

Integration of Balanced Scorecard and Game Theory for Business Entity's Performance Measurement

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Abstract. Business management faces serious challenges in a severe competition especially in the era of disruption. The development of television business in Indonesia is getting higher by years. Therefore, to be able to enter and to win in this business competition, improving company management is an important factor to consider. Companies need a new strategy to face this competitive competition. To be particular, performance measurement is a prominent tool to measure a company performance. In this study the authors propose a BSC and Game Theory, hereinafter is referred as GT, integration model that assumes a measure of disputes between decision makers in making decisions. The main process of integration is within the process of determining the weight of each perspective by using Analytical Network Process or in short ANP to evaluate and measure performance in the company. Collaboration between decision makers or a number of different players is expected to help find the best strategy by comparing the choice of strategies in the relevant BSC perspective. Moreover the aim of this task is also to determine the most accommodating and representative strategies to the preferences of the players involved in performance measurement. The results of performance measurement from each strategy of the decision maker have analysed in the GT matrix payoff. It is shown that the Nash Equilibrium value for each decision maker with a relative score of performance measurement is 81.05% after integrating BSC and GT. This is a win-win solution for systematically finding strategies in performance measurement that involves more than one decision maker.

Keywords: Balanced Scorecard, Game Theory, Performance Measurement, Analytical Network Process

1. Introduction

Performance measurement in business is to monitor performance goals, identify areas that need attention, increase motivation, improve communication and strengthen accountability [1]. An effective performance measurement can tell the following things:

1. How well the work is being done
2. Has it achieved its objectives yet?
3. Does the customer feel satisfied or satisfied?
4. Is the work process already in the proper count control?
5. And are there the latest developments that need to be done?

BSC is a strategic management system performance approach that can be used to describe the company's vision and strategy. The purpose and size of the BSC are determined by the company's vision and strategy which is intended to measure company performance using four perspectives. The results of

the elaboration are used as parameters to measure company performance [2]. This approach is intended to answer the main questions, namely:

1. What is the company's appearance in the eyes of the shareholders? (financial perspective)
2. How do customers view the company? (customer perspective)
3. What are the company's advantages? (internal business perspective)
4. Does the company have to continuously make improvements and create value continuously? (growth and learning perspective)

Game theory aims to model an interaction situation as a game with the aim of getting a fair solution where those who contribute more will get greater profits as well. This leads to the involvement of several aspects such as players, information, choices of strategies that can be made, and at the same time how this affects the revenue to be received [3]. This theory was developed to analyse the decision making process that is the optimum strategy of different competitive situations and involves two or more interests [4].

ANP is defined as the application of mathematical theory that allows one to make dependence and feedback systematically so that they can capture and combine tangible and intangible factors [5]. In the decision making applications ANP method is not as much of AHP, the following are some examples of applications of ANP and each difference between AHP and ANP, among others the issue of re-engineering, supply chain, logistics, project selection, policy issues, and improving the quality evaluation of the performance has been applied in various organizations with different theories and methods over the years. The selection of an appropriate method for measuring criteria can facilitate the evaluator and analyst to process the cases to be evaluated and determine the best alternative strategy [6]. As the complexity of the problems associated with performance management systems today, the development of performance measurement system research is quite significant with a wider scope of applications both for profit and non-profit organizations [7]. Changes in the dynamic business environment with increasingly fierce competition require not only financial aspects but also non-financial aspects. Therefore, the need for an integrated performance measurement system (financial and non-financial aspects) becomes a necessity for the company [8]. From then on a number of frameworks and models for measuring performance evolved and evolved, one of which was the Balanced Scorecard (BSC).

Previous research has introduced a new approach in designing mixed performance measurement systems for supply chain environments using evolutionary game theory and BSC. BSC is the best tool in measuring performance, while game theory is accepted as the best tool in making decisions [9]. The study illustrates the circumstances for selecting policies in the area of the supply chain environment by involving performance measurement indicators as a framework for making decisions. But in this study the focus is on a situation where the process of dynamics of strategic change is not influenced by quality, but rather on the effect of the frequency of strategies found in the population.

