

Improving GQM+Strategies with Balanced Scorecard's Perspectives: A Feasibility Study

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Abstract—Aligning business goals and strategies to software requirement is becoming more critical as corporate relies more on software for their business activities. While GQM+Strategies gives the solution to this problem, GQM+Strategies does not explicitly offer attention to relationships between various stakeholders. We propose an integration of Balanced Scorecard's perspectives into GQM+Strategies framework to solve that problem. We evaluated the possibilities by classifying goals and strategies of three existing grids totaling at 73 goals and 127 strategies. We also analyzed the relationship between those perspectives in those grids. We found that current application of GQM+Strategies followed balanced scorecard's principles of perspective and concluded that it is possible to use balanced scorecard's perspectives on GQM+Strategies framework. We also provided a semi-automated review tool as an example of how to use balanced scorecard's perspectives on GQM+Strategies framework.

Index Terms—GQM+Strategies, balanced scorecard, business-IT alignment.

I. INTRODUCTION

Corporations have become increasingly dependent on software for their business activities [1]. This condition has increased the importance of linking and aligning business goals and strategies into software requirements. However, challenges remain when creating appropriate linkages. Misalignment between goals and strategies can cause discordance between targeted goals and business activities, which may fail to achieve those goals. One method to resolve such issues is GQM+Strategies [2]. Several organizations around the world have implemented GQM+Strategies for their business-IT alignment. Examples include the Japan Aerospace Exploration Agency [3] and the global oil and gas industry [4]. GQM+Strategies provides a platform for businesses to align their goals and strategies across different levels of an organization. GQM+Strategies utilizes a hierarchical model to align the top strategic organizational unit's goals to lower operational units. Strategies are derived from goals using rationales based on contexts or assumptions. Achievement of goals is measured using metrics generated from the Goal-Question-Metrics model.

While the vast range of advantages of GQM+Strategies offers, there is no explicit attention to different aspects of the project. This lack of awareness can lead to poor alignments of goals and strategies. Some elements of projects may not be

covered in developed GQM+Strategies grids, potentially lead some of critical goals and strategies not being executed and monitored. Therefore, this problem needs to be solved to improve GQM+Strategies capabilities to create business-IT alignment.

We propose usage of balanced scorecard's perspectives on developing GQM+Strategies grids to solve this problem. As a performance management tool, balanced scorecard brings more attention to non-financial measurements instead of traditional financial-based performance measurement methods [5]. The balanced scorecard did this by dividing the focus of an organization to four perspectives: financial, costumer, business-internal-processes, and learning and growth.

In this research, we aim to investigate the possibilities of using balanced scorecard's perspectives in GQM+Strategies framework. Those perspectives may be used as a guideline during development or review process of GQM+Strategies grids.

To achieve our goal, we define these research questions:

- RQ1. Does current application of GQM+Strategies already cover the principles of balanced scorecard's perspectives?
- RQ2. How do the balanced scorecard's perspectives work on goal and strategies on GQM+Strategies?
- RQ3. How can we utilize balanced scorecard's perspectives on GQM+Strategies?

Our research has two contributions. First, we improve the understanding of the strengths and weaknesses of the current application of GQM+Strategies. Second, we present an idea of how to enhance GQM+Strategies capabilities to create a better business-IT alignment.

II. BACKGROUND

A. GQM+Strategies

GQM+Strategies is a registered trademark of the Fraunhofer Institute for Experimental Software Engineering [7]. GQM+Strategies [2] is an extension of the Goal-Question-Metrics (GQM) paradigm to align goals and strategies based on measurements. It allows developers to consistently manage alignment between goals and strategies across different levels of an organization and provide metrics to monitor the achievement of goals and strategies. Figure 1 shows the basic

