Integration of balanced scorecard and analytical hierarchy process to measure the performance of supporting unit in aircraft maintenance service companies

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ABSTRACT

Dynamic and challenging business environment in the aircraft maintenance services industry require company to survive and ensure business continuity. To realize effective performance, performance measurement is needed as a management system for managing and controlling performance. The purpose of this research is to measure the performance of supporting unit at PT. XYZ by using balanced scorecard framework that is integrated with AHP. The steps in this research includes identification strategy objective, identification key performance indicator (KPI), design and measure performance using integrated balanced scorecard and AHP. The method used in this study combines quantitative data with the Analytical Hierarchy Process (AHP) approach. The AHP method is used for KPI weighting. The design of KPI weights for each perspective in balanced scorecard are 42,3 % for the learning and growth, 33,5% for internal business process, 17,3% for financial, and 6,8% for the customer perspective. The results of supporting unit performance show the lowest score in the learning and growth perspective with average performance indicator, while in internal business process, financial and customer perspective have good performance indicator. The result of measuring total performance of four perspective are 74,5% which indicates that the performance of PT.XYZ's BSC is in the good enough category.

1. Introduction

The aircraft maintenance service industry is one of the supporters of the aviation industry. Changes in the dynamic and challenging business environment after the pandemic, require companies to be able to survive and ensure business continuity. One effort that can be done is to carry out continuous improvements to improve performance. Effective performance not only affects the reduction of operational costs, but also has an impact on improving customer service and satisfaction. In realizing effective performance, performance measurement is needed as a management system that is important for managing and controlling performance in achieving company goals (Andrias & Vanany, 2021).

PT. XYZ, which is engaged in the aircraft maintenance service industry, cannot be separated from the role of human resources as one of the drivers in providing integrated and reliable aircraft maintenance solutions. Overall, the performance of the line maintenance segment is based on information data from the 2022 annual report decreased by 39.7% compared to the previous year which was more influenced by a decrease in activity flights due to pandemic. In terms of human capital, the involvement of human resources is very important in the formulation of strategies in aircraft maintenance companies. This is done to ensure that the goals of the company are aligned with what

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the employees do (Erlinda Muslim et al., 2019). The relationship between size and performance is influenced by the measures used by the company internally. In other words, the internal measurement system used will affect performance at the individual and organizational levels (Yaghoobi & Haddadi, 2016). In general, performance management systems are divided into 2 categories, namely systems that focus on self-evaluation and systems to measure and improve business processes. Several models in the performance measurement system have changed and developed along with the complexity of managing an organization. The balanced scorecard is the newest and most popular performance measurement system model today (Mitrea-Curpanaru, 2021).

Current performance measurement uses a balanced scorecard framework in which there are 4 key perspectives, namely finance, customers, internal business processes and learning and growth. However, there is a weakness, namely that the weighting is processed manually. What can be done in this research is to combine qualitative and quantitative data by integrating the balanced scorecard framework with the AHP (Analytical Hierarchy Process) approach in unit performance measurement.

Balanced Scorecard has been widely adopted by many companies both manufacturing and services as a strategic management system. The approach with an integrated method between the balanced scorecard and AHP has also been successfully applied in research (Yaghoobi & Haddadi, 2016). In this research, the object under study is an IT company, where the results of this research are determining the best unit of the organization and the results of these measurements can contribute to the organization in evaluating its next strategy. In another study (Kurnia et al., 2021), integrating the balanced scorecard with AHP in the education industry. The result of this research is the determination of the best strategy model in improving performance at the Faculty of Engineering, Krisnadwipayana University. Another service industry, namely the health industry, has also succeeded in implementing the integration between BSC and AHP in its organizational performance measurement system. Study (Dekrita et al., 2019)concluded the results that the performance measurement of the Dr.TC.Hillers hospital has a fairly good value, and this value can be used as a reference for determining strategic priorities to be implemented and developed later. In another study (Canitez et al., 2018)In the field of public transportation modes, the balanced scorecard approach provides many benefits to the transportation sector as a performance management tool. While research (Moradi & Moradi, 2021)concluded that the AHP method is used to weigh the size of the strategy and the perspective of the balanced scorecard.

