

Identifying Misalignment of Goal and Strategies across Organizational Units by Interpretive Structural Modeling

Abstract

To achieve the business objectives of an organization, the business goals and strategies must align. GQM+Strategies® is a method that aligns goals and strategies, including IT strategies. By repeatedly defining lower-level goals and strategies, GQM+Strategies creates grids, which are specified from the initial set of goals and strategies, to link goals and strategies across different level units. Although the above approach can maintain consistency within a vertical refinement tree, horizontal relations at different branches may be missed. Herein we propose the Horizontal Relation Identification Method (HoRIM) to identify horizontal relations. HoRIM is an approach that detects the difference between the initial GQM+Strategies grid and a model obtained by applying Interpretive Structural Modeling (ISM) to the initial grid. ISM provides a hierarchical structure from the relation matrix that presents the relations between elements. An experiment confirms that HoRIM identifies about 1.5 times more horizontal relations than an ad hoc review. Additionally, an industrial application demonstrates the practical value of HoRIM.

1. Introduction

Aligning organizational goals and strategies is important in the Business Process Management (BPM) community [1]. The BPM framework proposed by Burlton indicates that separating ends-means and making them traceable are essential activities. Balanced Scorecard [2][3], Business Motivation Model [4], and GQM+Strategies®¹ [5][6] support these activities. In particular, GQM+Strategies provides a hierarchical structure called a GQM+Strategies grid based on the organizational structure and a measurement model called the GQM (Goal Question Metrics) model to help identify performance measures in BPM activities [7].

A GQM+Strategies grid aligns business goals with strategies, including IT strategies. A

GQM+Strategies grid is iteratively generated by decomposing the initial goal into strategies, which support the achievement of the goal and related goals on lower levels. These grids coordinate goals and strategies across different levels.

Figure 1 shows an example of a GQM+Strategies grid where the relation (e.g., contribution) connects a child strategy to its parent strategy. This type of connection is defined as a vertical relation. GQM+Strategies grids also contain horizontal relations between strategies in different branches. For example, Strategy 3 (S3) and Strategy 4 (S4) are similar because both use the same approach (e.g., improve their web service). However, GQM+Strategies grids cannot describe horizontal relations clearly. If horizontal relations are missed, the following problems may occur:

- Failure in strategies by contradicting or negatively influencing each other
- Inefficiencies due to omissions of additional contributions
- Double investment in similar strategies

If horizontal relations are identified and handled, organizations can combine each strategy effectively. Because a GQM+Strategies reviewer subjectively identifies horizontal relations, horizontal relations are often missed, especially in a large and complex GQM+Strategies grid.

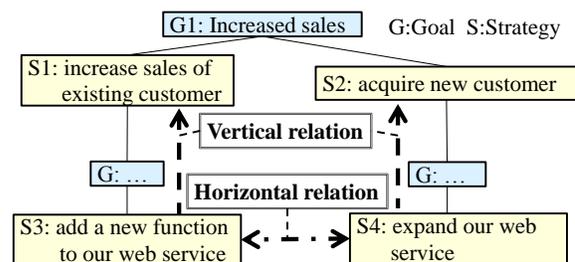


Figure 1. Example of a GQM+Strategies grid in GQM+Strategies

We propose the Horizontal Relation Identification Method (HoRIM) to identify horizontal relations and align the strategies in a GQM+Strategies grid. HoRIM detects the difference between the initial GQM+Strategies grid and a model obtained by applying Interpretive Structural Modeling (ISM) [8] to the initial grid. ISM generates a hierarchical

¹ GQM+Strategies® is a registered trademark (No. 302008021763 at the German Patent and Trade Mark Office and international registration number IR992843).

structure, which analyzes the system for related elements. Our experiment addresses the following research questions (RQ):

- RQ1: Does HoRIM more effectively identify horizontal relations in GQM+Strategies grids compared to an ad hoc review?
- RQ2: Does HoRIM more efficiently identify horizontal relations in GQM+Strategies grids compared to an ad hoc review?
- RQ3: Is HoRIM applicable to real GQM+Strategies grids used in industry?

The contribution of this paper is that it suggests a method to identify horizontal relations. Here we demonstrate the effectiveness of our method and confirm that it has practical value by applying it to a real example.

2. Background

2.1. GQM+Strategies

GQM+Strategies is an extension of the GQM approach, which is used to create and establish measurement programs [6]. It also provides a hierarchical structure called a GQM+Strategies grid to align organizational goals and strategies at different levels.

Several case studies have researched the effectiveness of GQM+Strategies, including in an international gas and oil company [9], the Japanese aerospace agency [10], the military training domain [11] and a small organization consisting of 10 people [12]. GQM+Strategies have practical value in industry, and found that it can address real-world problems [13].

