employing mangosteen rind in powder form, which was discovered by experts from the food technology department at Jenderal Sudirman University, will make coconut sugar less expensive and free of dangerous chemicals. To assist processing for the commercialization of technology between inventors and future technology users as investors, a technology valuation method to be commercialized is being developed [8]. With this value, technology developed as a consequence of research efforts requiring an investment of time, money, and knowledge will receive just financial compensation [9]. This incentive can be utilized by innovators to do long-term research in the same field, i.e., to create technology that is consistently more competitive and generates income as a result of putting their research findings to use [10].

It is, therefore, necessary to conduct research on the technology valuation system to determine the value of mangosteen rind powder as a natural preservative on the physicochemical properties of coconut sugar. As a result of this research, it is hoped that entrepreneurs and innovators will be able to collaborate more effectively and advance technology in a sustainable way.

## 2 Research Framework

### 2.1 Research method

By determining the beliefs of investors and innovators, technology is valued. This identification is made because, in accordance with their opinions, investors and inventors each have different determining factors for the valuation of technology. Then an evaluation

and formulation of the technology valuation determinants follows. The risks associated with the technology's commercialization can be determined based on the findings of this formulation. If the new technology is to be commercialized, risk considerations can also be utilized to classify it in the technological stage [13].

The worth of innovation will be decided by the opinions of various investors and inventors. Investors' and innovators' varying perspectives showed that both groups seemed interested in evaluating technology [14, 15). The fundamental objective of the evaluation is to establish the fair market value of technology to these competing interests [16]. What constitutes fair market value is the price at which a willing buyer and seller may reach an agreement.

Technology is valued by figuring out how investors and innovators see it. The fact that investors and inventors both value the criteria in accordance with their unique conceptions of technology made it possible to identify them. technology valuation factors' evaluation and formulation. This formula's results can be used to calculate the risk of technology commercialization. Risk factors can be used to classify the technological level at which new technologies will be commercialized [17].

We used primary data in this research. The originator of mangosteen rind powder and investors interested in commercializing mangosteen rind powder as a natural preservative on the physicochemical properties of coconut sugar was among those who were observed, questioned, and interviewed for the primary information. The management offices of IPRs served as the source for both theorists and practitioners. A range of processing methods from the V-Tech v1.3 Model of Decision Support System (DSS) of Technology Valuation has been used to process the data on the acquired primary data.

## 2.2 Methods of analysis

### *2.2.1 Risk factors*

Decision-making that involves various parties (stakeholders) or experts and is faced with multiple criteria is called Multi Expert-Multi Criteria Decision Making (ME-MCDM) [18]. One important aspect of decision-making in ME-MCDM is opinion aggregation and one of the techniques that can be used is fuzzy.

The fuzzy technique is used in the decision-making process because not all problems encountered in the real world can be stated exactly, namely yes or no, but contain uncertainty. This is often by the expressions: close to, approximately, almost, slightly greater than, and so on which are difficult to express in exact quantities [19].

The Independent Preference Evaluation (IPE) technique is one way of making decisions. [20] formulated a non-numeric computational method for fuzzy group decision-making processes. The computational method is carried out in stages, namely: (1) aggregation of criteria; and (2) aggregation of all experts with Ordered Weighted Averaging (OWA-Operator). In the free choice evaluation method, each decision maker $d_j\,(j = 1,2,\ldots,m)$ can evaluate alternatively $s_i$ $(i = 1,2,\ldots,n)$ on each criterion $a_k$ $(k = 1,2,\ldots,l)$ independently. The rating scale uses qualitative symbols (linguistic labels) with possible scores of “perfect” (S7), “very high” (S6), “high” (S5), “medium” (S4), “low” (S3), “ very low” (S2), and “none” (S1) or the set S = (S1, S2, … S7).

This study only uses the OWA-Operator method as an aggregation to calculate the ranking of each criterion variable linguistically, that is, each expert through in-depth interviews $d_j$ ($j$=1,2,3,4) assesses each criterion $a_k$ ($k$=1,2,…$n$) on technology valuation factors independently. The assessment uses five linguistic labels, namely: Not important (T), Less important (K), Fairly important (C), Important (P), and Very important (S).

