



## Performance Measurement Using Balanced Scorecard, Analytical Hierarchy Process, Objective Matrix, and Traffic Light System

Alina Cynthia Dewi<sup>1</sup>, Akhmad Nidhomuz Zaman<sup>2</sup>

<sup>1,2</sup>Program Studi Teknik Industri, Universitas Pembangunan Nasional Veteran Jakarta, Jl. RS Fatmawati, Pondok Labu, Jakarta Selatan 12450  
E-mail korespondensi: acd@upnvj.ac.id

**Abstract.** *Balanced Scorecard and Analytical Hierarchy Process (AHP) methods was carried out in this study to design a performance measurement system and weighting based on a specific scheme. The Key Performance Indicator (KPI) design that has been weighted using the Analytical Hierarchy Process (AHP) method is then applied in measuring the performance of the Company and the Department using the Objective Matrix (OMAX) method. Measurement results are grouped using a Traffic Light System which is then analyzed so that a strategy for improving performance is obtained. Data collection begins with an assessment of the vision, mission, corporate strategy, and SWOT analysis to identify the Company's KPI. The Department designed by its KPI are two main Departments namely the Exploration & Development (E & D) Department and the Production & Operation (P & O) Department. Next, questionnaires were conducted to determine the weight of KPI using the AHP method. Then the performance measurement is done using the OMAX method then grouped using the Traffic Light System. Data processing results show that the Company's performance reaches a value of 7,83, E & D Department performance reaches a value of 7,29, and P & O Department performance reaches a value of 7,65. Some strategies in improving performance are then designed based on KPIs that have low values.*

**Keywords:** *Performance, Balanced Scorecard, Analytical Hierarchy Process, Objective Matrix*

### INTRODUCTION

Some researchers criticize the weaknesses of the Balanced Scorecard such as the absence of a general measurement scale and the lack of standardization or benchmarks as performance comparisons (Banker, Potter, and Srinivasan, 2000). According to Rickards (2007), the Balanced Scorecard does not have a mathematical model or weighting scheme. On the other hand, researchers have previously combined the Balanced Scorecard method with the Analytical Hierarchy Process (AHP) method and they found that the AHP method can complement the deficiencies found in the Balanced Scorecard method (Kartalis et.al., 2013). Kartalis et al. (2013) implemented the Balanced Scorecard method and the Analytical Hierarchy Process method in designing a performance measurement system in industries in the heavy industrial sector in Greece with 200 employees.

Some previous studies have applied the Objective Matrix (OMAX) model as a model in measuring the performance of companies and departments (Mahmudi et al., 2014; Fiati, 2015; Kosasih et al., 2015). Mahmudi et al. (2014) combines Balanced Scorecard, AHP, and OMAX to assess college performance. Meanwhile, Fiati (2015) measures the performance of urban village office services based on service criteria, working hours, and employee attendance using the OMAX model with weight determination using the AHP method. Then, Kosasih et al. (2015) identified the KPI and measured the performance of the Engineering Department in a sanitary ware company where the method of identifying KPI was The Maintenance Scorecard which consisted of 6 perspectives which were then determined using AHP and measured its performance using the OMAX and Traffic Light System models. Based on the results of literature studies that have been conducted, this study will be carried out by implementing the Balanced Scorecard, AHP, OMAX, and Traffic Light System in petroleum exploration and exploitation company.

Based on the literature and information obtained, it is known that the root cause is the absence of a comprehensive performance measurement system accompanied by a weighting scheme on performance measures that affects the determination of company and department strategies. Therefore, the purpose of this study is to design a performance measurement system, measure the performance, and analyze company and department strategy in order to improve performance.

### RESEARCH METHODOLOGY

This research was conducted at PT. SPR Langgak, one of petroleum exploration and exploitation company in Indonesia which the field located in Langgak, Riau. Whereas for data processing carried out in the Industrial Engineering Study Program, Universitas Pembangunan Nasional Veteran Jakarta. Data processing is carried out in several stages as follows:

1. Identify Strengths, Weaknesses, Opportunities, Threats (SWOT)  
Identifying Company Strengths, Weaknesses, Opportunities, Threats (SWOT) based on Company vision, mission, and strategies.
2. Develop Key Performance Indicators (KPIs)  
Grouping Company strategies based on Balanced Scorecard perspective then develop KPI based on Company strategies.
3. Calculate weighting value using Analytical Hierarchy Process (AHP)

Weighting each KPIs in accordance with the questionnaire that has been filled by the experts. The experts have a position as a manager or head of division and have worked for minimum 2 years.

#### 4. Performance measurement using Objective Matrix (OMAX)

Measuring performance achievement for each KPI from mid-year data using Objective Matrix (OMAX), then the assessment results are classified using the Traffic Light System.