A GQM+Strategies grid consists of GQM graphs [14] and GQM+Strategies elements (Fig. 2). The GQM graph monitors all goals at various levels of an organization to evaluate whether each goal has been achieved using three concepts: goals, questions, and metrics. In a GQM graph, the goal is stated to show the necessity of measuring (e.g., improve the reliability of product X). Then questions are posed to determine whether the goal is achieved (e.g., what is the probability of failure for function Z in product X?). Finally, metrics are defined to concretely answer the question (e.g., probability of failure) [15]. Hence, goals are evaluated based on the collected metrics for a specific question.

GQM+Strategies elements align goals and strategies throughout an organizational hierarchy. They specify organizational goals, strategies, rationales, and their mutual relationships. An organizational goal is an anticipated state that an

organization wants to achieve (e.g., increased customer satisfaction). A strategy is a planned procedure to achieve an organizational goal (e.g., increase software functionality), while the rationale justifies why the goal and strategy are necessary (e.g., customers want higher software functionality because their demands has diversified).

The GQM+Strategies grid is specified from the initial goal, which is repeatedly decomposed to create a concrete goal. A GQM+Strategies grid is generated by the following four steps:

- (1) Define the initial goal.
- (2) Specify strategies to achieve the goal and rationales to explain how the strategies will realize the goal.
- (3) If the strategies can be refined, go to 4. If the strategies cannot be refined, the GQM+Strategies grid is finished.
- (4) Define the goals of the lower level units and return to step 2.

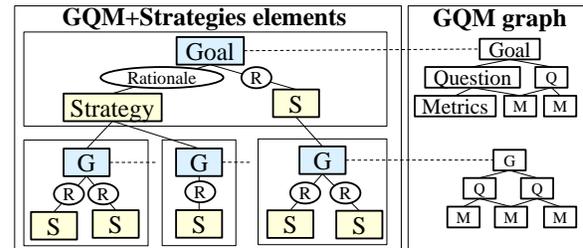


Figure 2. GQM+Strategies grid [16]

2.2. Problem and Motivating Example

Our efforts focus on the strategies in GQM+Strategies grids. We define a vertical relationship as a parent-child relation between strategies. Although GQM+Strategies grids frequently have horizontal relations between strategies in different branches, GQM+Strategies does not support horizontal relations. In particular, the horizontal relations across the organizational units indicate re-organization and re-design of business processes because these relations often cause misalignment [17].

Horizontal relations can be classified into three categories:

- (1) Conflicting strategies, which contradict or negatively influence each other
- (2) Additional contributions, where one strategy contributes to strategies in other branches
- (3) Similar strategies, which are executed by the same approach or have the same target

Here we explain three concrete examples and problems due to missing horizontal relations in the GQM+Strategies grids. Consider a GQM+Strategies grid to address the problem of Goal 1 (G1) “increased

sales”, which has two strategies S1 “increase sales of existing customer” and S2 “acquire new customers” (Fig. 3). The goals and strategies of unit 2.1 and unit 2.2 are derived from the goal and strategies of unit 1.1. However, the strategies of unit 2.1 and unit 2.2 may have horizontal relations.

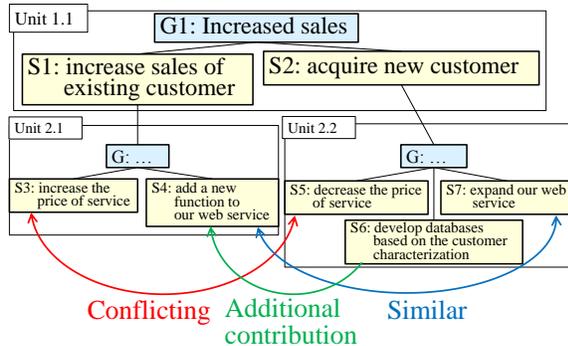


Figure 3. Example of a GQM+Strategies grid with horizontal relations

2.2.1. Conflicting strategies. The first problem in Fig. 3 is conflicting strategies. S3 is defined as “increase the price of service” from S1, whereas S5 is defined as “decrease the price of service” from S2. Because S3 and S5 contradict each other, unit 2.1 and unit 2.2 have to negotiate the service price to execute their strategies. Thus, conflicting strategies must be identified and resolved in order for an organization to run smoothly and efficiently.

2.2.2. Additional contributions. The second problem is that the organization cannot maximize outcomes due to missed additional contributions from other strategies. As an example, S4 is defined as “add a new function to our web service” from S1, whereas S6 is defined as “develop databases based on the customer characterization” from S2. This rationale analyzes the customer characteristics in order to increase the number of customers within the database. However, the outcome of S6 could help unit 2.1 decide which new service to add based on the characteristics of the existing customers. Consequently, S6 has an additional contribution to S4. If the additional contribution of S6 is clear, the probability that S4 is successful increases. Therefore, an organization should identify additional contributions to other strategies to improve the quality of its products.