The aggregation steps in decision-making with OWA Operators as follows:

1. Each decision-maker will get a set of values ($L$) on each alternative and each criterion with the following formula:

$$L = \left[ v_j(a_1), v_j(a_1), .., v_j(a_k) \right] \quad (1)$$

Whereas,

$v_j(a_k)$ : Evaluation score against the $k$ criterion by the $j$ decision maker

2. Calculate the value weighting by using the formula:

$$w_{(j)} = \text{Int}\left[ 1 + \left( j * \frac{q-1}{r} \right) \right] \quad (2)$$

Whereas,

$w_{(j)}$ : Weighting the value of $j$th expert
$j$ : $j$th expert
$r$ : Number of experts
$q$ : Total scale
Int : Integer

3. Aggregate determination of the final conclusion by using the formula:

$$v_{(j)} = \max\left[ w_{(j)} \wedge b_{(j)} \right] \quad (3)$$

Whereas,

max : Maximum
$w_{(j)}$ : Weighting the value of $j$th expert
$\wedge$ : Minimum
$b_{(j)}$ : The solution of equation (2) is ordered from lowest to highest

The risk factor values were obtained based on expert opinion, both sourced from the identification module and the risk factor form. Expert opinions are ordinal values with a score of 1-4. Based on the opinion assessment given by the expert, then the probability of the emergence of the scale values is calculated. With a predetermined range, the probability of occurrence is adjusted to obtain the risk factor value. To calculate the value of a risk factor, the first thing is determine the frequency with which an assessment score as follows:

$$F_{(l)1} = \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{f=1}^{p} X_{jkf1}, X_{jkf1} = l \quad (4)$$

$$F_{(l)2} = \sum_{j=1}^{m} \sum_{k=1}^{n} \sum_{f=1}^{p} X_{jkf2}, X_{jkf2} = l \quad (5)$$

$$F_l = F_{(l)1} + F_{(l)2} \quad (6)$$

$$P_l = \frac{F_l}{\sum_{l=1}^{4} F_l} \quad (7)$$

Whereas,

$F_{(l)1}$ : Frequency of the $l$th score for the 1st calculation
$F_{(l)2}$ : Frequency of the $l$th score for the 2nd calculation
$j$ : $j$th expert
$k$ : $k$th criterion
$f$ : $f$th factor
$X_{jkf}$ : Opinion of the $j$th expert for the $k$th criterion on the $f$th factor
$P_l$ : Probability of getting the $l$th score

Next determine the weight of the assessment score with the following formula:

$$w_l = \frac{l-1}{q-1}(r_{\max} - r_{\min}) + r_{\min} \quad (8)$$

Whereas, $w_l$ : Weighted score $l$th ($l$=1…$q$)
$l$ : $l$th score
$q$ : Total score
$r_{min}$ : Minimum risk factor
$r_{max}$ : Maximum risk factor

The risk factor value can be obtained by adding up the product of the frequency of opportunities and the weight of each score with the following formula:

$$k = \sum_{l=1}^{q} P_l \times w_l \quad (9)$$

Whereas, $k$ : Frequency risk factor value
$P_l$ : $l$th score chance
$w_l$ : Weighted score $l$th
$q$ : Total score

According to [21], risk factors can be divided into seven categories, namely: (1) Risk-free; (2) Very low risk; (3) Low risk; (4) Moderate risk; (5) High risk; (6) Very high risk; and (7) Extremely high risk. Expert panel is a way to determine risk factors based on expert opinion that focuses on two elements of technology commercialization, namely technology risk and marketing targets.

### *2.2.2 Discounted Cash Flow (DCF)*

The Discounted Cash Flow (DCF) method is a useful method in determining the price that prospective technology users are willing to pay at the time the agreement occurs, with the aim of obtaining the benefits derived from acquiring the rights to the technology [22].

The License Agreement (LA) is a calculation of the level or type of license agreed between the buyer and the seller which includes the license period and the type of exclusive license. The term of the license is usually agreed upon in the memorandum of understanding at the beginning of the license agreement. Exclusivity relates to the number of users (buyers) of the license desired by the patent owner (n). If the first buyer wants an exclusive license type, then the value of n = 1.

$$LA = \left[ P_{LC} C_0 \left( \sum_{1}^{t} (1 + k + P_{LC})^t \right) \right] / n \quad (11)$$

Whereas, $LA$ : License agreement
$P_{LC}$ : License/Cost Ratio (possibility of developing existing technology in the future)
$C_0$ : Investment costs in the first year
$t$ : License term
$k$ : Return risk
$n$ : Number of license users

## 3 Results and discussion

### 3.1 Valuation technology version 1.3 (V-Tech v1.3) application

The V-Tech v1.3 application is developed to value technology easy and fast. This application can be accessed on a computer or smartphone because it is made to run through a browser and the internet. Figure 1 displays a screenshot of the V-Tech v1.3.