Studies of previous research show that the AHP method has been widely used to measure performance in the service industry. Based on this background, the purpose of this research is to measure the performance of supporting units in aircraft maintenance service companies using a balanced scorecard framework that is integrated with AHP. The balanced scorecard translates an organization's mission and strategy into a comprehensive set of performance measures for strategic measurement and management systems (Yaghoobi & Haddadi, 2016). The balanced scorecard as a managerial performance measurement system, the measurement results can be accounted for and can be used for continuous improvement. The balanced scorecard uses performance measures related to employee productivity and competencies that enable the company to grow and develop (Megawaty et al., 2022).

2. Methods

The object of research is carried out in the supporting unit by direct observation and discussions with managers and senior managers. The method used in this study combines qualitative and quantitative based on the balanced scorecard framework.

This research requires some information from related parties for relevant data in data collection. In this study there are 2 major parts, there are primary data and secondary data. Primary data is data obtained by digging information directly from sources by researchers. The data was collected through interviews and observation. In-depth interviews were conducted as a technique for collecting data and information by communicating directly with the respondents (4 Managers and 1 Senior Manager in Supporting Unit). Observation or grounded research provides data which are facts obtained for research purposes. Interviews and discussions with managers and senior managers of supporting units were conducted to obtain information about the company's internal conditions. While secondary data is a source of information obtained from related company documents. This research includes the company's vision, mission and values obtained from the annual report and other company documents.

The first stage carried out in this study was to conduct interviews and internal meetings to obtain data and information regarding current performance levels. After obtaining the desired information, then designing a performance measurement system with a balanced scorecard framework. Data processing using the AHP method is carried out to give priority weight to the factors that are influenced. The methodology of the research stages can be seen in Fig. 1.

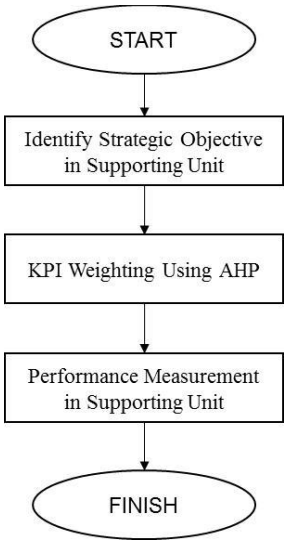


Fig. 1 Research stages methodology.

Identify Strategy Objectives

Strategy Objective is the stage used in designing a performance measurement system. By paying attention to the suitability of the company's vision and mission, strategic planning is obtained based on the results of interviews and discussions with company management.

Identification of Key Performance Indicators (KPI)

The determination and determination of performance measures is a crucial part in designing a performance measurement system. So at the KPI identification stage, it is necessary to determine performance measures based on the elaboration of the company's vision and mission and initial strategic objectives. The Strategy Objectives and KPIs for each perspective can be seen in Table 1.

Table 1 Strategy objective and KPI BSC aircraft maintenance service company

Perspective	Code	*Strategy Objective*	Code	*Key Performance Indicators*
Finance	F1	Maximize Shareholder Return through Synergized Groups	F11	Budget Realization
			F12	Inventory
Customer	C1	Improve Customer Experience and Retention	C11	Customer Satisfaction Index
	C2	Consistent Product and Service Excellence	C21	Compliance with Customer SLA
Internal Business Process	I1	Improve Processes for Effective QCDS	I11	Data Quality Integrity (DQI)
			I12	Fulfillment Index
			I13	Billing
	I2	Product Development & Capacity Expansion	I21	Profit Enhancement Program
			I22	Capacity and Capability Development
			I23	Continuous Improvement Program
Growth and Learning	L1	Acceleration of Human Development	L11	Readiness of Human Capital (HCR)
	L2	Leading Organization capital increase	L21	Organizational Capital Readiness (OCR)
	L3	Driving IT as a Business Empowerment	L31	Information Capital Readiness (ICR)

Source: Company Plans and Management Discussion Results (2022)

Key Performance Indicator (KPI) Weighting with AHP

The next step is data processing using AHP. This method is used to give priority weights to the balanced scorecard hierarchy in each perspective, strategy objective and KPI hierarchy. The mathematical formulation of the AHP model can accommodate multi-criteria problems involving qualitative and quantitative criteria(Dewayana & Dani, 2016). AHP is done by using a comparison matrix. Pairwise comparisons start from the highest level of the hierarchy, namely the perspective hierarchy, followed by the hierarchy, strategy objective as a criterion, and KPI as a sub-criteria. Pairwise comparisons use a 1-9 time scale as shown in Table.2. The steps taken in the weighting of the hierarchical importance level in the balanced scorecard design follow(Maulani & Hasibuan, 2021)and also assisted with the use of the online AHP Priority Calculator software. The maximum Consistency Ratio value is 10% as a condition for validating the results of interviews and internal meetings.

