Application of Analytical Network Process and Conditional Probability Co-occurrences Matrix for Business Modelling of Small-Medium Enterprises

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Abstract

In Indonesia, the scope of agroindustry are related to the food and non-food industry managed by Small-Medium Enterprises (SME). The classical problem of Indonesian Agroindustry were related to logistic, infrastructure, technology, high-cost economy, regulation, and financing constraint. Therefore, an innovative business model is required for competitive and sustainable SME. Importance rate of the model can be defined by determining some criteria in a business model. Analytical Network Process (ANP) is required to determine importance rate of business model. However, ANP could not minimize the subjectivity factor of the respondent in determining the criteria. Application of Conditional Probability Co-occurrences Matrix (CPCM) is required to minimize the subjectivity factor by comparing priority weight of each criterias. The research objectives are: 1) To apply ANP method for representing business model criteria and attribute of SME; 2) To apply CPCM method for criteria pattern extraction. The case study of research is SME Bakpia Tela Ungu and Telopia. CPCM Pattern extraction of Contrast, Energy and Local Homogeneity indicated the significant different of business model criteria between food, non-food agroindustry and local governmental board. The research results indicated that there were different subjectivity to determine criteria priority weight.

Keywords: *Priority weight, Contrast pattern, Energy pattern, Local homogenity pattern, Geometric average*

1. BACKGROUND

Generally, agroindustry is associated with food industry managed by Small-Medium scale Enterprises (SME or known as by Usaha Kecil Menengah/UKM). In other word, agroindustry is an industry which processes the agricultural product in the form of SME. Based on BPS data on 2011, SME has contributed employing more than 97% worker in Indonesia. In 2008, at least there were 54, 67 million unit SME and 26,4 million of it were in agricultural, poultry and fishery industries. The existence of SME has focused on the food industry and required special treatment from Indonesian government for their sustainability.

OUTLOOK INDUSTRI 2012 has recommended the development strategy of agroindustry. It recommended that the classical problem of Indonesian Agroindustry were related to logistic, infrastructure, technology, high-cost economy, regulation and financing constraint. Subsequently, high rate of investment and difficulties to access financing has became specific problem for the development of Indonesian agroindustry. The other specific problem is higher risk profile. Fund provider assumed that SME is a higher risk industry including risk of competition compared to other large industry, lack of human resources capability and fund, lack of accounting system which is a barrier to access information of profitability.

An appropriate SME business model is required as a problem solution. Business model consist of some factors and criteria of SME which has function of key performance indicator (KPI) and key success factor. It is considered that every stakeholder has different importance and priority rate to the development of SME. Therefore, importance and priority rate can be determined using the factors and criteria in SME business model.

Analytical Network Process (ANP) can be used to determine the importance rate by considering relationship between factors and criteria (Saaty, 1999).

However, the application of ANP could not minimize the subjectivity component from respondent in determining the criteria. Conditional Probability Co-occurrences Matrix (CPCM) is required to minimize the subjectivity of respondent by interfering the comparison of priority weight (Ushada *et al.*, 2008). The case study of research is SME Bakpia Tela Ungu, Kaliadem, Cangkringan Sleman. It is a SME which developed by society of Merapi Disaster Prone Area since 2010. This kind of SME has been developed in to the commercial scale named as Bakpia Telopia.

The research objectives are:

a. To determine a business model for SME
b. To apply ANP for representing factors and criteria for business model of SME
c. To apply CPCM for pattern extraction of business model criteria

The research advantages are:

a. Dissemination of determined business model to the SME in Yogyakarta Special Province.
b. As a policy decision support for the agroindustrial stakeholders in developing and enlarging the competitive and sustainable SME.

2. METHODOLOGY

The research hypothesis assumed that SME business model consist of 4 (Four) main factors that is offering, internal capability, partnership and economic factors. The dependent factor is offering which is the output of SME. Offering factor consist of some criteria that is: (a) Standard, refers to the offered product priority is based on the market standard and industrial regulation; (b) Product mix, refers to product combination in agroindustry, and (c) Innovative, refers to the innovative component of a SME.