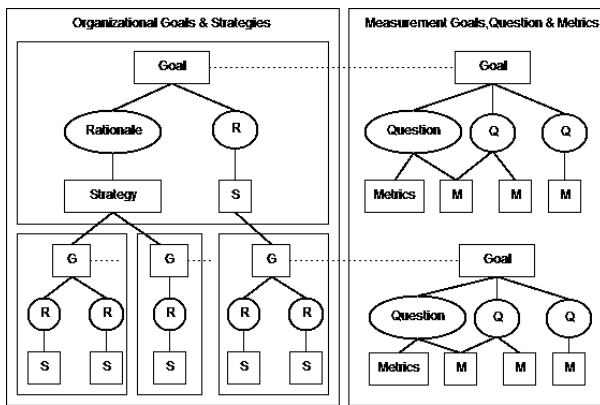


Fig. 1. GQM+Strategies basic structure

structure of a GQM+Strategies grid. It consists of goal and strategies generated by context and assumptions across all levels of an organization and measurements generated by GQM. A goal is described as an achievable objective inside an organization. It can be realized by executing one or more strategies determined by rationales, which consist of contexts and assumptions. Strategies can be further expanded to another goal, forming a hierarchical structure. Each goal in GQM+Strategies corresponds to a GQM graph. GQM provides a measurement for a goal with questions to characterize the object of the measurement and metrics to answer each question [8].

B. Balanced Scorecard

The balanced scorecard is a performance management tool developed to draw attention to non-financial measurements [5]. It utilizes measurements to align strategies of an organization. The balanced scorecard separates business strategies into four different perspectives: financial, customer, business-internal-process, and learning and growth. Figure 2 shows how each perspective is related according to the balanced scorecard framework. The financial perspective consists of financial measures such as income and expenditures. Customer perspective talks about the market and customers such as customer retention and satisfaction that will generate profit for the organization. Business-process-internal discusses the organizational business activities such as production and supply chain to satisfy consumer demand. Lastly, learning and growth support business activities in the form of human capabilities and information system capabilities.

Strategy maps, which were introduced in the second version of the balanced scorecard, focus on aligning and measuring intangible assets [6]. Strategy maps are structured similarly as GQM+Strategies where strategies are aligned on cause and effect relation. The difference is that strategy maps are based on directed graph structure while GQM+Strategies are based on the tree structure.

C. Motivating Example

To successfully apply GQM+Strategies, goals and strategies need to be aligned. Adequately aligned GQM+Strategies grids can provide organization guidance on how to achieve their



Fig. 2. Balanced scorecard framework [9]

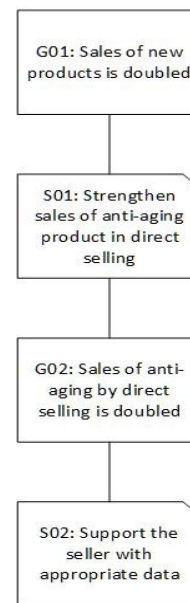


Fig. 3. Motivating example

business goals. Proper measurements are also needed to evaluate the performance of strategies toward realizing goals.

Figure 3 shows part of a grid taken from one of our test cases. This example's primary goal is to improve the number of sales from new product explained in G01. Further expansion of the goal is explained on S01 and G02. The problematic part is shown between G02 and S02; it shows that to double the sales of an anti-aging product we need to support the seller with appropriate data. While proper data may contribute to better sales number, the grid does not show solid strategy how it contributes to the sales. Important aspect such as how appropriate data improve the efficiency of selling process or how it affects the interaction between seller and customer.

III. RELATED WORKS

There are some previous works done with same goals of improving GQM+Strategies in term of business-IT alignment. C. Shimura et al. introduced metamodel and design principles to identify risks and problems on a GQM+Strategies grid [10],

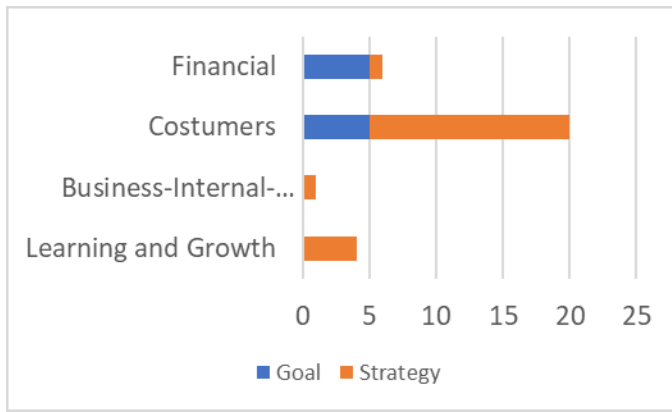


Fig. 4. Cosmetic company classification result

T. Kobori et al. proposed a stakeholder relationship analysis to exhaustively identify rationales efficiently [11] and Y. Aoki et al. proposed a horizontal relation identification method (HoRIM) to identify misalignment between goals and strategies across organizational units [12]. Other works have extended the usage of GQM+Strategies for business value analysis [7] and model-based analysis and testing [13].

