BALANCED SCORECARDS AND GQM: WHAT ARE THE DIFFERENCES?

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Abstract: *This paper compares two quantitative approaches recommended for developing and supporting software process improvements, that is, the Goal-Question-Metric (GQM) technique and the Balanced Scorecard (BSc) framework. While both offer the opportunity to implement a quantitative analysis of software projects, they are often misinterpreted as either interchangeable or, on the contrary, mutually exclusive. After summarising the key aspects of the two approaches, three main characteristics are proposed as a basis of comparison: measurement object, nature of the approach and strategy. These make it possible to identify similarities as well as key differences. In particular, it will be illustrated that strategy is the key point of differentiation between the two. More specifically, the added value in the BSc approach resides in its structuring of a causal relationship chain among the business goals of the various perspectives, which allows for a proper alignment of business and operative goals for achieving success. Examples of the research effort on the joint use of GQM and BSc are presented, as well as the way in which they can contribute to improving the extensions of BSc to the IT field, such as improvements to the ESI-Balanced IT Scorecard (BITS).*

Key words – GQM, Balanced Scorecard, strategic alignment, performance measurement, metrics.

Conference Topics – IT Balanced Scorecard, Measurement support for business process change, Software Process Improvement.

1. Introduction

Until a few years ago, many companies had relegated the management of their software development process to their technical staff who were without proper professional management training. Growing competition and decreased time-to-market, as well as poor performance in terms of meeting cost and schedule commitments, has raised the awareness of management to the need to take control of this component which is increasingly critical to the success of their business. To improve success rates in terms of quality, productivity and scheduling commitments, the Software Process Improvement (SPI) paradigm gained considerable following in management circles during the '90s. This paradigm is variously defined as: "*The continual and iterative improvement of both the software process and products through the use of project experiences*" [NASA95]; "*A deliberate, planned methodology following standardized documentation practices to capture on paper (and in practice) the activities, methods, practices, and transformations that people use to develop and maintain software and the associated products. As each activity, method, practice and transformation is documented, each is analyzed against the standard value added to the organization*" [SZYM96]; and "*A plan derived from the recommendations of a software process assessment (SPA) that identifies the specific process capability and performance*" [PAUL93]. Each of these definitions "captures" a possible dimension, from interaction to the need for documentation, from process assessment to the achievement of business goals.

There are four basic tenets behind SPI [KUNT97]:

- Evolution is possible and it requires time and resources;
- At higher process maturity levels, risk decreases and performance increases;
- Evolution implies the existence of a predefined sequence to keep processes under control;
- Organisational maturity will decrease if it is not maintained over time.

There are two generic types of approach to Process Improvement [THOM94] [PFLE94]:

- **Analytic models**. These are *open, goal-oriented, measurement-based* and *bottom-up-driven.* This type of approach uses quantitative evidence in determining where an improvement is needed and, later, whether or not the improvement initiative has been successful. The Plan-Do-Check-Act Cycle, by Shewhart & Deming, and the GQM technique [BASI84] can be categorised as analytic models. There are few organisations which create *ad hoc* measurement programs, just for their own processes[1];
- **Prescriptive models**. These are *closed, staged, assessment-based* and *top-down-vision-driven*. This type of approach uses a formal and prescriptive improvement model which includes a structured set of practices. A basic assumption with this type of approach is that the defined roadmaps of these prescriptive models have general validity. SW-CMM© and similar formal SPI models can be categorised as prescriptive SPI models.

This paper briefly reviews both types of model, and, through an example, compares them. In section 2, a summary of the Goal-Question-Metric (GQM) technique and its evolution are presented. In section 3, some limitations of prescriptive models for software process improvement are described, and both GQM and BSc are introduced as candidate support approaches for quantitative analysis. In section 4, key characteristics of the Balanced Scorecard (BSc) and its variants for the IT field are described, while in section 5, the way in which the alignment with business goals is achieved in a software context is illustrated. Then, in section 6, the comparison between GQM and BSc is presented, as well as the way in which each can bring added value in aligning software process initiatives with business needs. Finally, a summary of observations is given in section 7.

