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Integration of a Balanced Scorecard, DEMATEL, and ANP for Measuring the Performance of a Sustainable Healthcare Supply Chain

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Abstract: The main purpose of this study is to develop a sustainable healthcare supply chain performance measurement (SHSCPM) model, which simultaneously considers intangible characteristics and sustainability aspects to ensure customer and/or stakeholder satisfaction. This model combines a balanced scorecard (BSC) with a decision-making trial and evaluation laboratory (DEMATEL) and analytical network process (ANP). After the arrangement and classification of perspectives and indicators from a literature review, the strategy map of the BSC is designed with DEMATEL. Furthermore, this study used a survey with in-depth interviews of seven expert respondents to make a pair-wise comparison between perspectives and indicators in order to determine the weights of indicators, perspectives, and sustainability aspects on ANP. The study finds the following. First, the innovation and learning perspective that reflects intangible assets has the most influence on the others but is not important, while the customer perspective has the most importance for SHSC performance. Second, the economic aspect has the greatest weight, followed by social and environmental aspects. Finally, indicators of the financial and customer perspectives as drivers of SHSC performance consist of profit, quality of service, revenue, customer satisfaction, and stakeholder satisfaction. Further, indicators of the economic aspect of sustainability have the most effect on SHSC performance, followed by social and environmental aspects. Furthermore, human resources, as an intangible asset and key factor in social aspects, are main factor in improving SHSC performance.

Keywords: sustainable healthcare supply chain; performance measurement; performance of perspectives and indicators; sustainability aspects; intangible characteristics

1. Introduction

In recent decades, the service sector's have made a significant contribution to gross domestic product (GDP) and affects the global economy [1]. This phenomenon has driven the development of the service supply chain (SSC) concept [2–4]. Methods of supply chain and performance measurement can be used to develop healthcare performance [5]. The healthcare supply chain (HSC) is an implementation of the SSC into healthcare businesses. HSC implementation stimulates healthcare service providers to collaborate with supply chain actors to ensure customer and/or stakeholder satisfaction [2] and cost reduction [6]. The HSC performance measurement (HSCPM) can be used to measure the success of the collaboration between healthcare service providers with other HSC actors.

In 2013, the service business contribution to Indonesia's GDP was 39.87% [7]. In the period from 2012 - 2015, the service business contribution to the Product Domestic Regional Brute (PDRB) of the

East Java Province was an average of 71.11%. The service contributions show increasing trends in: tourism, hotels and restaurants, professional services, banking and insurance, and healthcare [8]. On the other hand, pressure from globalization and stakeholders requires the HSC operation to give attention to the environment, community, economic, and intangible assets [9]. Implementation of sustainable service supply chain could minimize the negative effects of operation on the environment and society and maximize profits [10]. Based on the contribution to GDP and/or the PDRB and as well as globalization and stakeholder pressure, healthcare businesses need a sustainable healthcare supply chain (SHSC), especially in the Province of East Java, Indonesia. SHSC implementation is expected to be able to improve the performance of healthcare businesses. Besides, the development of SHSC is feasible because healthcare businesses are concerned with improving public health and wellbeing.

The SHSC performance requires a performance measurement system. Sustainable supply chain performance is defined as a company's capacity to reduce the use of materials, energy, or water and to find more eco-efficient solutions by improving the supply chain [11]. Performance measurement of the SHSC can be adapted from the sustainable service supply chain performance measurement models. The performance of sustainability aspects in the supply chain are often difficult to measure [12]. The scope of sustainable service supply chain performance measurement (SSSCPM) includes environmental management, social responsibility, management of health, safety and risk, and customer management [13]. SSSCPM is still dominated by economic and environmental aspects, and less by social aspects [14]. SHSC performance measurement (SHSCPM) is also still oriented toward economic and environmental (green) aspects, such as the environmental supply chain performance measurement [15], life cycle assessment, and life cost assessment [16]. The social aspect of SHSC is important and is becoming a key objective within the SHSC because healing patients is the primary outcome of the HSC, and the social aspect of the SHSC is concerned with human aspects [17]. Social aspects are similar to intangible assets and are the main characteristic of the services sector [18]. Thus, SHSCPM implementation must consider both intangible assets and sustainability aspects.

The concept of the SHSCPM has been developed and reported. There has been is littleness integration between economic, environmental, and social aspects simultaneously. Furthermore, SHSCPM research is suitable for development in East Java Province, Indonesia. This study aims to propose an SHSCPM by combining the balanced scorecard (BSC) with the decision-making trial and evaluation laboratory (DEMATEL) and the analytical network process (ANP), while with simultaneously considering to the intangibility characteristics and sustainability aspects. The BSC will be combined with DEMATEL to design a strategy map that represents the relationships between perspectives and indicators. The relationships are designed based on the level of importance and influence by DEMATEL. Finally, the BSC strategy map will be used as input in the design of the ANP structure model. The ANP structure model will determine the weights of the performance indicators, performance perspectives, and sustainability aspects.

Integration of the BSC with DEMATEL and ANP for SHSCPM can improve previous SHSCPM models, which SHSCPM has designed by integrating of the BSC and DEMATEL [9]. This study aims to add the ANP method into the SHSCPM model, along with BSC and DEMATEL, where the ANP output is the weight of the performance indicators based on the BSC strategy map. Finally, integration of the BSC with DEMATEL and ANP for SHSCPM can enrich the SHSCPM literature based on BSC.

