Combining Analytical Hierarchy Process and Simple Multi-attribute Rating

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Combining Analytical Hierarchy Process and Simple Multi-Attribute Rating Technique for designing a Sustainable Balanced Scorecard as Strategic Performance Measurement System

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Abstract – One of the challenges for the companies is to set the right strategic performance measurement system that meet the need of all business challenges but at the same time also meet the need of an efficient and effective strategic performance measurement system. While in today's business environment, sustainability has become more important to companies in order to achieve their competitive advantage. Therefore, integrating sustainability aspect into their strategy , identifying KPIs and priority setting are major challenges in designing a strategic performance measurement system based on a sustainable balanced scorecard model. This research is a case study of an education technology company in Indonesia. The aim of this research are to integrate sustainability perspective into the company's balanced scorecard and find the KPIs to be used in the company's performance measurement system and also to identify priority level of those KPIs. Six evaluation criteria were applied to identify KPIs. These criterias were weighted using Analytical Hierarchy Process (AHP) and all potential indicators were weighted trough Simple Multi-Attribute Rating Technique (SMART). From this research 8 strategic objectives and 25 KPIs from 60 potential KPIs were identified, and KPI priority were set to 25 selected KPI. This article reveals how sustainability perspective were integrated to the other 4 perspectives by adding the fifth perspective. This article also reveals a structure to guide decision makers through a systematic process in designing a Sustainable Balanced Scorecard and its KPIs identification and selection in order to help the company to achieve their competitive advantage.

Keywords – *Sustainable Balanced Scorecard, Performance Management, Analytical Hierarchy Process, Simple Multi-Attribute Rating Technique*

1. Introduction

The basic prerequisite for the successful long-term operation of a business is finding competitive advantages for a company, linked primarily to the performance of this company but also to other areas of company operations (Striteska & Jelinkova, 2015). During the past three decades, various multi criteria performance management models have been proposed due to various shortcomings of traditional finance based performance measures (Kasie, 2013). The most famous method in performance management is the balanced scorecard.

In today's business environtment, sustainability is a trend which can allow companies to implicate social, economic, and environmental pillars to the strategy of the company (Kalender & Vayvay, 2016). In a BSC all aspects relevant for achieving a permanent competitive advantage should be included (Figge, 2002). Balanced scorecard has high potential to integrate environmental and social aspects into the general management system (Kalender & Vayvay, 2016)

A balanced scorecard may have up to 25 measures (Kaplan & Norton, 1996). However, in almost all cases, when developing a balanced scorecard the people involved in thr process end up with a huge list of measures (Valiris et al, 2005). Identifying which measures should be employed is a crucial step (Valiris et al, 2005).

In order to identify the balanced scorecard's KPIs to be employed, some approaches have been use in some research, namely AHP or SMART. This article apply the advantages of both AHP and SMART method to select the company's critical KPIs. The combine use of AHP and SMART.

This article is based on a real case study from a multinational digital education company in Indonesia. This research aim to identify company's critical KPIs and their priority level. This article begin with introduction and followed by a brief literature review on sustainable balanced scorecard, AHP, and SMART. Next the article presents how each the stage involved Finally the conclusion of this research are described

2. Literature Review

2.1 Sustainable Balanced Scorecard

Balanced scorecard was introduced by Robert Kaplan and David Norton in 1990s, this method provide managers with the instrumentation they need to navigate to future competitive succes. The balanced scorecard retains an enphasize on achieving financial objectives, but also includes the performance drivers of these finacial objectives. The scorecard measures organizational performance accross four balanced perspetives: financial, customer, internal business process and learning and growth. (Kaplan & Norton, 1996).

Perspectives in balanced scorecard give balance between internal process and external factors (Hladchenko, 2014) and what give balanced scorecard an advantage is that every measure has causal relationship with other perspectives.

In today's business environtment, sustainability is a trend which can allow companies to implicate social, economic, and environmental pillars to the strategy of the company (Kalender & Vayvay, 2016). Although the term sustainability is not new, it has gained a significant amount of importance and attention over the past view years in every major internationan and national policy having implications on almost every modern day business, institution and activity (Chowdury, 2013). Sustainable development can be defined as the development that meets the needs of the present without compromising the ability the future generation to meet their own needs and balanced scorecard has high potential to integrate environmental and social aspects into the general management system (Kalender & Vayvay, 2016).