2. Goal-Question-Metric (GQM) technique

The Goal-Question-Metric (GQM) technique, an example of the first type of approach, is widely used in the IT field for determining software project measures. It was originally developed to quantitatively define goals and monitor achievements at NASA's Goddard Space Flight Center. This technique, proposed by Victor Basili et al. in the early '80s [BASI84] [BASI85], has since been refined and improved. The basic mechanism, which provides a practical approach for bounding the measurement problem, is the following: for each goal an organisation wants to achieve, a set of related questions must be established, each of which can be answered through the selection of one or more numerical values (metrics).

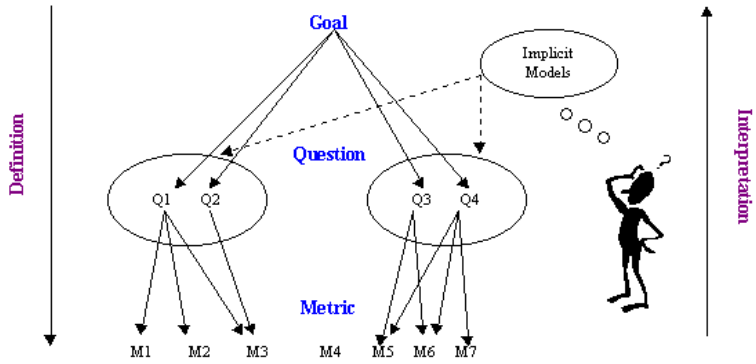

Figure 1 **–**Goal-Question-Metric (GQM) approach

Over the years, this technique has been enhanced by adding new elements such as multi-perspective goal analysis, an improvement cycle (QIP – Quality Improvement Paradigm) [BASI93] and categorisation of information in a more formal way [BASI88], [OFFE97], [SOLI99] [GRAY97].

However, a problem not explicitly addressed by this technique is the alignment between the technical and business objectives in an

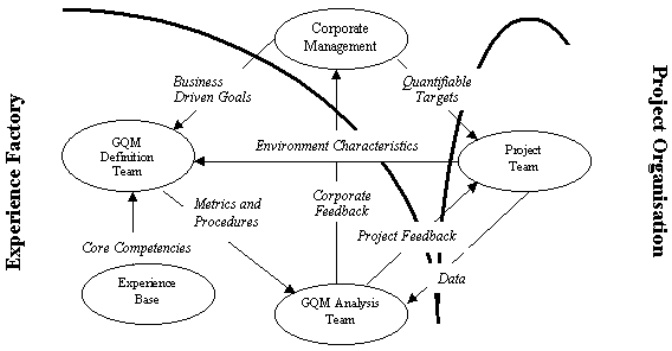

Figure 2 - The Experience Factory

[1] "*There is no **right** way to improve quality. Every organization must come up with an approach that works for them [...] A **solution** imposed from the outside is by definition **not** the answer*" [PYZD92].

organisation, and this question was only partially addressed later in the Experience Factory [BASI94], where four categories of stakeholder were defined: GQM definition team, GQM analysis team, project team and corporate management. But the main object of interest for measurement activities in GQM has been, and remains, the software project. However, every business and environmental element is still considered from a technical viewpoint.

3. Software Process Improvement approaches

Aligning software development objectives to overall business goals is crucial to achieving business success. A fairly simple example is provided below to illustrate the second type of approach, a prescriptive model for implementing an SPI initiative [REO00]. For the implementation of an SPI in organisation XYZ, the **basic organisational requirements** were identified as:

- on-time delivery, and
- highly reliable software;

and its **differentiator requirements** were:

- increased functionality,and
- relationship management.

