Key Factors of Success Technology Transfer from Higher Education To Creative Industry in Bangkalan, Madura

Retno Indriartiningtias
Industrial Engineering Department, Trunojoyo University, Madura, Indonesia
retno.indriartiningtias@trunojoyo.ac.id, retnotmiiitb@gmail.com

Andi Rahadiyan W, Subagyo, Budi Hartono
Industrial Engineering Department, Gadjah Mada University, Yogyakarta, Indonesia

Abstract. Technology is one of key factors in achieving competitive advantage of an organization, especially those in creative industries. Through effective technology transfer is it expected to be transferred technology really can be absorbed and used by the creative industries. There are several factors that influence the effectiveness of technology transfer, this research using four factors, there are: characteristics of transfer agent, characteristics of transfer recipient, form of technologies and Transfer Mechanism. Some models and framework can also be used to study the relationship of the key factors of success with the effectiveness of technology transfer. Based on a conceptual model, this research aims to identify the key success factors of the process of technology transfer from the Trunojoyo University to creative industries in Bangkalan Madura. This study uses a multivariate approach by using principal component analysis and linear regression. Based on data from the four creative industries in Bangkalan obtained mathematical models $Y = 0.830 + 0.379 \text{Form Technology} + 0.450 \text{Characteristics of Transfer Agent} - 0.371 \text{Characteristics of Transfer Recipient}$. The model has a $R^2$ value of 0.299, which means those factors capable identifies the effectiveness of technology transfer by 29.9%. the rest is explained by other factors that have not been identified. From the model concluded that characteristics of transfer agent is the main factors of technology transfer.

Key Words: effectiveness of technology transfer, creative industries, principal component analysis, characteristics of transfer agent, characteristics of transfer recipient

1. Introduction
Creative industry is an industry derived from the utilization of creativity, skills and individual talents to create welfare and employment through the creation and utilization of creative power and creativity of these individuals[1]; [16]. Creative industry as a form of creative economy is believed to be able to answer the challenges of short-and medium-term basic problems faced by the Indonesian nation after the economic crisis: (1) relatively low economic growth post-crisis (average only 4.5% per year); (2) high unemployment rate (9-10%), high poverty rate (16-17%), and (4) low industrial competitiveness in Indonesia. In addition to these problems, the creative economy is also expected to respond to challenges such as global warming, renewable energy use, deforestation and carbon emission reductions, as the direction of developing this creative industry will lead to the pattern of environmentally friendly industries and the creation of value added products and services derived of the
intellectual human resources possessed by Indonesia, where the intellectuality of human resources is a renewable resource.

One characteristic of the creative industry lies in the renewal and added value of the resulting product. So to produce products with high renewal requires the role of knowledge and technology [2]. Knowledge plays a role in the creation of new ideas that are indispensable in the process of creativity, whereas technology is needed to implement these new ideas in the form of creative products. Technology is all knowledge, products, processes, instruments, methods and systems used to produce goods and services [6]. In practice, technology is used by companies to produce a variety of goods and services to meet human needs. The performance of a technology is how well the technology is able to meet human needs as a consumer of goods from the company's products [3]. Technology has four basic components, namely Technoware, Humanware, Orgaware and Infoware [4].

Madura Island as one of East Java region plays an important role in the economic sector of East Java. Bangkalan which is the closest regency with Surabaya has an excellent potential of creative industry in the field of fashion and also craft. One of the leading steps of Creative Industry in Madura is the use of local knowledge-based technology (indigenous knowledge) conducted by the government in cooperation with universities [5].

Trunojoyo University (UNIJOYO) as one of the educational institutions located in Madura is responsible for developing the creative industries. The responsibility of UNIJOYO can be seen from transfer of technology that has been done with the form of real work lecture conducted on the surrounding community (KKN), various research involving several small business units and other activities. The existence of UNIJOYO should really be felt and have a positive impact on the creative industry around it. Based on the potential of the creative industries in Indonesia and particularly in Madura, this paper aims to identify what factors influence the successful transfer of technology that occur between UNIJOYO and creative industries in Bangkalan.