The balanced scorecard (BSC) has recently been considered a proper tool for evaluating and designing the objectives of corporate sustainability (Nikolaou & Tsalis, 2013). Once a company has established its approach to sustainable operations, management next must decide on the manner in which the sustainable operations will be reported and assessed using the BSC. Options for incorporating sustainability into the BSC include:

1. Adding a fifth perspective to the BSC
2. Developing a separate sustainable balanced scorecard (SBSC), and
3. Integrating the measures throughout the four perspectives. (Butler, 2014)

However, companies define sustainability differently from each other. For that reason, indicator system which is set up to measure sustainability will vary form company to company because these indicator systems will be based on the strategy and goals of the related company.

A balanced scorecard may have up to 25 measures (Kaplan & Norton, 1996). However, in almost all cases, when developing a balanced scorecard the people involved in thr process end up with a huge list of measures (Valiris et al, 2005). Identifying which measures should be employed is a crucial step (Valiris et al, 2005).

2.2 Analytical Hierarchy Process

AHP was developed by Thomas L. Saaty. AHP is a flexible model that allows us to make a decision by combining conderations logically (Saaty, 1986). The main use of AHP is to solve a related to a complex situation by defining that complex sitution into a smaller elemen and set into a hierarchy. Desicion making in AHP based on three main principle below:

1. Hierarchical structure
2. Priority setting
3. Consistency of decision

Pairwise comparisons are made to set priority in decision making problem by using preference scale which use numeric values to different levels of preference. The stndard preference scale set by Saaty is shown in below.

Table 1: Preference scale for pairwise comparisons

Preference Level	Numeric value
Equally preferred	1
Equally to moderately preferred	2
Modertely preferred	3
Moderately to strongly preferred	4
Strongly preferred	5
Strongly to very strongly preferred	6
Very strongly preferred	7
Very strongly to extremely preferred	8
Extremely preferred	9

AHP could be more consistent and accurate as long as the matrix is not greater than ten criterias. Its consistency detoriates and it become tedious and time consuming when the number of fctor are increasing (Kassie, 2013).

2.3 SMART

SMART model was originally developed by Edwards in 1977 as part of multi-attribute utility measurement (MAUM). The SMART is by the far the most common method actually used in real, decision guiding multi-attribute utility measurement (Edwards & Baron, 1994).

The SMART is based on a linear additive model. This mean that an overall value of a given alternative is calculated as the total sum of the performance score (value) of each criterion (attribute) multiply with the weight of that criterion.

For the SMART, ratings of alternatives are assigned directly, in a natural scale of criteria where available. The advantage of the SMART model is that it is independent of the alternatives. Since the rating of alternatives are not relative, changing the number of alternatives considered will not in it self change the decision scores of the original alternatives (Valiris et al, 2005). SMART can also be applied for any number of alternatives or criterias without limitation (Kassie, 2013).

3. Methodology

This research is a quantitatif descriptive research. The object of this research is a multinational digital education company as a case study in order to design a sustainable balanced scorecard wihich is specific to the object company.

At early step, this researh clarify the vision and mision of the company. To set the strategic objectives and its causal relationship, a top down direction was set by the company's CEO along with the designing of the company's sustainable balanced scorecard.

The next step was to establish a strategic planning comitee which consist of the company's senior managers. This comitte responsible to identify all possible KPIs related to the company's strategic objectives.

After all possible KPIs were identified, the commite need to find 25 KPIs which suit the strategic objectives. Six evaluation criterias were used to evaluate all possible KPIs (Kasie, 2013). Those criterias are:

1. Alignment with strategic objectives (ASO)
2. Leading and lagging (LL)
3. Consistency and continuity (CC)
4. Focus on improvement (FI)
5. Simplicity and clarity (SC)
6. Accesibility (Ac)

These six evaluation criterias were weighted by the company's CEO using AHP method. In order to set the priority of the criterias, Pairwise comparisons are made to set priority by using preference scale which use numeric values to different levels of preference.

Next was to list down all possible KPIs related to strategic objectives using brainstorming by each member of the commitee and also by using the existing KPIs. From the discussion 60 KPI alternatives was indentified as shown in Table 2.