This research is assumed that there are disputes between decision makers in the object of observation namely PT.X which is one of the companies engaged in television in Indonesia. Assuming different points of view in determining the weight of importance in measuring company performance at PT.X. The assumption of weighting competition between decision making is based on each strategic goal, because not all targets start to have the same level of importance. There are some strategic goals that take precedence over other strategic ones. To accommodate these interests, analysis and preferences are carried out by asking the theory of non-sum-sum games to structure and analyse the selection of strategies to help make decisions. In this study the authors propose a BSC integration model and cooperative game theory with a non-zero sum model that assume a benchmark of the relationship between decision makers in making decisions, especially when determining the value of weights in each perspective to evaluate and measure performance in the company. This proposed model is expected to help find the best strategy by comparing the choice of strategies in the relevant BSC perspective. Collaboration between decision makers or different players is expected to help determine the most representative strategy for the preferences of the players involved in performance measurement.

1.2. Problem formulation

Based on the background description of the problem above, then the problem can be formulated as follows; How to formulate a representative performance measurement of different management preferences by integrating BSC and non-zero sum game theory at PT. X?

1.3. Research Objectives

The objectives of this study are:

1. Redetermining company performance using BSC by weighting ANP
2. Develop a framework for analysis of decision making in measuring performance in determining the weight of perspective in the BSC which involves more than one decision maker.

2. Methods

Data retrieval is carried out at PT X after the data collected the next step is to begin by identifying key performance indicators (KPI) based on 4 perspectives of the BSC method and the results of measures that have been applied in the company. After that, it validates the work indicators that most influence the company's performance, which in determining the weight of each KPI is determined by the ANP model while for perspective in general it is determined by the subjectivity of the experts in each director, which later it will be assumed a dispute in determining the weight on each perspective.

The assumption of weighting competition between decision makers is based on the achievement of each strategic goal. But not all strategic goals have the same level of importance. There are some strategic goals that take precedence over other strategic ones. To accommodate these interests, an analysis and preferences were carried out using the non zero-sum game theory approach to structuring and analysing the selection of strategies to help make decisions. So as to find performance measurement strategies that are accommodating to various management preferences.

The stages of data processing with game theory approach solutions to help make decisions in weighting competition in every perspective can be done by using the structure of the game theory model itself. The stages of structuring game theory are as follows: identify decision makers (players), generate each player's strategy, arrange matrix pay off, determine the value of Nash equilibrium.

3. Result and Discussion

3.1. Preliminary Results of Company Performance Measurement

The case study in this study is performance measurement at PT.X. Reference data used in measuring and evaluating the performance of PT. X for each KPI is an adjustment to the 2018 company performance achievement data. After knowing the target data and achievement data on the observed objects, then weighting each KPI based on the ANP model using the help of super decision 2003 3rd edition software. The following are indicators of company performance and weighting results:

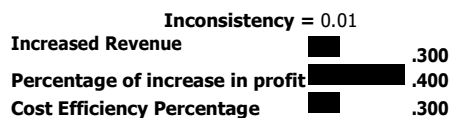


Figure 1. The result of ANP process of the Financial perspective

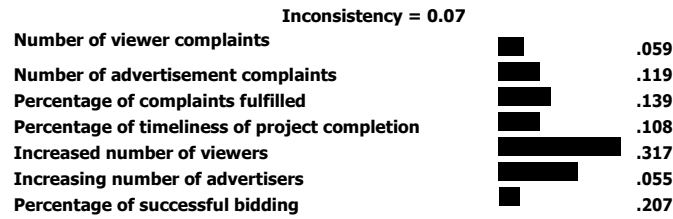


Figure 2. The result of ANP process of the customer perspective

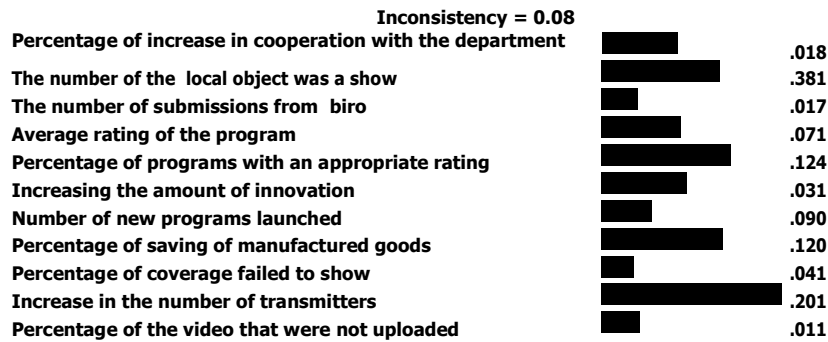


Figure 3. The result of ANP process of the Internal Business Process customer perspective