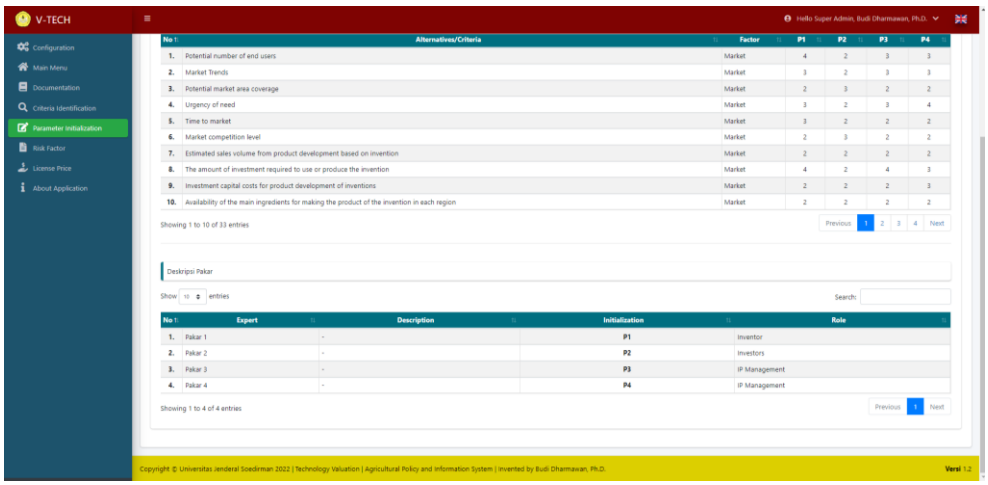


**Fig 1.** Screenshot of the V-Tech v1.3.

### 3.2 Technology commercialization risks

There are two features that characterize the risk of technology commercialization: (1) sub-model ranking of technology valuation variables, and (2) sub-model identification of technology valuation attributes. The technology valuation attribute identification submodel aims to pinpoint the state of the technology under evaluation, while the technology valuation variable ranking submodel aims to identify the valuation variables that are thought to be significant in relation to the technology under evaluation.

Utilizing the Ordered Weighted Averaging-Operator (OWA-Operator) method, the technology valuation variables were ranked. Technology valuation characteristics that are thought to be important for the technology being evaluated are used in the ranking procedure.

**Table 1.** Variables that affect the commercialization of mangosteen rind powder technology as a natural preservative on the physicochemical properties of coconut sugar.

| Very influential | Influential | Influential enough | Less influential |
|---|---|---|---|
| a.5, a.7, a.10, a.11, a.12, b.1, b.2, b.3, b.5, b.6, b.8, b.9, b.12, b.13, c.1 | a.1, a.2, a.3, a.4, a.6, a.8, a.9, b.4, b.7, b.10, b.11, c.2, c.3, c.4, c.6, c.8, c.9, c.10 | c.4 | c.6 |

Table 1 shows that the physicochemical characteristics of coconut sugar are the elements that have the greatest impact on the commercialization of the technology for mangosteen rind powder as a natural preservative. The marketing factor has the most bearing. The Expert Panel approach is used to identify the characteristics that contribute to technology valuation. According to the sort of technology being evaluated, this number may vary, but generally, the attribute equals 4 for each of the 10 variables and the 3 technology valuation factors.

The values of risk factors, technology class, and level of confidence will be determined based on the result of the research on the ranking of the evolution of technology's valuation factors and the variables already in place. [23] suggests categorizing risk variables into seven groups: (1) Risk-free ($k \leq 0.2$); (2) Very low risk ($0.2 < k \leq 0.3$); (3) Low risk ($0.3 < k \leq 0.4$); (4) Moderate risk ($0.4 < k \leq 0.5$); (5) High risk ($0.5 < k \leq 0.6$); (6) Very high risk ($0.6 < k \leq 0.7$); and (7) Extremely high risk ($k \geq 0.7$). Table 5 lists the risk associated with the evaluated invention.

**Table 2.** Risk factors and technology class on mangosteen rind powder as a natural preservative on the physicochemical properties of coconut sugar.

| Name of technology | Risk factor | Technology class |
|---|---|---|
| Mangosteen rind powder as a natural preservative on the physicochemical properties of coconut sugar | 0.4277 | Moderate risk |

Table 2 provides the risk variables that have been determined for the technology. These risk factors stand in for aspects of technology valuation, such as intrinsic quality (technology), market potential, and marketing potential. As a result, the development of this technology can be observed through the interaction of the S curve (life cycle) of technology, product life cycle, and market share growth of a product in a specific market. Figure 2 depicts the industrial sector.