In the prescriptive model of SW-CMM© version 1.1, Level 2 would have been the path selected (the roadmap) for this organisation, with the following two prescriptive-level Key Process Areas (KPAs):

- Requirements Management (**RM**)
- Software Project Planning (**SPP**)
- Software Project Tracking and Oversight (**SPTO**)
- Software Subcontract Management (**SSM**)
- Software Quality Assurance (**SQA**)
- Software Configuration Management (**SCM**)

However, a direct mapping of the KPAs, without the constraints of a stage model, to the specific organisation's requirements would have been as follows:

Basic requirements achievable through:

- Software Project Planning (SPP) – ML2
- Project Tracking & Oversight (PTO) – ML2
- *Peer Reviews (PRs) – **ML 3***
- *Software Product Engineering (SPE) – **ML3***

Differentiators achievable through:

- Requirement Management (RM) – ML2
- Software Quality Assurance (SQA) – ML2
- *Software Product Engineering (SPE) – **ML3***

This illustrates that organisation XYZ needs to implement some Level 2 KPAs (but not all of them), as well as some at Level 3. This provides an illustration of how staged models in specific instances do not address the requirements of a specific business context in an optimal way[2]. However, a new management framework based on measurement has recently gained market attention in management circles: the Balanced Scorecard (BSc). The BSc basically uses a decomposition-style GQM to identify a list of indicators for each driver related to each goal the company is pursuing. The BSc was initially developed in the business domain, but it has recently been adapted to the specifics of the software domain.

Because of these similarities and commonalities, a question frequently asked about the BSc is as follows: "*So, is using the GQM the same as using the BSc? What are the differences, if both techniques adopt the same three-tier decomposition format from goals to measures?*" Indeed, both offer the opportunity to implement a quantitative analysis of software projects, and this has led to misinterpreting them as either interchangeable or, on the contrary, mutually exclusive. Further comparative analysis of both similarities and dissimilarities is therefore required.

[2] There is an implicit admission of the relevance of this open problem in the new SEI initiative, Capability Maturity Model Integration (CMMI) [SEI99]. CMMI models can be represented in a staged or in a continuous way. In the first, the consolidated path traced by the well-known CMM models is followed, while the second, based on the SPICE architecture heritage (the new and upcoming ISO/IEC 15504 standard on Software Process Assessment & Improvement), is designed to overcome the above-mentioned problem.

4. Balanced Scorecard (BSc)

Kaplan and Norton have defined the Balanced Scorecard (BSc) [KAPL96][3] as a multi-dimensional framework for describing, implementing and managing strategy at all levels of an enterprise by linking objectives, initiatives and measures to an organisation's strategy. The scorecard then provides an enterprise view of an organisation's overall performance by integrating financial measures with other key performance indicators around customer perspectives and internal business processes, and around organisational growth, learning and innovation. It must be noted that the BSc is not a static list of measures, but rather a framework for implementing and aligning complex programs of change, and, indeed, for managing strategy-focused organisations. In summary, a scorecard is to be used to facilitate the translation of strategy into action.