There are also some related works that involved balanced scorecard to improve software development like our approach. S. A. Becker and M. L. Bostelman introduced an approach to embed GQM from balanced scorecard's perspectives [14]. L. Buglione and A. Abran implemented a comparative study between the balanced scorecard and the GQM approach for software process improvement [15].

Previous studies have not specifically focused on introducing balanced scorecard on GQM+Strategies. This condition serves as the basis to conduct this research.

IV. TEST CASES

We investigate the possibilities of using balanced scorecard's perspective on three test cases. The investigation is done by classifying every goal and strategy in each grid to a balanced scorecard's perspective. Then we inspect the relationship between each goal and strategy based on their perspective to determine the answer to RQ1. We specifically look for relations that do not satisfy the proper relationship between perspective to answer RQ2.

We investigated three test cases. The first one is an example from GQM+Strategies training, and the other two are from real companies. Those cases that came from real companies are confidential, so we generalize the contents from those two cases in this paper. No modifications are made to contents during the actual analysis process.

A. Cosmetic Company

This test case is an example of GQM+Strategies training. The project's primary goal is to increase the sales of a cosmetic company. This goal is targeted to be done by expanding the market into Asian market and development of new products to satisfy current trend of customer's demand on top of holding the previously captured market. The grid consists of 10 goals and 21 strategies. The goals are from

financial and customer perspective. The strategies mostly came from customer perspective, with only one from business-internal-process perspective and the rest came from financial perspective summarized in figure 4.

Table I show number of relations between goals and strategies that satisfies balanced scorecard's principles of relations between perspectives on cosmetic company grid. Transition between perspectives mostly happened in the derivation of a goal into strategy mainly from financial perspective to consumer perspective with only one goal into strategy relationship from customer to business-internal-process. Similar with the rest of goal to strategy derivation, those derivations from strategy to goal all happened inside the same perspective.

The rest of relationship that doesn't satisfy balanced scorecard's principles of relationship between perspectives is summarized in table II. Almost all those relationships involved goals and strategies from customer perspective, which is expected given that most of the grids consist of them. Lack of strategies and goals from business-internal-process seems to be related to goals from customer perspective directly linked to strategies from learning and growth perspective. Figure 5 shows two of those relations that doesn't satisfy the principles.

TABLE I. COSMETIC COMPANY'S PROPER RELATIONSHIP

Perspective		Relation	
From	Perspective	Goal to Strategy	Strategy to Goal
Financial	Financial	1	1
	Costumer	8	0
	Business-Internal-Process	0	0
Costumer	Costumer	7	5
	Business-Internal-Process	1	0
Business-Internal-Process	Business-Internal-Process	0	0
	Learning and Growth	0	0
Learning and Growth	Learning and Growth	0	0

TABLE II. COSMETIC COMPANY'S IMPROPER RELATIONSHIP

Perspective		Relation	
From	Perspective	Goal to Strategy	Strategy to Goal
Financial	Learning and Growth	1	0
Costumer	Financial	0	3
	Learning and Growth	3	0
Business-Internal-Process	Financial	0	0
	Costumer	0	0
Learning and Growth	Financial	0	0
	Costumer	0	0
	Business-Internal-Process	0	0

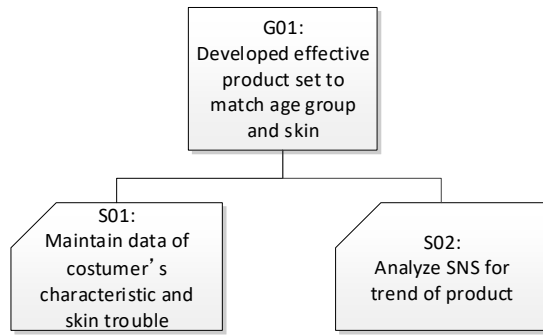


Fig. 5. Improper relationship sample

Both of strategies in figure 5 are expected to contribute to successful development of a useful product to match customer's need. Based on balanced scorecard perspective, the goal's perspective is customer for dealing with customer's demand while both strategies are learning and growth for dealing with usage of data and information to support the business process of organization. A potential problem with both strategies contribution to achievement of the goal is how the result of SNS analysis and customer's data will be used to develop effective product. Some extrapolation might be needed to understand how the relationship works, which means the alignment between the goal and strategies are not precise enough. Some goals and strategies from business-internal-process may be able to clarify how the result of those strategies are contributing to the goal.