2. Literature Review
2.1 Technology Transfer

[6] defines technology as all knowledge, products, processes, instruments, methods and systems used to produce goods and services. [7] says that technology is the knowledge or study of the art of practice in industry, the terminology used in knowledge and technique, the application of knowledge, while [8] defines technology as all techniques or knowledge, know-how and organizational relationships that are dimensions Soft technology among individuals, industries, universities, research institutions, governments and countries. The technology needed to improve overall productivity is a combination of 4 (four) components attached to the input of technoware, humanware, infoware and orgaware [4]. The technology in this study uses the definition conveyed by UNESCAP, the technology in which attached four components attached to inputs such as Technoware, Humanware, Infoware and Orgware.

Technology transfer is defined as the transfer of ability to utilize and master the science and technology among institutions, bodies or persons residing within the domestic and abroad as well as those coming from abroad into the country or vice versa [9]. According to Roessner in 1992, technology transfer was seen as the concept of know-how, knowledge or technology from one organization to another [7]. According to [8] technology transfer is defined as the transfer of knowledge, scientific or technical know-how, technology, technology based on ideas or research results, developed within academic institutions, from academic to industrial institutions. According to Jain and Triandis in 1990 technology transfer is a process whereby science and technology are transferred from individuals or groups to individuals or other groups that combine this new knowledge into a way of doing things [6]. Aprianto in 2001 saw the transfer of technology as a process of learning in such a way that technical knowledge is continually accumulated on existing human resources to be applied in production activities [3]. From some definition of technology transfer can be concluded technology transfer is transfer of knowledge, scientific or technical know-how, technology based on idea or research result from individual or group to other individual or group.
2.2. Creative Industry in Indonesia

In Indonesia, the role of the creative industry in the Indonesian economy is significant, with a large contribution to the average GDP of 2002-2006 at 6.3% or equivalent to 104.6 Trillion rupiah (constant value) and 152.5 trillion rupiah (nominal value). This industry has been able to absorb the average workforce in 2002-2006 is 5.4 million with a participation rate of 5.8%. In terms of exports, based on the estimation of sub-sector classification, the role of the creative economy to the total average export for 2002-2006 is 10.6% [1].

The development of creative industry in Indonesia is still sterile barren although has the potential of human resources that is tested internationally. The development of the creative industry is in the range of 9% per year but does not produce work, so it does not produce economic value and new aesthetic value [10]. Yet if viewed from the potential and market share of creative industries is very creative industry in Indonesia is very potential to be developed.

Compared to roles in some countries, the role of the creative industry in Indonesia is not so much different. The creative industry in Indonesia contributed 6.28% of the country's GDP in 2002-2006, higher than the contribution of the (1) transportation and communications sector; (2) Buildings; And (3) electricity, gas and clean water [11]. In terms of annual growth rate, creative industry in Indonesia is still very low compared to the growth of creative industry in other countries in the world only 0.74%. This very low growth is due to the creative industry in Indonesia the product is still similar between one industry with other industries (RI, n.d.), so the dependence on the supplied company is very large.

2.3. Conceptual Transfer Technology Model

Many factors influence the success of the knowledge transfer process, but all researchers agree that technology is essential to achieve competitive advantage of an organization [7], [9], [12], and [13]. Factors affecting the effectiveness of technology transfer among others [12] (Figure 1).

1. Transfer Agent

Transfer agent is an institution that provides technology and possesses mastery and technological expertise [7] and [13]. This factor has characteristics or attributes such as education, experience, age, gender and so forth [14] and [15]. In this research, transfer agents are lecturers in UNJOYO who have transferred technology to some creative small industries in Bangkalan.

![Figure 1. Factors of Technology Transfer](image-url)
2. Transfer recipient
Transfer recipient is an organization that buys and expects the mastery of certain knowledge [7] and [13] which has characteristics such as education, absorption, motivation, age, business type and so forth [14] and [15]. Transfer recipient on the research is a creative small industry in Bangkalan which has received technological transfer from lecturer UNJOYO there are four creative industries used as sample of research that is a painting creative industry, one of batik industry and two of culinary industries.

3. Form of technology
Form of technology to be provided, both commercial and non-commercial [7]. The technology transferred in this case is four components technology based on UNESCAP Technoware, Humanware, Infoware and Orgaware.

4. Transfer mechanism
Transfer mechanism are mechanisms/channels/ways that can be used in technology transfer processes [7]. In this study the transfer method used by the transfer agent to the transfer recipient is based on the length of technology transfer process. There is a form of mentoring with different times, seminars, and workshops.

5. Effectiveness of Technology Transfer
The effectiveness of technology transfer is a measure of the success of the technology transfer process. The measure of success can be seen from the increase in the number of production and the speed of production time.