Table 2 Paired comparison scale

Score	Interest Level	Description
1	Equally important	Both contribute equally to the goal
3	A little more important than the others	Experience and judgment slightly favor one element over another
5	More important than anything else	Experience and judgment strongly support one element over another
7	The absolute importance of the others	Element one is considered much more important than the other
9	Very absolutely important than the others	Evidence that supports one element over another has the highest possible affirmation level
2,4,6,8	Between two adjacent judgment values	This value is given if there are two compromises between the two choices

Source: Saaty 1993 (Stofkova et al., 2022), (Hussain et al., 2015)

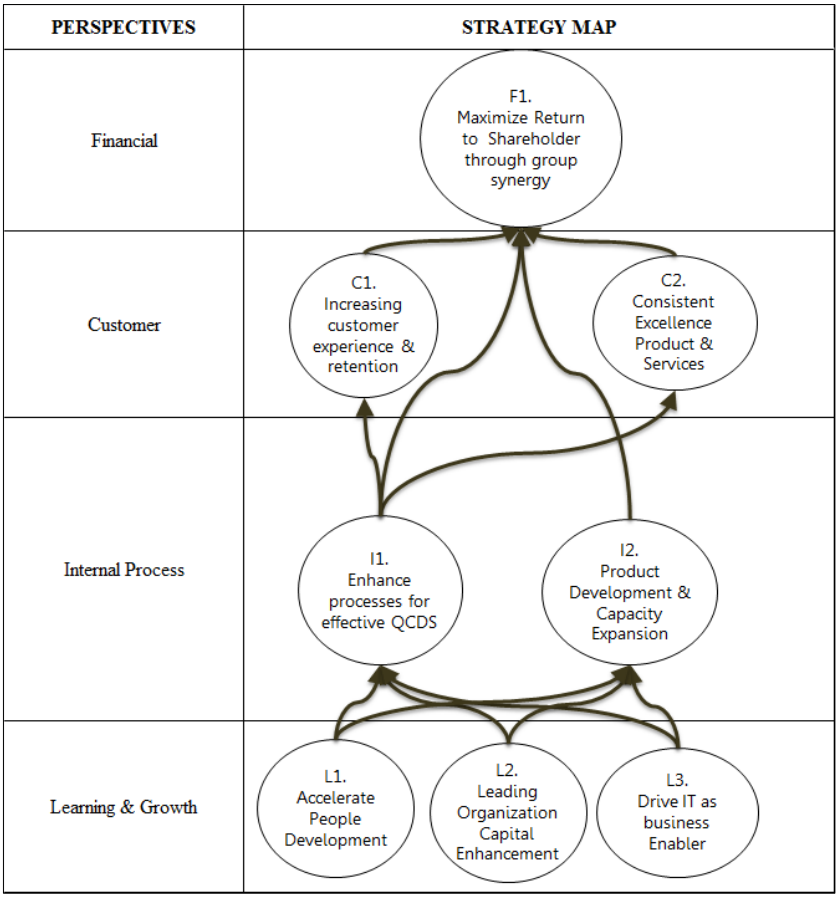
Performance Measurement of Supporting Units in Aircraft Maintenance Service Companies

Measurement of BSC performance in the aircraft maintenance service industry can be carried out by taking into account benchmarks, targets and rating scales. The rating scale used is a Likert scale 1-5 (5=Very Good; 4=Good; 3=Enough; 2=Poor; 1=Very Bad).

3. Results and Discussion

Identification of Strategy Objective and Strategic Map

The results of the analysis of the cause-and-effect relationship carried out produced a strategic map of the BSC design which refers to the Vision and Mission of the aircraft maintenance service company as presented in Figure 2 (Data is sourced from Company Plans and Management Discussion Results 2022). The eight strategies above are described in one strategic map by grouping them into four perspectives, namely: finance, customer, internal business processes and growth and learning. Growth and learning performance is the starting point of the BSC performance management system framework that leads to financial performance. Data is sourced from business development unit.