The relationship among factors in a business model can be defined using an arrow marker. If the arrow marks inside to a specific factor and then the relationship is outer dependence. Internal capability and partnership factors indicated the feedback relationship. In other side the internal capability has the relationship of inner dependence.

A questionnaire was developed and filled by some respondents for SME of food, non-food industry and policy maker (Local government). Respondents of Food SME are: `Bolo Telo`, `Warung Mikro`, `Salakka`, `Oleh-oleh Jogja`, `Kripik Jamur`, `Omah Jagung`and `Café La Sekul`. Respondents of Non-food SME are: `Fotokopi dan Cetak`, `Prme kidz`, `Bioactiviti Morinda`, `Mutia fashion`, `Mesin TG`, `Jual Burung`. `Rizki Salon`, `Elektronik`, `Dewi Konveksi`, `Rental gue`. `Pren`, `Jogja Transport`, `Arai Education`, `Batik Distro` and `Konveksi`. Respondents of local goverment/policy maker are: `Dinas Perindag (Permodalan)`, `Pemda Sleman (KP3M)`, `Dinas Perindag (Penyuluhan Industri)`, `Pemda Sleman (Perekonomian)` and `Kepala Dinas Perindag`.

Figure 1 indicated the research methodology as follows:

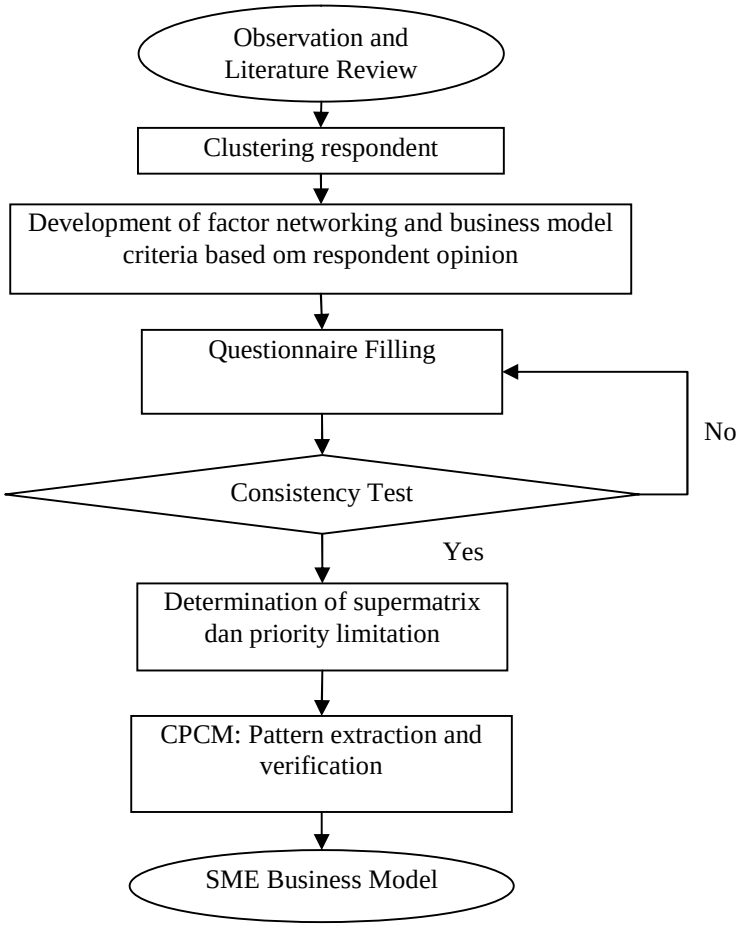


Figure 1. Research Methodology

This research combined two different methods that is ANP and CPCM. The structure of factor networking and business model criteria was developed based on literature review. The analysis was pursued based on the following description:

ANP

ANP was applied using software of Super Decisions (ANP Team, Creative Decision Foundation, 2012). The procedure can be described as followed:

a. Developing the network between component cluster/factor with each criterion
b. Developing networking/interaction between factors. The developed network can be two ways or outer dependence (Feedback) and loop or the interaction between criteria in a component cluster (inner dependence).
c. Weighting. ANP required the priority of factors influence to the other factors. This kind of influence is determined based on pairwise comparison related to control criteria. Priority of each component is used for the priority weight from the entire element inside a component. Therefore the multiplication of priority feedback can be pursued to unlimited.
d. Pairwise comparison to determine the relationship between component or element using scale of 1 to 9. The scale indicated the importance rate from not more important (Scale of 1) to more very important (Scale of 9). For example if a component is more important (Scale of 5) then it can be read inverted 1/5 (One fifth) not more important than other component.
e. Calculation of supermatrix. This procedure was pursued by developing the table with each column representing the element.
f. Weighting of supermatrix if the amount of column from supermatrix table have the value of 1 the normalization was pursued.
g. Supermatrix limitation. Normalization value can be increased using the powered multiplication until the stable value. The value of matrix limitation is the decision priority level.

CPCM

Software CPCM was developed and improved using Visual C++ (MI, 1998). Random weight of CPCM can be defined as follows (Ushada dan Murase, 2008):

1. Generating random weight from ANP

1	2	3	4	5
0.853	0.118	0.934	0.409	0.544

2. Determining relative weight from each Likert response in the questionnaire

1	2	3	4	5
0	0.061	0.235	0.449	0.255

3. Multiplying each column (Step 1) with each weight (Step 2)

1	2	3	4	5
0	0.007	0.219	0.184	0.139

4. Normalizing the value in step 3 to 0 and 1.

1	2	3	4	5
0	0.013	0.399	0.335	0.253

5. Determining Specific Scale (SC). SC aSC is defined as a scale generated by multiplying normalized value (step 4) with Scale C = 255 (Maximum within zero until 255)

1	2	3	4	5
0	3.315	101.745	85.425	64.515

6. Input the SC in all rows to the CPCM algorithm. CPCM is represented as the number of *SC* occurrences at each conditional probability A and attributes scale B inside $i \times j$ matrix. It has size of 256 ×256. The minimum value of SC is zero and the maximum is C = 255. The pseudo code is described as following:

```
Repeat
For A = 0 to Conditional Probability (25)
        Do
For B = 0 to Attributes Scale (5) Do
        For i = 0 to C (255) Do
        For j = 0 to C (255) Do
                Do P(1,0) (i, j) (Co-
                occurrences matrix)
End
```

7. Pattern extraction

The following patterns can be extracted from CPCM (Haralick et al., 1973):

a. Energy

$$\sum_i \sum_j P^2(1,0)(i,j) \qquad (1)$$

b. Contrast

$$\sum_i \sum_j (i-j)^2 P(1,0)(i,j) \quad (2)$$

c. Local Homogeneity (LH)

$$\sum_i \sum_j \frac{P(1,0)(i,j)}{1+(i-j)^2} \quad (3)$$

Notes:

d	=	distance between two neighboring specific scale
q	=	angle between two specific scale
$P(1,0)(i,j)$	=	joint probability density function at $d = 1$ and $q = 0$
i, j	=	notation for conditional probability and attributes scale
x, y	=	notation for d position

3. RESULTS AND DISCUSSION

3.1 Case Study of Bakpia Ungu

Figure 2 describe the manual-type production, while Figure 3 describe the selling activity in SME Bakpia Ubi Ungu Merapi Disaster Prone Area, Gondang, Cangkringan, Sleman. SME Bakpia Ungu is managed by Koperasi Kaliadem Sejahtera and has shown the significant profit growth. SME Bakpia Ungu was founded on 15 November 2011. The average revenue per month approximately Rp 14.000.000,00. Figures 3 and 4 described the production activity and product sample of SME Bakpia Ungu.

Figure 2. Manual-type of production activity

Figure 3. Selling activity of Bakpia Ubi Ungu

Figure 4. Production activity

Figure 5. Product Packaging

Figure 6 indicated CPCM patterns of Business Variety, Product Price, Production Volume and Profit Margin. Figure 7 indicated CPCM patterns of Product Distribution, Information Technology, Process Innovation and Human Resource Development. Figure 8 indicated CPCM patterns of Amount of Partner, Institutional Support and Alliance. Figure 9 indicated the CPCM patterns of Standard Product, Product Variation and Complementary Service. High consistency was indicated by the high value of contrast and low value of energy and LH (Ushada dan Murase, 2008).