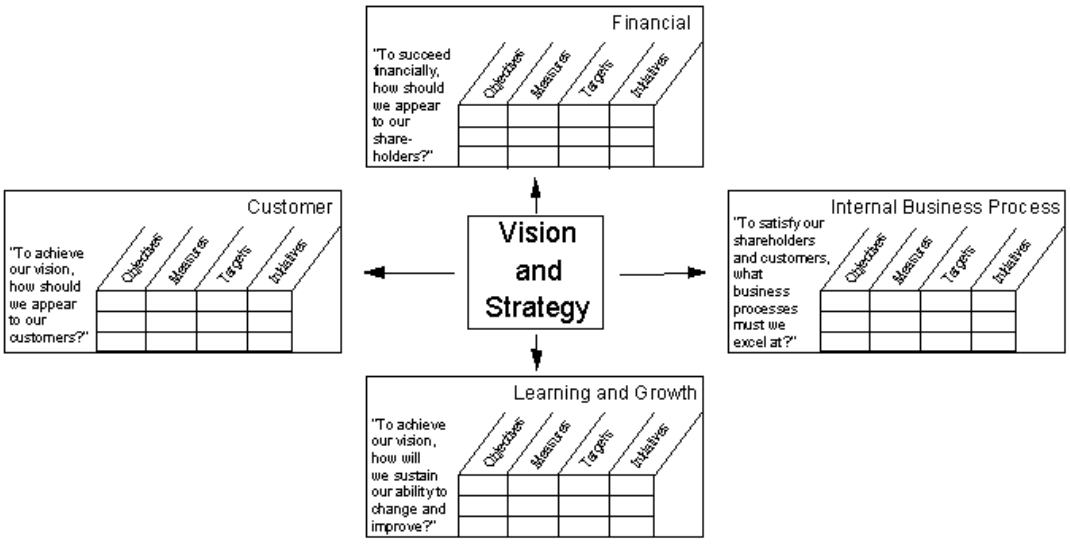

Figure 3 – *Balanced Scorecard: original perspectives*

The BSc provides a framework for studying a causal link analysis based on internal performance measurement through a set of goals, drivers and indicators (lag and lead types) grouped into four different perspectives:

- ✓ Financial: typically relates to profitability – measured by ROI, ROCE and EVA, for instance;
- ✓ Customer: includes several core or generic measures of the successful outcomes of company strategies - for instance, customer satisfaction, customer retention, and market and account share in targeted segments;
- ✓ Internal processes: focuses on the internal processes that will have the greater impact on customer satisfaction and on achieving the organisation's financial objectives;
- ✓ Learning and growth: identifies the infrastructure the organisation has to build in order to create long-term growth and improvement through people, systems and organisational procedures.

According to Renaissance [4], a good BSc should tell the story of the organisation's strategy. Three criteria help in determining whether or not this objective has been achieved:

- **Cause-and-effect relationship**: *every measure selected should be part of a cause-and-effect relationship (causal relationship chain) that represents the strategy;*
- **Performance Drivers**: *the drivers of performance (lead indicators) tend to be unique since they reflect what is different about the strategy of a company. They should be properly mixed with lag indicators;*
- **Linked to financial indicators**: *while there is a proliferation of new strategic goals such as quality, customer satisfaction or innovation, these goals must also translate into measures that are ultimately linked to financial measures.*

The key concepts of the BSc date back to Epstein & Manzoni [EPST97] and to the concept of the *Tableau de Bord* which emerged in France at the turn of the 20th century. The aim of the

[3] [KAPL96] is an extended and more comprehensive reference on the BSc. The first two publications on the BSc by Kaplan and Norton are [KAPL92] [KAPL93].

[4] http://www.balancedscorecard.com

Tableau was to translate each company's unit vision and mission into a set of objectives, passing through the identification of Key Success Factors and Key Performance Indicators.

The relevance and effectiveness of the BSc in the business world has been recognised by the Harvard Business Review (HBR) which identifies it as one of the most important management practices of the past 75 years[5]

5. Aligning Software Process Improvement with business goals [BUGL99]

Software Process Improvement (SPI) is not a goal in itself. ISO defines process improvement as an "*action taken to change an organisation's processes so that they meet the organisation's business needs and achieve its business goals more effectively*" [ISO95]. SPI is therefore a means to achieve better business results by continuously improving the performance of the software processes. While it is expected that improving the software process will result in better business results, measures are needed to verify, in business terms, the return on their investments in process improvements.

The value added by aligning internal processes and activities with business objectives has been recognised as an important factor in maintaining business competitiveness. One of the best-known examples is Porter's Value Chain [PORT85], which emphasises the need to identify those activities that directly add value to both internal and external customers. Whether the business strategy is to serve customers on time or to ensure that they receive the appropriate product for their needs, internal processes need to reflect the strategy selected. If the processes have been adequately aligned with the organisation's objectives, anyone external to the organisation should be able to identify the company's strategy simply by observing its processes. However, how does the manager of a Software Intensive Organisation (SIO[6]) identify and define the critical and value-added activities that support the business strategy?