2.2.3. Similar strategies. The third problem is similar strategies, which results in a double investment and dispersion of knowledge. In Fig. 3, S7 is defined as “expand our web service” from S2. However, S4 and S7 are similar in that both improve

the web service. If both of these strategies are executed independently, investments are wasted due to redundancy. To improve efficiency, similar strategies should be identified and merged.

To avoid these three problems, organizations must identify and handle horizontal relations. Although the example of a GQM+Strategies grid in Fig. 3 is simple, an actual GQM+Strategies grid is more complex and much larger. In the case of the Japanese Aerospace Exploration Agency [10], the GQM+Strategies grid includes 24 strategies.

Horizontal relations tend to be missed because they are currently identified subjectively and superficially. In the next section, we propose an approach to identify and display horizontal relations.

3. Approach

We propose the Horizontal Relation Identification Method (HoRIM) to identify horizontal relations of strategies in GQM+Strategies grids. HoRIM detects the difference between an initial GQM+Strategies grid and the model obtained by applying Interpretive Structural Modeling (ISM) to the initial grid. ISM uses a relation matrix to determine the relations between any two elements. The hierarchical structure, which presents the relations between elements, is generated from the relation matrix.

ISM is mainly used to analyze relationships between elements (e.g., complex system elements) [18], for knowledge management barriers [19], and as educational factors [20]. Fuzzy Structural Modeling (FSM) [21], which expands ISM, can express the relation strength by fuzzy logic. In this paper, we employ ISM since FSM requires the more time to create the relationmatrix compared to ISM.

In general, a supervisor or promoter of GQM+Strategies reviews a GQM+Strategies grid as well as those who constructed the grid. Reviewers who can use HoRIM include the supervisor, promoter, and person who constructed the GQM+Strategies grid.

The contributions of HoRIM include:

- A reviewer can analyze the all relations between strategies with a relation matrix.
- A reviewer can initially identify whether horizontal relations exist between strategies. Then the type of horizontal relations can be determined.
- A reviewer can focus on only horizontal relations by removing excess relations.
- A reviewer can classify three or more strategies.

- A reviewer can refine the GQM+Strategies grid with the hierarchical structure of HoRIM.

Figure 4 overviews HoRIM to identify and handle the horizontal relations in the GQM+Strategies grid. After constructing the GQM+Strategies grid, HoRIM is applied via a review. HoRIM consists of the following steps:

- (1) Indicate the elements.
- (2) Judge the relations between strategies.
- (3) Generate a hierarchical structure.
- (4) Analyze and refine.

Step (2) and step (4) are manual, while step (1) and step (3) are semi-automatic and automatic, respectively.

Although identifying horizontal relations from a GQM+Strategies grid can be difficult, it is easy to judge the relations between strategy pairs. Strategy pairs are evaluated with the relation matrix in step (2). In step (3), which automatically generates a hierarchical structure from the result of step (2), the reviewer can understand the overall relations of the GQM+Strategies grid.

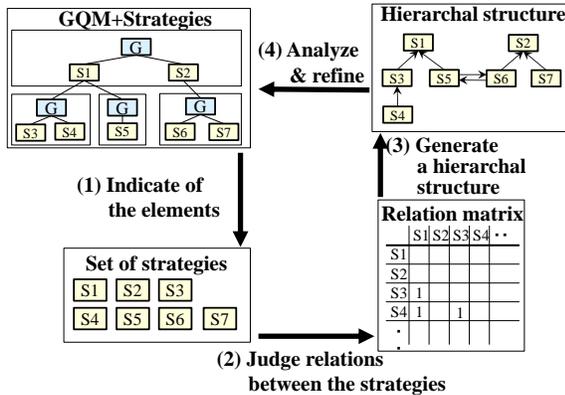


Figure 4. Overview of our approach

3.1. Indicate the elements

In this step, elements, which comprise the hierarchical structure, are listed. Some strategies in GQM+Strategies grids are defined as the elements. The extent that HoRIM is applied can be limited by listing a part of the strategies. For example in Fig.3, all strategies are defined as elements in order to apply HoRIM to the whole GQM+Strategies.

3.2. Judge the relations between strategies

In this step, a reviewer roughly identifies the relations between strategies. Relation matrix $A = \{a_{ij} | i, j=1, 2, \dots, n\}$ is created to express all direct binary relationships [18]. n means the number of the strategies which are the row and column of the

relation matrix. If the row and column elements are related, a value of 1 is input. If they are not, then a value of 0 is input. The diagonal elements are not evaluated in this step.