This article is organized as follows. This study discusses the BSC and DEMATEL in the SHSCPM, including a strategy map framework from a previous study in Section 2. Section 3 presents the DEMATEL and ANP for performance measurement, especially SHSC. Then, the methodology that describes the research stages and the structural model are presented in Section 4. Section 5 discusses data from an expert preference questionnaire survey of professionals in the healthcare business; this questionnaire is used in the processes of the ANP, and in weighting the performance indicators, performance perspectives, and sustainability aspects. Next, the limitations of this study are discussed in Section 6. The last section presents conclusions that describe the phenomenon of SHSCPM and future research opportunities.

2. BSC and DEMATEL on SHSCPM

The actors in the healthcare supply chain consist of a producer, suppliers, healthcare service providers, and patients [19,20]. The orientation of HSCPM comprises eleven elements, i.e.: continuous improvement and customer satisfaction [21], demand, customer relationship, supplier relationship, capacity and resources, information technology [5], trust, knowledge exchange, IT integration between the supplier and service provider [22], and costs and benefit [23].

The BSC is a model of performance measurement that describes the relationship between the performance of perspectives and indicators as a strategy map. The strategy map is a business strategy that is related with financial and non-financial execution [24]. Besides that, BSC can be used simultaneously by several organizations that are collaborating together [25]. The BSC has been used to measure the performance of sustainable SCPM [26]. Finally, the BSC can be adapted to measure supply chain performance because a supply chain is a reflection of the collaboration between producers, suppliers, providers and customers.

The BSC is dynamic and innovative because it can integrate with other methods [27] for the design of sustainable or green SCPM practices. Examples include BSC and AHP (analytical hierarcy process) –PGP (pre-emptive goal programming) [28], BSC and game theory [29], BSC and a fuzzy analytical networking process (ANP) [30], BSC and data envelopment analysis (DEA) [31], and BSC and DEMATEL [9]. Based on this, the design of the SHSCPM can integrate the BSC with another method.

The DEMATEL is a multi-attribute decision-making (MADM) method that can be used as a tool to help in decision-making processes [32]. The DEMATEL has used to analyse the component structures from decision variables. It can analyse the direct or indirect relationships between variables [33]. It is used to determine the relationship between the impact of the performance of perspectives and indicators on the performance measurement, including on BSC [33]. Furthermore, the DEMATEL can describe both the level of importance and the level of influence of an attribute or a variable in a system and then use a matrix system to determine all the causal relationships between the attributes and variables [33]. Finally, the DEMATEL can be used to determine the level of importance, level of influence, and supplier selection on the sustainable supply chain [34,35].

Integration of the BSC and DEMATEL for SHSCPM has been published. This past research shows that the SHSCPM orientation has similarities with the perspectives used in services sector performance: finance, customers, operational, information, and innovation & growth [9]. The relationship between perspectives is shown in Figure 1.

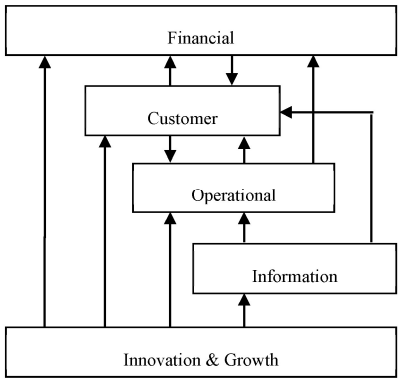

Figure 1. Strategy map of a sustainable healthcare supply chain performance measurement (SHSCPM).

Table 1. Relationship between performance indicators and perspectives performance based on sustainability aspects.

Sustainability Aspects	Performance Perspectives									
	Financial		**Customer**		**Operational**		**Information**		**Innovation and Learning**	
Economic	Demand (patient) Effectiveness Efficiency Profit Revenue	X1 X2 X3 X4 X5	Quality of service Delivery	X6 X7	Inventory level Standard of service Flexibility Supplier timeliness	X11 X12 X13 X14	Integration of information system	X20	Capacity and professionalism Innovation Training and education Research and development	X24 X25 X26 X27
Environmental					Green technology Green material Waste treatment Work physic environment	X15 X16 X17 X18	Environmental certification	X21		
Social			Customer satisfaction Patient loyalty Stakeholder satisfaction	X8 X9 X10	Collab. with supplier	X19	Medical information system Sharing of information & knowledge	X22 X23	Health and safety Organization behavior	X28 X29

Once the strategy map has been determined, the performance indicators of the SHSCPM can be identified. The identification of the performance indicators was based on a literature review, and in this paper, twenty nine indicators are used [9]. Furthermore, the performance indicators have been classified into the sustainability aspects and performance perspectives that are show in Table 1.

Figure 1 and Table 1 still do not show the weights of the performance perspectives and indicators of the SHSCPM, which indicate their contribution to performance. More study is still needed to determine the performance weights of indicators and perspectives based on the relationships between them, and these aspects can be done by using the ANP.

3. DEMATEL and ANP for Performance Measurement

The ANP is a general theory of relative measurement used to derive a composite priority ratio from an individual ratio that represents the relative measurement of the influence of elements that interact with control criteria [36]. For the performance measurement, ANP is usually combined with the DEMATEL [32], where the DEMATEL is used to relate of indicators and perspectives, and then the relationships created are used to make the ANP model. Finally, the ANP model can determine the weights of perspectives and indicators based on inner and outer dependence.