3. Research methodology
3.1. Sample research and data collection
This research uses quantitative method with analysis technique such as Principal Component Analysis (PCA) or Major Component Analysis and continued with Linear Regression. PCA is used to simplify data, by transforming data linearly to form new coordination with maximum variance. PCA can be used to reduce the dimensions of a data without significantly reducing the characteristics of the data. In this study PCA is used as a prefix to determine the dominant variables that affect the effectiveness of technology transfer. Data PCA results will be made mathematical model by using linear regression. The data used are technological transfer process data from Trunojoyo University to several Creative Small Industries in Bangkalan in 2007-2014. At that time, there are only 4 creative small industries that have been trained by Trunojoyo University, such as: 1 Shoe Painting Industry, 1 Batik Industry and 2 Culinary Industry.

4. Result
4.1. Screening and Data Centering
All the collected variables are created in tabular form in order to see the data type for each variable. It turns out the data collected into categories of different data types, ranging from data with nominal scale to scale ratio. For the purposes of advanced analysis, the variables chosen for use in the study are metric variables (interval and ratio scale). After that done the screening and centering process so that between variables do not have values that are too different.

4.2 Correlation
The next step to calculate the level of correlation between variables in order to select the appropriate analysis process. In this study have identified 13 variables of the metric. The relationship between variables quite varied. There are some variables that have a relationship above 0.5 with other variables, but also there are some variables that have a very small relationship that is below 0.1. Some variables that have a correlation above 0.5 are proof that some variables have a strong correlation relationship. The strong correlation relationship in some variables shows the existence of interdependence relationship between variables (mutually correlated variable). Based on the number of variables that
many and interdependence relationship between these variables then the analysis used is Principal Component Analysis.

4.3. PCA

The next step is to analyze the data with Principal Component Analysis. In the analysis process using PCA data with the categorical form is eliminated. The initial eigenvalues value is said to explain if it has a minimum value of 80%. Eigenvalue value with three PCA components formed has a value of 80.519%, meaning that it needs to form at least into 3 groups of PCA to categorize all the factors used. The next step is plotting the value of the components of each variable in the form of graphs in order to see the grouping of each variable. Scores of each variable in each component can be seen in Table 1.

Table 1. The Score of Variables

| Variable               | Symbol          | Component 1 | Component 2 | Component 3 |
|------------------------|-----------------|-------------|-------------|-------------|
| Lecturer teaching      | LDosen          | -.009       | .328        | -.200       |
| Number lecturer        | KSDosen         | .062        | .312        | -.226       |
| cooperation            |                 |             |             |             |
| Lecturer position      | JDosen          | -.097       | .291        | .117        |
| Technoware             | Technoware      | -.154       | -.068       | -.065       |
| Humanware              | Humanware       | .201        | .039        | -.028       |
| Infoware               | Infoware        | .208        | .023        | .135        |
| Long of accompany      | LMendampingi    | -.065       | .254        | .113        |
| Age of industry        | UIKM            | -.168       | .030        | .365        |
| Number of workers      | JmlhPkrja       | .112        | .078        | .519        |
| Worker education       | PddknPkrja      | .087        | -.040       | -.304       |
| Owner education        | PddknPmlk       | .208        | .023        | .135        |

Based on Figure 2 it appears that the variables have been clustered on PC1 and PC2. The variables that enter the PC1 group with positive values include owner education, infoware, humanware, number of workers, workers education. While the variables that enter the PC1 group with a negative value, among others technoware and age of IKM. Variables that enter the PC2 group with positive values include lecturer teaching, number of lecturer cooperation, lecturer position and long accompanying.
Figure 3. shows that variables have been clustered on PC1 and PC3. The variables that enter the PC1 group with positive values include education owner, infoware, humanware, workers education. Variables that enter the PC3 group with positive values include the number of workers and SME enterprises.

\[ Y = PC1 + PC2 + PC3 \]  
(1)  
\[ PC_1 = 0.208PddknPmlk + 0.208Infoware + 0.201Humanware - 0.168UIKM - 0.154Technowar \]  
(2)  
\[ PC_2 = 0.328Ldosen + 0.312KSDosen + 0.291Jdosen + 0.254Lmendampingi \]  
(3)  
\[ PC_3 = 0.519JmlhPkrja + 0.365UIKM - 0.304PddknPkrja - 0.226KSDosen - 0.2Ldosen \]  
(4)

