Transaction Cost of Economics: Understanding the Barriers of Financial Retrofitting in Indonesia's Energy Problem

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ABSTRACT

As one of the most populated nations in the world, Indonesia's energy consumption has been growing at a rapid pace. While various programs have been promoted by the government in order to increase efficiency in energy consumption, effort to maximize its utility remains constrained due to limited awareness from the general public. Based on the theoretical concept of transaction cost economics, this study proposed a solution to understand retrofit financing in Indonesia, as seen from the perspectives of the end-user (consumers) and supplier (product provider). Using a working example from the lighting industry, the study found uncertainties and asset specificities as the main driver behind the customer's intention to engage in retrofit financing. In order for them to gain maximum benefit of efficiency in energy savings, a sufficient understanding of retrofit financing and assurance of return on investment have to be primarily assured.

Keywords
Energy Efficiency, Retrofit Financing, Transaction Cost Economics, Lighting Industry

Article Received: 10 August 2020, Revised: 25 October 2020, Accepted: 18 November 2020

Introduction

As one of the most populous nations in the world (DESA - United Nations, 2015), Indonesia could reap a long-term financial benefit from the implementation of energy efficiency programs (Oberman, Dobbs, Budiman, Thompson, & Rosse, 2012). While the average electricity consumption continues to grow in parallel with the positive economic outlook, the Indonesian state-owned electricity company (Perusahaan Listrik Negara/PLN) continues to struggle in keeping up with the extensively growing demand for energy (ASEA Brown Boveri, 2013). Therefore, it is arguable that referring to an average annual increase of 8% between 2001 to 2015 in electricity price does not properly represent economic growth but rather, becomes an indicator of scarcity in supply (Central Bureau of Statistics – BPS).

Under regulation no. 70 (2009), the Indonesian government provides incentives and disincentives in the form of custom and tax facilities, reduction or alleviation of provincial taxes, and relaxed interest rate from banks to businesses that consume renewable energy in an equivalent of 6000 TOE (a Ton of Oil Equivalent). However, while the incentives provided are appealing, many companies struggle to maximize its benefit due to limited understanding and inadequate awareness in practicing efficient energy usage.

The recent success of LED lighting products has been seen as a way to provide the renewable path for humanity to embrace their future (U.S. Department of Energy, 2016), and could provide Indonesia with the solution to maximize efficiency in energy consumption. In Indonesia's industrial sector, shifting to LED usage from conventional lighting systems can have energy savings of up to 30%. In the commercial sector, productive businesses that have long operating hours can have an energy savings of up to 25%. As the largest consumer of energy, the Indonesian household sector could save up to 30% in electricity bills, this could have desirable indirect consequences. This could allow Indonesian households to better allocate their spending to achieve better health, shelter, and food, thereby increasing overall welfare.

Energy efficiency in the context of artificial lighting could be materialized through *retrofitting.* In engineering terms, retrofitting means substituting a conventional system with a better system without completely discarding the old equipment and replacing it with new ones (Hejazi, Ramanathan, & Jaffar, 2016; Husin, Ahmad, Wahid, & Kamaruzzaman, 2017; McWilliams & Walker, 2005; Oberman et al., 2012). Seen from the technological perspective, retrofitting is an economically feasible investment and could provide long-term benefits in reducing waste through longer product lifetime (International Energy Agency, 2013). The common lifetime of conventional lamps ranges between 8.000 hours compared to 20.000 hours in LED lamps, or an approximate 15 years, under normal usage.

However, this benefit has a low acceptance rate among business owners and is yet to be fully recognized as one of the most effective solutions in preserving energy. While many have acknowledged the superiority of LED lighting, various businesses are still astounded by the capital required to use the products.

In relation to LED lighting as a retrofit solution, the economic barrier of substantial financial investment could be overcome through the implementation of retrofit financing (Torgal, Buratti, Kalaiselvam, Grangvist, & Ivanov, 2016). A common goal of this solution is to increase the general public's awareness of LED products as a source of energy efficiency and the financial options it offers through savings in electricity bills.

This study explores the level of understanding and acceptance in retrofit financing implementation in Indonesia. As the word *retrofit* itself means adding new components in equipment that previously made without the customer need (Hejazi et al., 2016; Husin et al., 2017; McWilliams & Walker, 2005; Oberman et al., 2012), *retrofit financing* in this sense is used to describe transactional methods of disbursements through financial savings made from the monetary balance between previous and future electricity costs.

