Innovation Process Audit Model: A Case Study in an Electronics Company

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Abstract. Competitive advantage can be achieved through innovation. In order to ensure that the innovation process runs effectively, organization must conduct an audit. This research develops an innovation process audit model. The model is constructed by analyzing the impact of Technological Innovation Capabilities (TICs) on Technological Innovation Performances (TIPs). TICs are represented by eight independent variables which are Learning Capability, R&D Capability, Resource Allocation Capability, Manufacturing Capability, Marketing Capability, Organizational Capability, Strategic Planning Capability, and External Environment Capability. TIPs are represented by one dependent variable which is Product Performances. This innovation process audit model is validated using expert judgement in an electronics company then tested using forward stepwise regression. Based on the empirical testing, three TICs variables identified as the variables which influence TIPs. The three variables are Resource Allocation Capability, Manufacturing Capability, and External Environment Capability. The regression coefficient for the three variables are 0.765, 0.424, and 0.219 consecutively.

Keywords: innovation process audit model, technological innovation capabilities, technological innovation performances

1. INTRODUCTION

Innovation capabilities and utilization become key success factor in current and future competition (Papinniemi, 1999). Baregheh, et al. (2009) defines innovation based on 60 definitions from seven disciplines from 1934 until 2008. Innovation is defined as the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace (Baregheh, et al., 2009). This definition affirms the role of innovation in competition.

In order to gain advantages from innovation, company must understand the innovation process and factors affecting innovation (Chiesa, et al., 1996). Innovation process describes in several stages. There are different stages in different literatures. Hansen and Birkinshaw (2007) states three stages of innovation process which are idea generation, idea conversion, and idea diffusion. Salerno, et al. (2015) develops the innovation process based on Hansen and Birkinshaw (2007). The innovation process consists of idea generation, screening / idea selection, development, and diffusion / market / sales (Salerno, et al., 2015).

Besides understanding about innovation process,

company must also understand the factors affecting innovation (Chiesa, et al., 1996). The factors affecting innovation can be identified through auditing the existing process. By doing audit, company can improve technological innovation management and performance (Chiesa, et al., 1996).

An audit model in a company is useful to identify the impact of Technological Innovation Capabilities (TICs) on Technological Innovation Performances (TIPs). Therefore, an audit is needed to assess the innovation process and identify the innovation capabilities that influence the innovation process (Chiesa, et al., 1996).

An audit by analyzing the impact of TICs on innovation performance has been done by Yam, et al. (2004). The research by Yam, et al. (2004) was conducted on 213 Chinese companies in Beijing, China. The correlation between TICs and innovation performance in Yam, et al. (2004) examines by using regression analysis. Based on the result of regression analysis, company can formulate innovation strategy.

The innovation strategy of a company is differ from the other company. This difference is the result of different business strategy and different innovation capabilities (Pisano, 2015). In order to develop an innovation strategy, a company needs an audit that analyze the innovation capabilities and performance. This research aims to develop an innovation process audit model that specifically tested in an electronics company.

2. LITERATURE REVIEW

The main concepts discussed in this paper are innovation process audit, Technological Innovation Capabilities (TICs), and Technological Innovation Performances (TIPs).

2.1 Innovation Process Audit

There are several innovation process audit instruments. dos Santos (2014) identified seven different instruments with different measurement dimensions. Among the seven instruments, the work of Chiesa, et al. (1996) provides significant contribution in the development of innovation process audit instrument (dos Santos, 2014).

Chiesa, et al. (1996) proposed an audit which comprised of process audit and performance audit. The processes consist of four core and three enabling processes of innovation. These seven processes are divided into twenty three sub processes. The performance indicators were developed for each innovation process. This instrument, the innovation scorecard, was tested in eight companies from various size and type of industry.

2.2 Technological Innovation Capabilities (TICs)

TICs are defined as comprehensive set of organization's characteristics that facilitates and supports its technological strategies (Yam, et al., 2004). This set of characteristics is described in several capabilities. The critical capabilities related to successful technological innovation is not only technological capability, but also capabilities in manufacturing, marketing, organization, strategy planning, learning, and resources allocation (Yam, et al., 2004).

There are several approach in assessing TICs, which are asset approach, process approach, and functional approach (Yam, et al., 2011). This research uses functional approach. Functional approach is easier to understand and facilitates multi-informants approach (Yam, et al., 2011), which are adopted in this study.