Fi. 2 Strategy map.

Key Performance Indicator (KPI) weighting

On research (Yaghoobi & Haddadi, 2016), where the object of research is IT companies, it can be concluded that the financial perspective is far more important than other perspectives, namely customers, internal business processes and growth and learning. While on research (Kurnia et al., 2021)with the object of research being the education industry, has a different view, namely the customer perspective as the highest priority in performance measurement. Results of research (Canitez et al., 2018)also stated that the biggest weight based on AHP calculations is in the customer perspective. In another study (Dekrita et al., 2019)with the object of research, namely hospitals, internal business process perspective criteria are the highest priority in performance measurement. Based on previous research in measuring performance in the service industry, there are different perspectives on determining perspective priorities as performance measurement criteria. The balanced scorecard and AHP have also been successfully applied to the construction service industry cited by research (Kim et al., 2021). The weighting is done by the AHP method with the greatest weight on the financial perspective, followed by customers, growth and learning and internal business processes. Study (Satybaldiyeva et al., 2018)with the research object of airlines using the AHP method to find effective indicators for aviation industry activities which are very important for the company's strategy. The greatest weight of interest in this research is in the customer perspective which shows the assessment of customer satisfaction.

It can be seen from the calculation with the AHP Online Calculator Figure 3 that the largest weight at 0.423 is generated from a growth and learning perspective, followed by an internal business process perspective of 0.335, a financial perspective of 0.173 and a customer perspective with a weight of 0.068. This research yielded different findings, the highest priority results in the perspective weighting stage were actually given to the growth and learning perspective. This balanced scorecard design prioritizes growth and learning perspectives as well as internal business processes because these two perspectives are directly related to an important component in the aircraft maintenance service industry, namely reliable and quality human resources.

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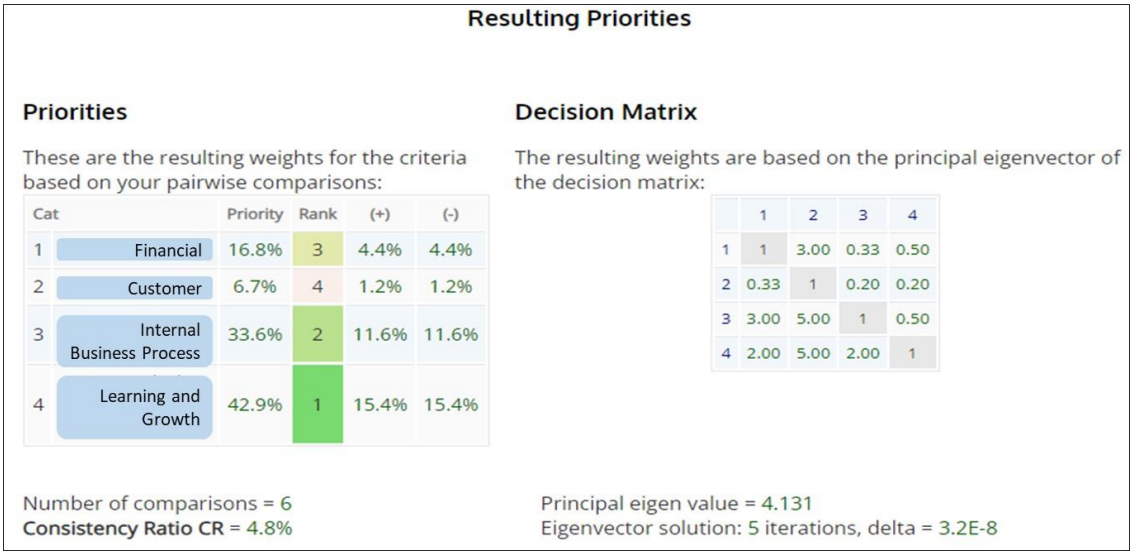

Resulting Priorities

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons:

Cat		Priority	Rank	(+)	(-)
1	Financial	16.8%	3	4.4%	4.4%
2	Customer	6.7%	4	1.2%	1.2%
3	Internal Business Process	33.6%	2	11.6%	11.6%
4	Learning and Growth	42.9%	1	15.4%	15.4%

Number of comparisons = 6
Consistency Ratio CR = 4.8%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix:

	1	2	3	4
1	1	3.00	0.33	0.50
2	0.33	1	0.20	0.20
3	3.00	5.00	1	0.50
4	2.00	5.00	2.00	1

Principal eigen value = 4.131
Eigenvector solution: 5 iterations, delta = 3.2E-8

Fig. 3 Example output AHP online calculator for BSC perspective.