The ANP can improve the limitation of AHP, especially for accommodating the relationships between criteria and alternative [36]. There are two relationships in ANP, namely inner and outer dependence. Inner dependence is the relationship between indicators within a cluster, and outer dependence is the relationship between indicators in different clusters.

The ANP provides a way to input judgment and measurements to derive the ratio of a priorities scale for the distribution of influence among the criteria and groups of criteria in the decision process [33]. ANP is a qualitative multi-attribute decision-making approach that provides structured communication to address the business model [30]. The weight of an indicator on performance measurement can be determined by the ANP. The ANP can help decision-makers to determine a strategy for improving performance based on the strategy map.

Figure 1 and Table 1 still do not show the weights of the performance perspectives and indicators of the SHSCPM, which can indicate their contribution to performance. More study is still needed to determine the performance weights of indicators and perspectives based on the relationships between them, and these relationships can be processed using the ANP.

4. Research Methodology

The healthcare business in the Province of East Java, Indonesia was used for the design of the SHSCPM. The healthcare business consists of producers, suppliers (distributors), health clinics, and hospitals. In this study, the BSC will be combined with DEMATEL to design a strategy map that represents relationships between perspectives and indicators. The relationships are designed based on the level of importance and influence by DEMATEL. Furthermore, the BSC strategy map will be used as an input for design of the ANP structure model. Finally, the ANP structure model can be determine the weights of the performance indicators, performance perspectives, and sustainability aspects as final output of this study.

4.1. Data Collection

The development of the SHSCPM model in this study was based on a survey with in-depth interviews with seven expert respondents for data collection. The respondents were representatives of the healthcare business as supply chain actors. The respondents consisted of: one pharmaceutical industry manager, one supplier owner, two private hospital professional managers, one public hospital professional manager, and two clinical professional managers. All of the respondents had more than 10 years of experience in their profession. The surveys were obtained for the period from March 2018 to December 2018. Respondents were asked about pair-wise comparisons between perspectives and indicators based on their perceptions.

4.2. Stages of This Research

The stages of development of the SHSCPM model by combining the balanced scorecard with DEMATEL and ANP, and using Super Decisions software version 2.8.0 for ANP data processing, were based on the respondents' perceptions. The research stages were as follows:

a. Determine the BSC strategy map that describes the relationships between the performance of perspectives and indicators using DEMATEL.
b. Development of ANP structure model based on the BSC strategy map.
c. Survey to perform pair-wise comparisons between the performance of perspectives and indicators on a scale of 1–9. The survey results were processed according to the ANP steps [30] with Super Decisions software version 2.8.0. The validity of the pair-wise comparison considered the inconsistency value. If the value of inconsistency <1, the pair-wise comparison is valid [36].
d. Running the process to determine the weights of performance indicators. These were classified into two types: performance indicator weights based on clusters (performance perspective) and indicator weights based on the system (partial indicator weight). Based on the performance indicator weights, the weights of the performance perspectives and sustainability aspects can be calculated.

4.3. Determination of BSC Strategy Map by DEMATEL

The DEMATEL used for design of strategy map. Survey result was processed for the DEMATEL steps. Survey to identify level of influence between perspectives and indicators with 0–4 scale (0 = no influence, 1 = low, 2 = normal, 3 = strong, 4 = very strong). The BSC strategy map was designed by using DEMATEL with following steps:

a. Building direct relation matrix (A) based on average of influence value from a_i to a_j by survey:

$$A = [a_{ij}]_{nxn}$$

$$A = \begin{bmatrix} 0 & a_{12} & \dots & a_{1n} \\ a_{21} & 0 & \dots & a_{2n} \\ : & : & \dots & : \\ a_{n1} & a_{n2} & \dots & 0 \end{bmatrix}.$$

b. Building normalization matrix (X):

$$X = A \times s$$

$$s = \min\left[\frac{1}{\max\sum_{j=1}^{n} a_{ij}}, \frac{1}{\max\sum_{i=1}^{n} a_{ij}}\right].$$

c. Building total relationship matrix (T), $T = X(I - X)^{-1}$; I is a identity matrix. Calculating of importance level and influence level of the perspective and indicator. Element of $T = \left[t_{ij}\right]_{nxn}, i, j = 1, 2, \ldots, n$; where, i = rows, and j = columns; D and R represent direct and indirect relationships from rows and columns:

$$D = \left[\sum_{j=1}^{n} t_{ij}\right]_{nx1}, (i = 1, 2, \ldots, n)$$

$$R = \left[\sum_{i=1}^{n} t_{ij}\right]_{nx1}, (j = 1, 2, \ldots, n)$$

where, (D + R) indicates of importance level and (D − R) indicates of influence level.

d. Building a significant matrix to describe the relationship between the perspective and the indicator. Steps to design of significant matrix:

- Calculation of the average of T: $\overline{X} = \frac{\sum T}{\sum ij}$; where, i = the sum of the row and j = the sum of the column.
- Reduction of all T with $\overline{X}$ or $(T - \overline{X})$, the value of the significant matrix indicates the level of the relationship

e. The significant matrix describe of relationship between perspectives and indicators. Relationship between perspectives and indicators are made into a BSC strategy map, which is used for ANP structure model.

The direct relation matrix is shown in Table 2, and Table 3 shows the total relationships matrix. Then, the level of importance and influence is shown in Table 4. Finally, the significance matrix has illustrate of relationships between perspectives and indicators shown in Table 5.

