Is GQM+Strategies Really applicable as is to non-Software Development Domains?

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ABSTRACT

This paper reports on the ongoing experience of applying a variant of the GQM+Strategies approach to non-software development domains (e.g., military training domain). However, we found that it is not directly possible to apply the GQM+Strategies approach as is to non-software development domains, but it needs to be generalized, i.e., it needs to be turned into a context free approach. On the other hands, the required adaptations were very a few. Overall, we found so far that, apart from those specific adaptations, the GQM+Strategies approach can be effectively applied to those domains which have the same nature as software development (i.e., human-intensive domains). This practical application of the GQM+Strategies approach shows that the scope of this technology may be much larger than expected with great benefits for the software development industry.

Categories and Subject Descriptors

D.2.8 [**Software Engineering**]: Metrics – *performance measures*

General Terms

Management, Measurement, Economics.

Keywords

GQM+Strategies, Goal/Question/Metric paradigm, Metrics, Measurement, Software engineering.

1. INTRODUCTION

The idea of this paper stemmed from the assertion contained in the paper where the GQM+Strategies approach was defined [1]. The authors argued that "*Although we derived the approach from software development experiences, it is not necessarily applicable solely to this domain*". Actually, this was the same as we thought when we read the paper where the authors first presented the GQM+Strategies approach in 2007 [2].

Owing to the global financial crisis world-wide, which has strongly affected a number of domains all over the world and, in particular, the Defense one, in 2009, the Italian Army General Staff faced the problem that budget cuts, operated by the government, were as huge as never happened before. In practical terms, it seemed that the Army could no longer effectively sustain its activities for guaranteeing the service expected by the domestic

audience and the governments of the countries participating in the same Alliances as Italy (e.g., NATO).

To sustain military activities, the idea was to launch a strategy aiming at retaking control of all financial expenses over all Army business domains. Examples of Army business domains are: Human Resources, Military Training, Education, Logistics (i.e., materials, vehicles, weapons, ammunition, fuel, aircrafts, healthcare, food rationing, systems, quadrupeds etc.), Real Estates and Facilities, Public Information, Finance, Weapons acquisition, Advanced Technologies, Software Systems, Intelligence, Well-being of personnel etc.

As usual when dealing with budget cuts, the keyword to save money is "*optimization*". However, no one usually thinks that optimization is not for free and so, before applying it to real situations, a suitability analysis whether "*the cure may be worse than the disease*" should be performed. However, the optimization program was considered a good strategy to show the complete will of the Army toward saving public money. Additionally, for the activities that were not cut off, the optimization program could eventually increase the overall sustainability. These were the reasons why, even though the Return on Investment (ROI) of the optimization program was not accurately checked, the Italian Army undertook the program anyway and the Army research team was committed to finding a way of finalizing the optimization plan.

In this paper, we describe the ongoing work of figuring out whether it is really doable to adapt GQM+Strategies to non-software development domains, that is, if it is true that the measurement framework proposed by Basili et al. can be exported as is to other domains. The research questions which summarize the aim of this paper are the following [5]:
1) What kind of assumptions should we make to apply the GQM+Strategies approach to other domains?
2) To what extent is the GQM+Strategies approach exportable to other domains?
3) Can non-software development personnel easily apply software measurement frameworks to other domains?
4) Is it convenient (e.g., efficient and/or effective) from an economic point of view to apply the GQM+Strategies approach to non-software development domains?

Even though we did not answer all of the research questions listed above (in particular, question no. 4 and partially question no. 3), we positively answered the question whether it is true that *the approach [...] is not necessarily applicable solely to* software development domains. In fact, the experiences we have gained so far from working on this program seem to be extremely encouraging to continue on applying this technology to non-software development domains.

2. BACKGROUND

2.1 Motivations

The GQM+Strategies approach completes the GQM paradigm in the parts where the latter was lacking a way of linking software development and business strategy at all levels. What we have found very interesting both in general terms and compared to other goal-oriented approaches such as Balanced Score Card [4] and Practical Software Measurement [6], is that the GQM+Strategies approach:

- Is based upon a sound and tested measurement framework as GQM which provides a way of defining goals, specifying them into the data to be collected and analyzed, and interpreting the data with respect to the original goal [1], avoiding that useless, harmful, and expensive variables may be collected,
- Allows for improvements over time. In fact, both GQM+Strategies and GQM can be applied in the context of the Quality Improvement Paradigm (QIP) [3],
- Uses an interpretation model which is known beforehand, so that each organizational level can receive fair performance evaluations without any surprise,
- Can explicitly motivate and integrate the measurement of goals at different organizational levels. The problem is that huge organizations (e.g., military forces, federal police, healthcare system etc.), where their levels of responsibility are represented by complete departments composed of hundreds of people, need to organize their measurement programs/performance analyses into different levels having specific strategies, contexts, assumptions, and goals.