As an overall framework for the study, this research uses transaction cost of economics to focus on the difficulty to secure contractual agreements subsequent to the success of receiving the transactional commitment from customers. It is important to understand that this research does not emphasize firm-level commitment but rather on the managerial-level perception of retrofitting as a plausible solution for their financial barrier. While this research extensively discusses the benefit of LED usage in comparison with its conventional counterparts, discussion on the technological aspect of the LEDs is not the concern of this study.

Using a transactional cost of economic theory, three variables (uncertainty, assets specificity, economic utility) are discussed as the main drivers of consumer behavior in relation to transaction cost prior to the intention to engage in retrofit financing. These variables are later defined in further detail to ease measurement and presented together with seven hypotheses.

Literature Review

There are limited understanding of economic aspects and noneconomic factors that affect retrofitting decision in the current literature (Friege & Chappin, 2014). Meanwhile, limitation of access to information also decreases the likelihood for building owners and other users of energy to implement retrofitting actions (Hoicka, Parker, & Andrey, 2013). This limited access to information increases uncertainty (consumer's point of view) to the benefits of efficient energy usage even further. Based on current conditions, the decision to engage in retrofitting actions is strongly dependent on the operational costs (Palmer, Walls, & O'Keeffe, 2015), especially when the cost of LED products are considered to be substantial in comparison with conventional lighting products. Retrofitting in this sense becomes an issue of financial commitment which requires solutions derived from the transactional perspective (Leventis, Fadrhonc, Kramer, & Goldman, 2016; O'Malley, Scott, & Sorrell, 2003).

In its most basic term, the transaction is described as the materialization of conflict, mutuality, and order, which occurs when a certain product or service is transferred across the boundaries of organizations (Williamson, 2002). Using the theory, one can conclude that all transactions are unique. There are 3 differences that make all transactions unique. The first difference includes the degree of involvement between user and supplier, in relation to the assets they possess which defines their transactional relationship in the first place, the second difference involves uncertainties about actions of the other parties, while the third difference relates to the economic utility that involves the complexity of transactional agreement prior to the actual transaction occurrence (Williamson, 2002, 2008). These concepts are discussed in detail as follows:

Customer's Intention

This refers to some research findings that there is a significant correlation between purchase intention and consumer behavior (de Cannière, de Pelsmacker, & Geuens, 2010; Zeithaml, 1988). Therefore, the theory of reasoned action and the theory of planned behavior on individuals' intentions (Ajzen, 2006; Ajzen & Fishbein, 2005) (Ajzen, 2006; Ajzen & Fishbein, 2005) are used as the main idea for this study, where intentions are widely used and have good predictive validity (Infosino, 1986). In the service sector, behavioral motives are related to the willingness to deliver services (Anderson & Mittal, 2000; Homburg, Koschate, & Hoyer, 2005; Verhoef, Franses, & Hoekstra, 2001).

Transactional Costs

Transaction Cost of Economics ("TCE") elements such as boundary rationality, opportunism, the specificity of assets, uncertainty, and amplitude of relationships have been used. Bounded rationality tends to increase the transaction cost, as the participating parties have limited capability to accumulate, process, and transmit information (Riordan & Williamson, 1985). Moreover, there is also a possibility of opportunistic actions being taken by the parties. All of these contribute to increasing transaction cost to cover for the risks the parties are taking in making an agreement (Leiblein, 2003; Maia, Cerra, Gomes, & Filho, 2010).

Uncertainty

Refers to Weber & Mayer (2010), the role of uncertainty is to reveal the limits of bounded rationality that tend to increase the transaction cost (Grover & Malhotra, 2003). Under the TCE, an appropriate response to a high degree of uncertainties within a transaction is to quit the transaction since uncertainty is a major important factor in the transaction cost analysis (Williamson, 1981).

Asset Specificity

Measures the degree to which the assets that sustain the contract are customized to it and can be viewed as some opportunity costs for the use of the same assets in the next best option if the deal is ended early (Varadarajan, 2015). Asset specificity provides an insight into investment relationships involving both technological and social capital, along with other intangible assets such as organization knowledge, ability, and R&D capabilities (Belloc, Laurenza, & Rossi, 2016). It is also important to understand that while specificity in assets could become a leading differentiator a firm could possess, a highly specific asset tends to increase a firm's exit cost, as this particular asset can only be used to support a particular transaction (Heil & Helsen, 2001).

Economic Utility

One of the factors postulated to affect the perceived transaction cost is an economic utility (Teo, Wang, & Leong, 2004). The economic utility is one of the determining factors for a customer in making a purchase decision. However, Teo et al. (2004) found that economic utility is negatively related to transaction costs.