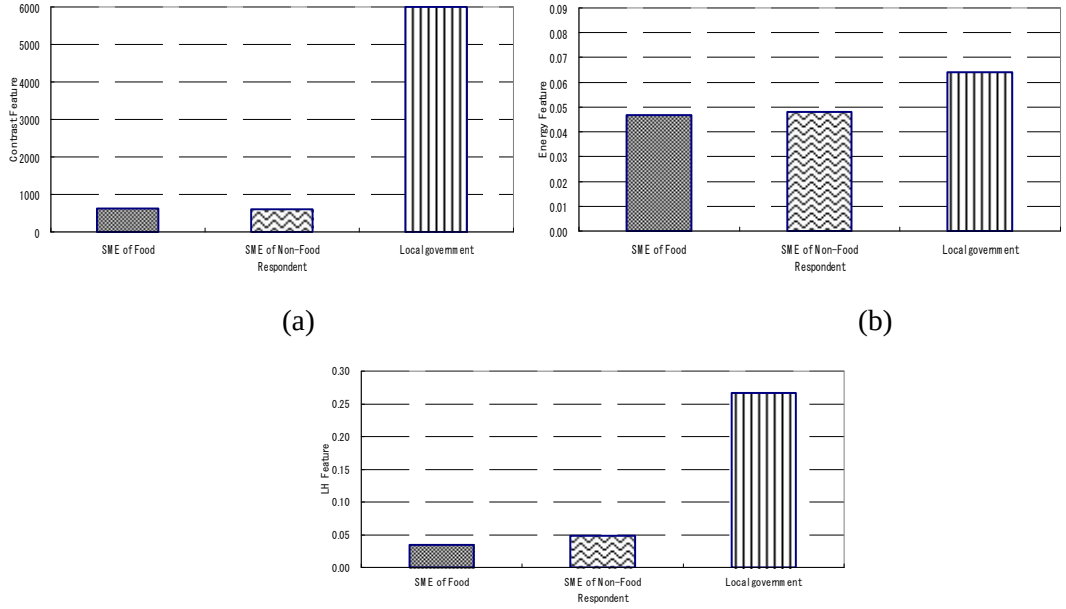


Figure 6. CPCM patterns for the reasoning of capability factor to the economic factor using control criteria of standard product; a) Variability; b) Consistency; c) Structuring