There are three kinds of relations between the rows and columns: affect/affected, support/supported, overlap/overlapped approaches, and targets of strategies. A unidirectional relation such as cause, affect, or support, is common in the ISM approach. The mutual relations of overlap are peculiar to our approach to express similar and conflicting strategies.

An additional contribution of a strategy is expressed by affect/affected and support/supported relations. Since similar strategies or conflicting strategies have the overlapped area of interest, they are expressed by the overlap/overlapped approaches and targets. In addition, the type of conflicting strategy, such as a negative influence, is expressed by the relation of affect/affected.

For example, Fig. 5 shows the relation matrix created based on the GQM+Strategies grid shown Fig. 3. S6, which is “develop the databases based on the customer characterization” supports S4, which is “add a new function to our web service” because the databases is useful for proposing the new function. In this case, 1 is input to a_{64} . S3, which is “increase the price of service”, overlaps S5, which is “decrease the price of service”, from the viewpoint of the price of service. Thus, 1 is input into a_{35} and a_{53} . In this way, any direct relations between two elements can be determined.

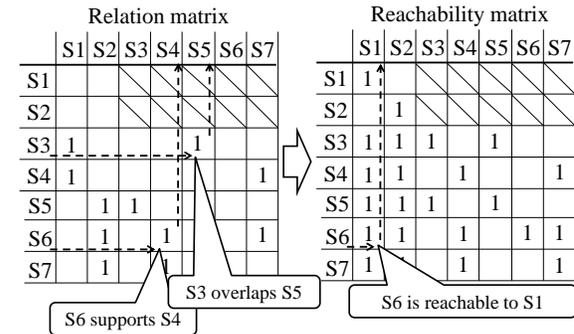


Figure 5. Relation matrix and reachability matrix

Several cells are input automatically. A value of 1 is input into elements of a vertical relation because the child strategy should contribute to the parent strategy. In this work, we aim to identify horizontal relations. Consequently, HoRIM does not inspect, vertical relations.

Because a higher-level strategy likely overlaps with a lower-level one, the relation of the higher-level strategy to the lower one does not need to be determined. When 1 is input for an element whose

row is a higher-level strategy but the column is a lower-level strategy, the hierarchical structure has circulation. The highest-level strategies should be placed at the top of hierarchical structure because the structure is compared to the initial GQM+Strategies grid in step (4).

3.3. Generate the hierarchical structure

In this step, the hierarchical structure is automatically generated by the same algorithm as ISM. First, reachability matrix M , which indicates the element itself and the column elements that can be reached by the row element [22], is calculated from the relation matrix. The reachable matrix in Fig. 5 is calculated in this manner. In this example, S6 can reach to S1 because S4 is related to S6 and has the relation to S1.

Reachability matrix M is calculated by the following equations

$$(A+I) \neq (A+I)^2 \neq \dots \neq (A+I)^k = (A+I)^{k+1} \quad (1)$$

$$M = (A+I)^k \quad (2)$$

"I" is the unit matrix. When $(A+I)$ to the power of $(k+1)$ equals $(A+I)$ to the power of k , then $(A+I)$ to the power of k is a reachability matrix.

Second, the reachability set and the antecedent set are calculated from the reachability matrix. The reachability set consists of the element itself and other elements that it may reach. The antecedent set consists of the element itself and the other elements that may reach it [23]. For example, in Fig. 5, the reachability set of S3 is S1, 2, 3 and 5. The antecedent set of S3 is S3 and 5.

Third, the intersection of the reachability set and the antecedent set is derived to separate the elements into different levels. The element where the reachability and intersection set are the same is the top-level element of the hierarchical structure. Physically, the top elements of the hierarchy will not reach to any element above their own level. Once the top-level element is identified, it is separated from the other elements. Then by repeating this process, the next level elements are found [23]. Table 1 shows the reachability, antecedent, intersection sets, and levels from the example in Fig. 5.

Table 1. Element levels

	Reachability set	Antecedent set	Intersection set	Level
S1	1	1 3 4 5 6 7	1	I
S2	2	2 3 4 5 6 7	2	I
S3	1 2 3 5	3 5	3 5	II
S4	1 2 4 7	4 6 7	4 7	II
S5	1 2 3 5	3 5	3 5	II
S6	1 2 4 6 7	6	6	III
S7	1 2 4 7	4 6 7	4 7	II

Finally, the rows and columns of reachability matrix M_2 are rearranged in order of the level of elements. In M_2 , if element S6 has a relation to element S2, which is two or more levels away from S6, the reachability sets of other elements with a relation to S6 are reviewed. If S6 can reach to S2 via other elements, the relation between S6 and S2 is removed, simplifying the hierarchical structure. From reachability matrix M_2 , the hierarchical structure is generated via vertices or nodes and lines of the edges. Figure 6 shows the hierarchical structure generated from the reachability matrix in Fig. 5.