Materials And Methods

Retrofit financing is innovative and very complicated because it involves a variety of consequences that need to be

considered. The design concept for this research is demonstrated as follows:

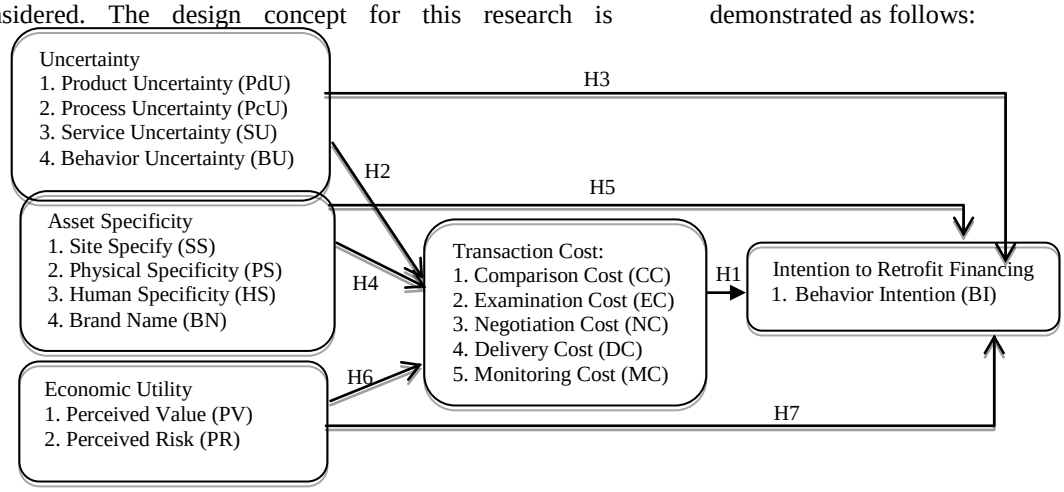

Figure 1. The theoretical framework

To examine the complexity of retrofit financing, this study conducted quantitative research to explore the risks of current business financing activities from the perspective of modern finance. This study uses a structural questionnaire, interviews adhering to the principles of TCE theory, and secondary data gathered from several reports and journals as its main sources of information.

In an attempt to diminish the responsiveness of the questionnaire survey, an internet-connected strategy (Baruch & Holtom, 2008) was used to upload a set of questionnaires to Google Forms to be delivered to others via email, WhatsApp and Line smartphones. The Likert scale was used to evaluate the questionnaires, whit higher scores describing agreement, and lower scores describing disagreement. Of the 53 survey questions that were sent, 91% of the reply gain was achieved, with 48 replies in 10 working days. Participants were assumed to be a group of individuals, managers, or managers with specialized knowledge of the retrofit project. Most of the participants are professionally trained and informed in the sector with a strong understanding of the process within the industry.

Transactional Costs

The costs involved in the retrofit financing process such as comparison cost, examination cost, and negotiation cost. The mentioned costs affect the customers' transaction costs in the form of time and effort that is needed to compare, examine, and negotiate all relevant products and services or other attributes among different retrofit providers. Meanwhile, delivery costs and monitoring costs affect the customer's transaction costs in the form of time and resources regarding the products and services during the implementation stage to ensure that the details of the settlement are encountered and assistance during the retrofit time frame. In conclusion, the consumers will choose to minimize perceived transaction costs, and thus, the following hypothesis was made:

H1: Transaction Costs is negatively related to Consumer's intention

Uncertainty

This study chose the TCE aspects of uncertainty under an interpretive analysis and is based on the set of data collected during the field survey. Product uncertainty as a transaction that is based on retrofitting finance, process uncertainty, and service uncertainty, refers to the difficulty in ascertaining the quality of products and services that are promised in the terms of the contract as per customers' expectations. Meanwhile, behavior uncertainty refers to the difficulty in ascertaining the provider's performance or their adherence as per contractual (Riordan & Williamson, 1985). Based on the mentioned understandings, the following hypotheses were made:

H2: Uncertainty is positively related to Transaction Costs

H3: Uncertainty is positively related to Consumer's Intention

Asset Specificity

Shows the amount of money that has been committed to a single transaction. These transaction-specific assets were barriers to having opportunistic behavior and threats of exchange as these transaction-specific assets will minimize the transaction costs (Palmatier, Dant, & Grewal, 2007). The site-specificity refers to locations close to enhancing collaboration and reducing production and transport costs. The specificity of physical assets refers to particular capital expenditures, and the specificity of human assets applies to specific know-how (De Vita, Tekaya, & Wang, 2011). Brand specificity refers to the use of products' brands from other parties, which is used in retrofit financing. Based on the understanding laid out, the following hypotheses were made:

H4: Assets Specificity is positively related to Transaction Costs

H5: Assets Specificity is positively related to Consumer's intention

Economic Utility

The transaction cost model and no-upfront investment in energy efficiency products will have the possibility for customers to achieve more economic utility. Therefore, the following hypotheses can be made:

H6: Economic Utility is positively related to Transaction Costs
H7: Economic Utility is positively related to Consumer's intention

Result And Discussion

The hypothesized model was analyzed using SmartPLS 3.0 software. The structural model (Inner Model) and the outer model (Outer Model) were tested for validity and reliability in a series of tests. As a result, most indicators with loading factors of less than 0.6 (Ghozali & Latan, 2012) have been removed. The design reliability test was carried out by measuring two criteria: Cronbach's Alpha and Composite Reliability, and the ensuring full the reliability of all metrics above the minimum value of 0.7.

According to the test result, the mean extracted variance (AVE) at each observed variable is greater than the acceptable threshold of 0.5 (Bagozzi & Yi, 1988). It shows that the construct measurements are related and that most of the indicators are statistically significant. All variables have a certain percentage of loads on their support than on any other structure. The consistency between the actual and the predicted model is also appropriate. Accordingly, this analysis concluded that the reliability test had correctly differentiated between the designs and that the testability criteria had been met.

Following the validation of the estimation model, the study analyzed the structural equation model. The description of the structural model indices is shown in Table 1 below. The findings show that the coefficient of the determinant (R2) is 30.7% of the variance intended for retrofit and that 19.5% of the variance for Transaction Costs is accounted for by the model. For dependent variables, the coefficient of determination (R2) values of 0.75, 0.50, and 0.25 are considered to be significant, moderate, and low (respectively) by Hair, Hult, Ringle, and Sarstedt (2014). However, Sanchez and Heene (2015) consider the coefficient of determination (R2) values of > .60 to be high, between 0.30 and 0.60, to be moderate and below 0.30 to be low. Therefore, based on Table 1, the R2 values are small to moderate. Meanwhile, the percentages of the coefficient of determination (R2) described by the model are higher than 10%, indicating a reasonable and vital model (Falk & Miller, 1992).

Table 1. Summary of Structural Model Indices

	R Square	**R Square Adjusted**
Intention to Retrofit	0.361	0.307
Transaction Costs	0.243	0.195

Table 2 represents the loading (estimate) of assets specificity, economic utility, transaction costs, and uncertainty on the intention to retrofit and transaction costs. The regression weights for the effect of assets specificity on transaction cost and uncertainty on the intention to retrofit are statistically highly significant at 1%. Hence, the hypothesis of H3 - uncertainty is positively related to consumer's intention, and H4 - assets specificity is positively related to transaction costs is **highly accepted**. The other weight for the effect of asset specificity on the intention to retrofit is statistically significant at 5%, thus, the hypothesis of H5 - assets specificity is positively related to consumer's intention is **accepted**. Meanwhile, the weight for the effect of economic utility on the intention to retrofit is statistically significant at 10%, therefore, the hypothesis of H7 - Economic Utility is positively related to consumer's intention is **moderately accepted**.

Table 2. Total Effects

Mean, STDEV, T-Stat, Pvalues	**Original Sample (O)**	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics**		**P-Values**
Transaction Costs > Intention to Retrofit	0.228	0.239	0.170	1.338		0.181
Assets Specificity > Transaction Cost	0.466	0.481	0.147	3.173	*	0.002
Assets Specificity > Intention to Retrofit	0.318	0.342	0.149	2.127	**	0.033
Economic Utility > Transaction Cost	0.038	0.036	0.133	0.284		0.777
Economic Utility > Intention to Retrofit	0.281	0.253	0.151	1.863	***	0.063
uncertainty > Transaction Cost	0.020	0.021	0.137	0.146		0.884
uncertainty > Intention to Retrofit	-0.349	-0.352	0.107	3.254	*	0.001

*significant at 0.01; **significant at 0.05 and *** significant at 0.1

The remaining loading estimates are statistically insignificant, therefore, the hypothesis for H1 - transaction cost is negatively related to consumer's intention; H6 - economic utility is positively related to transaction costs, and H2 - uncertainty is positively related to transaction costs are **rejected**. Clearly, it can be seen from the models that uncertainty and assets specificity are the most significant construct for intention to retrofit. The difference may be due to a learning effect, which will be discussed in the conclusion.