Weighting is done by knowing the level of importance and priority from each perspective, strategy objectives and KPIs. Determination of weight based on the results of management discussions by expert respondents is carried out using the AHP matrix pair method between criteria(Maulana et al., 2022). The following is the calculation of the weighting of 4 perspectives from a sample of 4 expert respondents consisting of 2 Senior Managers and 2 Managers randomly.

These four perspectives are weighted by simplifying the questionnaire results into a pairwise comparison matrix between criteria. The next step is to find the priority vector value obtained from the average value of each perspective. After getting the priority vector value, then look for the vector value where the vector value is obtained from multiplying the priority vector value and the comparison matrix from each perspective. Priority vector values and Eigen values as shown in Table 3 are used to calculate consistency values. Consistency is obtained by dividing the vector value by finding the previous CI (Consistency Index) value. Comparative assessment results that have a ratio smaller than 10% can be declared consistent and priority weights can be used for each hierarchy of perspective criteria obtained from the calculation results above.

Table 3 Priority vector and eigen value

Perspectives	Financial	Customer	Internal Business Processing	Learning and Growth	Priority Vector	Eigen Value
Financial	0.158	0.214	0.094	0.227	0.173	1.099
Customer	0.053	0.071	0.057	0.091	0.068	0.951
Internal Business Processing	0.474	0.357	0.283	0.227	0.335	1.185
Learning and Growth	0.316	0.357	0.566	0.455	0.423	0.931
Total	1.000	1.000	1.000	1.000	1.000	4.165

At the top level of the hierarchy, namely the perspective hierarchy, the greatest weight is on the learning and growth perspective, namely 42.3%, followed successively for the internal business process perspective by 33.5%, for the financial perspective by 17.3%, and for the perspective customers by 6.8%. Weighting is also done for the strategy objective hierarchy and the KPI hierarchy. The results of the weighting can be seen in Figure 4.

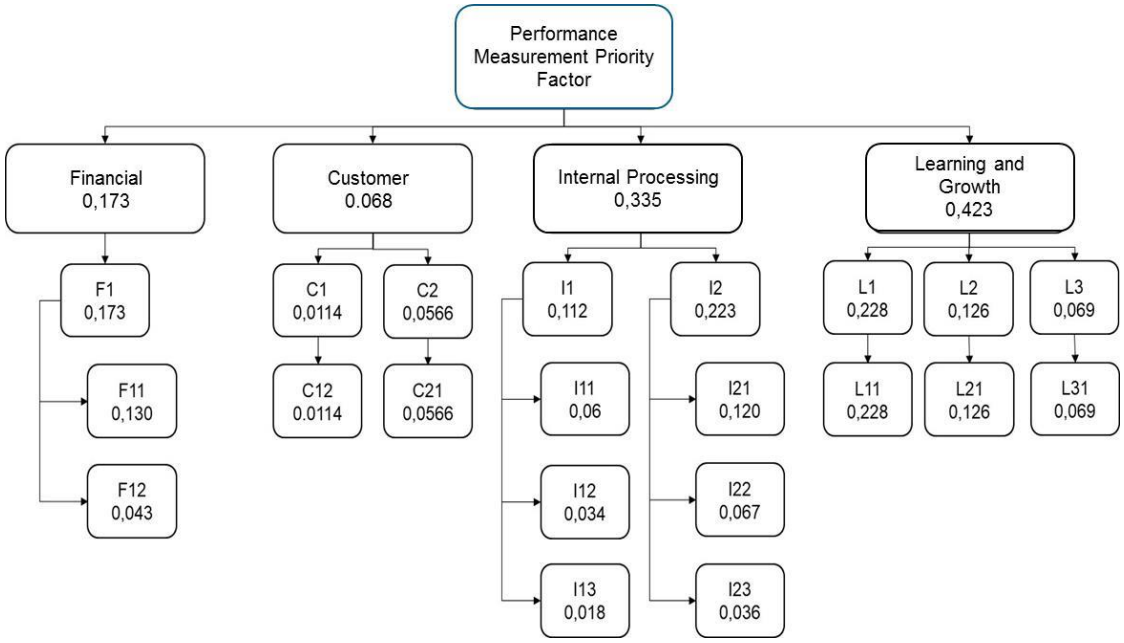

Fig. 4 Balanced scorecard performance measurement framework.