Based on the level of importance (D + R), the important indicators on the SHSCPM are quality of service, stakeholder satisfaction, customer satisfaction, flexibility, collaboration with supplier, standard of service, innovations, and organization behavior. These are incorporated in the customer perspective and innovation and learning perspectives. After that, all of indicators incorporated into the innovation and learning perspective have the most influence compared to other indicators, with the values of all of the influence levels (D − R) being positive (+).

Finally, the indicators incorporated into the customer perspective and innovation and learning perspectives are closely related with human resources, so the existence of human resources is important in the SHSCPM.

Table 2. Direct relation matrix as initial matrix based on expert preferences.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29
X1		4	2	4	4	3	3	4	4	4																			
X2	4		4	3	0	4	3	4	4	3																			
X3	0	3		4	4	3	0	0	0	4																			
X4	0	0	1		0	3	0	0	0	4																			
X5	0	0	1	4		4	0	0	0	4																			
X6	4	2	4	4	4		4	4	4	4	3	2	3	0	3	1	3	3	4										
X7	4	4	3	2	4	4		4	4	4	0	4	4	0	0	0	3	0	0										
X8	4	2	0	4	4	4	0		4	4	0	4	4	0	0	0	0	0	4										
X9	4	0	0	4	4	4	0	4		4	0	0	4	2	0	0	0	0	0										
X10	4	3	0	2	3	3	3	4	1		0	0	3	3	3	0	3	3	4										
X11	4	4	4	4	3	3	4	3	4	1		0	4	4	0	0	2	0	4										
X12	3	4	2	3	3	4	4	4	4	4	3		4	3	3	0	4	4	0										
X13	4	4	4	4	4	4	4	4	4	4	4	4		3	4	3	4	3	4										
X14	4	4	3	3	0	4	4	3	4	4	4	4	4		0	0	0	0	4										
X15	4	4	4	4	3	4	3	4	3	4	0	3	4	0		2	4	3	1										
X16	2	0	2	2	0	3	0	3	3	0	3	3	3	0	1		4	0	3										
X17	3	3	4	3	4	4	0	2	4	4	3	0	0	0	4	0		4	4										
X18	4	4	0	0	3	4	0	4	4	4	0	4	0	0	3	0	3		1										
X19	4	3	3	4	3	4	3	3	3	4	4	0	3	4	4	2	4	0											
X20						4	4	3	3	4	4	0	4	4	2	0	2	0	3		4	4	4						
X21						4	0	3	3	3	0	2	2	0	4	3	4	3	3	4		3	3						
X22						4	4	4	4	4	4	0	4	4	3	2	2	3	4	4	2		4						
X23						4	4	4	4	4	4	3	4	4	4	2	4	0	4	4	0	4							
X24	4	4	4	4	4	4	4	4	4	4	3	4	4	3	4	2	4	3	4	4	2	4	4		4	3	4	4	4
X25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		3	4	4	4
X26	3	4	3	3	4	4	4	4	4	4	0	0	4	0	4	2	4	4	4	4	3	4	4	4	4		4	4	4
X27	4	4	4	4	4	4	3	4	3	4	3	4	4	3	4	4	4	3	4	4	3	3	4	4	4	4		4	4
X28	4	4	4	4	4	4	0	4	0	4	0	0	4	0	4	3	4	2	0	0	4	4	0	4	4	3	4		4
X29	4	4	4	4	4	4	4	4	4	4	3	0	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	