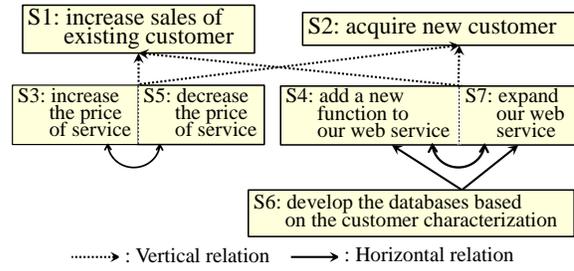


Figure 6. Hierarchical structure

3.4. Analyze and refine

In this step, horizontal relations are identified by the hierarchical structure and the GQM+Strategies grid is modified. To identify horizontal relations, all relations except vertical ones are considered in the hierarchical structure.

Similar and conflicting strategies are identified by checking the mutual relation. If the strategies use the same approaches and targets or negatively influence each other, they are probably similar or conflicting. For example, S4 and S7 in Fig. 6 have a mutual relation as both aim to develop a new service. Therefore, the relation between S4 and S7 is similar. Furthermore, S3 and S5 also have a mutual relation, whereas S3 and S5 have a conflicting relation because S3 aims to increase the price of the service, while S5 aims to decrease it.

The reviewer can identify additional contributions to the strategy by checking the unidirectional relation. For example, S6 has relations to S4 and S7, indicating that S6 has additional contributions to S4 and S7. In this way, the reviewer can identify horizontal relations within the hierarchical structure.

After identifying the horizontal relations, the GQM+Strategies grids are modified from the viewpoint of horizontal relations. An organization should separate the area of interest for each unit to resolve all similar and conflicting strategies. While unit 2.1 and unit 2.2 are separated by existing and new customers in the GQM+Strategies grid, both have the same areas of interest: service and price. Therefore, the organization should separate units by

existing customers, new customers, service, and price. The strategies about service or price are controlled by the higher-level unit.

A strategy with an additional contribution should be moved to a lower level than the strategy that it contributes to. Then the two should be linked. As S6 contributes to S4 and 7, S6 is placed so that it is under them, changing the GQM+Strategies grid of Fig. 3 into the one in Fig. 7. However, our proposal is only one example because the best GQM+Strategies grid depends on the organizational structure or principle.

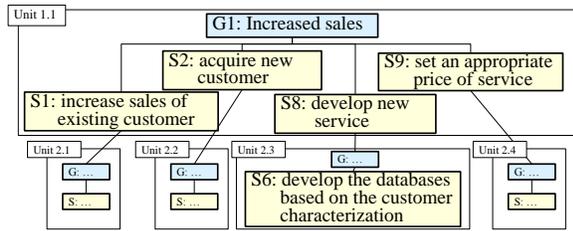


Figure 7. Refined GQM+Strategies grid

4. Evaluation

We compared the effectiveness in identifying horizontal relations by HoRIM and an ad hoc review, where each person subjectively identifies horizontal relations. During our evaluation and case study, we investigated the already indicated research questions in section 1 :

RQ1, which is the main question, evaluates the effectiveness of HoRIM. RQ2 indicates the efficiency, which is defined as the number of horizontal relations identified per minute, using HoRIM and an ad hoc review. This question examines the practicality of HoRIM. RQ3 is investigated by the case study in section 5 where HoRIM is applied to the GQM+Strategies grid of Recruit Sumai Company Co., Ltd., which provides services and products related to housing.

4.1. Experiment

To answer to the above research questions, we conducted experiments involving university students majoring in computer sciences. Figure 8 shows the experimental overview. The students were divided in two groups of three students each (Groups A and B). All students were familiar with how to model GQM+Strategies grids. Prior to the exercise, we explained the concept of a horizontal relation to the subjects.

In the exercises the subjects identified the horizontal relations from the received

GQM+Strategies grid. Both groups received the same GQM+Strategies grids, but one was asked to use HoRIM and the other an ad hoc review. When a horizontal relation was identified, the subject wrote down the set of strategies and the reason why the written strategies indicate a horizontal relation. There was no time limit; the exercise was finished when the subject thought that all horizontal relations were identified. We measured the number of identified horizontal relations and the time required to complete the exercise.

This experiment employed materials for GQM+Strategies introduced in other seminars. The domain of exercise 1 was a cosmetic company, while that of exercise 2 was a stationery company. Both GQM+Strategies grids included 3 level layers and had about 23 strategies. Group A completed exercise 1 by HoRIM, while Group B executed exercise 1 by an ad hoc review. In exercise 2, the methods were reversed for each group.

After the exercises, the subjects completed questionnaires. The questionnaires included questions about ease of identifying horizontal relations by each method and the utility of HoRIM. Each answer was ranked on a six-point scale. The results were used to determine the effectiveness of HoRIM.