The graphical representation of the postulated model with the regression coefficients can be seen in Figure 2 below,

where the bootstrap is processed, and 'N' samples were replaced from the original data set to 5000 samples using the bootstrap facility with 95% confidence interval.

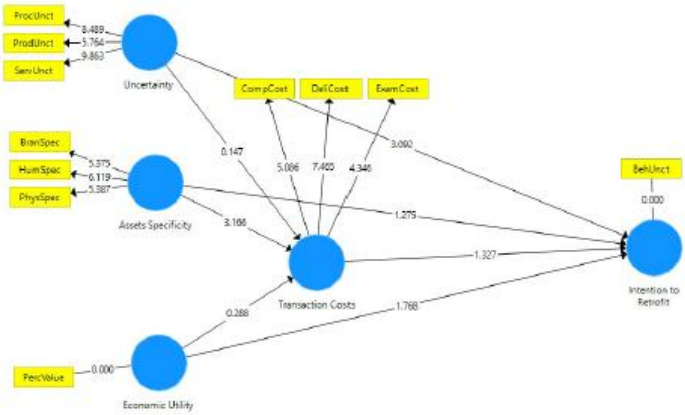

Figure 2. The Graphical representation of the model with the loadings

Conclusions

The results of this study show some interesting findings; first, it confirmed the initial argument that retrofit financing is relatively new in the financing scheme. The results of this study suggest that retrofit financing is more likely to be influenced by uncertainty and asset specificity instead of economic utility and transaction costs. This may primarily be attributed to the difference in people's perceived transaction costs. The higher the perceived transaction costs, the less likely people will do the retrofit financing. One can draw a few guidelines from analyzing the Transaction Cost of Economics models regarding what factors are more suitable for retrofit financing. The results implied that transaction cost is not the key factor in the success of retrofit financing projects, and that is one of the reasons why people are reluctant to do the retrofit financing projects. It also means that they are less desirable to consumers, at least in their current form.

Another problem is the learning effect of retrofit ventures, which showed that both the precision of assets and the volatility of assets influence the consumer's decision-making process. Especially for asset specificity, it is quite a likely finding that the customer has a higher expectation of brand-specificity, human-specificity, and physical-specificity as their main concern on their decision. Accordingly, in this study, the assets-specificity of customers is found to be well appreciated. The other finding is that the provider uncertainty has the strongest effect, especially on the intention to retrofit as opposed to consumers' perceived transaction costs. The study also found that the 3 most important/significant loading factors/indicators are service uncertainty, process uncertainty, and product uncertainty.

The findings that assets specificity and uncertainty are the main factors in determining the success of a retrofit project may be explained by the customer getting used to the project's stages and processes. They might also feel more comfortable as they have more experience in getting involved in retrofit projects as well as being familiar with the providers. These processes eliminate problems associated with transaction costs. Finally, the transaction cost model for the retrofit project in Indonesia is confirmed by the data. That is the customer's intention/decision is more strongly affected by the uncertainty and asset specificity rather than transaction cost as was previously hypothesized. To ensure that a particular market can adopt the retrofit concept successfully, products, process, service uncertainties, and the involvement of specific assets should be properly managed.

This study hopes to contribute to the theory of transaction cost economics in several ways. Firstly, we have built and test a retrofit model based on the transactional cost to be used as an analytical tool for retrofit financing. Furthermore, findings in this study could assist managers to understand and to hopefully be willing to participate in the future engagement of retrofit financing in their respective firms. As the concept of retrofit financing is relatively new in the field of products and/or service area, it can be used as an encouragement to tackle uncertainties through a rather simple method of transactional management.

Especially for the energy efficiency industry, this study could be used by industry practitioners as tools to analyze the strategy for implementing such a business strategy, addressing the problem of developing the client's perspective of retrofit financing. The current developments are changing from selling goods to providing product-service systems (Ceschin, 2014; Prabhu, Taisch, & Kiritsis, 2013).

Nevertheless, this study is not free from limitations. It is clear that we only measure transaction costs from the context of perceived costs, and not real-time cost or actual financial cost. Also in relation to this limitation, the modeling approach adopted in this study was only calculated as structural equations with the SmartPLS 3.0 software. Although the results of the coefficients are shown as acceptable fit to the analysis, some inherited limitations may contribute to the reduction of validity and reliability scores (Lee, Barua, & Whinston, 1997). Further investigation into the same problem, adopting different calculation methods should be one of the aims of future research.

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