B. ABC Company

Our next GQM+Strategies grid case is about a project to improve development process of a company to increase the sales number. This project mainly consists of goals and strategies that deal with internal part of organization rather than external stakeholders and customer. The grid consists of 22 goals and 27 strategies. Figure 6 shows the distribution of goals and strategies based on their perspectives. The grids are dominated by goals and strategies from learning and growth perspectives, primarily dealing with knowledge management system and improvement of employee's capability. The primary strategy is quickly followed by strategies that focused on strengthening both existing and new business, supported by improvement of efficiency and effectiveness of business activities inside of the organization. Those goals and strategies are driven by improvement of human resources.

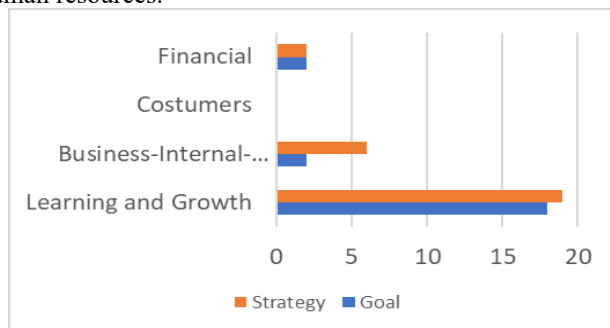


Fig. 6. ABC Company classification result



Fig. 7. XYZ Company classification result

The relationship between goals and strategies inside ABC company's grid are summarized in table III. Since the grid structure consists of two goals conjunct at same set of strategies, we decided to treat that relationship as two different set of relationships. Those relationships exist in goal to strategy relationship between and to business-internal-process perspective.

For the relationship between perspectives, all the relations between goals and strategies in this grid follow the balanced scorecard's perspectives. Transitions between different perspectives all happened in derivation of a goal into strategies. However, derivation between same perspectives outnumbers those that changed perspective by 21 relations to 4. For strategy to goal relationship, there is no relationship where a transition to another perspective happens.

C. XYZ Company

XYZ company's project is about implementation of AARRR (Acquisition, Activation, Retention, Referral, Revenue) on the organization's business model. The grid consists of two separate trees, one for Revenue part and another one for the rest of AARRR model. This grid is the biggest one from our test cases with 40 goals and 77 strategies. The classification result is shown in figure 7.

TABLE III. RELATIONSHIP ON ABC COMPANY

Perspective		Relation	
From	To	Goal to Strategy	Strategy to Goal
Financial	Financial	2	1
Financial	Customer	0	0
Financial	Business - Internal - Process	3	0
Customer	Customer	0	0
Customer	Business - Internal - Process	0	0
Business - Internal - Process	Business - Internal - Process	1	8
Business - Internal - Process	Learning and Growth	1	0
Learning and Growth	Learning and Growth	18	18

Growth	Growth
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TABLE IV. RELATIONSHIP ON XYZ COMPANY

Perspective		Relation	
From	Perspective	Goal to Strategy	Strategy to Goal
Financial	Financial	1	2
Financial	Costumer	1	0
Financial	Business - Internal - Process	0	0
Costumer	Costumer	33	27
Costumer	Business - Internal - Process	25	0
Business - Internal - Process	Business - Internal - Process	15	11
Business - Internal - Process	Learning and Growth	1	0
Learning and Growth	Learning and Growth	0	0

In correspondence with AAARR model, there are good numbers of goals and strategies from costumer perspective inside the grid. Goals and strategies from financial perspective only shown in top of branch of Revenue part. The number goals and strategies from business-internal-process perspective are also quite significant, all of them acting as support to achieving more costumer. Those business activities, however, are not supported by either goal or strategy from learning and growth perspective.

Table IV summarized the relationship between goals and strategies according to balanced scorecard's perspectives. Same as two previous test cases, the transition between two perspectives happens all inside derivation of a goal into strategies. Derivation of a strategy into goals also happened inside same perspectives. This grid also doesn't show a relationship that violates balanced scorecard's principle on its perspectives.

V. APPLICATION

To investigate the utilization of our findings, we developed a semi-automated tool to detect relationship between goals and strategies that do not satisfy balanced scorecard's principle from a GQM+Strategies grid. We named the tool as "Perspective Checker." Perspective Checker is developed in JAVA as a stand-alone application. Figure 8 show how Perspective Checker looks like. The top table show perspective of each goal and strategy while the bottom table show problems found based on information shown on top table.