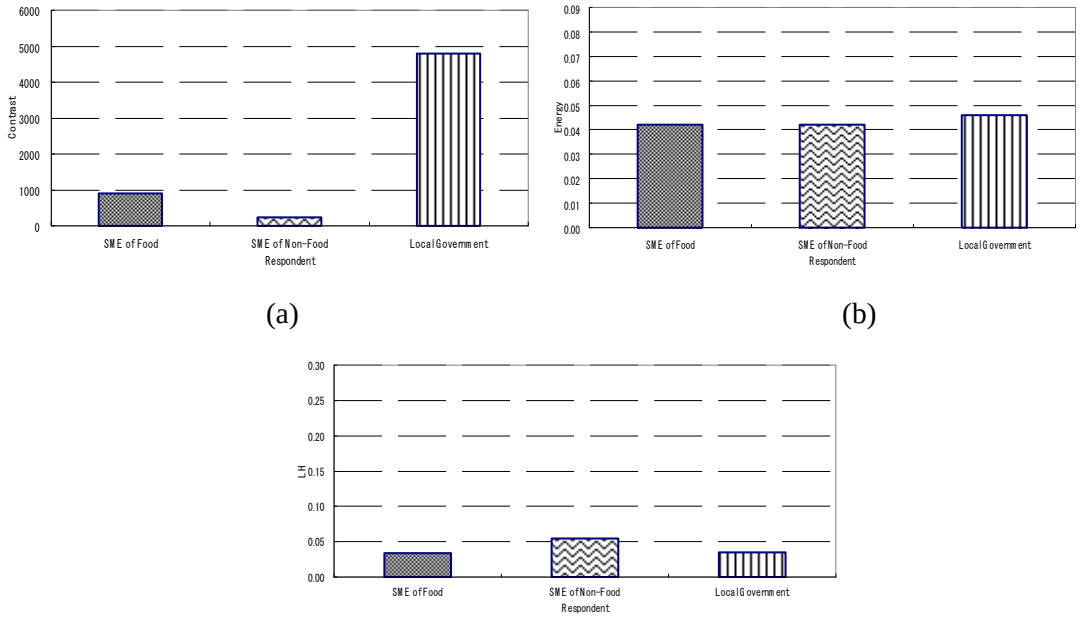
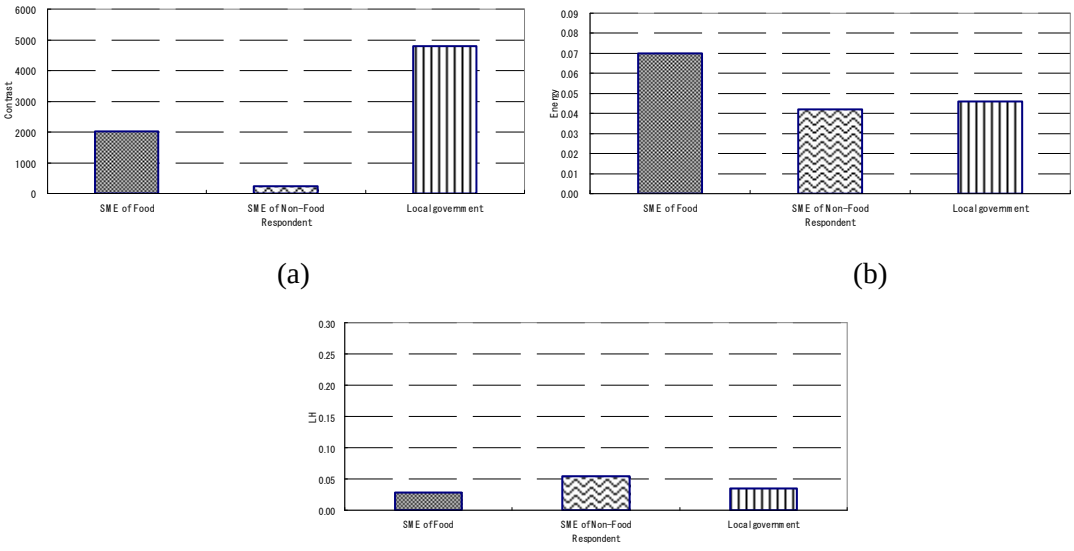


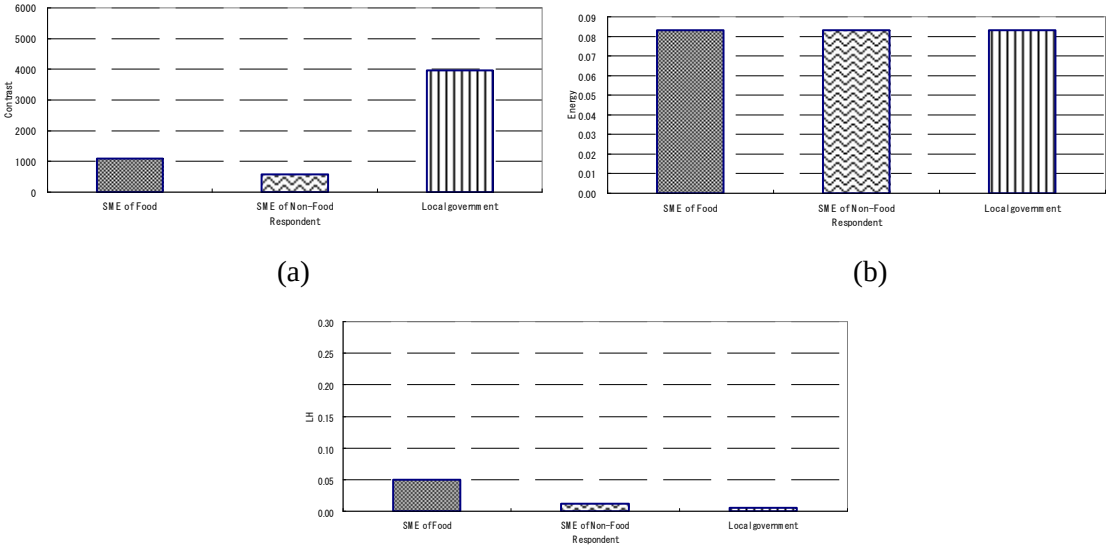
Figure 7. CPCM patterns for reasoning inner dependence of capability factor using control criteria of product variation and innovation ; a) Variability; b) Consistency; c) Structuring