Another positive aspect, that other approaches do not have, is that each GQM+Strategies level contributes to satisfying goals at other organizational levels.

A keystone question is then: Is it conceptually correct to apply GQM+Strategies to non-software development domains? As broadly known, software development is a human-intensive activity implying that success and failure of the development process strongly depends on the human factor. To put it simply, the human factor is represented by knowledge, experience, and current attitude/motivation of each person taking part in the development process. When scope and complexity of what is being produced increase, the situation does not change at all. To succeed, we need people having more knowledge, more experience, and more attitude/motivation.

Our experience was that, we can apply GQM+Strategies to those domains which have the same nature as the domain of software development. In other worlds, we may fairly apply GQM+Strategies to those domains that are strongly based on the human factor, i.e., where *knowledge*, *experience*, and *current motivation/attitude* of each person participating in the activity make the success or the failure of the activity.

Since planning activities such as the ones developed in the public sector (e.g., defense, security, healthcare, and so forth) are conceptually very close in nature to software development and since organizations that support and develop those activities are organized in many levels, GQM+Strategies is a excellent candidate to be used everywhere better than similar approaches that do not take into account organizational levels.

2.2 Assumptions

Before applying GQM+Strategies within domains different from software development, we need to specify some assumptions and redefine some elements. The GQM+Strategies approach considers at least three levels 1) business level, 2) software level, and 3) project level. Bluntly enough, if we want to apply GQM+Strategies outside the software domain we have to specify the scope of these three levels, even though conceptually the new ones do not change at all. The proposed mapping is the following:

- Business level into *Conceptual/Strategic level*,
- Software level into *Organizational/Design level*, and
- Project level into *Production/Execution level*.

It is important to note that, what we call conceptual level is actually the highest organizational abstraction where an organization determines how to succeed in those activities that are strategic for the existence of the organization itself. In other words, this level is what usually is called the strategic level where the organization decides its future, i.e., its prospective existence. GQM+Strategies allows us to define specifically goals and strategies for this level so that, once we apply the GQM approach, we can check whether or not the strategy, at that level, was successful.

The organizational level is the level where we define the goals and strategies that are specific for a certain domain. We may also identify this level as the d*esign level* where we devise all of the organizational details to satisfy the stated goals.

The production level is the level where we execute what we have conceived in previous levels.

3. AN APPLICATION

To illustrate the generalization of the GQM+Strategies approach to non-software development domains, we consider a real domain where we have executed that generalization. This domain is the training branch of the Italian Army, which is a representative kind of domain where the GQM+Strategies approach may be effectively used. The organization XYZ that we refer to is a generic military unit such as Regiment, Brigade, and Division. XYZ needs to complete the usual military training using -10% of budget with respect to the previous financial year. What we illustrate for XYZ can be used for higher levels of responsibility up to the top of the military hierarchy. However, for the sake of simplicity, our explanation is limited to XYZ, even though we applied the approach more broadly.

3.1 Strategic goals

The complete generalized GQM+Strategies model, adapted to XYZ in the domain of the military training branch, is shown in Figure 2 (see Appendix 1). As we know, GQM+Strategies allows finding the relevant context factors and assumptions which are necessary for dealing with the stated goals. In our example, one context factor refers to the training expense which in turn has to be taken into account (Figure 1).

The complete GQM goal for G1 (Figure 2) is:

> **Analyze** the training expense **for the purpose of** evaluation **with respect to** a 10% cut in annual budget per year **from the point of view** of XYZ's training branch **in the context of** the XYZ unit

This goal leads to questions Q1 and Q2, that is:

Q1: What is the current training expense? Measured by **E:** current training expense.
Q2: What is the percentage of budget cuts for this year, year 2 and year 3? Measured by BC_X: percentage of budget cuts year X.

Based on the interpretation model related to G1, the decision whether or not the strategic goal "Reduce the training expense by 10%" has been satisfied can be made. Therefore, what we really evaluate is the strategy (i.e., Strategy 1) associated with this strategic goal.