The measurement indicators for TICs in previous research are as follow.

a. Yam, et al. (2004): learning capability, R&D capability, resource allocation capability, manufacturing capability, marketing capability, organising capability, and strategic planning capability.
b. Guan, et al. (2006): learning capability, R&D capability, manufacturing capability, marketing capability, resource exploiting capability, organizational capability, and strategic capability.
c. Wang, et al. (2008): R&D capability, innovation decision capability, marketing capability, manufacturing capability, capital capability.
d. Cheng and Lin (2012): planning and commitment of the management capability, marketing capability, innovative capability, R&D capability, operations capability, knowledge and skills capability, information and communication capability, and external environment capability.

2.3 Technological Innovation Performances (TIPs)

TIPs are defined as additional economic value in the market which are led by new technological development, new combination of existing technologies, and creative utilization of other technology learnt from outside of the company (Choi, et al., 2012). The economic value in the market is related to financial term. Financial term is the best measurement of any innovation performance (Yam, et al., 2011).

Although financial term is best indicator for any innovation performance, including TIPs, companies would not easily reveal any confidential financial information. Therefore, alternatives indicators are needed. Indicators for TIPs are as follow (Yam, et al., 2004).

a. Innovation performance, related to number of commercialized new products.
b. Sales performance, related to the average annual sales growth rate.
c. Product performance, related to various aspects, such as average concept-to-launch time, programming product

series, quality level, cost, analyzing market competitive intensity, market need and growth potential, technology characteristics, product manufacturing process, and price/function advantage.

3. METHODOLOGY

The first step in this research is literature review. The literatures that support this research are related to innovation process audit, TICs, and TIPs. The main literatures that support this research are Chiesa, et al. (1996), Yam, et al. (2004), Guan, et al. (2006), Wang, et al. (2008), Cheng and Lin (2012), and Yam, et al. (2004).

The second step is company selection. This research uses case study approach. The case study is conducted in an electronics company, which has experience in conducting product, process, and strategy innovations.

The third step is model development. The developed model consists of two constructs, which are TICs and TIPs. Indicators for each construct is formulated mainly based on the work of Yam, et al. (2004), and supported by Guan, et al. (2006), Wang, et al. (2008), and Cheng and Lin (2012).

The fourth step is model operationalization. The model is operationalized into preliminary questionnaire. The questionnaire is enriched using expert judgement. Expert judgment provides information from qualified individuals that can be used to solve problem or make decision (Meyer & Booker, 2001). There are five managers involved in expert judgment, which are manager of marketing and business development, manager of industrial technology, manager of production, manager of logistics, and manager of operation management and strategy. Then the result is validated using Content Validity Ratio (CVR). Based on this step, the final questionnaire is constructed. The questionnaire statements with CVR value less than zero are removed from the questionnaire (Lawshe, 1975). Some questionnaire statements are inserted based on suggestion from experts. The final questionnaire uses seven points Likert scale, from strongly disagree to strongly agree.

The fifth step is data collection. The respondents of the final questionnaire are 32 persons from middle management. Most of the respondents, 18 persons of 32 persons, are holding bachelor degree. These 32 persons are chosen because they have experience related to innovation in the company.

The sixth step is data processing. In this step, the questionnaire is tested for validity and reliability. The validity test uses pearson correlation. The acceptable pearson correlation value is more than 0.3 (Gomm, 2008). The reliability test uses Alpha Cronbach. The acceptable Alpha Cronbach reliability coefficient is more than 0.6 (Malhotra & Birks, 2007). After that, the data are transform from ordinal scale into interval scale. This must be done because the data for correlation test must be in interval or ratio scale (Hair, et al., 2010). The transformation is executed using successive interval method. The other tests done to check the classical regression assumptions are normality test, multicollinearity test, auto correlation test, and heteroscedasticity test. After that, the hypothesis is tested using multilinear regression, F test, and T test.

The seventh step is analyzing the result. The analysis is done based on the result of multilinear regression and the coefficient of determination. The last step is formulating the conclusion of this research.

4. RESEARCH MODEL

The innovation process audit model consists of two constructs, TICs and TIPs. This research model represents the relationship between TICs and TIPs. Indicators and operational definitions for each indicator of TICs are formulated based on Yam, et al. (2004), Guan, et al. (2006), Wang, et al. (2008), and Cheng and Lin (2012). Indicators of TICs are learning capability, R&D capability, resource allocation capability, manufacturing capability, marketing capability, organizational capability, strategic planning capability, and external environment capability.

Indicators and operational definitions for each indicator of TIPs are formulated based on Yam, et al. (2004). Indicators of TIPs are sales performance, innovation performance, and product competitiveness.