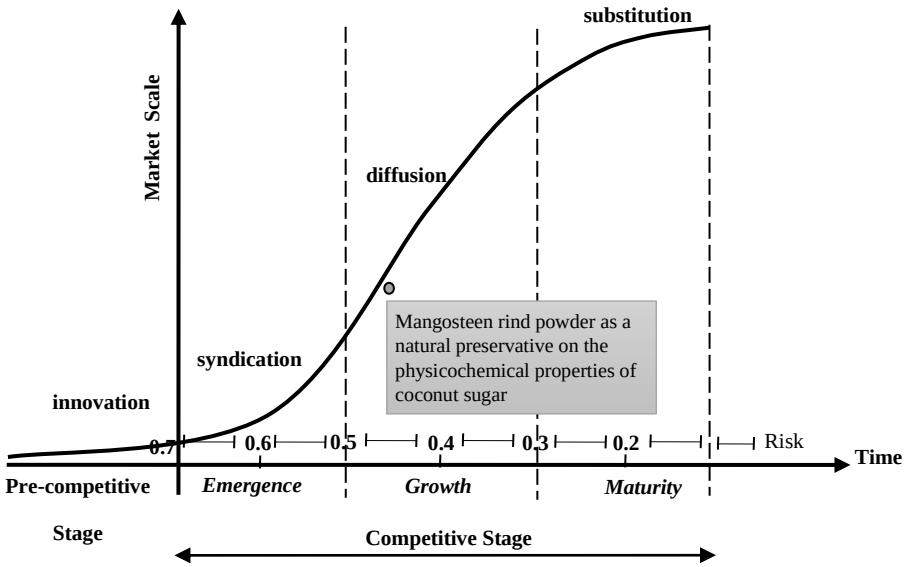


**Fig 2.** Position of Mangosteen rind powder technology as a natural preservative on the physicochemical properties of coconut sugar in the S curve (life cycle) of technology, product life cycle, and market growth of a product in an industry.

The coconut sugar technology using mangosteen rind powder as a natural preservative has a risk factor of 0.4277 and is classified as a moderate risk technology. Then, it is in the growth stage, which is characterized by a rising market and competitive pressures. Due to competition for products that are already on the market, this technology is in a stage of development. Competitor products include substances that have been utilized by artisans but are dangerous to your health if used repeatedly. The technology is in the diffusion stage, according to the product life cycle, where mass production can be conducted and the product is ready for distribution and commercialization. Because the invention's shape is in its formula and may be used with coconut sugar, the risk at the scale development stage is thought to be low.

### 3.3 Technology license pricing

Following a description of the negotiation process in the risk factor value, the determination of the technology licensing price seeks to establish the cost of the agreement between the

inventor and the potential investor. Based on this, Table 3 presents the technology license price that has been determined.

**Table 3.** Investment costs, license agreement, license benefits, and technology license price mangosteen rind powder technology as a natural preservative on the physicochemical properties of coconut sugar (in IDR)

| Investment cost | License agreement | License profit | Technology license price |
|---|---|---|---|
| 455,001,663 | 390,667,022 | 439,211,094 | 635,684,336 |

Based on Table 3, it can be shown that the inventor invested IDR 455,001,663 in the production of technology. The agreed-upon value of the license agreement between the inventor and the investor was IDR 390,667,022. The license profit value offered to inventors from technology commercialized by investors was IDR 439,211,094, however the license fee for this technology if other inventors wish to commercialize it was IDR 635,683,336.

When it comes to the physicochemical qualities of coconut sugar, the use of mangosteen rind powder technology as a natural preservative is still in its early stages of development due to the dissemination of innovation and the features of new technology consumers. A product's success will be significantly influenced by marketing. The sap can be kept in its original condition and harm to the sap is prevented for eight hours by adding *laru* from mangosteen rind. The sap that had been treated by the addition of mangosteen rind solution had a high beginning pH because of which its final pH after 8 hours was still higher than 5. The presence of an antibacterial tannin component in the mangosteen rind solution prevented sap damage caused by leaching from mangosteen rind.

Producing coconut sugar that is more resilient and keeps its freshness requires combining the ratio of mangosteen rind powder to sap with the quantity of *laru* added to one liter of sap. The competitive advantage of coconut sugar will increase on a national and international level if all coconut sugar craftsmen embrace this format. Therefore, fostering and developing this late adopter image among coconut sugar craftsmen and the general public is a solid marketing strategy to increase market share for mature late adopter consumers.

## 4 Conclusions

Risk variables and a technology class were developed using the submodel of technological commercialization risk. The physicochemical characteristics of coconut sugar were affected by the technology of mangosteen rind powder as a natural preservative, which had risk factors of 0.4277 and technology class in moderate risk. The pricing of the technology license submodel came to IDR 635,684,336 for the technology license fee, IDR 455,001,663 for the licensing agreements, and IDR 390,667,022 for the license profit. Based on the new technology's innovation diffusion toward consumer characteristics, this technology was in a stage of development that holds the function of marketing will be crucial to a product's success.

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