A. Application Workflow

Figure 9 shows the flowchart of our tool. Perspective Checker starts by reading a *vita* file that contains information of a GQM+Strategies grid including description of each goals and strategies on the grid. Information about goals and strategies then extracted and prepared for classification, where

stop words and common words such as improving, adding, and decreasing get removed. Then those goals and strategies are classified using Naïve-Bayes method [17]. After that, we restore relationship between goals and strategies and search for those that do not follow balanced scorecard principles. Those classification result and improper relationships are then shown into the user interface.

ID	Type	Description	Perspective
0	GOAL	Increased number of customers	FINANCIAL
1	GOAL	Delivered new features and fixes fast	PROCESSES
2	GOAL	Improved customer interaction process	COSTUMER
3	GOAL	Improved reliability of products	PROCESSES
4	GOAL	Increased productivity of development	PROCESSES
5	GOAL	Improved information quality of Enter...	LEARNING
6	GOAL	Decreased defects slipped	PROCESSES
7	STRATEGY	Improve IT products	PROCESSES
8	STRATEGY	Improve processes	PROCESSES
9	STRATEGY	Increase productivity of development	PROCESSES
10	STRATEGY	Improve QA activities	PROCESSES
11	STRATEGY	Provide more complete and consiste...	LEARNING
12	STRATEGY	Introduce agile development	PROCESSES

No	Parent Id	Child Id	Parent Perspective	Child Perspective
0	8	2	PROCESSES	COSTUMER

Fig. 8. Distribution of perspective transition on goal to strategy relationship

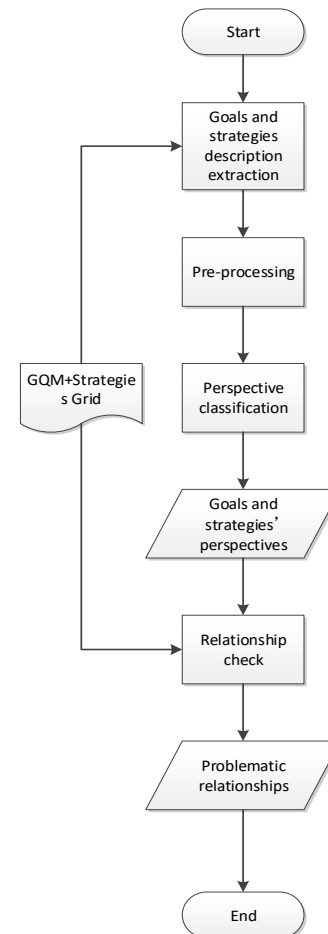


Fig. 9. Application workflow

B. Training Material and Accuracy

We compiled examples of strategies from various sources on internet to create training material necessary for Naïve-Bayes model. We made a training model of 77 pairs of strategy and its perspective. The perspectives are determined by the same method applied to goals and strategies in our test cases.

To see the accuracy, we conducted 11-fold cross-validation test on our Naïve-Bayes model. We decided on an 11-fold test can split our training model evenly. We got a result of 46.75% average accuracy.

C. Evaluation

We tested our application with a sample vita file from GQM+Strategies visualization tool containing 7 goals and 8 strategies. We found that it can classify the perspectives correctly on 86.67% of the time. This may cause a false alarm or miss on the detection of unsatisfactory relationship. On the other side, we found that it potential problem on unsatisfactory relationship can be detected using our tool. We found a problem on the grid where a goal from business-internal-process perspective is followed by a strategy from costumer perspective due to the goal being ambiguous.

VI. DISCUSSION

In this chapter, we will review the result of classification and analysis of relationship of goals and strategies done in the previous chapter to answer research questions of this research.

RQ1 focused on whether current application of GQM+Strategies already followed the principles of balanced scorecard's perspectives without any explicit rules about it. The answer to this research question includes coverage of all balanced scorecard's perspectives and the relationships between each perspective. RQ2 considers role of goals and strategies of GQM+Strategies on transitioning between perspectives. Lastly, RQ3 considers application of our findings.

A. Balanced Scorecard's Perspective Coverage

We looked into distribution of goals and strategies based on their perspective on three previous cases. We found that in all those cases there is a higher number of goals and strategies on a single perspective while some perspective might have little to none at all. On cosmetic company and XYZ company grids, costumer perspective covered more than 50% of the grid while ABC company grid are dominated by goals and strategies from learning and growth by 75%.