Every indicator then operationalized into several questionnaire statements. Indicators for TICs are shown in Table 1, while indicators for TIPs are shown in Table 2. The research model is represented in Figure 1.

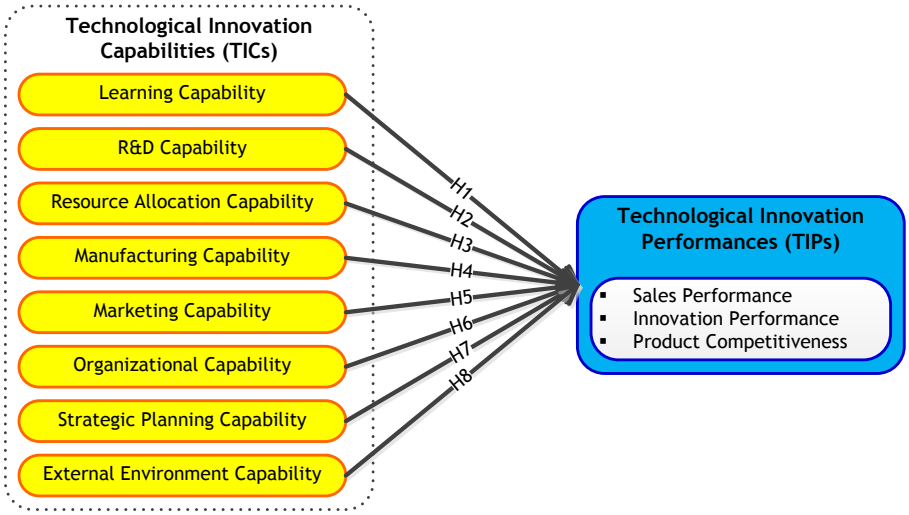

Figure 1: Innovation process audit model.

Table 1: Indicators of TICs.

Indicators	Operational Definition	Number of Questionnaire Statement (Preliminary)	Number of Questionnaire Statement (Final)
Learning Capability (X_1)	Company's ability to identify, assimilate, and utilize knowledge from internal and external environment	9	9
R&D Capability (X_2)	Company's ability to integrate R&D strategy, project implementation, project portfolio management, and R&D expenditure	17	15
Resource Allocation Capability (X_3)	Company's ability to acquire and to allocate appropriately capital, professional expertise and technology in the innovation process	9	6
Manufacturing Capability (X_4)	Company's ability to transform R&D results into products that fulfill market needs in accordance with the design requirement, to manufacture products, and to improve product quality	7	8
Marketing Capability (X_5)	Company's ability to publicize and sell products on the basis of understanding consumer needs, the competitive environment, costs and benefits, and the acceptance of the innovation	9	8
Organizational Capability (X_6)	Company's ability to secure organizational mechanism and harmony, cultivate organizational culture, and adopt good management practices	7	6
Strategic Planning Capability (X_7)	Company's ability to identify internal strengths and weaknesses and external opportunities and threats, formulate plans in accordance with corporate vision and missions, , adjusts the plans for implementation, and execute technological innovation decision	6	5
External Environment Capability (X_8)	Company's ability to cooperate with external institutions such as innovation centers or universities to confirm technological comparisons of the competition and to make certain of new product competitiveness	7	8

Table 2: Indicators of TIPs (Y).

Indicators	Operational Definition	Number of Questionnaire Statement (Preliminary)	Number of Questionnaire Statement (Final)
Sales Performance	Company's average annual sales growth rate over the last three years	1	0
Innovation Performance	Company's number of commercialized new products expressed as a percentage of all products over the last three years	1	0
Product Competitiveness	Company's portfolio concept encompassing various aspects, such as average concept-to-launch time, programming product series, quality level, cost, analyzing market competitive intensity, market need and growth potential, technology characteristics, product manufacturing process, and price/function advantage	9	9

There are simultaneous and partial hypotheses in this research. The simultaneous hypothesis is as follow.

H9: Learning Capability (X_1), R&D Capability (X_2), Resource Allocation Capability (X_3), Manufacturing Capability (X_4), Marketing Capability (X_5), Organizational Capability (X_6), Strategic Planning Capability (X_7), and External Environment Capability (X_8) positively influence Technological Innovation Performance (Y).

The partial hypotheses are as follow.

H1: Learning Capability (X_1) positively influences Technological Innovation Performance (Y).

H2: R&D Capability (X_2) positively influences Technological Innovation Performance (Y).

H3: Resource Allocation Capability (X_3) positively influences Technological Innovation Performance (Y).

H4: Manufacturing Capability (X_4) positively influences Technological Innovation Performance (Y).