### RESULT AND DISCUSSION

First step to developing KPIs is to identify Company Strengths, Weaknesses, Opportunities, and Threats (SWOT) based on Company vision, mission, and strategies. Based on SWOT analysis, the strategies were grouped into Balanced Scorecard perspective. However, this data processing already calculated and were explained in Dewi et. al. (2017) paper. The weight for each KPIs are shown as table below. Based on the company's KPI, a cascading was carried out to identify the Exploration & Development Department's KPIs and Production & Operation Department's KPIs.

**Table 1.** PT. SPR Langgak's KPIs (Dewi et. al., 2017)

PT. SPR Langgak KPIs		
Perspective	KPIs (code)	Weight
Financial (33%)	Oil Production (1a)	44%
	Exploration & Development (E&D) Expenses (1b)	15%
	Production & Operation (P&O) Expenses (1c)	31%
	General Administration Expenses (1d)	11%
Perspective	KPIs (code)	Weight
Customer (36%)	E&D Work Program & Budget (2a)	15%
	P&O Work Program & Budget (2b)	32%
	General Administration Work Program & Budget (2c)	12%
	Financial report and budget realization report (2d)	41%
Perspective	KPIs (code)	Weight
Internal Business (15%)	Fatality (3a)	40%
	LTI (3b)	22%
	TRI (3c)	14%
	Oil spill (3d)	8%
	E&D work realization (3e)	6%
	P&O work realization (3f)	8%
	General Administration work realization (3g)	4%
Perspective	KPIs (code)	Weight
Learning & Growth (16%)	Number of employees participating in <i>training</i> and sertification (4a)	20%
	Employee compliance (4b)	50%
	Performance appraisal (4c)	30%

The next data processing is measuring performance using OMAX. Performance appraisal is divided from level 1 to 10. Level 10 is the highest assessment or target achieved, level 3 is the average value of performance achievement or the first achievement. Meanwhile, level 0 is the worst assessment ever experienced. Other block is level, weight, value, and index block. The level line is filled with the achievement of levels for each KPI. The weight line is filled with the weight of each KPI. The value line is the result of multiplying the level and weight for each KPI. While the index line is the total value of each KPI. Company's performance measurement for each perspective can be shown as follows.

**Table 2.** Exploration & Development Department's KPIs

Exploration & Development Department KPIs		
Perspective	KPIs (code)	Weight
Financial (21%)	Oil Production (E1a)	66%
	Facilities & Equipment Maintenance Expenditure (E1b)	21%
	Oil Well Operation Expenditure (E1c)	13%
Perspective	KPIs (code)	Weight
Customer (29%)	AFE CO2 (E2a)	40%
	Plan of Future Development (POFD) (E2b)	40%
	Exploration & Development Work Program & Budget (E2c)	20%
Perspective	KPIs (code)	Weight
Internal Business (41%)	Fatality (E3a)	40,1%
	LTI (E3b)	9,5%
	TRI (E3c)	12,7%
	Oil spill (E3d)	17,6%
	Fulfilled review (E3e)	9%
	Well Service (E3f)	6,1%
	CO <sub>2</sub> progress (E3g)	4,9%
Perspective	KPIs (code)	Weight
Learning & Growth (10%)	Number of employees participating in <i>training</i> and certification (E4a)	30%
	Employee compliance (E4b)	54%
	Performance appraisal (E4c)	16%

**Table 3.** Production & Operation Department's KPIs

Production & Operation Department KPIs		
Perspective	KPI	Weight
Financial (35%)	Loss production opportunity planned shutdown (P1a)	24,6%
	Loss production opportunity unplanned shutdown (P1b)	29,6%
	Facilities & equipment maintenance cost (P1c)	24,6%
	Well service expenditure (P1d)	21,1%
Perspective	KPI	Weight
Customer (25%)	Production & Operation Work Program & Budget (P2a)	57,1%
	Major equipment reliability report (P2b)	14,3%
	Major equipment availability report (P2c)	14,3%
	Oil production report (P2d)	14,3%
Perspective	KPI	Weight
Internal Business (20%)	Fatality (P3a)	28,5%
	LTI (P3b)	13,1%
	TRI (P3c)	13,1%
	Oil spill (P3d)	13,3%
	Facilities & equipment maintenance realization (P3e)	6,4%
	Well service realization (P3f)	8,0%
	Major equipment reliability (P3g)	5,3%
	Major equipment availability (P3h)	5,9%
Perspective	KPI	Weight
Internal Business (20%)	Transportation of B3 waste (P3i)	3,8%
	SOP for Pin Insulator replacement work (P3j)	2,5%
Perspective	KPI	Weight
Learning & Growth (20%)	Number of employees participating in <i>training</i> and certification (P4a)	14%
	Employee compliance (P4b)	43%
	Performance appraisal (P4c)	43%