Figure 4. PC2 and PC3

Based on Figure 4 it appears that the variables have been clustered on PC2 and PC3. Variables that enter the PC2 group with positive values include lecturer teaching, number of lecturer cooperation, lecturer position and old accompanying. Variables that enter the PC3 group with positive values include the number of workers and SME enterprises.
4.4. Linear Regression Equation

After forming the Principal Component Analysis equation, the next step is to form a Linear Regression equation. The equation is obtained by entering the initial data in equations 1 through equation 4. The regression model has $R^2$ value of 0.289. The value is categorized a small value, meaning that PC1, PC2 and PC3 variables are only able to explain the effectiveness of technology transfer is only 28.9%, while the rest is explained by other variables. But the model can be used to predict the effectiveness of technology transfer because the significant value of F under 0.05 is 0.004. From Table 2 all of independent variables give insignificant effect because the value of significance t above the value of 0.05.

Regression model formed: $Y = 0.838 + 0.217 \text{PC1} + 0.385\text{PC2} - 0.276\text{PC3}$

Based on equations 2 to 4 it appears that there are some independent variables that have a very small value. Therefore, the experiment of model re-formation is done by removing some variables that are very small value, because the very small value is indicated as a confounding variable. After eliminating some very small valuable variables, the regression modeling process is re-established. The omitted variables are UIKM variables found in two groups: PC1 with value -0.168 and PC2 with value 0.365. The missing UIKM variable is UIKM contained in PC1.

PC 1 = 0.208 PddknPmlk + 0.208 Infoware + 0.201 Humanware - 0.154 Technoware
PC 2 = 0.328 Ldosen + 0.312 KSDosen + 0, 291 Jdosen + 0.254 Lmendampingi
PC 3 = 0.519 JmlhPkrja + 0.365 UIKM - 0.304 PddknPkrja

### Table 2. Correlation of Independent Variables (PC1, PC2 and PC3)

| Model  | Unstandardized Coefficients | Standardized Coefficients | t     | Sig. |
|--------|----------------------------|---------------------------|-------|------|
|        | B  | Std. Error | Beta |       |       |
| (Constant) | .838 | .119 |       | 7.027 | .000 |
| PC1    | .230 | .161 | .217  | 1.422 | .163 |
| PC2    | .347 | .134 | .385  | 2.593 | .013 |
| PC3    | -.265 | .158 | -.276 | -1.678 | .102 |

After several factors were removed the regression model had $R^2$ value of 0.299. The value is only up 0.01 from the previous model and also categorized a small value, meaning that PC1, PC2 and PC3 variables are only able to explain the effectiveness of technology transfer is only 29.9%, while the rest is explained by other variables. The model can also be used to predict the effectiveness of technology transfer because the significant value of F under 0.05 is 0.003. Table 3 shows that two of three variables, PC1 and PC3, gave insignificant effect with t value above of 0.05, while PC2 gave significant effect with t value 0.001.

### Table 3. Correlation of Independent Variables (PC12, PC22 and PC32)

| Model  | Unstandardized Coefficients | Standardized Coefficients | t     | Sig. |
|--------|----------------------------|---------------------------|-------|------|
|        | B  | Std. Error | Beta |       |       |
| (Constant) | .830 | .119 |       | 6.996 | .000 |
| PC12   | .379 | .228 | .305  | 1.665 | .104 |
| PC22   | .450 | .123 | .498  | 3.654 | .001 |
| PC32   | -.371 | .193 | -.352 | -1.924 | .062 |
New equations formed: \( Y = 0.830 + 0.379 \text{ PC1} + 0.450 \text{ PC2} - 0.371 \text{ PC3} \)

Based on the characteristics of predictor group (PCA), each group is named:

\[ Y = 0.830 + 0.379 \text{ Form of Technology} + 0.450 \text{ Characteristics of Transfer Agent} - 0.371 \text{ Characteristics of Transfer Recipient} \]

4.5. *Model Validation*

Validate models by comparing between models using all data and models using two-thirds of data. The regression model to validate the model has an \( R^2 \) value of 0.281. The value is not different from the previous model 0.299. These two values are categorized small values, it means that PC1, PC2 and PC3 variables are only able to explain the effectiveness of technology transfer is only 28.1%, while the rest is explained by other variables. The model can also be used to predict the effectiveness of technology transfer because the significant value of \( F \) is 0.044. Two of three independent variables, PC1 and PC3 gave insignificant effect because \( t \) value above 0.05, while PC2 gave significant influence with \( t \) value 0.001.

