DEMATEL operation as supporting tool in defining Strategic issue of Strategic Environmental Assessment (SEA): A case study of SEA for development plan of Jombang Municipality

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Abstract. The difficulty in performing Strategic Environmental Assessment (SEA) for the municipal development planning process has not merely concerned with aspects such as time, data, and budget for the project. One crucial problem involves the limitation of knowledge and practical capability of the local government to conduct the analysis. At the municipal level, defining the environmental issue has become a catastrophe in the decision-making process. Most Indonesian municipal governments have difficulties in drafting the most strategic environmental issue regarding messy ecological phenomena. Meanwhile, the most strategic issue plays vital roles for developing the scenario of the development plan. This paper aims to demonstrate the application of the DEMATEL Technique in defining the strategic environmental issue at a municipal level. In addition, this paper examines the SEA process of Jombang Municipality, especially the conducted analysis in assisting the municipal government decision-making towards Jombang’s most strategic environmental issue. As a result, the DEMATEL has proved to be the effective technique to draw the logical interrelation map among the critical environmental issues. Further, upon applying the interrelation map, the most influencing issue for others are feasible to be identified and defined as the most strategic environmental issue.

1. Introduction

Ever since the stipulation of Indonesian National Law 32/2009 (Law 32/2009) of Environmental Protection and the Management by Indonesia national government, the necessity for more valuable efforts in building environmentally perspective towards the development has broadly emerged [1][2][3]. Under the perspective of Law, conducting SEA (Strategic Environmental Assessment) or Kajian Lingkungan Hidup Strategis (KLHS – in Indonesian) is obligated for all administrative levels, especially for municipal development policy [4]. So far, policymakers see SEA as a partial environmental impact assessment rather than a comprehensive assessment of a development policy. In this case, SEA has been considered merely as environmental impact analysis of a specific project [5]. Unlike SEA, Law 32/2009 has never appointed the environmental impact assessment as a method to solve the comprehensive impact of development policy. Practically, it is difficult to integrate the impact assessment into the complicated framework of decision-making [6]. Then, the aimed function
of SEA in ensuring the Indonesian municipal government's policy to accommodate the sustainable development principles is still far from implementation.

The various obstacles emerged under the above situation, such as ill-managed time, budget, data, information, and legal procedures. One of SEA practical problems in Indonesian municipality is less-capability of the policymakers to disclose the necessary information or create open discussion opportunities required by the flexibility and participatory principles of EA [7] [8], especially in defining the strategic issues should be examined by the analysis. It means the stressed analysis toward the role of institutions and governance conditions and the aimed nonlinearity of public decision-making may not be achieved by the process.

The article 7 of Government Regulation no 46/2016 (Peraturan Pemerintah 46/2016 or PP 46/2016) on the Implementation Procedure of SEA and the Management stipulates that the assessment of development policies, plans, and programs for the existing environmental conditions must follow this procedure [9]: 1). Identification of sustainable development issues related to ecological, economic, and social issues; 2). Identification of the content of policy, plan, and program; 3). analysis of points 1 and 2; 4). Formulation of alternatives; 5). Recommendation for the improvement of policy, program, and project improvement. For the first, Ministerial Regulation of Environment and Forestry 64/2017 (Peraturan Mentri KLHK 64/2017 or Permen KLHK 64/2017), as the instrumental regulation of PP 46/2016, regulates that policymaker should conduct SEA by utilizing strategic municipal development issues as the key problems that the development plan should address [10]. However, due to municipal policymaker's incapability in handling participatory approach and the analysis, the strategic issues are more complicated to be negotiated and clearly defined.

So far, the strategic issue is defined by conducting the weighting method, such as doing the Analytic Hierarchy Process (AHP) and simple weighted score, to get the most critical issue by a set of criteria. As a technical procedure, PP 46/2016 defines the criteria as the impact of each issue on the municipality's existing environmental condition. However, the decision for determining a suitable weighting method is a difficult task and becomes a common pitfall in answering a multi-criteria decision problem [11]. Several researchers have dismissed the difficulty in measuring the criteria weights and assume that the importance of criteria consequences is conversant with all decision-makers [12]. For the definition of the SEA strategic issue, the weight still is not based upon the interrelation among the issues. The resulted weight of issues depicts the individual importance of each for the criteria. Meanwhile, the remaining question about 'why is it important?' still may not be answered.