After identifying all potential KPI, a numeric score between 0 and 100 were assigned to indicate how well the KPI fit the evaluation criteria, where a score of 100 shows that the KPI is very well fit the evaluation criteria and a score of 0 shows that the KPI is not fit the evaluation criteria. At the end, the total score X_i for each decision alternative A_i was calculated by appliying the formula :

$$X_i = \sum_{j=1} w_j \, a_{ij} \qquad (1)$$

Where:
W_j = normalized weight assigned for each evaluation criteria C_j (j = 1...6) using AHP
A_{ij} = scored performance of KPI alternative A_i against criterion C_i using SMART.

An alternative with the higher score of X_i is the better desision alternative.

Table 2 All potential KPIs

Perspectives	*Strategic Goals*	*KPI Alternatives*
Financial Perspective	*F1*	*A1*
		A2
		A3
		A4
		A5
		A6
		A7
		A8
		A9
		A10
Stake Holder Perspective	*SH1*	*A11*
		A12
		A13
		A14

		A15
		A16
		A17
	SH2	A18
		A19
		A20
		A21
		A22
Sustainability Perspective	S1	A23
		A24
		A25
		A26
		A27
		A28
		A29
		A30
		A31
		A32

Perspectives	*Strategic Goals*	*KPI Alternatives*
Internal Business Process	IBP1	A33
		A34
		A35
		A36
		A37
		A38
		A39
		A40
	IBP2	A41
		A42
		A43
		A44
		A45
		A46
		A47
		A48
		A49
		A50
Learning and Growth Perspective	LG1	A51
		A52
		A53
		A54
		A55
		A56
	LG2	A57
		A58
		A59
		A60

The flow chart of this research were shown in Fig 1.

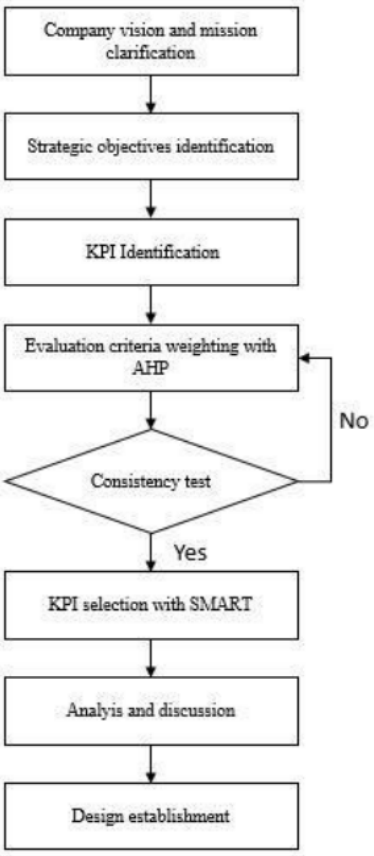

Fig 1 Designing SBSC flow chart

4. Result and Discussion

4.1 Designing sustainable balanced scorecard model

Design of a sustainable balanced scorecard model for this company was developed with discussion with the company's CEO, by identifying strategic objectives derived from company's vision and mision as stated below.

- The vision of the company is to become "distributor of wisdom"
- The mission of the company is "to deliver the education to all corners of Indonesia"

Kaplan and Norton's BSC have 4 perspectives namely financial perspective, customer perspective, internal business process prespective and learning and growth perspective. In this case, sustainability perspective were integrated by adding another persepective namely sustainable perspective (Butler, 2014).

From those vision and mision, strategic objectives were set up in order to overcome business challenges based on five perspectives on sustainable balanced scorecard as stated below.

- To maximise profitability
- Brand awareness
- Company credibility
- To improve SMA graduation level at mid-low economic students
- Product delivery quality
- To improve product quality and innovation
- To get highly motivated and skilled staff
- To create competitive working environment

Causal relation between these strategic objectives are shown in Fig 2

From that 8 strategic objectives and 5 persepectives, 60 potential KPIs alternative were identified based on discussion with strategic planning committe and some are existing KPIs as shown in Table 3.