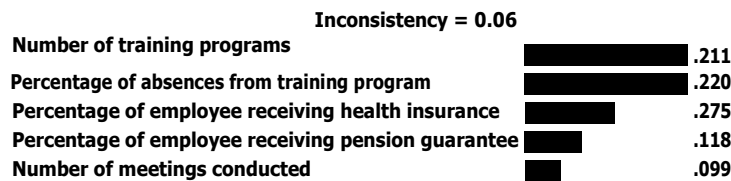


Figure 4. The result of ANP process of the learning and growth perspective

From the weighting, it produces a measurement of company performance with a relative score (79.90%) and absolute score (22.43) The relative score is obtained from the comparison of actual performance achievements with performance targets multiplied by the total weights for each KPI. These results indicate that the achievement of performance at PT. X. still have not met most of the targets set by the company.

This value still indicates the yellow colour for the performance of PT. X as stipulated in the traffic light method in measuring performance, the green colour is 81-100%, the yellow colour is 41-80%, while for the red colour is 0-40%. The meaning of the colour green is the achievement of a performance indicator has been fully achieved. The yellow colour is the achievement of an indicator has not been achieved even though the value is close to the target. While the red colour shows that the achievement of an indicator is really below the target set and requires immediate improvement.

3.2. integration of BSC and Game Theory.

After the initial performance results of performance measurement using the BSC are known, the next step is to integrate the model of the BSC performance results with game theory. The first step in using game theory is to explicitly determine the players (players).

3.2.1. The players here are:

- Player 1: Director of Finance and General
- Player 2: Director of Marketing and Programs.

3.2.2. Generate the strategies of each player

Table 1. The strategy set of the player 1

Perspective	S1.1	S1.2	S1.3
Financial	0.25	0.35	0.20
Customer	0.25	0.25	0.30
Internal Business Process	0.25	0.15	0.30
Learning and Growth	0.25	0.25	0.20

Source: Based on brainstorming with player

Table 2. The Strategy Set of the Player 2

Perspective	S1.1	S1.2	S1.3
Financial	0.25	0.25	0.20
Customer	0.25	0.35	0.30
Internal Business Process	0.25	0.15	0.20
Learning and Growth	0.25	0.25	0.30

Source: Based on brainstorming with player

The value of the weight priority is determined subjectively by using the judgment of expert judgment by each decision maker namely the Finance Director and the Marketing Director in accordance with the scenario created by the researcher to make it easier to simulate competition between decision makers whose interests are inversely proportional to each other. From one series of these strategies the results of performance measurements are obtained for each strategy in each player showed in the table 3, and the result of absolute score is 22.43 (NAPK).

Table 3. The results relative scoring for each Player Strategy (NRPK)

<i>Player 1</i>	
S1.1	79,90 %
S1.2	81,05 %
S1.3	80,71 %
<i>Player 2</i>	
S2.1	79,90 %
S2.2	80,68 %
S2.3	80,14 %

3.2.3. Arrange Pay-off Matrix. Pay-off matrix is a table consisting of elements in the form of magnitude or utility of the results of the strategies used by both parties. So in this study the results of the achievement of the calculation of the measurement of the relative value performance in each strategy of each player will be made a reference in making the pay-off matrix value for each strategy. To determine the pay-off matrix obtained from the relative value (relative scoring) with the absolute value of performance measurement (absolute scoring), with the following formula:

$$[NRPK \times NAPK] \tag{1}$$

While the size of the relative value of performance measurement (NRPK) is determined by the strategy of each player. Weights on each perspective are calculated in relative values. So the payoff matrix value can be obtained by the following equation:

$$p_{ij} = (S1n/S2n) \times NAPK \tag{2}$$

or

$$p_{ij} = (S2n/S1n) \times NAPK \tag{3}$$

Note:

S1 = Strategy for player 1

S2 = Strategy for player 2

n = Strategy to - (1,2,3,)

p_{ij} = Pay-off matrix for column rows resulting from interaction between players.