Table 3. Total relationships matrix.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29
X1		0.11	0.09	0.12	0.11	0.11	0.09	0.11	0.1	0.11																			
X2	0.11		0.09	0.11	0.08	0.11	0.1	0.11	0.1	0.09																			
X3	0.08	0.09		0.11	0.1	0.09	0.07	0.09	0.07	0.1																			
X4	0.08	0.08	0.07		0.08	0.09	0.07	0.08	0.07	0.09																			
X5	0.07	0.06	0.07	0.09		0.09	0.06	0.08	0.07	0.09																			
X6	0.12	0.11	0.11	0.12	0.12		0.11	0.12	0.11	0.13	0.1	0.11	0.11	0.07	0.1	0.08	0.11	0.09	0.12										
X7	0.1	0.09	0.08	0.09	0.09	0.1		0.1	0.08	0.1	0.06	0.09	0.08	0.05	0.06	0.06	0.07	0.06	0.08										
X8	0.1	0.07	0.06	0.1	0.09	0.1	0.05		0.09	0.1	0.06	0.06	0.08	0.04	0.06	0.05	0.06	0.05	0.09										
X9	0.09	0.06	0.05	0.09	0.07	0.08	0.05	0.08		0.09	0.05	0.06	0.07	0.04	0.04	0.03	0.04	0.04	0.08										
X10	0.1	0.09	0.07	0.09	0.08	0.09	0.07	0.08	0.07		0.06	0.09	0.08	0.06	0.08	0.05	0.08	0.08	0.1										
X11	0.1	0.1	0.09	0.11	0.09	0.1	0.09	0.1	0.08	0.08		0.09	0.09	0.08	0.07	0.06	0.08	0.06	0.1										
X12	0.11	0.11	0.09	0.11	0.1	0.12	0.1	0.12	0.11	0.11	0.09		0.11	0.07	0.1	0.07	0.1	0.09	0.09										
X13	0.12	0.11	0.1	0.12	0.11	0.12	0.1	0.12	0.11	0.12	0.1	0.11		0.08	0.09	0.08	0.1	0.08	0.1										
X14	0.1	0.1	0.09	0.11	0.08	0.1	0.09	0.09	0.1	0.1	0.09	0.1	0.1		0.06	0.05	0.07	0.06	0.1										
X15	0.12	0.1	0.1	0.12	0.1	0.11	0.08	0.11	0.1	0.11	0.07	0.1	0.1	0.07		0.08	0.1	0.09	0.1										
X16	0.09	0.07	0.07	0.08	0.06	0.09	0.06	0.09	0.08	0.09	0.07	0.07	0.07	0.05	0.08		0.09	0.07	0.08										
X17	0.1	0.09	0.09	0.1	0.09	0.1	0.07	0.09	0.09	0.1	0.07	0.09	0.08	0.06	0.08	0.07		0.08	0.09										
X18	0.1	0.08	0.07	0.09	0.09	0.1	0.06	0.09	0.1	0.1	0.06	0.09	0.09	0.06	0.08	0.07	0.09		0.08										
X19	0.12	0.1	0.1	0.12	0.1	0.1	0.09	0.11	0.09	0.12	0.1	0.09	0.09	0.09	0.1	0.08	0.1	0.08											
X20						0.11	0.1	0.1	0.1	0.11	0.09	0.11	0.1	0.07	0.08	0.07	0.09	0.07	0.09		0.09	0.09	0.07						
X21						0.08	0.06	0.09	0.08	0.09	0.07	0.08	0.07	0.05	0.08	0.07	0.09	0.08	0.09	0.07		0.07	0.06						
X22						0.11	0.09	0.1	0.09	0.1	0.08	0.1	0.09	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.07		0.08						
X23						0.1	0.08	0.1	0.09	0.1	0.09	0.09	0.09	0.07	0.07	0.06	0.08	0.05	0.09	0.09	0.07	0.09							
X24	0.13	0.12	0.11	0.13	0.12	0.13	0.11	0.12	0.12	0.13	0.1	0.12	0.11	0.08	0.1	0.09	0.1	0.09	0.12	0.1	0.1	0.1	0.09		0.1	0.1	0.08	0.1	0.12
X25	0.13	0.13	0.12	0.14	0.13	0.14	0.11	0.13	0.12	0.14	0.11	0.13	0.12	0.1	0.1	0.1	0.12	0.11	0.13	0.12	0.11	0.12	0.13	0.1		0.11	0.09	0.09	0.13
X26	0.12	0.12	0.1	0.13	0.11	0.13	0.11	0.12	0.11	0.13	0.08	0.12	0.12	0.07	0.1	0.09	0.1	0.09	0.12	0.11	0.1	0.11	0.12	0.12	0.07		0.09	0.1	0.12
X27	0.11	0.11	0.1	0.12	0.12	0.11	0.09	0.12	0.1	0.12	0.09	0.1	0.1	0.07	0.1	0.09	0.11	0.1	0.11	0.1	0.1	0.09	0.12	0.11	0.1	0.07		0.09	0.11
X28	0.1	0.1	0.08	0.1	0.1	0.1	0.06	0.09	0.07	0.1	0.06	0.09	0.09	0.05	0.08	0.06	0.08	0.08	0.07	0.07	0.08	0.08	0.09	0.09	0.08	0.08	0.06		0.09
X29	0.13	0.13	0.12	0.13	0.12	0.13	0.11	0.13	0.12	0.13	0.1	0.12	0.12	0.09	0.1	0.09	0.11	0.1	0.12	0.12	0.1	0.12	0.13	0.13	0.11	0.11	0.1	0.09	

Table 4. Level of importance and influence.

Performance Indicators		D	R	D + R	D − R
Demand (patient)	X1	1.03	2.72	3.75	−1.69
Effectiveness	X2	0.97	2.53	3.5	−1.55
Efficiency	X3	0.85	2.29	3.13	−1.44
Profit	X4	0.79	2.83	3.62	−2.05
Revenue	X5	0.73	2.53	3.26	−1.8
Quality of service	X6	2.02	3.15	5.18	−1.13
Delivery	X7	1.5	2.49	3.99	−0.99
Customer satisfaction	X8	1.37	3.07	4.44	−1.7
Patient loyalty	X9	1.16	2.79	3.95	−1.63
Stakeholder satisfaction	X10	1.49	3.17	4.66	−1.69
Inventory level	X11	1.64	1.97	3.6	−0.33
Standard of service	X12	1.88	2.34	4.22	−0.47
Flexibility	X13	1.96	2.33	4.3	−0.37
Supplier timeliness	X14	1.63	1.63	3.26	0.001
Green technology	X15	1.83	2.02	3.84	−0.19
Green material	X16	1.41	1.75	3.16	−0.35
Waste treatment	X17	1.59	2.19	3.78	−0.6
Work physic environment	X18	1.55	1.88	3.43	−0.34
Collaboration with supplier	X19	1.87	2.39	4.26	−0.52
Integration of information system	X20	1.61	0.99	2.59	0.62
Environmental certification	X21	1.32	0.94	2.26	0.39
Medical information system	X22	1.54	1	2.55	0.54
Sharing of inform. and knowledge	X23	1.46	0.86	2.32	0.6
Capacity and professionalism	X24	3.11	0.74	3.85	2.36
Innovation	X25	3.41	0.77	4.18	2.65
Training and education	X26	3.08	0.62	3.7	2.45
Research and development	X27	2.97	0.65	3.62	2.32
Health and safety	X28	2.36	0.58	2.93	1.78
Organization behavior	X29	3.31	0.72	4.03	2.59

4.4. The ANP Structure Model

The ANP structure model was designed by BSC strategy map. The ANP is used to determine weight of perspectives and indicators performance. The ANP processes using survey of expert respondents. Survey has used to perform a pair-wise comparison between indicators with a scale of 1–9. Survey results were processed by ANP steps. The validity of the pair-wise comparison has considered the inconsistency value. If value of inconsistency <1, so the pair-wise comparison is valid. The ANP uses an initial matrix derived from average value of the survey result.