(a) (b)

(c)

Figure 8. CPCM patterns for reasoning feedback between capability factor and partnership with the criteria control of complementary service a) Variability; b) Consistency; c) Structuring



(a) (b)

(c)

Figure 9. CPCM patterns for reasoning of partnership factor to the offering using criteria control of business variation: a) Variability; b) Consistency; c) Structuring

Contrast feature identified the reasoning variability. The higher value of contrast feature then it indicated the higher knowledge level of respondent. Energy feature identified the reasoning consistency. The higher value of Energy then it indicated the consistency of respondent in reasoning. Local homogeneity indicated the structure of reasoning. The higher value of Local homogeneity, then it indicated the comprehensive structure in reasoning.

Figure 6a indicated that respondent cluster of local government have higher level of reasoning knowledge than SME of food and non-food related to the reasoning of capability factor. Figure 13b indicated that local government have higher consistency while SME of food and non-food have relative same consistency. Figure 13c indicated that local government have higher structuring than other cluster.

Figures 7a indicated that local government have higher knowledge than SME of food and non-food in the reasoning of capability factor to the economic factor. Figure 7b indicated the same value of consistency among the clusters. Figure 7c indicated that cluster of SME non-food have higher structuring while local government and SME of food have the relatively similar value.

Figure 8a indicated that local government have higher knowledge than SME of food and non-food in the reasoning feedback between capability factor and partnership. Figure 8b indicated that SME of food have higher consistency while SME of non-food and local government. Figure 8c indicated that SME of non-food have higher structuring while SME of food and local government have relatively similar value.

Figure 9a indicated that local government have higher reasoning than SME of food and non-food in reasoning of capability factor to offering. Figure 9b indicated that local government have the value of consistency among the clusters. Figure 9c indicated that SME of food have higher structuring than SME of non-food and local government.

3.2 Scenario of Inner ANP.

Figure 10 indicated the scenario scheme of inner ANP. The questionnaire which is used for the data can be described as follows:

a. Questionnaire 1 with the control criteria of standard product for pairwise comparison of element 1,2,3,4,5,6,7,8 and 9.
b. Questionnaire 3 with the control criteria of standard product for pairwise comparison of element 1,2,3,5 to looping.
c. Questionnaire 6 with the control criteria of complementary service for pairwise comparison of element 1, 2, 3, 4, 5, 10, 11, and 12.