The value of \( R^2 \) between the model and the validation model did not differ significantly three are 0.299 and 0.281. This value indicates that the model is valid to explain the effectiveness of technology transfer.

4. **Conclusions**

The results can be summarized as follows:

1. The effectiveness of technology transferers is influenced by technology form and transfer agent characteristics positively with values of 0.379 and 0.450.
2. Factor of teaching lecturer, number of lecturer cooperation, lecturer position and long assisted contribute positively to transfer agent characteristics.
3. Educational owners, humanware and infoware contribute positively to forms of technology, but technoware negatively affects the shape of technology.
4. The number of workers and the age of the creative industry contribute positively to the transfer recipient characteristics whereas educational workers contribute negatively.
5. Regression equation formed: \( Y = 0.830 + 0.379 \text{ Form Technology} + 0.450 \text{ Characteristics of Transfer Agent} - 0.371 \text{ Characteristics of Transfer Recipient} \)

5. **References**

[1] RI, K. P. dan E. K. (n.d.). Kekuatan Baru Indonesia Menuju 2025.
[2] Rozentale, I., & Lavanga, M. (2014). The “universal” characteristics of creative industries revisited: The case of Riga. *City, Culture and Society*, 5(2), 55–64.
[3] Putra. (2006). Perancangan Kebijakan Transfer Teknologi Mesin CNC pada CV Cipta Sinergi Manufacturing dengan Menggunakan Metode Dinamika Sistem, Final Report of Industrial Engineering Department, ITB, Bandung.
[4] UNESCAP (United Nations – Economic and Social Commission for Asia and The Pacific), *Technology Atlas Project*, Asian Pasific Centre for Transfer of Technology, Bangalore, India, 1998.
[5] Brain. (2008). Analisa Kelayakan Investasi Usaha Mikro Kecil Dan Menengah (UMKM), Skripsi, www.indokripsi.com
[6] Khalil, M. T. (2000). Management of Technology: The Key to Competitiveness and Wealth Creation. McGraw-Hill, Singapore.
[7] Bozeman, B. (2000). Technology transfer and public policy : a review of research and theory.
[8] N. Murovec and I. Prodan, “Technovation Absorptive capacity its determinants and influence on innovation output : Cross-cultural validation of the structural model,” *Technovation*, vol. 29, no. 12, pp. 859–872, 2009.
[9] Samirahayu. Perancangan Model Alih Teknologi pada Lembaga Penelitian dan Pengembangan, Tesis of Magister Teknik and Industria Management Industri ITB, Bandung, 2007.
[10] Liang, S. C. I., 2013. Industri Kreatif dan Ekonomi Sosial di Indonesia: Permasalahan dan Usulan Solusi Dalam Menghadapi Tantangan Global, Proceeding The 5th International Conference on Indonesian Studies: “Ethnicity and Globalization”, Yogyakarta, ISSN 2087-0019

[11] Indonesia, D. P. R. (2008). Rencana Pengembangan Ekonomi Kreatif Indonesia 2025. Departemen Perdagangan Republik Indonesia.

[12] Indriartiningtias, R., & Wirajmadja, I. I. (2009). Pengembangan Model Konseptual Transfer Pengetahuan dari Perguruan Tinggi ke Industri Kecil. Jurnal Teknik Industri, 10(2), 158-166.

[13] Khabiri, N., Rast, S., & Senin, A. A. (2012). Identifying Main Influential Elements in Technology Transfer Process: A Conceptual Model. Procedia - Social and Behavioral Sciences, 40, 417–423. https://doi.org/10.1016/j.sbspro.2012.03.209

[14] Emery, D. J, Designing Firm Integrating Processes from the Knowledge-based View Graduate Student Best Paper Award, CASOS 2002 Conference, Duke University, Durham, NC, 2002.

[15] Gouza, A, Key Factors of Knowledge Transfer Within University Spinn-Offs, Business Economics Departement, Autonomous University of Barcelona, 2006.

[16] Indriartiningtias, R., Subagyo, & Hartono, B. (2017). Creativity in Organization : A Literature Review. In International Conference on Industrial Engineering and Engineering Management (IEEM).

[17] Indriartiningtias, R., Subagyo & Hartono, B. (2019). Creativity of small firms in creative industry: Initial evidence from Indonesia, 11, 1–13. https://doi.org/10.1177/1847979019849135