Weight calculation of perspectives and indicators on ANP can be process by inputting average values of pair-wise comparison into software of super decision version 2.8.0. The value of the consistency ratio can also be seen directly in the super decision software after values of pair-wise comparison inputted into the software system.

The structure model illustrates the inner dependence and outer dependence in this study shown in Figure 2. Inner and outer dependence were designed by relationships between perspectives and indicators as significant matrix. Inner dependence is relationship between indicators based on the same perspective. Outer dependence is relationship between indicators with other indicators based on the different perspectives.

Table 5. Relationship between perspectives and indicators.

	Impact on																												
	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**	**X12**	**X13**	**X14**	**X15**	**X16**	**X17**	**X18**	**X19**	**X20**	**X21**	**X22**	**X23**	**X24**	**X25**	**X26**	**X27**	**X28**	**X29**
X1		√	√	√	√	√	√	√	√	√																			
X2	√		√	√		√	√	√	√	√																			
X3		√		√	√	√		√		√																			
X4						√				√																			
X5				√		√				√																			
X6	√	√	√	√	√		√	√	√	√	√	√	√		√		√	√	√										
X7	√	√		√	√	√		√		√		√																	
X8	√			√	√	√			√	√									√										
X9	√			√						√																			
X10	√	√		√		√						√							√										
X11	√	√	√	√	√	√	√	√				√	√						√										
X12	√	√	√	√	√	√	√	√	√	√	√		√		√		√	√	√										
X13	√	√	√	√	√	√	√	√	√	√	√	√			√		√		√										
X14	√	√	√	√		√	√	√	√	√	√	√	√						√										
X15	√	√	√	√	√	√		√	√	√		√	√				√	√	√										
X16	√					√		√		√							√												
X17	√	√	√	√	√	√		√	√	√		√							√										
X18	√			√	√	√		√	√	√		√					√												
X19	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		√												
X20						√	√	√	√	√	√	√	√				√		√		√	√							
X21								√		√							√		√										
X22						√	√	√	√	√		√	√						√	√									
X23						√		√	√	√	√	√	√						√	√		√							
X24	√	√	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√		√	√	√	√	√
X25	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√
X26	√	√	√	√	√	√	√	√	√	√		√	√		√	√	√	√	√	√	√	√	√	√	√		√	√	√
X27	√	√	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√		√	√
X28	√	√		√	√	√		√		√		√	√											√	√				√
X29	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	

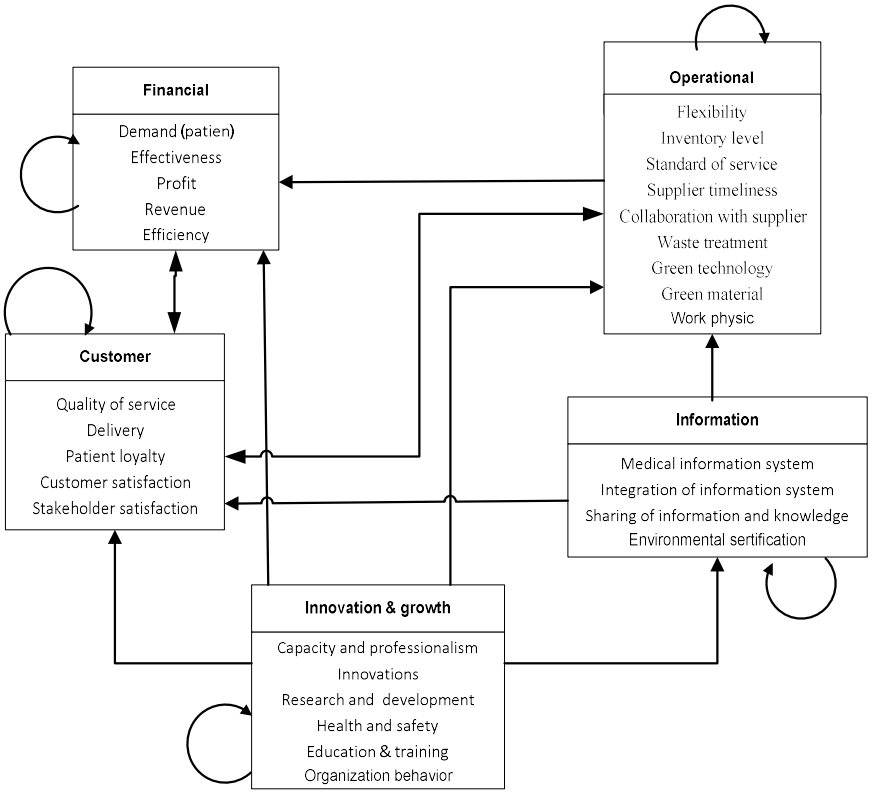

Figure 2. Inner and outer dependence.