H5: Marketing Capability (X_5) positively influences Technological Innovation Performance (Y).

H6: Organizational Capability (X_6) positively influences Technological Innovation Performance (Y).

H7: Strategic Planning Capability (X_7) positively influences Technological Innovation Performance (Y).

H8: External Environment Capability (X_8) positively influences Technological Innovation Performance (Y).

5. RESULT AND DISCUSSION

5.1 Expert Judgment

The preliminary questionnaire consists of 82 statements. Among the statements, there are 13 statements with CVR value less than zero. Because of that, the thirteen statements are removed from the questionnaire. The experts suggest to add five more statements. Therefore, the final questionnaire consists of 74 statements.

5.2 Validity and Reliability of Measurement Tool

The 74 statements in the final questionnaire are answered by 32 persons from middle management. The validity of the questionnaire as the measurement tool is tested using pearson correlation. There are two questionnaire statements of Strategic Planning Capability (X_7) that have pearson correlation value less than or equal to 0.3. This shows that the two statements are not valid. Therefore, the two statements are removed and not used in the next data processing steps.

The reliability of the questionnaire as the measurement tool is tested to find reliability coefficient for each questionnaire statement. The test results shows that all of the reliability coefficient is more than 0.6. This means that all of the questionnaire statements are reliable. After processed through the validity and reliability test, the data are converted from ordinal into interval form using successive interval method. This transformation is needed in order to prepare the data for the regression calculation.

5.3 Classical Regression Assumptions

The classical regression assumptions are tested using normality test, multicollinearity test, auto correlation test, and heteroscedasticity test. The normality test is done using Kolmogorov-Smirnov test. The result supports that the data were taken from normally distributed population.

The multicollinearity test is applied to the eight independent variables. In a good regression model, all of the independents variables are not multicollinear. The variables are proven to be not multicollinear if the variance inflation factor is below 10 and the tolerance value is higher than 0.01 (Hair, et al., 2013). The test result shows that all of the eight independent variables are not multicollinear.

The auto correlation test is done using Durbin-Watson test. The result shows that there is no autocorrelation in the variables. The heteroscedasticity test is done using Spearman

rho test. The result shows that there is no heteroscedasticity in the model. Based on these four test, it can be concluded that regression analysis is suitable for this model and data set.

5.3 Hypotheses Test

To test the simultaneous hypothesis, multilinear regression approach is applied. The multilinear regression involves all independent variables. The result shows that there is no independent variable that influences the dependent variable. Because of this, the forward stepwise regression is conducted. The result shows that three of eight hypotheses are accepted, which are H3, H4, and H8. The multilinear regression equation is as follow.

$$Y = 2.805 + 0.765X_3 + 0.424X_4 + 0.219X_8$$

Based on the F test, Resource Allocation Capability (X_3), Manufacturing Capability (X_4), and External Environment Capability (X_8) simultaneously have significant impact on Technological Innovation Performance (Y). After the F test, the T test is conducted to test the hypotheses partially. The result shows that the three independent variables partially have significant influence on the dependent variable.

The multiple correlation coefficient is 0.841. This shows very strong correlation among the variables (Hair, et al., 2010). The determination coefficient is 0.707. This means that approximately 70.7 percent of the variation in Resource Allocation Capability (X_3), Manufacturing Capability (X_4), and External Environment Capability (X_8) are associated with Technological Innovation Performance (Y) (Hair, et al., 2010).

Resource Allocation Capability (X_3) positively influences Technological Innovation Performance (Y). The company allocates less than 1% of its annual income for innovation activities. This allocation needs to be increased in order to increase TIPs.

Manufacturing Capability (X_4) positively influences Technological Innovation Performance (Y). The company has good manufacturing capability. It can produce various products in signaling, solar energy, and defense category. If the manufacturing capability increase, TIPs will also increase.

External Environment Capability (X_8) positively influences Technological Innovation Performance (Y). The company cooperates with other institution such as universities, research institution, and similar companies. The cooperation is conducted in innovation context. By enhancing external environment capability, TIPs will be higher.

6. CONCLUSION

In this research an innovation process audit model is developed. The model consists of eight independent variables and one dependent variable. The independent variables are Learning Capability, R&D Capability, Resource Allocation Capability, Manufacturing Capability, Marketing Capability, Organizational Capability, Strategic Planning Capability, and External Environment Capability. The dependent variable is Technological Innovation Performance. Based on empirical testing, Resource Allocation Capability, Manufacturing Capability, and External Environment Capability are positively influences Technological Innovation Performance.

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