The interpretation model says that:
Starting in year 2, if $(E_1-E_2)/E_1 >= BC_2$ then the goal has been satisfied. The assumption is that the training activities are performed meeting all the stated regulations.

Activity:	Decrease
Focus:	Expense
Object:	Military training of XYZ
Magnitude:	-10% per year
Time frame:	Annually, beginning in 2 years
Scope:	Operational units assessed to operate home and abroad
Constraints:	To meet the specific training regulations
Relations:	/

Figure 1. Strategic Goal "Reduce the training expense by 10%" illustrated by a GQM+Strategies goal template.

3.2 Organizational /Military Training goals
Goal 2 is to apply a selective training approach in order to reduce the number of trainees by xx. Goal G2 leads to question Q3, Q4, and Q5, that is:
Q3: What is the elementary training expense per trainee? Measured by **ET**: elementary training expense per trainee.
Q4: How many trainees are experienced? Measured by **TE**: no. of trainees who are experienced.
Q4: How many trainees are not experienced? **TNE**: no. of trainees who are not experienced.

Unfortunately, if we want to satisfy G2 we need to reduce the number of trainees by a specific number xx. To satisfy goal G2 we first calculate:
ET = E/(TE+TNE), elementary training expense per trainee, then if $ET_2 \cdot TE_2 / E_1 >= BC_2$ then both G1 and G2 are satisfied because the number of experienced trainees is fairly enough to reduce the expense by 10% and then $TE_2 <= xx$.

3.3 Production-specific goals
The lowest goal level in Figure 2 is composed of goals derived from the higher strategy levels. Goal 3 is to "check the overall training ability". In other words, it is necessary to understand whether those who did not receive the elementary training (non-experienced trainees) keep comparable training abilities with respect to those who received the complete training.

Goal 3 leads to questions Q4 (seen above), Q5 (seen above), Q6: What is an acceptable confidence level in evaluating the performance of those who received the training against the others? Measured by **CO**: confidence in evaluating the difference in training.

The interpretation model says that once we randomly collect a significant number of trainees from those who are experienced and non-experienced, we can check their training result (e.g., fire accuracy) and then empirically evaluate whether there is any significant difference between their results by the stated confidence CO.

4. CONCLUSION
In this paper we have shown that so far the GQM+Strategies approach can be effectively applied to non-software development domains. However, our experience shows that, people who are not familiar with the GQM methodology usually find the GQM+Strategies approach quite hard to understand.

This means that, before applying the GQM+Strategies approach to other domains, an intensive training on goal-oriented measurement approaches and on the GQM methodology is required. It would increase the total cost somehow.

Since the reduction of expense is currently affecting all of the sectors world-wide, we believe that the answer to the optimization problem can only come from suitable measurement programs, which can show whether or not the organization is effectively using its money, i.e., satisfying its goals.

We finally believe that, to avoid that the stated measurement programs may result in a complete costly failure, the GQM+Strategies approach, harnessed by context-free features, may be the right answer to the measurement problems at different levels of the organization.