Recently, the application of system dynamics in drawing the causal relation among the issue has been a trend in defining the strategic issue. Here, many practitioners and policymakers use System Dynamic to draw an interrelation model among the issues. System Dynamics Modeling brings the advantage of modeling this complexity by combining the technical grounding from mathematics and engineering with the nonlinearities of social sciences, organizational behavior, and psychology [13]. Models are constructed by incorporating various elements that could affect the system either from the inside or the outside; including those variables that could wrongly be overlooked because no historical data is available, for example. Indeed, omitting such variables is equivalent to saying they have zero effect, which is probably the only value that is known to be wrong [14]. Forrester states that system dynamics has a unique ability to represent the real world [15]. It can accept the complexity, nonlinearity, and feedback loop structure attached to the social and physical systems.

In more detail, Fuchs explains the advantages of system dynamics, which include: (1) system dynamics modeling is simple, (2) system dynamics modeling is powerful, (3) system dynamics modeling is helpful, and (4) system dynamics modeling is natural [16]. However, concerning various issues of SEA, logical relation among them is complicated to be defined. In this case, the application of system dynamic does not help draw the basic structure of the relation, especially to define certain issues as the most strategic in influencing the others. Therefore, an additional tool is needed to define the causal relationship as well as the key issue among the other issues.
DEMATEL (Decision Making Trial and Evaluation Laboratory) is one among various MCDM tools that helps the policymaker in define the causal relationship among the variables of a system [13]. DEMATEL technique can build the relationship and construct the corresponding Impact Relation Maps (IRMs) [13]. In the process of SEA, this capability might be utilized in building the logical structure of interrelation among the issues that will be further analyzed using system dynamic technique [17]. In this case, DEMATEL fills the gap between Decision making and System Dynamic toward insufficient information in building the model of variables relation. By conducting DEMATEL before System Dynamic, a better causal loop diagram built-in system dynamic technique may be expected.

This paper examines the SEA of Municipal Development Plan that is held for Jombang Municipality in 2021. Jombang is a municipality in East Java Province, Indonesia. The recent development of Jombang has already moved from agriculture to manufacture. So far, the development of manufacture causes various environmental issues such as growing air-water-land pollution, decreasing agricultural land, and increasing the problem of human resources. Sadly, the Global Pandemic of Covid-19 brings a worse environmental situation and a significantly growing social economy problem.

This research is focused on the applied method in defining the strategic issue of sustainable municipal development. To build the comprehension about the process, this paper presents the four chapters. Firstly, this paper theoretically discusses how DEMATEL can be the initial step in defining the strategic issue of SEA. Secondly, this paper describes the conducted method in building the causal relation among the issues by operating DEMATEL. Thirdly, the resulted interrelation (logical causal relation map) is discussed. Finally, some conclusion is defined.

2. Methods

2.1. SEA for Municipal Mid-Term Development Plan

Since the National Government publishes National Mid-Term Development Plan 2019-2024, all Indonesian provinces and municipalities must review and amend their development plan to accommodate the top-down principles of the Indonesian planning system. Here, National Law 25/2004 of the National Planning System (UU 25/2004) and Permendagri 86/2017 regulate that process. These laws also oblige SEA as part of the municipal development planning process. Here SEA is considered a method in assured that sustainable development principles have been properly accommodated in the planning process, especially in decision-making. Since 2018, under Ministerial of Interior Regulation 7/2018 of SEA Management (Permendagri 7/2018), SEA for development is focused on each indicator of SDGs to be further accommodated into the development plan.

According to Permendagri 7/2018, SEA for Municipal Mid-Term Development Plan is conducted before the process of plan-making. Further, SEA evaluates the existing attainment of SDGs by the municipality in the past 5 years by comparing the defined target for each indicator by National SDGs Action Plan. Upon defining the problem for each indicator, the relation with ecological conditions is further analyzed comprising capacity and ecosystem services of the municipality as well as the financial management of the municipality. The above analysis results in various issues of sustainable development that some of them should be defined as the strategic issues. Finally, the recommendation is highlighted on improving the municipal SDG’s based upon the circumstance of defined strategic issue.