The subjects used the College Analysis Ver5.1 [24]. College Analysis has a function to show the hierarchical structure from the relation matrix by ISM. The subjects created the relation matrix of the strategies, generated the hierarchical structure using the function of College Analysis, and analyzed the structure.

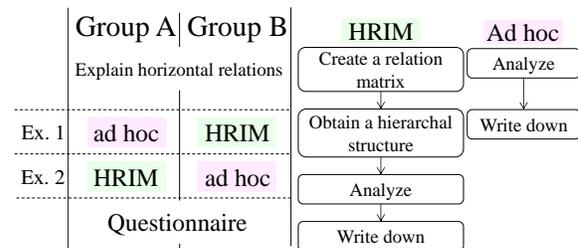


Figure 8. Experimental overview

4.2. Results

Table 2 shows the precision, recall, F measure, and time efficiency. After removing incorrect answers from the suggested horizontal relations, we aggregated the results. Dividing the number of the identified horizontal relations by the work time (minutes) determined the time efficiency. Therefore, a higher value means that the method is more efficient at identifying horizontal relations.

Table 3 shows the identification ease of conflicting strategies (CS), additional contributions

Table 2. Results of the experiment

		Precision	Recall	F measure	Number of correct horizontal relations	Work time (minute)	Time efficiency
Ex. 1	Ad hoc	1.00	0.44	0.61	5.67	17	0.30
	HoRIM	0.76	0.72	0.74	9.33	44	0.21
Ex. 2	Ad hoc	0.76	0.52	0.62	4.67	17	0.27
	HoRIM	0.87	0.70	0.78	6.33	42	0.15

Table 3. Results of the question, “Was it easy to identify the horizontal relation by an ad hoc review/HoRIM?”

	CS	AC	SS
Ad hoc	3.0	2.7	2.8
HoRIM	4.0	4.0	4.3

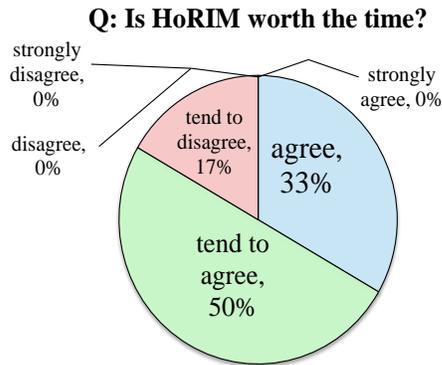


Figure 9. Results of the question, “Is HoRIM worth the time?”

(AC), and similar strategies (SS) based on the questionnaire results for the question, “Was it easy to identify the horizontal relation by an ad hoc review /HoRIM?” The responses were ranked on a six-point scale where 1 is “strongly disagree”, 2 is “disagree”, 3 is “tend to disagree”, 4 is “tend to agree”, 5 is “agree” and 6 is “strongly agree”. Thus, a higher value indicates that horizontal relations are easier to identify.

Figure 9 shows the results to the question, “Is HoRIM worth the time?” The subjects used the same six-point scale to respond.

4.3. Discussion

4.3.1. RQ1. According to Table 2, the average recall of HoRIM is about 1.48 times that of the ad hoc review, confirming that HoRIM is more effective. Subjects using HoRIM suggested relations involving three or more strategies compared to those using an ad hoc review, who identified relations between two strategies. These findings indicate that HoRIM helps understand more complex strategies, confirming it assists in analyzing complex GQM+Strategies grids

However, the precision of HoRIM is lower than that of the ad hoc review in the case of the cosmetic company in exercise 1. In addition, the group using

the ad hoc review in exercise 1 made more mistakes in exercise 2 using HoRIM. These results imply that not all suggested horizontal relations by HoRIM are correct. Most errors involved incorrectly identifying relations between the strategies in a unit as horizontal relations, indicating that the suggested horizontal relations must be examined.

It is subjectively easier to identify horizontal relations by HoRIM than by an ad hoc review (Table 3). When subjects searched for horizontal relations by HoRIM, they focused on non-vertical relations and easily identified horizontal relations.

4.3.2. RQ2. HoRIM requires more time to execute than an ad hoc review. The time efficiency of HoRIM is lower than an ad hoc review (Table 2) because creating the relation matrix in HoRIM is time consuming; the subjects had to check $n*n$ (n is the number of strategies) cells when creating the relation matrix. Although checking a cell is simple, much time is necessary due to the quantity of cells to be checked. Therefore, an efficient method should be created to easily create a relation matrix.

Although HoRIM requires more time, it is valuable due to the following three reasons. First, HoRIM can help to modify the GQM+Strategies in order to address horizontal relations. The hierarchical structure by HoRIM can provide an organization a logical argument for the GQM+Strategies grids and it can confirm whether the refined GQM+Strategies grid removes horizontal relations.

