Using DEMATEL approach to develop relationships of performance indicators on sustainable service only supply chain performance measurement

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Abstract. Service only supply chain (SOSC) concept is service supply chain (SSC) implementation on pure services. The globalization and stakeholder pressure makes operation of SSC should give the attention to the environment effect, community, economic and intangibility assets. SOSC performance measurement (SOSCPM) may be developed for measuring of performance for sustainability aspects and intangibility assets to meet customer satisfaction. This article discusses sustainable SOSCPM based on balanced scorecard (BSC), include sustainability aspects, intangibility and relations between perspectives and indicators. From literature review, it is found 34 performance indicators that must be confirm to expert and SC actors by survey. From survey validation using weighted average and level of consensus, it is found 29 valid indicators for processed by DEMATEL. From DEMATEL, it is found 26 indicators can be used on sustainable SOSCPM. Furthermore, innovation and growth perspective most influence to other, and customer perspective most important. Intangibility indicators incorporated on innovation and growth perspective very related with human resources. Finally, relations between perspectives and indicator used to design of BSC strategy maps.

1. Introduction
SSC implementation has become a trend because service sector has significant contribution to gross domestic product (GDP) [3] and affect to the world economic [4]. SSC has two categories, service only supply chains (SOSC) and product service supply chains (PSSC) [5]. SOSC is system which output orientation is pure services, for example: healthcare, hospitality, consultant, bank, etc. PSSC is system which output orientation are service and physical product, for example: restaurant, mass customization, etc. In 2013, services sector contribution to Indonesia GDP is 39, 87% [6] which most contributions from pure services, so pure services existence can be developed in Indonesia. The supply chain and performance measurement can used to develop of the pure service (service only).

The globalization and stakeholder pressure makes operation of SSC should more attention to sustainability issue which consists of economic, social and environment simultaneously [7]. Sustainability orientation on SC called sustainable SC [8]. The sustainable SC implementation on services can minimize of negative operation effect to environment and social and maximize of profit.
Main characteristic of services sector are intangibility assets that related with human resources [10]-[12], so SSC implementation must be attend to intangibility characteristic [2].

Sustainable SC needs performance measurement to success evaluation of: competitiveness increase [13], maximize of profit, minimize of environment negative effect and beyond of stakeholder expectation [14]. Limitations of sustainable SSCPM frameworks are less of interaction between SC actors on performance indicators determine [15], less on relationship between indicators based on sustainability aspect [7],[13], less on social aspect and focal company centralize [13],[16]. Besides, there aren’t models of sustainable SSCPM that focus to the intangibility characteristics. From the limitations, so sustainable SOSCPM need new model which all actors can participate on performance indicators define and describe relationship between indicators. Furthermore, the new model has attended to intangibility characteristic and sustainability aspects. Finally, the decision-making trial and evaluation laboratory (DEMATEL) can be used to develop sustainable SOSCPM based on BSC.

2. Literature review

2.1. The balanced scorecard (BSC) on SSCPM

The BSC is performance measurement model that describe of relationship between perspectives and or indicators on BSC strategy map as business strategy [17]. The BSC is dynamic and innovative method that can be developed and collaborated with other method [18]. The BSC can be used simultaneously by several organizations collaborate [19].

The determination of the performance perspective is starting point on the BSC because the perspectives explain view point of organization. There are 5 perspectives use on services sector: Financial, Customers, Operational, Information and Innovation & Growth [20].

2.2. The decision-making trial and evaluation laboratory (DEMATEL)

DEMATEL is one method on multiple-attribute decision making (MADM) as tool to help of decision making [21]. DEMATEL can be used to view direct or indirect relationship between variable or attribute using matrix to get all of causal relationship [22]. Beside, DEMATEL can describe of important level and influence level of an attribute or a variable on system [22].

2.3. Performance indicators of sustainable SOSC

Performance indicators on sustainable SOSCPM taken from literature review with topics: performance measurement, service SC, service SCPM and sustainable SSC practices show on table 1.

| Economic aspect | Environmental aspect | Social aspect |
|-----------------|----------------------|--------------|
| Indicators      | References           | Indicators   | References | Indicators   | References |
| Operational costs | [23], [24]          | Conservation | [25], [26] | CSR          | [14], [27] |
| ROI             | [15], [24], [28]    | Green service | [14]      | Customer satisfaction | [14], [15], [28] |
| Profit          | [4], [14], [29]     | Energy consumption | [26], [30], [31] | Stakeholder satisfaction | [25], [32]-[36] |
| Total Revenue   | [15], [24], [37]    | Water consumption | [30], [31] | Local suppliers | [9], [31] |
| Efficiency      | [9], [26], [38]-[40] | CO₂ emission | [14], [26], [39] | Local human resources | [25], [30], [41] |
| Quality of service | [4], [24], [26], [42], [43] | Waste treatment | [26], [30], [31] | Health & safety | [9], [26], [27], [39] |
| ROA             | [4], [14], [24], [26], [42] | Green material | [36]      | Organization behaviour | [38], [39] |
| Delivery Time   | [24], [28]          | Reuse & recycle | [9], [36], [39] | Information sharing | [44], [46] |
| Flexibility     | [4], [15], [24], [28] | Green collaboration | Error! Reference source not found. | Regulations & laws | [9], [26], [31], [33], [38], [39] |
| Level of inventory | [15], [28]       | Integrated of IT | Reference source not found. | [36], [46] |
| Cost of TIC     | [14], [28]         |              | [23], [45], [47] |
| Capacity of TIC | [28], [46], Error! Reference source not found. | | | |
| Human resources | [14], [31], [38]    |              |             |             |             |
3. Methodology

Model development used survey with in depth interview. In this study we asked three scholars and six managers from suppliers and provider of service only business. Stage on model development:

a. Validation of survey result of indicators with weighted average (WA) and level of consensus (LC). Indicator cut off: WA ≥ 4.2 & LC ≥ 0.5 (economic) and WA ≥ 4.5 & LC ≥ 0.7 (environmental and social)[50], and then classification based on BSC perspectives

b. Survey to level of influence between perspective and indicator.

c. Design of BSC strategy map based on DEMATEL steps: build matrix of direct relation, normalization, total relationship, calculate important level and influence level and make a relationship diagram with significant matrix [22].