2.2. Sustainable Development Issues

Defining the strategic issue of municipal development refers to drawing the interrelation among the existed issues to draw the most influencing issue to the others. According to The PP 46/2016, the aimed issues are defined as an essential phenomenon that influences the achievement of municipal sustainable development goals. It deals with social, economic, environmental, and administrative
matters. It is commonly believed that the issues are abstractly qualitative defined. According to Law 32/2009 chapter 15 (2), the issues should be defined by the relation to 7 existed environmental situation, that are: climate change, biodiversity, escalation disasters intensity, natural resources, land-use changes, poverty, health, and safety. The four steps in defining the issue include: 1. Collecting environmental issues that are proposed by all stakeholders (government, public, universities, and NGO); 2. Grouping the issues based upon the similarity of theme and target; 3. Confirming and verifying the issues by the available data; and 4. Defining the strategic issue. These steps must be participatory conducted by the municipal government, except the fourth.

Upon collecting and confirming the issues proposed by the stakeholders, Analytical Hierarchy Process (AHP) may be conducted to draw the importance level of each issue. By AHP, some issues with higher rank to another may be the most important issues. However, the resulted rank and priority doesn’t reflect the position of each issue in influencing the sustainable municipal development. Considering the term 'strategic issue', ‘the most important’ ought to be the most influencing issue on the system of municipal sustainable development.

2.3. Reviews of DEMATEL

DEMATEL technique was launched by the Geneva Research Centre of the Battelle Memorial Institute to examine the complex structure of causal relationships through matrixes or graphs [18]. DEMATEL as a structural modeling approach is beneficial in analyzing the cause-and-effect relations among factors (or here are issues) of a system (here is the achievement of sustainable development goals). DEMATEL confirms interrelationship among factors and depicts the map to show relative relationships among them. DEMATEL is efficiently used for examining and solving complex and interlinked problems. This instrument also realizes the key factors of a complicated structure system through the interrelation map. Additionally, DEMATEL is built to draw improved decision making.

DEMATEL started by generating the group direct-influence matrix Z (1). To examine the relationships between n factors, \( F = \{ F_1, F_2, \ldots , F_n \} \) in a system, presume that l experts in a decision group \( E = \{ E_1, E_2, \ldots , E_l \} \) are required to reveal the direct influence of factor \( F_i \) on factor \( F_j \). Here, the integer scale of (starting from 0 to 4) “no influence,” “low influence,” “medium influence,”“strong influence,” and "very big influence" is operated. As following, individual direct-influence matrix \( Z_k = [z_{ij}]_{n \times n} \) supplied by the kth expert can be formed, where all principal diagonal elements are equal to zero and \( z_{kij} \) represents the judgment of decision-maker (experts) \( E_k \) on the degree to which factor \( F_i \) affects factor \( F_j \). By accumulating the l experts’ judgments, the group direct-influence matrix \( Z = [z_{ij}]_{\times n} \) can be obtained.

\[
    z_{ij} = \frac{1}{l} \sum_{k=1}^{l} z_{kij}, \quad i, j = 1, 2, \ldots , n
\]

(1)

Second step (2) is determining the normalized direct-influence matrix \( X \). When the group direct-influence matrix \( Z \) is acquired, the normalized direct-influence matrix \( X = [x_{ij}]_{\times n} \) can be achieved by the followed formula:

\[
    X = \frac{Z}{s}
\]

\[
    s = \max \left( \max_{i=1}^{n} \sum_{j=1}^{n} x_{ij}, \max_{j=1}^{n} \sum_{i=1}^{n} x_{ij} \right)
\]

(2)

All elements in the matrix \( X \) are complying with \( 0 \leq x_{ij} < 1, 0 \leq \sum_{j=1}^{n} x_{ij} \leq 1 \), and at least one \( i \) such that \( \sum_{j=1}^{n} x_{ij} \leq s \).

The Third Step (3) is building the total-influence matrix \( T \). Using the normalized direct-influence matrix \( X \), the total-influence matrix \( T = [t_{ij}]_{\times n} \) is then calculated by summing the direct effects and all the indirect effects by

\[
    T = X + X_2 + X_3 + \cdots + X_h = X(I - X) - 1
\]

when \( h \to \infty \),

(3)
in which \( I \) is denoted as an identity matrix.