The main performance of the company can be divided into 5 levels and represents the evaluation level domain (Gong et al., 2021). The evaluation levels used to analyze the results of performance measurements in this study include poor, marginal, average, good and excellent as shown in Table 4.

Table 4 Performance monitoring system scale

Monitoring System	Performance Indicator
<40%	Poor
40% - 50%	marginal
50% - 70%	Average
70% - 90%	good
>90%	Excellent

The main performance of the company can be divided into 5 levels and represents the evaluation level domain (Gong et al., 2021). The evaluation levels include poor, marginal, average, good and excellent as shown in Table 4.

Performance Measurement of Supporting Units in Aircraft Maintenance Service Companies

The results of the performance measurement of the supporting unit show that the growth and learning perspective has the highest priority weight, the performance level is low compared to other perspectives. The growth and learning perspective has a performance score of 0.275, followed by an internal business process perspective of 0.267, a financial perspective of 0.149 and a customer perspective of 0.055. Meanwhile, the total performance measurement results for the four perspectives are 0.745% which indicates that the balanced scorecard performance in the supporting unit is included in the Good performance indicator.

The weight for each perspective criterion that has been obtained through the AHP approach is then multiplied by the performance score obtained from the manager to produce weighted performance. The weighted performance is then added up to get the total percentage of overall performance.

Table 5 Weighted Performance Scores and Performance Indicators

Perspective	Code	*Strategy Objective*	Code	*Key Performance Indicators*	Weight	Perfor-mance Score	Weighted Perfor-mance	Indicator
Finance	F1	Maximize Sharehol-der Return through Synergized Groups	F11	Budget Realization	0.13	87%	0.113	Good
			F12	Inventory	0.043	83%	0.036	Good
Customer	C1	Improve Customer Experience and Retention	C11	Customer Satisfaction Index	0.0114	80%	0.009	Good
	C2	Consistent Product and Service Excellence	C21	Compliance with Customer SLA	0.0566	81%	0.046	Good
Internal Business Process	I1	Improve Processes for Effective QCDS	I11	Data Quality Integrity (DQI)	0.06	80%	0.048	Good
			I12	Fulfillment Index	0.034	80%	0.027	Good
			I13	Billing	0.018	80%	0.014	Good
	I2	Product Developme nt & Capacity Expansion	I21	Profit Enhancemen t Program	0.120	83%	0.100	Good
			I22	Capacity and Capability Development	0.068	77%	0.052	Good
			I23	Continuous Improvement Program	0.036	70%	0.025	Average
Growth and learning	L1	Acceleratio n of Human Developme nt	L11	Readiness of Human Capital (HCR)	0.228	67%	0.153	Average
	L2	Leading Organizatio n capital increase	L21	Organization al Capital Readiness (OCR)	0.126	60%	0.076	Average
	L3	Driving IT as a Business Empowerm ent	L31	Information Capital Readiness (ICR)	0.069	68%	0.047	Average
FINAL VALUE TOTAL							0.745	Good

4. Conclusion

Measurement of the performance of supporting units in aircraft maintenance service companies using the Balanced Scorecard is identified through 8 strategy objectives and 13 Key Performance Indicators (KPI). The design of KPI weights with AHP for each perspective in balanced scorecard are

42,3 % for the learning and growth, 33,5% for internal business process, 17,3% for financial, and 6,8% for the customer perspective.

The results of supporting unit performance show the lowest performance score in the learning and growth perspective with average performance indicator, while in the internal business process perspective, the financial perspective and the customer perspective have good performance indicator. The result of measuring total performance of four perspective are 74,5% which indicates that the performance of PT.XYZ's BSC is in the good enough category.

It is recommended to make developments taking into account a broader perspective of growth and learning. From the perspective of growth and learning in the service industry in particular, the KPIs that have been formed can be integrated with other methods that focus on measuring the performance of human capital

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