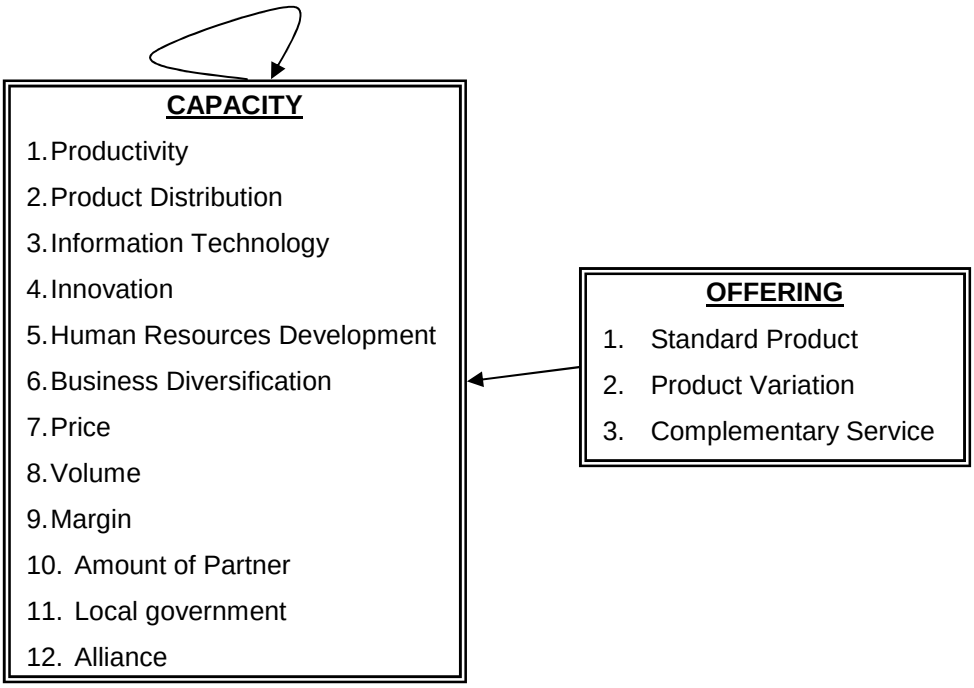


Figure 10. Scenario scheme of inner ANP

Table 1. Priority weighting results of ANP *inner* of scenario

No	Food SME	Global Weight	Non-food SME	Global Weight	Local Government	Global Weight
1	Productivity	0,31	Productivity	0,25	Productivity	0,27
2	Information Technology	0,18	Information Technology	0,19	Business variation	0,16
3	Product Distribution	0,15	Product Distribution	0,17	Information technology	0,14
4	Innovation	0,12	Innovation	0,14	Alliance	0,11
5	Human resources development	0,09	Human resource development	0,13	Human resource development	0,08
6	Institution	0,03	Volume	0,02	Product distribution	0,06
7	Amount of Partner	0,03	Business variation	0,02	Amount of partner	0,05
8	Business variation	0,02	Institution	0,02	Institution	0,04
9	Alliance	0,03	Price	0,02	Volume	0,03
10	Volume	0,01	Alliance	0,01	Innovation	0,03
11	Price	0,01	Amount of partner	0,01	Price	0,03
12	Margin	0,01	Margin	0,01	Margin	0,01

Table 1 indicated weighting priority results for SME food, non-food and local government.

3.3 Scenario of Inner-Outer ANP

Figure 11 indicated the scenario scheme of inner-outer. The questionnaires which are used for the data can be described as follows:

a. Questionnaire 1 with the control criteria of standard product for element pairwise comparison of 1,2,3,4,5,6,7,8,9
b. Questionnaire 3 with the control criteria of innovation for pairwise comparison of element 1,2,3,5 to looping
c. Questionnaire 5 with the control criteria of business variation for pairwise comparison of element 10, 11, 12, 13, 14 and 15 to the two ways arrow marker.