On the contrary, there are no goals and strategies from learning and growth perspective in XYZ company and costumer perspective in ABC company. There is also lack of goals and strategies from business-internal-processes perspective in cosmetic company and financial perspective in both ABC and XYZ company's grids with only 3.23%, 8.16% and 3.42% distribution, respectively. Table V and figure 10 shows the distribution of perspectives on all three test cases. This uneven distribution of perspective on all those test cases showed a sign that without explicit attention some aspect of the project may get left out during development of the

GQM+Strategies grid. One possible explanation for this situation is that current GQM+Strategies framework focus solely on scope of the project it works on. This condition resulted in aspects which stated on the scope get all the attention while other aspects that may be integral to accomplishment of the goal yet not explicitly explained in project scope get abandoned.

For example, the XYZ company's grid is developed with AARRR (Acquisition, Activation, Retention, Referral, Revenue) as primary basis. Being focused on costumer perspective, goals and strategies from business-internal-processes perspective are adequately addressed as support to goals and strategies from costumer perspective. However, there is no attention to human resources and technologies inside the organization despite their importance on improving business processes due to being "outside of the scope." In this case, balanced scorecard's perspectives can be used to find contributing aspects of the project that not explicitly stated in project description.

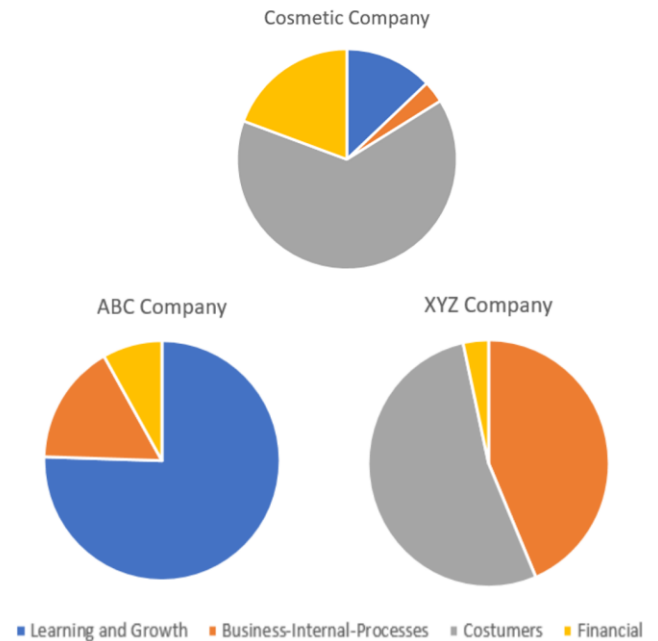


Fig. 10. Distribution of perspective on test cases

TABLE V. RELATIONSHIP ON ABC COMPANY

Perspective	Cosmetic Company	ABC Company	XYZ Company
Learning and Growth	12.90%	75.51%	0.00%
Business-Internal-Processes	3.23%	16.33%	43.59%
Costumers	64.52%	0.00%	52.99%
Financial	19.35%	8.16%	3.42%

TABLE VI. NUMBER OF SATISFACTORY AND UNSATISFACTORY RELATIONSHIPS

Test Case	Relationship	Satisfactory	Unsatisfactory
Cosmetic Company	Goal to Strategy	17	4
	Strategy to Goal	6	3
ABC Company	Goal to Strategy	25	0
	Strategy to Goal	27	0
XYZ Company	Goal to Strategy	76	0
	Strategy to Goal	40	0

B. Balanced Scorecard's Perspectives Relationship

After classifying goals and strategies test cases and analyzing the relationship between them we found that even without explicit attention, GQM+Strategies already follows balanced scorecard in term of relationship between perspectives. Out of 198 relationships between goal and strategies from our test cases, we only found seven relationships that do not satisfy balanced scorecard's principles. Table VI shows the details of satisfactory and unsatisfactory relationships on each test case.

All unsatisfactory come from cosmetic company's case, which is an example grid for GQM+Strategies training. Those unsatisfactory relationships that we found can be generalized into two categories. The first one is indirect relation, in this case between goals from costumer and financial perspective to strategies from learning and growth perspective. As previously explained, this can cause problem since it is unclear relationship on how they are related. The other one is trying to measure costumer with financial metrics such as the number of sales. This problem was shown in the grid by strategies from costumer perspective that derived to financial goals. Those goals may cause mismeasurement which create poor alignment.