Step Fourth (4) is produce the Influential Relation Map (IRM). Here, the vectors \( R \) and \( C \) speak for the sum of the rows and the sum of the columns from the total-influence matrix \( T \), are defined by the following formulas:

\[
R = [r_i]_{n \times 1} = \left[ \sum_{j=1}^{n} t_{ij} \right]_{n \times 1},
\]

\[
C = [c_i]_{n \times 1} = \left[ \sum_{j=1}^{n} t_{ij} \right]_{1 \times n},
\]

where \( r_i \) is the \( i \)th row sum in the matrix \( T \) and presents the sum of the direct and indirect effects dispatching from factor \( F_i \) to the other factors. By the same way, \( c_j \) is the \( j \)th column sum in the matrix \( T \) and depicts the sum of direct and indirect effects that factor \( F_j \) is accepting from the other factors. Let \( i = j \) and \( i, j \in \{1, 2, \ldots, n\} \); the horizontal axis vector \( (R + C) \) named “Prominence” illustrates the strength of influences that are given and accepted of the factor. \( (R + C) \) stands for the degree of central role that the factor plays in the system. Similarly, the vertical axis vector \( (R - C) \) called "Relation" presents the net effect the factor contributes to the system. If \( (r_j - c_j) \) is positive, then the factor \( F_j \) has a net influence on the other factors and can be grouped into cause group; if \( (r_j - c_j) \) is negative, then the factor \( F_j \) is being influenced by the other factors on the whole and should be grouped into effect group. Finally, an IRM is created by mapping the dataset of \( (R+C, R-C) \), which provides valuable decision-making insights.

Practically, these steps may be continued by observation toward the resulted value to get the key factors or issue in the causal relationship. Further, the step contains with identification of the degree of interrelationship. Therefore, by the interrelationship map among the issue may be developed as the basis analysis in determining the power of each issue in influencing the others. However, since the simple examination of value \( R \) and \( C \) is adequate to draw the interrelation map and identify the key issue, this paper doesn't further explain the continuing steps after the fourth step of DEMATEL.

3. Results and Discussion

3.1. Issue Collection

As the initial procedures of SEA, Jombang government conducts a Forum Group Discussion (FGD). It is attended by public representatives, expert or academic, private sectors, non-profit organizations, and local government agencies. By participatory process of FGD, Jombang municipality collects 29 public’s concerns about Jombang recent development that consists of social, economy, environment, and governmental organization management issues. After examining the 29 public concerns based upon the importance of each, Jombang government focuses on 9 main ideas. These nine ideas are further evaluated under the practical circumstances of SDG’s and environmental circumstances that are: carrying capacity, ecosystem services, disasters mitigation, progress of climate change, and biodiversity to get the issue of sustainable development comprehensively. Table 1 presents the main public concerns and the relation with practical environmental circumstances and the problem of SDG’s.

The relation among to Public Concerns, Environment and SDG’s situation is represented by the focused issue of the Jombang sustainable development in column Focused Issues in Table 1. There are 7 focused issues that are coded as X1 – X7. Further, the strategic issue should be defined by examining the relation among 7 focused. Then, DEMATEL is operated to draw the causal interrelationship. As the first stage, expert’s choices are done by utilizing pair-wise comparison among the issue. Experts are asked to make a cause-effect-comparison between one issue to the others. The
involved experts include the 2 academicians, 2 representatives of Jombang municipal agencies, and 1 representative of the public.

Table 1. Relation between focused public concerns to SDG’s and environmental situation

| Public Concerns | Existed Environmental Situation | SDG’s Situation | Focused Issues |
|-----------------|---------------------------------|-----------------|---------------|
| Quality of Human Resources | Municipal Budget Relocation for COVID19 | Escalation number of the poor, especially during the pandemic COVID-19 | Poverty and employment | X1 |
| Less-availability access to employment | Local Investment decline | Distribution of health facilities and education (including the quality) | Facilities and infrastructure for competitiveness | X2 |
| Lack access to health facilities and education | High Vulnerability to natural disasters | Increasing number of affected area and group by natural disasters | Natural disaster vulnerability | X3 |
| Escalation of natural disaster events | Lower ecosystem capacity in water management services | Degradation of local air and water quality by the development of manufacture, transportation, and urban activities. | Increasing level of water and air pollution | X4 |
| Ineffective controlling system toward high environmentally friendly standard for local product | Degradation of local air and water quality by the development of manufacture, transportation, and urban activities. | Unachieved nutrition prevalence and low quality of nutrition consumption | Ineffectiveness fulfilment of nutrition especially for infants | X5 |
| Increasing level of water pollution | | | |
| Degradation agricultural productivity | | | |
| Agriculture supply problems for agriculture | Lower level of Water carrying capacity | Escalating number of open employments | Declined local investment, especially during the COVID-19 pandemic | X7 |