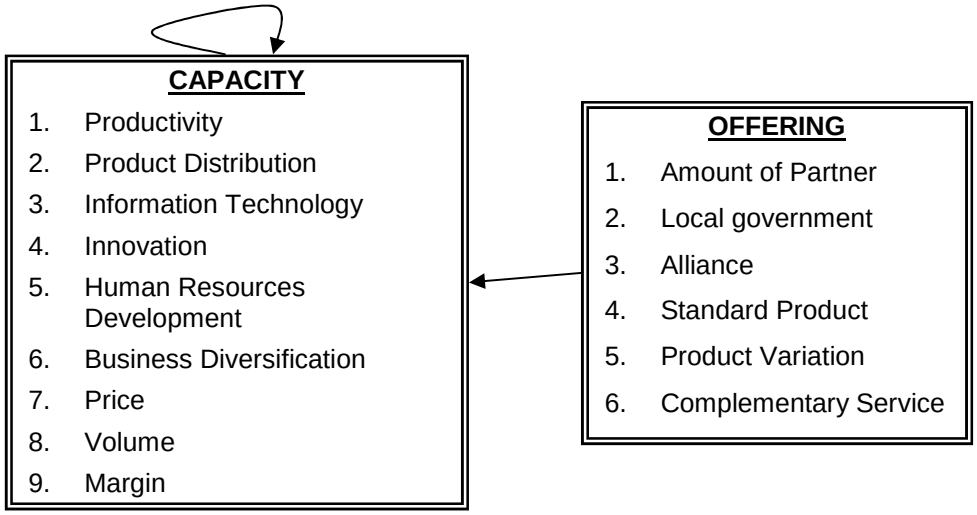


Figure 11. Scenario scheme of *inner-outer* ANP

Table 2. Priority weighting of ANP using scenario of inner-outer

No	Food SME	Global Weight	Non-food SME	Global Weight	Institution	Global Weight
1	Productivity	0,39	Productivity	0,34	Standard Product	0,24
2	Information Technology	0,15	Product Distribution	0,17	Business Variation	0,17
3	Product Distribution	0,12	Information Technology	0,15	Alliance	0,10
4	Innovation	0,12	Human Resources Development	0,08	Information Technology	0,10
5	Human Resources Development	0,05	Innovation	0,07	Productivity	0,09
6	Business Variation	0,03	Institution	0,04	Human Resources Development	0,06
7	Alliance	0,02	Volume	0,02	Product Distribution	0,05
8	Institution	0,02	Amount of Partner	0,02	Product Variation	0,04
9	Amount of Partner	0,02	Business Variation	0,02	Volume	0,04
10	Volume	0,02	Price	0,02	Amount of Partner	0,03
11	Price	0,02	Alliance	0,02	Price	0,03
12	Margin	0,01	Margin	0,01	Complementary Service	0,02
13	Complementary Service	0,01	Standard Product	0,01	Innovation	0,02
14	Standard Product	0,01	Complementary Service	0,01	Institution	0,01
15	Product Variation	0,01	Product Variation	0,01	Margin	0,01

Table 2 indicated results of priority weighting for the cluster of SME food, non-food and institution.

3.4 **CPCM Verification for Criteria Priority.**

Verification was pursued using pattern extraction of CPCM to iteration of inner and inner-outer scenario of ANP. As shown in Fig.11, verification result indicated the significant different of business model criteria between SME of food, non-food and local goverment institution. This result indicated that CPCM can prove the minimum subjectivity in utilization of two ANP scenario for SME business modelling. The result of weighting priority indicated that SME business modelling can be utilized using ANP and CPCM.

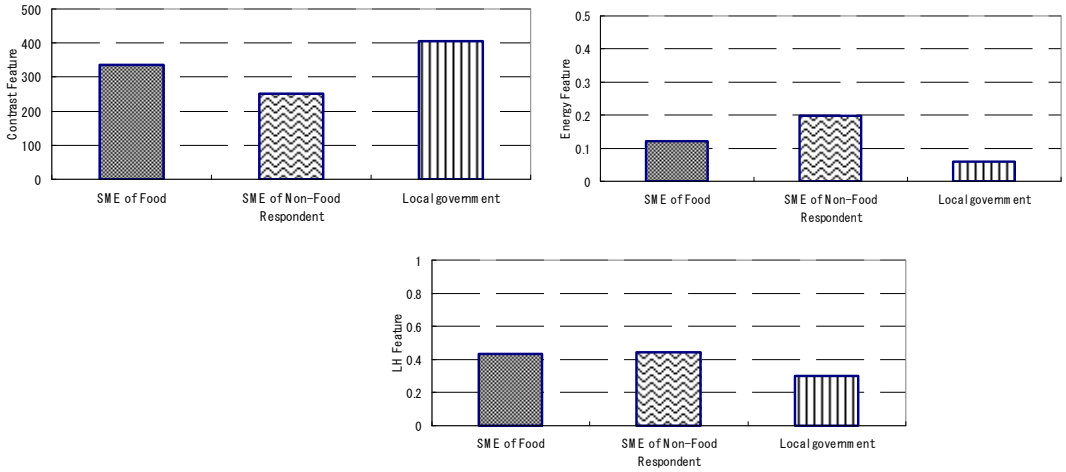


Figure 11. CPCM verification for criteria priority

4. CONCLUSSIONS

Business modelling of SME can be utilized using ANP and CPCM. The research result indicated the different priority of criteria weight among cluster of SME of food, non-food and local government institution. This result was supported by the verification of CPCM patterns. This result indicated that CPCM can prove the minimum subjectivity in utilization of two ANP scenario for SME business modelling. The result of weighting priority indicated that SME business modelling can be utilized using ANP and CPCM.

The research result can be used for dissemination of business model to the Indonesian SME. Besides, it can be used decision support for local goverment institution in developing sustainable and competitive SME.

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