NAPK = The absolute value of performance measurement (absolute score) value of performance measurement

NRPK = The relative (relative score).

The following is the pay-off matrix for each player's strategy from the equation above

Table 4. The result of the payoff matrix

Strategi		Player 2		
		S2.1	S2.2	S2.3
Player 1	S1.1	22.43	22.40	22.32
		22.43	22.50	22.61
	S1.2	22.26	22.19	22.16
		22.69	22.71	22.76
	S1.3	22.34	22.33	22.28
		22.50	22.54	22.60

3.2.4. *Determine the Nash Equilibrium Value.* After the pay-off matrix table is arranged in the game strategy, the next step is to determine the Nash Equilibrium value to analyse the results of the strategy interactions of several decision makers. In this research the game strategy uses non-zero sum which means that one player's profit does not become bad news for other players. Players who are involved in the non zero sum game have several complementary interests, this game has competitive and cooperative elements. As for determining the Nash Equilibrium value for this game that is choosing the most dominant value in making decisions by considering the decision of the parties another player. Payoff matrix arranged in the table 4 above shows that:

• Viewpoint for player 1

$$p_{j1} (S12,S21) \geq p_{j1} (S11,S21) \tag{4}$$

$$p_{j1} (S12,S21) \geq p_{j1} (S13,S21) \tag{5}$$

With value:

$$(22.69) \geq (22.43)$$

$$(22.69) \geq (22.43)$$

Nash Equilibrium for player 1 is located at $pi1 (S12, S21)$ with a value (22.69)

• Viewpoint for player 2

$$pi2 (S21, S12) \geq pi2 (S22, S12) \tag{6}$$

$$pi2 (S21, S12) \geq pi2 (S23, S12) \tag{7}$$

With value:

$$(22.26) \geq (22.19)$$

$$(22.26) \geq (22.16)$$

Nash Equilibrium for player 2 is located at $(S21, S12)$ with a value (22,26).

So the Nash Equilibrium points for both players are at (22.69) and (22.26). Player 1 chooses strategy two while player 2 chooses strategy 1. Therefore, to improve performance (81.05%) for the Director of Finance or players 1. This means that the size of the increase in the company gets green, which means the company has reached the specified target.

From the results of integrating non zero-sum game theory into the BSC it does not mean that performance improvements have been made. However, the formulation of the BSC integration model and the non zero-sum game theory shows that the formulation provides a solution to find a systematic strategy in measuring performance involving two or more decision makers. So that the model is expected to provide a win-win solution to management preferences in finding optimal solutions for both conflicting parties in various interests when making decisions. Because game theory is one of the best tools to make a reference in finding optimal solutions between related disputes involving two or more interests, while BSC is accepted as the best model in performance measurement to evaluate all aspects including financial and non-financial in the company.

4. Conclusion

1. Before doing game theory integration, company performance measurement PT. X. obtained a relative score (79.90%) with the assumption that there was no prior selection of strategy, which assumes all perspectives are the same. From this value shows that the company PT. X. still does not meet the target set by the company which is still showing yellow in the traffic light performance measurement. While the results of the integration of game theory and BSC after the assumption of choosing the chosen weighting strategy show that the results Nash Equilibrium for Marketing Director will continue to choose the 1st strategy by not prioritizing one perspective with a relative score (79.90 %) in accordance with the company's initial standards. Whereas the Director of Finance will choose the second strategy, which is to tend to finance. So the results of company performance evaluations will get a relative score (81.05%). This means that the company's performance measurement gets a green color, which means the company has reached the specified target.
2. In this paper, we have shown a successful integration process of BSC-GT. Such integration is more appropriate for business entities that have; generation level differences, namely the older generation and the millennial generation in the area of decision makers, there is an atmosphere of conflict or competition when making decisions, and not only prioritizes one perspective. Whereas BSC without including GT is more suitable to be used to assess company performance where there is no competitive atmosphere between decision makers and compromises
3. As a suggestion for our future works are; the selection of the company is expected to be observed not only by one company, but more than one company. In addition to compare disputes between the achievements of one company with another company. Hence determination of decision maker or player can be developed again not only limited to two players representing from four BSC

perspectives, but may cover all aspects of each of the four perspectives in BSC to be used as GT players in our system setting.

5. References

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