In contrary, ABC and XYZ company which is an actual company does not have unsatisfactory relationships in their grids. Experiences in their field may be affecting how developer of GQM+Strategies devise their goals and strategies and cause-effect relationship between them. Using balanced scorecard's perspectives to help an inexperienced developer in developing better grids if this true.



Fig. 11. Distribution of perspective transition on goal to strategy relationship

C. Transition Between Perspectives

Since balanced scorecard does not separate between goal and strategy, we need to investigate how the relationship between a goal and a strategy to see where the transition between perspectives happen. The number of derivation from goal to a strategy within the same perspective is higher compared to derivation that moved to another perspective by 66% to 34%. Figure 11 shows the distribution of derivation of goal into strategies that moved between perspectives and those that doesn't. While for the derivation of strategy into goals, we only found derivation that happened within the same perspective after removing those derivations that do not satisfy balanced scorecard's principles.

We can rationalize that no transition can happen within derivation of a strategy into goals because the goal measures the success of execution of its parent strategy. This means that if a goal has different perspective with its parent strategy, it is questionable whether the goal is correctly measuring the strategy or not. On the other hand, a strategy is contributing to the success of its parent goal. By contributing, there is no limitation on strategy should be from the same perspective, i.e., better efficiency decrease cost that increases profit at the end.

D. Application of Balanced Scorecard's Perspectives

We found that one way of utilizing balanced scorecard's perspective is on the review process of developed GQM+Strategies grids. We managed to detect a problem on a grid using a tool we developed based on balanced scorecard's principles. One other way to utilize the principle is to reverse our approach of utilization. Since we can utilize the principles for review process, it should be possible to use it in development phase of GQM+Strategies framework as a design principle.

E. Threat to Validity

The most prominent threat to validity of our findings is number of test cases. Despite the number of goals and strategies, with only three test cases we may not cover every real-life condition. While we try to cover as much as we can, we are having difficulties in getting GQM+Strategies from companies that used it due to sensitivity of its content.

Another threat is the fact that we did classification manually. This may cause misclassification of goals and strategies which affects the result. We tried to minimize this by doing the classification multiple times to make sure we get most accurate result.

VII. CONCLUSION AND FUTURE WORKS

A. Conclusion

Based on the findings from our research, we concluded that usage of balanced scorecard's principles in GQM+Strategies is feasible. This conclusion is based on these answers to our research questions:

- RQ1. Does current application of GQM+Strategies already cover the principles of balanced scorecard's perspectives?

Current application of GQM+Strategies followed the balanced scorecard principles of perspectives. Most of the goals and strategies in GQM+Strategies are already aligned in same way as balanced scorecard principles. However, there are trends of not addressing all balanced scorecard's perspectives inside GQM+Strategies grids

- RQ2. How do the balanced scorecard's perspectives work on goal and strategies on GQM+Strategies?
A goal and strategy inside of GQM+Strategies are different instances; it should not be treated as equal to balanced scorecard's strategy. Derivation of a goal to strategies is where transition between different perspective happened. In contrary, when a strategy is derived into goals transition between different perspectives should not happen due to the nature of goal and strategy in GQM+Strategy.
- RQ3. How can we utilize balanced scorecard's perspectives on GQM+Strategies?
The perspectives can be used as a basis for reviewing developed GQM+Strategies to detect potential problems. On top of that, using those perspectives in development phase as a basis of deciding what kind of goals or strategies should be derived also possible.

B. Recommendation

We found several possible usages of our findings that not yet covered in this research. Those possibilities are:

1. Use balanced scorecard's principles as supporting rules of existing alignment rules on GQM+Strategies.
2. Analyze resulting grids' distribution of perspective to see whether some perspectives may not have been treated well enough.
3. Check the percentage of relationships that do not satisfy balanced scorecard to see whether the grid is well aligned or not.

C. Future works

Some possible future directions can be taken from our current state of research. These are those possibilities:

1. Reproduce the research with another test cases to see whether our findings still stand true.
2. Investigate the effect of experiences with balanced scorecard to GQM+Strategies learning curve.
3. Experiment the effect of using balanced scorecard principles on the development phase of GQM+Strategies in term of efficiency and effectiveness.

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