The principles of the strategic management system developed by Kaplan and Norton address two critical issues:

- the alignment of the processes with the strategic business goals, and
- the identification and application of measures to comprehensively manage the performance of a business unit.

When organisational and project-level strategies are not aligned (Figure 4), an SIO can suffer negative consequences, such as:

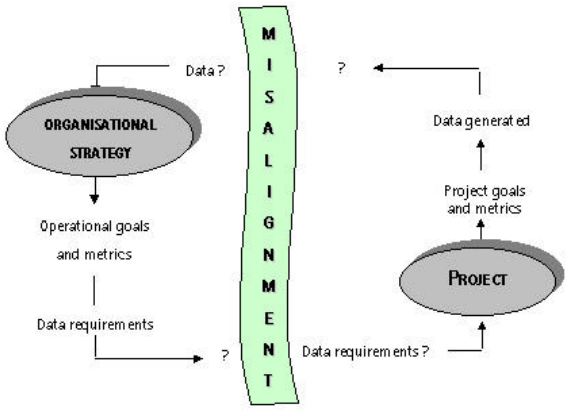

Figure 4 - *Organisational and project level strategy misalignment* [BECK99]

- a corporate strategy which is unknown or not used in the development of project goals and measures;
- data collection at the project level which does not support organisational goals;
- financial indicators tending to drive corporate decision-making;
- measurement carried out mechanically with no clear purpose;
- measurement carried out in isolation from other projects.

Two interesting ways to tailor the Balanced Scorecard have been proposed for the IT domain: the Balanced IT Scorecard (BITS) [IBAÑ98] [REO99a] [REO99b], proposed by the European Software Institute (ESI), which provides a new version of the four original perspectives (financial, customer, internal process, infrastructure and innovation) and the BSc of Advanced Information Services Inc. [FERG98] [FERG99], which considers the "employee" element as a distinct perspective[7], thereby expanding the analysis to five elements (financial, customer, employee, internal business process, learning and growth).

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[5] http://www.bscol.com

[6] SIOs are organisations whose main objective is software development and selling or software, departments of organisations that develop software as integrating part of its final products, or organisations that develop software for internal use to achieve better business results, or whose software department can be qualified as an independent organisational unit. This definition originated at the European Software Institute in 1997.

[7] Information from the employee perspective is obtained by surveying employees and asking each person to prioritise the KPA of the P-CMM. The strategic objective of this perspective is to "consistently meet or exceed employee

Particular attention is paid here to the first of these. The ESI has adapted and extended the principles of the Balanced Scorecard to provide a well-defined approach to quantitatively managing SPI programmes in SIOs. The technology is specifically oriented towards SIOs which are aimed at introducing a quantitative management system to monitor business performance and to support the decision-making process with quantitative evidence. It provides an easy-to-use and widely applicable method for quantitatively managing SPI programmes and validating their effect on organisational business goals. More specifically, BITS supports:
(a) the identification and prioritisation of software process improvement needs derived from the organisation's business goals;
(b) the agreement and communication of the business strategy among the SIO's manager, sponsor and software engineers, thereby strengthening the required commitment from all parties;
(c) the identification of the critical set of factors affecting the achievement of the SIO's business goals;
(d) the selection of the minimum set of indicators to monitor the performance of the software processes.

The four distinct perspectives, derived from the original scorecard, are[8]:
- **Financial Perspective**: How do our software processes and SPI add value to the company?
- **Customer Perspective**: How do we know that our customers (internal or external) are delighted?
- **Process Perspective**: Are our software development processes performing at levels sufficient to meet customer expectations?
- **Infrastructure & Innovation Perspective**: Are people, process, technology and organisational infrastructure issues being addressed to implement a sustainable improvement program?