3.2. Defining the causal relationship among the issue

Table 2. Total relation value (Total relation Matrix)

|       | X1     | X2     | X3     | X4     | X5     | X6     | X7     | R      |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|
| X1    | 1.2110 | 1.2390 | 1.0284 | 0.8477 | 1.1532 | 1.0637 | 0.9550 | 7.4979 |
| X2    | 1.4279 | 1.0303 | 0.9995 | 0.8406 | 1.1031 | 1.1251 | 1.0174 | 7.5440 |
| X3    | 1.3615 | 1.1050 | 0.8399 | 0.5886 | 0.8689 | 0.9472 | 0.8194 | 6.0025 |
| X4    | 1.0334 | 0.9050 | 0.8399 | 0.5886 | 0.8689 | 0.9472 | 0.8194 | 6.0025 |
| X5    | 1.0870 | 1.0105 | 0.7812 | 0.6417 | 0.7641 | 0.8553 | 0.7721 | 5.9118 |
| X6    | 1.1169 | 0.8778 | 0.8000 | 0.6967 | 0.8952 | 0.7686 | 0.7959 | 5.9511 |
| X7    | 1.1783 | 0.9209 | 0.8137 | 0.6579 | 0.8889 | 0.9073 | 0.6941 | 6.0611 |
| C     | 8.4160 | 7.0885 | 6.1199 | 5.1176 | 6.7181 | 6.7891 | 6.0198 |        |

After doing the first until the third step of DEMATEL, Total (T) relation Matrix among the issue is resulted. Table 2 indicates the total value of each issue in the matrix. Based upon the total relation
value C and R-value may be defined, where R is the row sum in the matrix $T$ and indicates the sum of the direct and indirect effects dispatching from each issue ($X$) to the other factors. Similarly, C is the column sum in the matrix $T$ and represents the sum of direct and indirect effects that each issue ($X$) accepts from the other factors. This value of C and R needs to be examined to get the Prominence value as the strength of influences given and received of each issue and Relation value as the net effect that the factor contributes to the system. Table 2 depicts the degree of Prominence and the relation of each issue. They have resulted under the calculation of each (C+R) and (C-R). Based upon the resulted value of Prominence and Relation in Table 2, the policymakers can clearly define the influencing issue to the sustainable development system of Jombang Municipality.

### Table 3. Total prominence and relation

| R     | C     | R+C  | R-C  | Identify |
|-------|-------|------|------|----------|
| 7.4979| 8.4160| 15.91| -0.92| effect   |
| 7.5440| 7.0885| 14.63| 0.46 | cause    |
| 7.3007| 6.1199| 13.42| 1.18 | cause    |
| 6.0025| 5.1176| 11.12| 0.88 | cause    |
| 5.9118| 6.7181| 12.63| -0.81| effect   |
| 5.9511| 6.7891| 12.74| -0.84| effect   |
| 6.0611| 6.0198| 12.08| 0.04 | cause    |

Figure 1 depicts the group or cause issues that play a role as the influencing issue to the system. Also, the affected group of issues is identified. X2, X3, X4, and X7 are the causes or the influencing issues. Meanwhile, the X1, X5, and X6 are the affected issues that receive any influences from X2, X3, X4, and X7. Further, the X2, X3, X4, and X7 are defined as the strategic issue of sustainable development of Jombang municipality.

Concerning the prominence value for the causes group (x-axis), Table 3 and Figure 1 show that X2 influences the system's most significant influence. In a practical context, Jombang has a serious problem in developing Human Resources. Based upon Jombang’s Statistic Data 2018-2020, the education level of Jombang people is still dominated by elementary education (6 until 12 years education). This circumstance is related also to the essential social culture of Jombang people as an agrarian society. However, in recent shifting trend from agriculture to manufacture, problem of low education level become a constraint of the people to compete in accessing job vacancy. Also based upon statistic data 2018-2020, Jombang has an escalation number of productive ages. However, the number of open un-employed are also increased. The impact of Covid-19 pandemic worsens this situation started in March 2020. Jombang is experienced with boosting a number of un-employed. Further, the problem of Human Resources has affected the escalation of poverty. It is commonly follows with public health problems and environmental degradation because of improper natural resources exploitation. By this situation, X2 should be identified as the key issue of sustainable development of Jombang municipality.