4.2 Weighting evaluation criteria using AHP

Evaluation criterias are used to evaluate the best KPI alternatives that suit the strategic objectives, six evaluation criteria were used to determine 25 KPIs among 60 potential KPIs:

1. Alignment with strategic objectives (ASO)
2. Leading and lagging (LL)
3. Consistency and continuity (CC)
4. Focus on improvement (FI)
5. Simplicity and clarity (SC)
6. Accesibility (Ac)

AHP is used to determine the weight of those evaluation criteria because AHP is preferable for comparison which are not more then then (Kasie, 2013). Pairwise comparison score by the company's CEO were shown in Table 3 below:

Table 3. Preference matrix

	(ASO)	(LL)	(CC)	(FI)	(SS)	(Ac)
(ASO)	1	4	7	3	3	5
(LL)	¼	1	5	1/2	2	2
(CC)	1/7	1/5	1	1/2	1/4	1/3
(FI)	1/3	2	2	1	1	2
(SS)	1/3	½	4	1	1	2
(Ac)	1/5	1/2	3	1/2	1/2	1

Next, the pairwise comparison were assigned into a normalised matrix by using decimal number in order to maintain accuracy and to make it easier to calculate, then sum each coloumn

Table 4. Normalised matrix

	(ASO)	(LL)	(CC)	(FI)	(SS)	(Ac)
(ASO)	1,000	4,000	7,000	3,000	3,000	5,000
(LL)	0,250	1,000	5,000	0,500	2,000	2,000
(CC)	0,143	0,200	1,000	0,500	0,250	0,333
(FI)	0,333	2,000	2,000	1	1	2,000
(SS)	0,333	0,500	4,000	1	1	2,000
(Ac)	0,200	0,500	3,000	2,000	0,500	1,000
Total	2,260	8,200	22,000	6,500	7,750	12,333

Partial weight were determined by dividing each value in the the cell by its corresponding column sum.

Table 5. Partial weight

	(ASO)	(LL)	(CC)	(FI)	(SC)	(Ac)	Average
(ASO)	0,4426	0,4878	0,3182	0,4615	0,3871	0,4054	0,4171
(LL)	0,1106	0,1220	0,2273	0,0769	0,2581	0,1622	0,1595
(CC)	0,0632	0,0244	0,0455	0,0769	0,0323	0,0270	0,0449
(FI)	0,1475	0,2439	0,0909	0,1538	0,1290	0,1622	0,1546
(SC)	0,1475	0,0610	0,1818	0,1538	0,1290	0,1622	0,1392
(Ac)	0,0885	0,0610	0,1364	0,0769	0,0645	0,0811	0,0847

Consistency ratio is then to be made in order to assure the consistency of the preseference matrix filled by the company' CEO. From the above table, the consistency index *CI* is 0.0636 (see Saaty, 1986 for computation), and from standard table with 6 criteria, random index *RI* is 1.24. the consistency ratio *CR* is determined by dividing *CI* with *RI,* from that calculation *CR* is 0.0513, which is less then 0.1, hence the degree of inconsistency is acceptable.

4.3 Weighting KPIs using SMART

After the weight of evaluation criterias were determined, the next step is to determined the weight of KPI alternatives to find 25 KPIs to be ised in the company's sustainable balanced scorecard. Values to each KPI alternatives were assigned againts evaluation criterias using SMART approach. The benefit of this technique is each alternative can be evaluated independently and it is particularly useful when new alternative or criteria are added to the existing comparison andoutdated ones are eliminated (Kasie, 2013)

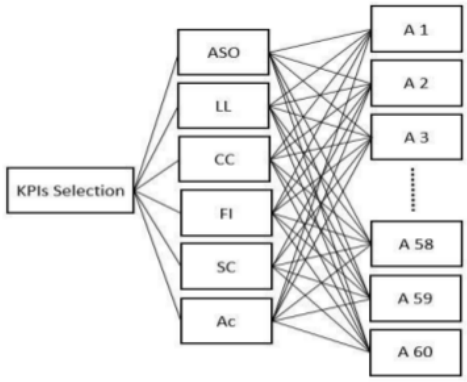

Fig 3. KPI Selection frame work

The strategic committe then were asked to score each KPI alternatives, the score values ranging from 0 (worst relation between criterion and KPI alternative) 100 (best relation between criterion and KPI alternative).the number scale can be any sequence of ordinal numbers but 0 to 100 is a convenient and easy scale for decision makess to use (Valiris et al, 2005).