**Table 4.** PT. SPR Langgak Financial Performance Measurement



FINANCIAL PERSPECTIVE					
KPI CODE		1a	1b	1c	1d
PERFORMANCE		408	228	1622	648
LEVEL 10: target 3: average or first achievement 1: lowest achievement	10	447	230,5	1635,5	718,5
	9	438,4	203,0	1440,4	631,3
	8	429,9	175,5	1245,4	544,1
	7	421,3	148,0	1050,3	456,9
	6	412,7	120,5	855,2	369,6
	5	404,1	93,0	660,1	282,4
	4	395,6	65,5	465,1	195,2
	3	387	38	270	108
	2	381,5	22	198	88
	1	376	6	126	68
LEVEL		5,5	9,9	9,9	9,2
WEIGHT		44%	15%	31%	11%
VALUE		2,42	1,49	3,07	1,01
INDEX		7,99			

Based on the measurement results, the achievement of financial performance is 7,99 which reaches a green color, this indicates that the performance reaches the target. However, even though the financial performance reaches the target, there is one KPI namely Oil Production which needs to be improved.

**Table 5.** PT. SPR Langgak Customer Performance Measurement

CUSTOMER PERSPECTIVE					
KPI CODE		2a	2b	2c	2d
PERFORMANCE		30	30	35	40
LEVEL 10: target 3: average or first achievement 1: lowest achievement	10	50	50	50	50
	9	45	45	45	45
	8	40	40	40	40
	7	35	35	35	35
	6	30	30	30	30
	5	25	25	25	25
	4	20	20	20	20
	3	15	15	15	15
	2	10	10	10	10
	1	5	5	5	5
LEVEL		6	6	7	8
WEIGHT		15%	32%	12%	41%
VALUE		0,9	1,92	0,84	3,28
INDEX		6,94			

Based on the measurement results, the achievement of customer performance is 6,94 which reaches a yellow color, this indicates that the performance was far from the target. There are two KPIs needs to be improved, that is E&D Work Program & Budget and P&O Work Program & Budget.

Based on the measurement results, the achievement of internal business performance is 9,96 which reaches a green color, this indicates that the performance reaches the target. This performance need to be maintained.

**Table 6.** PT. SPR Langgak Internal Business Performance Measurement

INTERNAL BUSINESS PERSPECTIVE								
KPI		3a	3b	3c	3d	3e	3f	3g
PERFORMANCE		10	10	10	10	99	99	90
LEVEL 10: target 3: average or first achievement 1: lowest achievement	10	10	10	10	10	100	100	100
	9	9	9	9	9	88,0	88,1	87,9
	8	8	8	8	8	76,0	76,3	75,7
	7	7	7	7	7	64,0	64,4	63,6
	6	6	6	6	6	52,0	52,6	51,4
	5	5	5	5	5	40,0	40,7	39,3
	4	4	4	4	4	28,0	28,9	27,1
	3	3	3	3	3	16	17	15
	2	2	2	2	2	9,5	12,5	12,0
1	1	1	1	1	3	8	9	
LEVEL		10	10	10	10	9,9	9,9	9,2
WEIGHT		39,6%	21,6%	13,7%	7,7%	5,7%	7,8%	3,9%
VALUE		3,96	2,16	1,37	0,77	0,56	0,77	0,36
INDEX		9,96						

**Table 7.** PT. SPR Langgak Learning and Growth Performance Measurement

LEARNING AND GROWTH PERSPECTIVE				
KPI		4a	4b	4c
PERFORMANCE		12	10	80,3
LEVEL 10: target 3: average or first achievement 1: lowest achievement	10	48	10	100
	9	42	9	95,6
	8	35	8	91,3
	7	29	7	86,9
	6	23	6	82,5
	5	17	5	78,1
	4	10	4	73,8
	3	4	3	69,4
	2	2	2	34,7
1	0	1	0	
LEVEL		4,3	10	5,5
WEIGHT		20%	50%	30%
VALUE		0,86	5	1,65
INDEX		7,51		

Based on the measurement results, the achievement of learning and growth performance is 7,51 which reaches a green color, this indicates that the performance reaches the target. However, there is two KPIs needs to be improved, that is number of employees participating in *training* and sertification and performance appraisal.

Overall company performance achievement is then calculated based on the weight of each perspective. Based on measurement results, the company's performance is 7.83 which reaches a green color.

**Table 8.** PT SPR Langgak Performance Achievement

PERSPECTIVE	WEIGHT	INDEX	TOTAL INDEX
Financial	33%	7,99	7,83
Customer	36%	6,94	
Internal Business	15%	9,96	
Learning and Growth	16%	7,51	

With the same step, the performance achievement for Exploration & Development Department and Production & Operation Department shown as follows.