A new, fifth perspective has recently been added, the **People Perspective**. In fact, personnel are the "prime material" (do you mean "raw material"?) of software development. The knowledge and experience of people represent a most important asset and should not be relegated to the infrastructure level. Competence, satisfaction and retention are the three drivers to reaching higher productivity levels [REO00].

6. A comparison of the Balanced Scorecard and GQM

Because they have some similarities, there has been a perception that the BSc and GQM are interchangeable: both have a three-tier structure and both strive to determine measures from business goals. For a more detailed comparison, three main points are investigated in this section:
- Object of measurement
- Nature of the tool
- Strategy

First, the **object** of the measurement activity in the BSc is the *organisation* (an SIO in the IT field), while in GQM it is the *project* that is the object of measurement. Even in the Experience Factory/QIP, the use of business and environmental data has a project focus and not an organisation focus.
Second, they are different in **nature**. The GQM can be defined as a *technique*[9] for obtaining and deriving quantitative measures from a list of goals, while the BSc can be viewed as a *performance management framework*. In a BSc, a GQM-like technique is used to derive the indicators, but this represents just one element of the framework. In fact, a BSc is a multi-level management tool which helps an organisation through the monitoring of four (or more) different perspectives which co-exist. Table 1 lists the correspondence between GQM and BSc elements, the so-called GDI (**G**oal-**D**river-**I**ndicator) elements.

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expectations for training, compensation, communication, work environment, performance management, and career development."

[8] Edberg [EDBE97] proposes a different view on how to adapt a BSc approach for IS measurement. In this case, the original four perspectives are translated in new four ones: project, product, process and performance. But the focus is limited to a single part of the organisation.

[9] Also, Offen & Jeffery [OFFE97] define the GQM *as "an explicit measure selection technology, which is a means for selecting measures that readily illuminate and support the achievement of business and development goals.*"

GQM	BSc	COMMENTS
Goal	Goal	*GQM goals are referred to a project, while BSc goals are referred to a certain particular perspective and a certain particular tier in the organisational pyramid (hierarchy).*
Question	Driver	*The BSc Drivers can be compared to GQM Questions since they represent the way to express how a goal can be achieved*
Metric	Indicator	*The BSc (lead) indicators can be compared to the GQM Metrics, since they reflect the control mechanisms and values used to verify the (indirect) achievement of goals (through the selection and use of a particular driver)*

Table 1 –Comparison of GQM and BSc structures

Third, the BSc takes into account the **strategy** of the organisation, one in which there is a common thread linking all the elements of the framework: the BSc foresees a chain of causal relationships among the various perspectives, as in Porter's *value chain*, which represents the path of the relationships among the goals, and their type, from the active to the passive ones. GQM, by comparison, considers only the analysis of project data[10]. This point can be easily demonstrated by simply looking at the outcomes produced by the two approaches: a measurement plan (GQM) and a strategic map for the analysis of relationships across data measurements collected (BSc).

Goal # x

Analyse (*object*)
for the purpose of (*purpose*)
with respect to (*quality focus*)
from the viewpoint(s) of (*viewpoint*)
in the following context (*environment*)

List of the "Question & Metric" elements deployed with a comment on results achieved:

Q1 .....
Q1.1 .....
M1.1 .....
M1.2 .....