Second, it is important to understand the process and reasons why the GQM+Strategies grid is refined because this information is used when an organization reviews the grids to develop the next model.

Third, the questionnaire responses indicate that the benefits of HoRIM are produced in a reasonable time frame as 83% of subjects agree that HoRIM is worth the time (Fig. 9). Although an ad hoc review is more efficient than HoRIM, HoRIM identifies more horizontal relations. In addition, an ad hoc review cannot determine whether all horizontal relations have been identified. In conclusion, although an ad hoc review is sufficient for a simple GQM+Strategies grid, HoRIM effectively identifies and visualizes horizontal relations in a large and complex grid.

4.3.3. Threats to validity. One threat to internal validity is the difference between the abilities and experiences of the subjects. However, this bias was removed by dividing the subjects into two groups. Group A did exercise 1 by HoRIM, while group B did exercise 1 by an ad hoc review. Then the method assigned to each group was reversed in exercise 2. Both exercises show that HoRIM is more effective than an ad hoc review. However, the small sample size cannot confirm the precision and effectiveness of HoRIM. A larger experiment should be designed in the future.

There are two threats to external validity. First, the subjects were students with limited knowledge of the strategies in the GQM+Strategies grids. Second, only two GQM+Strategies grids (a cosmetic company and a stationery company) were examined. The small number of strategies may decrease HoRIM’s superiority because simple GQM+Strategies grids are easily analyzed.

5. Case study

To confirm that the information from HoRIM is useful for those who create and implement GQM+Strategies grids, we introduced GQM+Strategies to Recruit Sumai Company Co., Ltd., which provides services and products related to housing. We focused on their goal, “improved business proposals through a contest”, and constructed a detailed GQM+Strategies grid. We did not advise the company on the goals and strategies of their GQM+Strategies grid. Instead the company constructed the GQM+Strategies grid on their own.

Figure 10 shows part of their initial GQM+Strategies grid to which HoRIM was applied. The following three improvements were noted:

- S1 depends on the S6. Therefore, S6 should be linked to S1.
- S5 and S7 are similar. Therefore, they should be merged.

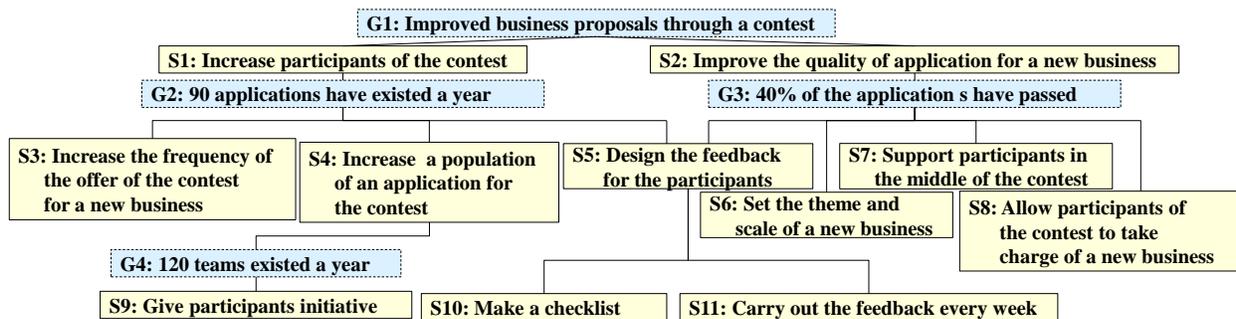
- S8 is one component of S9. Therefore, S8 should be moved so that it is under S9.

The first suggestion is the addition of a connection. S1, which specifies “increase participants of the contest”, was not linked to S6, which specifies “set the theme and scale of a new business”. However, the theme determines whether the number of participants increases or decreases. In other words, S1 depends on S6, and the theme should be set to increase the number of participants. Therefore, S6 should be linked to S1 to clarify this dependent relation between S1 and 6.

The second suggestion involves integrating strategies. S5 specifies “design the feedback for the participants” in the GQM+Strategies grid, while S7 specifies “support participants in the middle of the contest”. Because they are similar, they should not be treated as different strategies as this wastes resources. Therefore, S5 and S7 should be merged.

The third suggestion is to relocate a strategy. S8, which specifies “allow participants of the contest to take charge of a new business”, was not linked to S9, which specifies “give participants initiative”. In modeling the GQM+Strategies grid, we concluded that initiative means contest participants will take charge of the new proposed business. However, S8 was at a higher level than S9. To clarify that S8 is one component of S9, S8 should be moved to under S9.