### 4. Conclusion

By examining the practiced SEA in Jombang development planning process, DEMATEL assists the policymakers to more confidently define certain issue as the strategic one in influencing sustainable development. In this case, the interrelation map among the issues depicts the certain issue that gives more influence on the other in the system of municipal sustainable development. The matrix of total prominence and relation gives the value of each issue as well as the position of each in the causal relationship among them. Then, the Lack access to health and education facilities (X2), the Escalation of disasters event (X3), the Ineffective controlling system toward environmentally friendly standard
(X4), and the Insignificant economy growth under new trend of economy development (X7) become the influencing issue on the sustainable development system.

Further, the prominence value also indicates the Lack access to health and education facilities (X2) as the strategic issue among the others. It means that X2 plays the most important roles in the Jombang sustainable development system. X2 affects the performance of other issues and variables of Jombang. This result is related to the human resources circumstances of Jombang. In fact, Jombang faces problem of low education level of the people. Within the recent industrial economy development, low level education raises severe situation of employment and low-income level of the people.

References
[1] Rizal A 2019 A Strategic Environmental Assement for Southern Coastal of West Java Province, Indonesia World Scientific News WSN 137 188-209
[2] Susilowardhani A 2014 The Potential of Strategic Environmental Assessment to Address The challenges of Climate Change to Reduce The Risks of Disasters: A Case Study From Semarang, Indonesia Procedia social and Behavioral Sciences 135 3-9
[3] Umam A H 2020 Rapid Assessment of Climate Change Issues in Indonesia Strategic Environmental Assessment (SEA) – KLHS IOP Conf. Ser.: Earth Environ. Sci. 644 012045
[4] Kementrian Hukum Dan Hak Asasi Manusia 2009 Undang Undang Republik Indonesia No. 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup
[5] APIKI 2017 Substantial Issues Still Facing Strategic Environmental Review
[6] Fidler C, Noble B 2012 Advancing strategic environmental assessment in the offshore oil and gas sector Environ Impact Assess. Rev. 34 12–21
[7] Partidário M R 1996 Strategic environmental assessment: Key issues emerging from recent practice Environmental Impact Assessment Review 16(1) 31-55
[8] Slunge D, Huyen Tran T T 2014 Challenges to institutionalizing strategic environmental assessment: The case of Vietnam Environmental Impact Assessment Review 48 53–61
[9] Kementrian Hukum Dan Hak Asasi Manusia 2016 Peraturan Pemerintah Nomor 46 Tahun 2016 tentang Tata Cara Penyelenggaraan Kajian Lingkungan Hidup Strategis
[10] Kementrian Lingkungan Hidup dan Kehutanan 2017 Peraturan Mentri Lingkungan Hidup dan Kehutanan Nomor 64 Tahun 2017 tentang Tata Cara Penyelenggaraan Kajian Lingkungan Hidup Strategis
[11] ODU G O 2019 Weighting Methods for Multi-Criteria Decision Making Technique J. Appl. Sci. Environ. Manage. 23(8) 1449-1457
[12] Zardari 2015 Weighting Methods and their Effects on Multi-Criteria Decision Making Model Outcomes in Water Resources Management Springer Briefs in Water Science and Technology
[13] Chaker F, El Manouar A, Idrissi M A J 2015 Towards A System Dynamics Modelling Method Based on the DEMATEL International Journal of Computer Science & Information Technology (IJCST) 7(2)
[14] Forrester Jay W 1961 Industrial Dynamics Waltham, MA (Pegasus Communications) page 464
[15] Forrester Jay W 1994 System Dynamic, System Thinking, And Soft OR. System Dynamic Review 10(2-3)
[16] Fuchs H U 2006 System Dynamics Modeling in Fluids, Electricity, Heat, and Motion Examples, Practical Experience, and Philosophy Conference: GI REP Conference Amsterdam
[17] Lin C -L, Tzeng G -H A 2009 Value-created system of science (technology) park by using DEMATEL Expert Systems with Applications 36(6) 9683–9697
[18] Si S -L, You X-Y, Liu H -C, Zhang P 2018 DEMATEL Technique: A Systematic Review of the State-of-the-Art Literature on Methodologies and Applications Hindawi Mathematical Problems in Engineering