Next step is aggregating the weight of evaluation criteria and KPI alternatives scores. The model used in this step is an additive model, where total score of each alternative is accumulated from the weight of evaluation criteria and KPI alternative score. The calculation step of KPI A01 is shown below:

$$X_i = \sum W_j a_{ij}$$

=

= (0,4171 x 100) + (0,1595 x 100) + (0,0449 x 100) +

(0,1546 x 100) + (0,1392 x 100) + (0,0847 x 100)

= 100

Table 6 shows all 60 KPI alternatives were evaluated againts 6 evaluation criteria. And the 25 KPIs selected from 60 KPI are ahown in Table 7. The sustainable balanced scorecard established from this research were shown in Table 8

5. Conclusions

The aim of this paper was to integrate sustainability aspect into company's strategic performance measurement system in a balanced scorecard frame work and to provide a structure on how decision maker determine the KPIs to be used in a strategic performance measurement system.

At the time of designing the sustainable balanced scorecard, sustainability perspective were added as the fifth perspective of the company's balance scorecard. This perspective become one of leading indicator for customer perspective and also as one of lagging indicator for internal business process perspective.

AHP was choosen to determine the priority of the evaluation criteria. AHP provide consistency on the process of determining evalauation criteria. SMART was choosen to find which KPI match the evaluation criterias most and it is a faster way to determine the KPIs to be use due to the number of alternatives. Both AHP and SMART provide a faster and more consistent method in designing a strategic performance measurement system in a balanced scorecard frame work, 25 KPIs were identified using the combination of AHP and SMART method.

For future research, other suitable approaches such as fuzzy theory should be undertaken in order minimize the variations of decisions due to the subjectivity of the comitee in assigning each alternatives.

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Table 6. Scores and additive weighted values

KPI Evaluation Criteria	Wj	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11	A12	A13	A14	A15
ASO	0,4171	100	70	70	100	100	60	80	80	100	100	100	80	80	80	100
LL	0,1595	100	70	70	100	100	60	100	80	90	90	100	100	80	80	100
CC	0,0449	100	50	50	100	100	60	80	80	100	100	100	60	80	80	100
FI	0,1546	100	80	80	100	100	80	80	80	100	100	100	90	90	90	100
SC	0,1392	100	80	80	100	100	70	80	90	90	100	100	80	90	90	100
Ac	0,0847	100	100	100	100	100	100	100	100	100	100	90	100	90	90	100
$X_i = \sum W_j a_{ij}$		100	74,58	74,58	100	100	67,87	84,88	83,09	97,01	98,4	99,15	85,53	83,79	83,79	100

KPI Evaluation Criteria	Wj	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30
ASO	0,4171	70	80	100	80	100	80	70	80	100	60	60	60	100	90	90
LL	0,1595	70	70	90	50	100	90	60	100	100	80	80	80	100	90	60
CC	0,0449	50	80	90	50	100	90	80	70	100	70	70	70	100	90	60
FI	0,1546	60	90	100	80	100	80	60	70	100	70	70	70	100	90	80
SC	0,1392	90	80	100	80	100	80	90	80	90	70	70	70	100	90	80
Ac	0,0847	100	100	100	50	70	90	60	100	90	90	90	90	70	90	90
$X_i = \sum W_j a_{ij}$		72,88	81,65	97,96	71,33	97,46	82,89	69,25	82,89	97,76	69,12	69,12	69,12	97,46	90	80,93

KPI Evaluation Criteria	Wj	A31	A32	A33	A34	A35	A36	A37	A38	A39	A40	A41	A42	A43	A44	A45
ASO	0,4171	100	70	100	100	80	100	100	100	90	80	100	100	100	10	10
LL	0,1595	100	70	100	100	80	100	70	90	80	70	90	100	100	10	10
CC	0,0449	100	50	100	100	70	100	70	100	80	70	50	100	100	10	10
FI	0,1546	100	50	100	100	100	100	80	100	90	100	80	100	100	10	10
SC	0,1392	100	80	100	90	60	90	70	100	80	80	80	100	100	10	10
Ac	0,0847	70	70	100	70	60	90	60	100	100	90	80	100	100	10	10
$X_i = \sum W_j a_{ij}$		97,46	67,4	100	96,07	78,16	97,76	83,21	98,4	87,41	81,89	88,59	100	100	10	10

KPI Evaluation Criteria	Wj	A46	A47	A48	A49	A50	A51	A52	A53	A54	A55	A56	A57	A58	A59	A60
ASO	0,4171	10	10	100	90	90	90	80	100	100	100	100	90	80	100	100
LL	0,1595	10	10	100	90	90	90	80	100	100	100	100	80	80	100	100
CC	0,0449	10	10	100	80	80	90	80	100	100	100	100	80	80	100	100
FI	0,1546	10	10	100	90	90	90	90	100	100	100	100	90	100	100	100
SC	0,1392	10	10	100	90	90	70	90	100	100	100	100	90	80	80	80
Ac	0,0847	10	10	100	90	90	80	90	80	80	70	70	70	80	80	100
$X_i = \sum W_j a_{ij}$		10	10	100	89,55	89,55	86,37	83,79	98,31	98,31	97,46	97,46	86,26	83,09	95,52	97,22