5. ACKNOWLEDGMENTS

6. REFERENCES
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Appendix 1

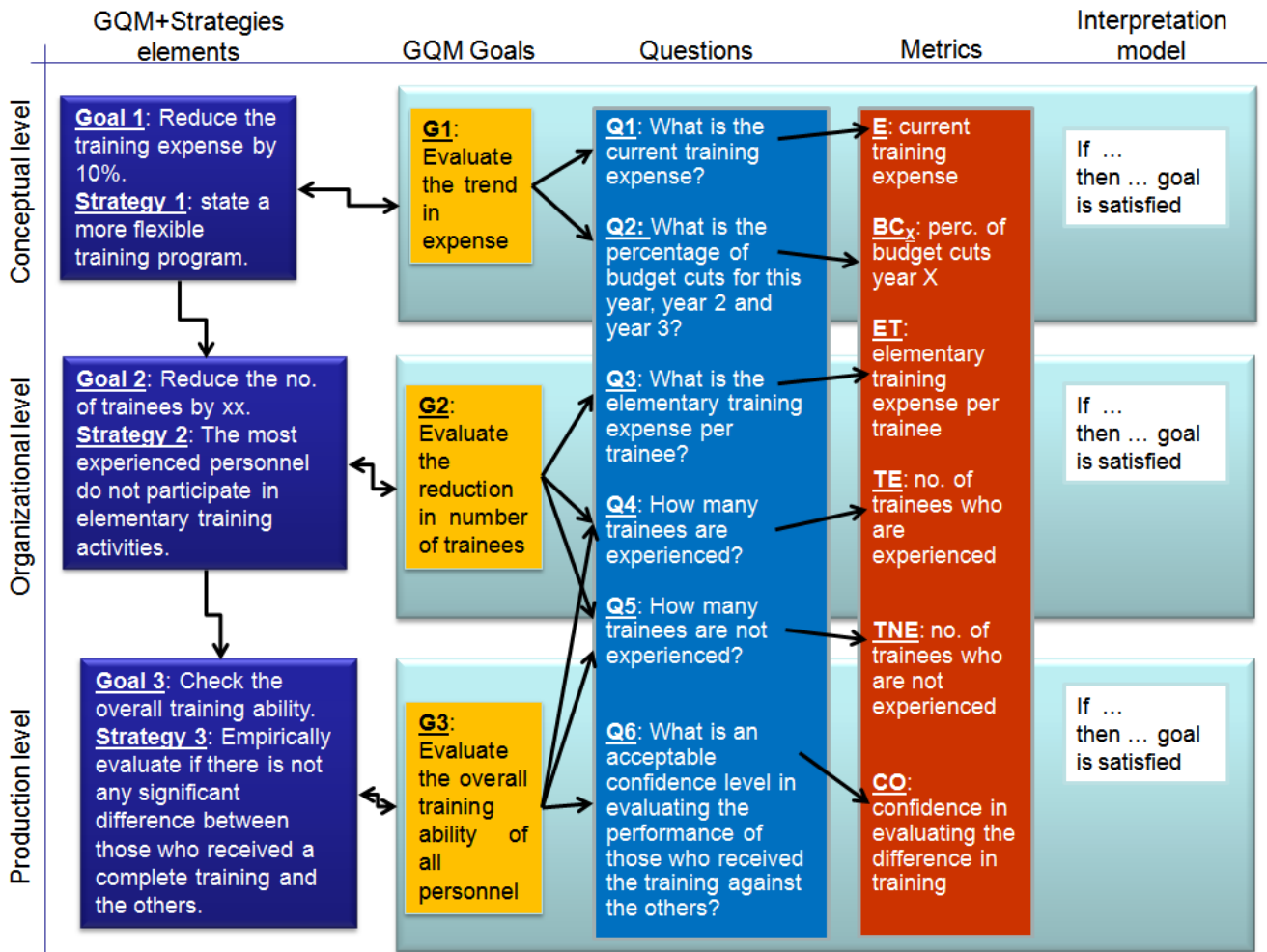| GQM+Strategies elements	GQM Goals	Questions	Metrics	Interpretation model
Conceptual level **Goal 1**: Reduce the training expense by 10%. **Strategy 1**: state a more flexible training program.	**G1**: Evaluate the trend in expense	**Q1**: What is the current training expense? **Q2**: What is the percentage of budget cuts for this year, year 2 and year 3?	**E**: current training expense **BC$_x$**: perc. of budget cuts year X	If … then … goal is satisfied
Organizational level **Goal 2**: Reduce the no. of trainees by xx. **Strategy 2**: The most experienced personnel do not participate in elementary training activities.	**G2**: Evaluate the reduction in number of trainees	**Q3**: What is the elementary training expense per trainee? **Q4**: How many trainees are experienced? **Q5**: How many trainees are not experienced?	**ET**: elementary training expense per trainee **TE**: no. of trainees who are experienced **TNE**: no. of trainees who are not experienced	If … then … goal is satisfied
Production level **Goal 3**: Check the overall training ability. **Strategy 3**: Empirically evaluate if there is not any significant difference between those who received a complete training and the others.	**G3**: Evaluate the overall training ability of all personnel	**Q6**: What is an acceptable confidence level in evaluating the performance of those who received the training against the others?	**CO**: confidence in evaluating the difference in training	If … then … goal is satisfied

Figure 2. An adaptation of a GQM+Strategies model [1] to a domain different from software development. The domain is the military training of the Italian Army that, in 2009, experienced drastic budget cuts. GQM+Strategies was experimentally used to figure out whether or not the stated strategies at different levels of responsibility were successful.