Figure 5 – GQM Plan example

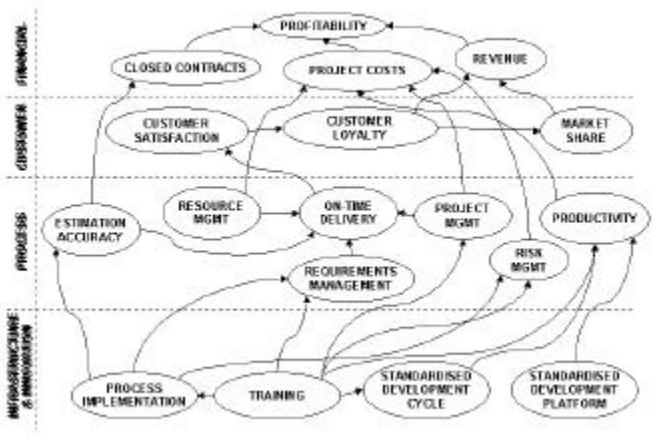

Figure 6 – *ESI BITS strategic map* [REO00] © ESI 2000

There is, of course, a clear parallel between the decomposition of the GQM goals in question and the solution of questions through the list of measures, and the decomposition of BSc goals into drivers, which can be achieved through a quantitative control on the performance indicators. However, the higher-level strategic view is missing from the GQM technique. Thus, interpreting GQM as a substitute for the BSc would be a mistake.

So, once this question (*Are GQM and BSc interchangeable?*) has been answered, the next one could be: "*Is GQM more inclusive than BSc, or vice versa?".*
The question of the inclusiveness of GQM was investigated by Offen & Jeffery [OFFE97], who proposed a framework called **M^{3}P** (Model, Measure, Manage Paradigm) to extend QIP/GQM to remedy the "*lack of well-defined links between the numerical data and the surrounding development and business contexts*." To do so, M^{3}P proposes a three-tier stakeholder hierarchy (Figure 6); the business, process and project measures (using three distinct GQM

[10] In support of this position, [ROCH97] lists a series of flaws in the GQM, the first of which is that *"goal derivation (is) too remote from business or technical objectives."*

decompositions) must be taken into account, and linked and aligned from operational to strategic issues[11].

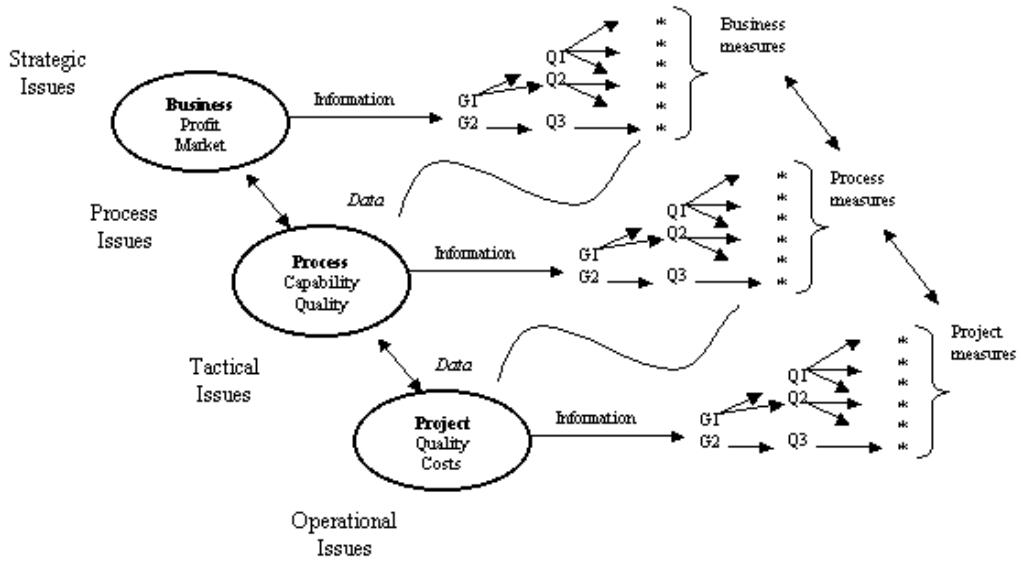

Figure 7 – The M[3]P metamodel stakeholder hierarchy *[OFFE97]*

Similarly for the opposite case: the correspondence between the structures of the GQM and GDI (Goal-Driver-Indicator) structures can facilitate the deployment and alignment of different scorecards, one for each organisational level, as recommended in some studies, [GAO98, pp.33-52] and [POLL] for instance. This mechanism, also known as the *multi-level balanced scorecard*, can be designed using either a top-down or a bottom-up approach to avoid a potential misalignment across multiple levels of issues. As suggested in [BECK99], the definition of each BSc goal could be reinforced by the elements proposed in GQM (purpose, issue, object and viewpoint).