Figure 2 makes two phenomena clear: the innovation and growth perspective is the most influential because it has an influence on all of the other perspectives, and the customer perspective is the most important perspective because it is influenced by all the other perspectives. Besides, performance indicators by inner and outer dependence can explain using examples: Demand indicator (X1) on the financial perspective has inner dependence with effectiveness (X2), efficiency (X3), profit (X4), and revenue (X5), and then, indicator of demand (X1) has outer dependence with indicators on the customer perspective (i.e. quality of service (X6), delivery (X7), customer satisfaction (X8), patient loyalty (X9), and stakeholder satisfaction (X10)). Furthermore, the organization behavior indicator (X29) on the innovation and learning perspective has inner dependence with capacity and professionalism (X24), innovation (X25), training and education (X26), research and development (X27), and health and safety (28). Besides, the organization behavior indicator (X29) on the innovation and learning perspective has outer dependence with all of indicators on the other perspectives.

5. Results and Discussion

This study uses Super Decisions software version 2.8.0 for data processing of the ANP. The data processing is the result of pair-wise comparison between performance perspectives and/or performance indicators derived from the inner dependence and outer dependence. Hence, the values of the pair-wise comparison are based on the preferences of the expert respondents.

5.1. Data Collection

Pair-wise comparison by the expert respondents' perceptions is used to collect the requirement data. Then, the data has been calculated to determine weights of the perspectives and indicators. Table 6 shows the results of pair-wise comparison for the performance perspectives.

Table 6. Normalized weight of pair-wise comparison between the performance perspectives.

Perspectives	Normalized Weight
Financial	0.245
Customer	0.448
Operational	0.091
Information	0.059
Innovation and learning	0.157
Sum	1

Validation of the pair-wise comparison result is based on the value of the inconsistency ratio. For pair-wise comparison of the performance perspectives, this value is 0.079, where $0.079 \leq 0.1$, which means that this perception by the respondents is valid.

5.2. Influence Analysis between Perspectives Based on Indicators Relationship

The influence between perspectives can be determined based on the relations between indicators. The Super Decisions software processed the values of influence between performance perspectives shown in Table 7.

Table 7. Influence between performance perspectives.

Perspectives	Influence on				
	F	C	O	I	IL
Financial (F)	0.250	0.750			
Customer (C)	0.380	0.507	0.113		
Operational (O)	0.258	0.637	0.105		
Information (I)		0.833		0.167	
Innovation and learning (IL)	0.245	0.449	0.092	0.058	0.156

Table 7 shows that the performance indicators incorporated in the perspectives of innovation and learning had an influence on all of the perspectives, including a self-influence. The performance indicators in the information perspective, operational perspective, and financial perspective too have the greatest influence on the customer perspective. Besides, the customer perspective has the highest value of self-influence. From these phenomena, the customer perspective is seen to be the most important in the SHSCPM.

5.3. Weight of Performance Perspectives and Performance Indicators

Based on the Super Decisions processing, the indicator weights on the cluster (perspectives), indicator weights in the SHSCPM system, and the perspective weights can be calculated. Table 8 shows the calculation of the weights of the perspectives and indicators.

Table 8. Weights of the perspectives and indicators in SHSCPM.

Performance Perspective	Performance Indicators	Indicator Weight on Cluster	Indicator Weight	Perspective Weight
Financial	Demand (patient)	0.3190	0.0964	0.3021
	Effectiveness	0.0808	0.0244	
	Efficiency	0.0576	0.0174	
	Profit	0.4773	0.1442	
	Revenue	0.0653	0.0197	
Customer	Quality of service	0.3626	0.2296	0.6331
	Delivery	0.0235	0.0149	
	Customer satisfaction	0.1915	0.1212	
	Patient loyalty	0.1949	0.1234	
	Stakeholder satisfaction	0.2274	0.1440	
Operational	Inventory level	0.1579	0.0102	0.0648
	Standard of service	0.1201	0.0080	
	Flexibility	0.1251	0.0081	
	Supplier timeliness	0.0137	0.0010	
	Green technology	0.0483	0.0030	
	Green material	0.0000	0.0000	
	Waste treatment	0.0389	0.0025	
	Work physic environment	0.0150	0.0010	
	Collaboration with supplier	0.4810	0.0310	
Information	Integration of information system	0.0000	0.0000	0.0000
	Environmental certification	0.0000	0.0000	
	Medical information system	0.0000	0.0000	
	Sharing of inform. and knowledge	0.0000	0.0000	
Innovation and learning	Capacity and professionalism	0.0000	0.0000	0.0000
	Innovations	0.0000	0.0000	
	Training and education	0.0000	0.0000	
	Research and development	0.0000	0.0000	
	Health and safety	0.0000	0.0000	
	Organization behavior	0.0000	0.0000	
	Sum		1.0000	1.0000

The indicator weights on the clusters in Table 8 indicate that profit and demand (patient) are very important for the financial perspective, while quality of service and stakeholder satisfaction are very important for the customer perspective. Then, collaboration with the supplier is very important for the operational perspective. Finally, the information perspective and innovation and learning perspective are not important indicators, because all of the indicators in this cluster have a value of zero (0).

Beside, big five dominant indicators in the SHSCPM are quality of service (0.2296), profit (0.1442), stakeholder satisfaction (0.1440), patient loyalty (0.1234), and customer satisfaction (0.1212). Furthermore, based on the performance perspectives, the customer perspective has the greatest weight compared with the other perspectives and is, therefore, the most influential on the performance of the SHSCPM, with a weight of 0.6331. Next, the financial perspective has a weight of 0.3021, followed by the operational perspective, with a weight of 0.0648. Finally, the perspectives of information and innovation and learning have no weight, so these perspectives have the least influence on the performance of the SHSCPM.