**Table 9.** Exploration & Development Department Performance Achievement

PERSPECTIVE	KPIs Code	WEIGHT	LEVEL	VALUE	INDEX	TOTAL INDEX
Financial (21%)	E1a	66%	5,5	3,63	4,23	7,29
	E1b	21%	1	0,21		
	E1c	13%	3	0,39		
Customer (29%)	E2a	40%	10	4	6,22	
	E2b	40%	1	0,4		
	E2c	20%	9,1	1,82		
Internal Business (41%)	E3a	40,1%	10	4,01	8,95	
	E3b	9,5%	10	0,95		
	E3c	12,7%	10	1,27		
	E3d	17,6%	10	1,76		
	E3e	9,0%	1	0,09		
	E3f	6,1%	6,2	0,3782		
	E3g	4,9%	10	0,49		
Learning and Growth (10%)	E4a	30%	10	3	9,34	
	E4b	54%	10	5,4		
	E4c	16%	5,9	0,944		

**Table 10.** Production & Operation Department Performance Achievement

PERSPECTIVE	KPIs Code	WEIGHT	LEVEL	VALUE	INDEX	TOTAL INDEX
Financial (35%)	P1a	25%	4,1	1,01	6,03	7,76
	P1b	30%	9,4	2,79		
	P1c	25%	5,9	1,45		
	P1d	21%	3,7	0,78		
Customer (25%)	P2a	57,1%	8,2	4,68	8,97	
	P2b	14,3%	10	1,43		
	P2c	14,3%	10	1,43		
	P2d	14,3%	10	1,43		
Internal Business (20%)	P3a	28,5%	10	2,85	9,01	
	P3b	13,1%	10	1,31		
	P3c	13,1%	10	1,31		
	P3d	13,3%	10	1,33		
	P3e	6,4%	7,5	0,48		
	P3f	8,0%	4,5	0,36		
	P3g	5,3%	10	0,53		
	P3h	5,9%	10	0,59		
	P3i	3,8%	0	0,00		
<b>PERSPECTIVE</b>	<b>KPIs Code</b>	<b>WEIGHT</b>	<b>LEVEL</b>	<b>VALUE</b>	<b>INDEX</b>	<b>TOTAL INDEX</b>
Internal Business (20%)	P3j	2,5%	10	0,25	8,03	
Learning and Growth (20%)	P4a	14%	8,2	1,15		
	P4b	43%	10	4,30		
	P4c	43%	6	2,58		

Data processing results show that the Company's performance reaches a value of 7.83, E&D Department performance reaches a value of 7,29, and P&O Department performance reaches a value of 7,76. In order to improve the performance, several strategies were develop as follows:

1. Strategies for company (KPI code: 2a and 2b):
  - a. Work program & budget should be done by October, employees need to work on it immediately
  - b. Arrange schedules for meetings with related parties in order to complete work program & budget
2. Strategies for E&D Department (KPI code: E1a, E1b, E1c, E2b):
  - a. Oil production is related to well service, in order to improve oil production, company needs to conduct well services according to plan



- b. Oil production also related to the age of wells, this can be anticipated by giving certain treatment to the well
  - c. Facilities and equipment maintenance and oil well operation need to operated as it can improve oil production, manager or head of division needs to follow up the related vendor
  - d. Arrange schedules for meetings with related parties in order to create Plan of Future Development (POFD)
3. Strategies for P&O Department (KPI code: P1a, P1c, and P1d):
- a. Loss production opportunity planned shutdown still below the limit (576 barrel), however, this number should be maintained to maximize the opportunity of oil production
- Facilities and equipment maintenance and oil well operation need to operated as it can improve oil production, manager or head of division needs to follow up the related vendor.

### CONCLUSION

Design of performance measurement system identified 18 KPIs for company level, 16 KPIs for E & D Department, and 21 KPIs for P & O Department. However, KPIs that has been developed by Balanced Scorecard and AHP method can be implemented to measure Company and Department performance. Data processing results show that the Company's performance reaches a value of 7.83, E & D Department performance reaches a value of 7.29, and P & O Department performance reaches a value of 7.65. In order to improve the performance, several strategies were develop as follows:

1. Strategies for company: Employees need to create and arrange schedules for meetings with related parties in order to complete work program & budget
2. Strategies for E&D Department: Operate facilities and equipment maintenance, oil well operation, and giving certain treatment to the well in order to improve oil production, also arrange schedules for meetings with related parties in order to create POFD

Strategies for P&O Department: Maintained the number of loss production opportunity planned shutdown

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