Table 7. Scores and additive weighted values

KPI	Weight
A01	100,00
A04	100,00
A05	100,00
A15	100,00
A33	100,00
A42	100,00
A43	100,00
A48	100,00
A11	99,15
A10	98,40
A38	98,40
A53	98,31
A54	98,31
A18	97,96
A24	97,76
A36	97,76
A20	97,46
A28	97,46
A31	97,46
A55	97,46
A56	97,46
A60	97,22
A09	97,01
A34	96,07
A59	95,52

Table 8.Sustainable balanced scorecard

Perspective	*Strategic Objective*	*KPI*
Financial	*F1*	A01
		A04
		A05
		A10
		A09
Stake Holder	*SH1*	A15
		A11
	SH2	A18
		A20
Sustainability	*S1*	A24
		A31
		A28
Internal Business Process	*IBP1*	A48
		A43
		A42
	IBP2	A33
		A38
		A36
		A34
Learning and Growth	*LG1*	A54
		A53
		A55
		A56
	LG2	A60
		A59

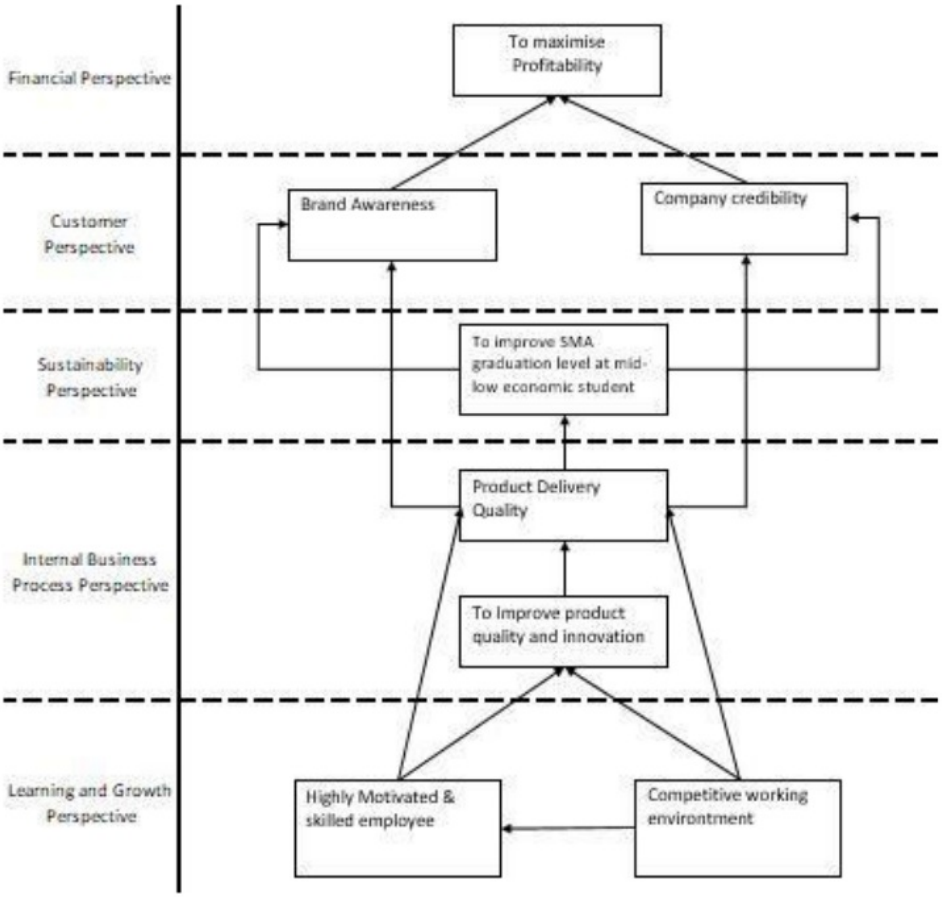

Fig 2. Strategic objectives causal relation

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