4. Result and discussion

4.1. Validation and classification of indicators

From literature review, the indicators were validated with survey. Then, survey result processed with WA and LC. It is found five indicators that not valid, namely: ROA, cost of TIC, CO2 emission, green material and local supplier. Finally, there are 29 valid indicators that classified into performance perspectives on table 2.

| Financial | Customer | Operational | Information | Innovation & Growth |
|-----------|----------|-------------|-------------|---------------------|
| (X1)      | Quality of service (X6) | Flexibility (X11) | Capacity of TIC (X20) | HR (X23) |
| ROI (X2)  | Delivery Time (X7) | Level of inventory (X12) | Integrated of IT (X21) | Qualification & competency (X24) |
| Profit (X3)| CSR (X8) | Conservation (X13) | Information sharing (X22) | HRD (X25) |
| Total Revenue (X4) | Customer satisfaction (X9) | Green service (X14) | | Organization behaviour (X26) |
| Efficiency (X5) | Stakeholder satisfaction (X10) | Energy consumption (X15) | Water consumption (X16) | Local HR (X27) |
|            |         | Water consumption (X17) | Waste treatment (X17) | Health & safety (X28) |
|            |         | Reuse & recycle (X18) | Green collaboration (X19) | Regulations & laws (X29) |

4.2. Relation between perspectives and indicators

The DEMATEL steps used to design of relationship. Table 3 shows of influence level (D – R) and important level (D + R) of perspectives and indicators. Innovation and growth perspective is most influence and customer perspective is most important. The indicators of ROI (X2), water consumption (X16) and local human resource did not important and significant relations with other, so the BSC strategy map can develop without their indicators.
Table 3. Total relation matrix of perspectives and indicators.

| Perspectives and Indicators | D   | R   | D+R | D-R |
|-----------------------------|-----|-----|-----|-----|
| **Financial**               |     |     |     |     |
| Operational costs           | 3.27| 3.756| 7.026| 0.485|
| ROI                         | 1.155| 1.686| 2.842| -0.53|
| Profit                      | 2.39 | 3.69 | 6.08 | -1.3 |
| Total revenue               | 2.677| 3.57 | 6.25 | -0.89|
| Efficiency                  | 3.386| 3.63 | 7.02 | -0.24|
| **Customer**                |     |     |     |     |
| Quality of service          | 3.715| 4.183| 7.898| 0.468|
| Delivery Time               | 2.694| 3.378| 6.072| -0.68|
| CSR                         | 2.697| 2.73 | 5.427| -0.03|
| Customer satisfaction       | 2.765| 2.038| 4.803| 0.727|
| Stakeholder satisfaction    | 2.854| 2.84 | 5.696| 0.013|
| **Operational**             |     |     |     |     |
| Flexibility                 | 3.518| 3.924| 7.442| 0.405|
| Level of inventory          | 3.283| 2.997| 6.28 | 0.285|
| Conservation                | 2.233| 2.044| 4.277| 0.189|
| Green service               | 2.06 | 2.554| 4.614| -0.49|
| Energy consumption          | 3.493| 3.2  | 6.693| 0.292|
| Water consumption           | 2.29 | 2.385| 4.675| -0.09|
| Waste treatment             | 1.867| 2.432| 4.299| -0.56|
| Reuse & recycle             | 2.67 | 2.71 | 5.381| 0.33 |
| Green collaboration         | 2.955| 2.71 | 5.666| 0.244|
| **Information**             |     |     |     |     |
| Capacity of TIC system      | 3.181| 3.194| 6.375| 0.013|
| Integrated of inf. system   | 3.048| 2.664| 5.712| 0.384|
| Information sharing         | 3.46 | 2.946| 6.4  | 0.515|
| **Innovation & Growth**     |     |     |     |     |
| HR                          | 4.421| 3.05 | 7.471| 1.371|
| Qualification & competency  | 3.17 | 2.8  | 5.978| 0.37 |
| HRD                         | 3.622| 2.89 | 6.513| 0.731|
| Organization behaviour      | 3.667| 3.056| 6.724| 0.611|
| Local HR                    | 3.617| 3.383| 7.0  | 0.234|
| Health & safety             | 2.954| 2.66 | 5.615| 0.292|
| Regulations & laws          | 3.072| 2.762| 5.834| 0.31 |

From the total relation matrix, we build significance matrix. The significance matrix describe of relationship between perspective and indicator and then will be input for BSC strategy map design. Figure 1 show of the BSC strategy map with twenty six indicators on five perspectives.
5. Conclusions
The sustainable SOSCPM can be developing based BSC and DEMATEL with five perspectives and twenty six indicators that oriented to sustainability dimensions and intangibility assets. We found two phenomenon’s on the sustainable SOSCPM performance measurement: first, an intangibility indicator on innovation and growth perspective is most influence to other indicator, and second, existence of customer perspective is most important. From the phenomenon, the human resource and customer must be more attention by services business. Further research need calculate weight of indicator base on relationship between indicators, then simulate by system dynamic to predict of performance in the future. Furthermore, the model can be implemented on several service only with similar of intangibility as baseline for improving of sustainable SOSCPM.

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