5.4. Weight of Sustainability Aspects

The weight of sustainability aspects can be processed by calculating the indicator weights based on the sustainability aspect classification. Table 9 shows the weights of the sustainability aspects based on the indicator weights.

Table 9. Weights of sustainability aspects.

Sustainability Aspects	Performance Indicators	Indicator Weight	Weight of Aspects
Economic	Demand (patient)	0.0964	0.5739
	Capacity and professionalism	0	
	Effectiveness	0.0244	
	Inventory level	0.0102	
	Quality of service	0.2296	
	Standard of service	0.0080	
	Efficiency	0.0174	
	Profit	0.1442	
	Revenue	0.0197	
	Innovations	0	
	Flexibility	0.0081	
	Supplier timeliness	0.0010	
	Integration of information system	0	
	Delivery	0.0149	
	Training and education	0	
	Research and development	0	
Environmental	Green technology	0.0030	0.0065
	Green material	0	
	Waste treatment	0.0025	
	Environmental certification	0	
	Work physic environment	0.0010	
Social	Customer satisfaction	0.1212	0.4196
	Medical information system	0	
	Patient loyalty	0.1234	
	Collaboration with supplier	0.0310	
	Stakeholder satisfaction	0.1440	
	Health and safety	0	
	Sharing of inform. and knowledge	0	
	Organization behavior	0	

Table 9 shows that the economic aspect has the greatest weight, and the environmental aspect has the lowest weight compared to the others. The social aspect was ranked second after the economic aspect, so this aspect was considered feasible in the SHSCPM. From the weight of the indicators, the performance indicators incorporated in the economic aspects still dominate compared to the others. The performance indicators incorporated in the environmental aspect have small weights, which means that environmental factors receive less attention from all the actors in the healthcare supply chain in Indonesia's Province of East Java.

The weight of the social aspect is 0.241, which means that social factors are highly regarded by actors in the healthcare supply chain in the Province of East Java. This is different from the opinion that social aspects were less explored in sustainable supply chain [14,37].

6. Conclusions

Integration of BSC with DEMATEL and ANP is a new model for measuring performance of sustainable SHSC. This model has more comprehensive with other models because all of the supply chain actors have involved to determining of performance indicators, strategy map, and weight of the performance indicators.

This study has been using five perspectives with twenty-nine indicators. The performance indicators included intangible characteristics and sustainability aspects. The performance indicators that reflect this intangibility are related to information and human resources, while performance indicators that reflect sustainability are related to economic, environmental, and social factors.

There are three major findings in this study. First, from the BSC and DEMATEL, the indicators incorporated in the customer perspective and innovation and learning perspectives were important, so the indicators incorporated into the innovation and learning perspective were the most influential on other indicators. Second, from DEMATEL and ANP, the innovation and learning perspective had the most influence on other perspectives, but on the other hand, this perspective was not important because it did not affect the performance value. Thus, the customer perspective is the most important because it has a major influence on the performance value. Third, based on the weights of the sustainability aspects, the economic aspect has the greatest weight, and the environmental aspect has the least weight compared to the others. The social aspect was ranked second after the economic aspect, so this aspect was considered feasible in the SHSC performance. Finally, the environmental aspect in the SHSC receives less attention in the healthcare business in East Java Province, Indonesia. Based on DEMATEL and the indicator weights from ANP, the performance indicators incorporated in the financial perspective and customer perspective are drivers of the SHSC's performance. The indicators driving the SHSC's performance consist of profit, quality of service, revenue, customer satisfaction, and stakeholder satisfaction. Besides, the performance indicators incorporated into the economic aspect of sustainability have the greatest effect on SHSC performance, followed by the social aspect and the environmental aspect. Furthermore, this study found a contradiction in the social aspect of sustainability, which received less attention than in some other studies, although this was an important aspect of sustainability after the financial aspect. Finally, human resources, as an intangible asset, are the main factor in the SHSC because they have a significant effect on the improvement of performance, especially from the customer perspective, innovation and learning perspective and the social aspect of sustainability.

Implementation of SHSCPM by integration of BSC with DEMATEL and ANP may help the management of the healthcare business to give more attention to human resources as one of intangible characteristics of a healthcare business, especially for innovation and organization behavior, because its exerts the most influence to other indicators. Beside that, the management of the healthcare business must be maintain customer satisfaction, patient loyalty, collaboration with suppliers, and stakeholder satisfaction as parts of social aspects for performance increasing. The SHSCPM model by combining BSC with DEMATEL and ANP can help management in the healthcare business to manage the company performance with simultaneously attention to intangible and sustainability aspects.

As with most empirical research, this article has limitations. First, the survey method with in-depth interviews was used with just seven expert respondents. So, the study could be improved by using more expert respondents. Second, the current study covered only East Java Province, so the findings cannot be generalized to other provinces in Indonesia.

Future research needs to explore the social and environmental aspects of sustainability in SHSCPM, where a contradiction was found. Furthermore, the SHSCPM system needs a new design with a simulation of system dynamics for predicting SHSC performance in the future based on the strategy map, weights of performance indicators and in the past performance values. The new design can help the healthcare business to prepare better its operations in order to achieve a high of the SHSC performance.

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