Then, the group at Recruit Sumai Company evaluated our three suggested improvements to refine their GQM+Strategies grid. They commented that the horizontal relations identified by HoRIM were missed in constructing the GQM+Strategies grid. Although HoRIM is useful when refining the GQM+Strategies grid to clarify the relations between strategies, we misunderstood the intent of S6, which specifies “set the theme and scale of a new business”. The theme in S6 did not mean the subject but the scale of the new business proposal. Hence, the first suggestion was rejected, but the word “theme” was



*The figures in the goal sentences are different from the actual figures.

Figure 10. Part of the Initial GQM+Strategies grid of the Recruit Sumai Company

removed to improve clarity. Consequently, our suggestions using HoRIM clarified their GQM+Strategies.

Figure 11 shows the refined GQM+Strategies grid of the Recruit Sumai Company by HoRIM. The word “theme” in S6 is removed. S5 and S7 are merged into a new S5, which specifies “design the system to provide feedback to the participants anytime”. S8 in the initial GQM+Strategies grid is moved so that it is under S7. Hence, by applying HoRIM to an actual GQM+Strategies grid, the strategies of different branches are better aligned (RQ3).

6. Related work

The GQM+Strategies method has been expanded. V. Mandic and V. Basili et al. have suggested how to perform business value analysis (BVA) using the GQM+Strategies approach [25], which provides an organization with a benefit-cost evaluation to select the strategies. T. Kobori et al. [26][27] suggested the Context-Assumption-Matrix (CAM), which refines the GQM+Strategies model by extracting rationales based on analyzing the relationships between stakeholders.

Other studies have focused on the hierarchical structures of GORE models and integrating GORE models with the method related with hierarchical structures. Vinay et al. suggested that the output of GORE and Analytic Hierarchy Process (AHP) can be combined in order to produce a metric to determine the best alternative among candidates [28]. AHP supports decision making by a hierarchical structure. They use GORE to identify the goals. AHP is then used to prioritize soft goals. Although both their research and ours focus on the hierarchical structures of GORE models, they focused on how to determine the best alternative, while we emphasized how to

construct the best model.

Some studies have strived to refine goal models. H. Nakagawa et al. suggested an elaboration process to refine the goal model to help developers identify where changes are required in subsequent development processes [29]. They determined a rule in which similar goals should be merged to avoid unnecessary couplings. Although both their research and ours refine goal models, we aim to identify relations between elements before refining the goal model.

7. Conclusion and future work

GQM+Strategies grids frequently have relations between the strategies in different branches. The relations between two strategies in different branches are defined as horizontal relations. Horizontal relations include similar strategies, additional contributions, and conflicting strategies. To handle horizontal relations, an organization must identify the horizontal relations exhaustively and model the structure to clarify these relations. Therefore, we propose the Horizontal Relation Identification Method (HoRIM) to determine horizontal relations. Although it requires more effort, our experiment demonstrates that HoRIM improves the effectiveness of identifying horizontal relations.

In the future, we plan to develop a method that easily and quickly creates a relation matrix in HoRIM. For example, the future method will suggest noteworthy relations based on similarity and dependence by natural language processing. In addition, we plan to expand HoRIM so that it can distinguish the types of relations (e.g., a positive effect, negative effect, and overlap), which should improve the analysis of the hierarchical structures.

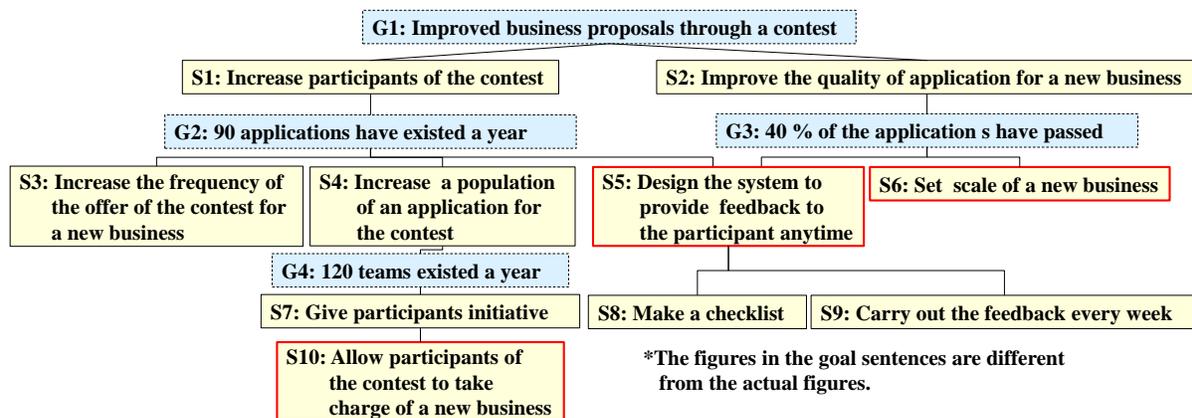


Figure 11. Refined GQM+Strategies grid of the Recruit Sumai Company

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