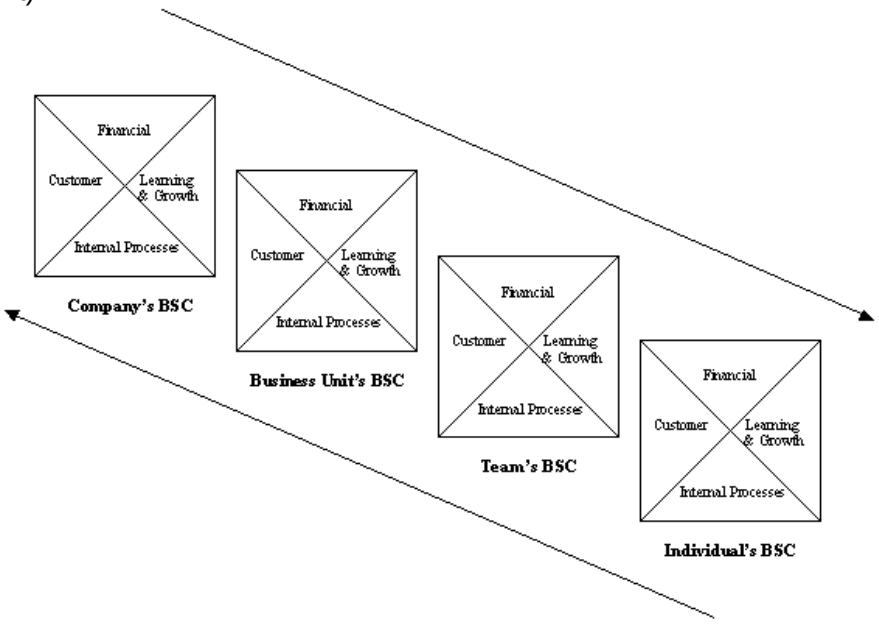

Figure 8 –*Multi-level BSc with four tiers* [POLL]

[11] This need is also expressed with a strong focus on process modelling in [ROCH97]. The Measurement Application Method (**MAM**) is intended to improve the GQM technique, by including it in a wider architecture where the starting steps are – as stressed above – the identification of business process needs and of organisational improvement needs or goals related to a process.

Finally, another question might be: "*Can GQM and BSc be profitably used jointly?*" Becker and Bostelman [BECK99] have tried to integrate the best of BSc and GQM, and have proposed a common measurement framework where the integration of BSc and GQM allows for a more detailed focus on the organisational measurement, facilitating the alignment between the strategic and project levels. It must be noted that this solution takes into account a refinement in defining high-level goals aligned with the organisation's strategy for achieving the vision, but with just a single-level deployment at a time.

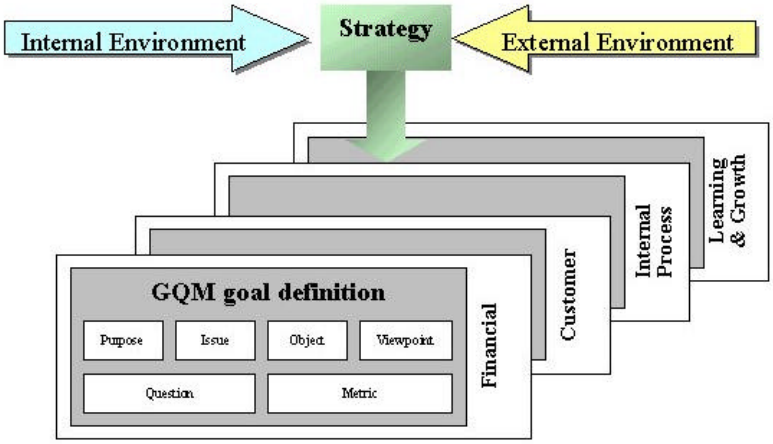

Figure 9 – *The integration of GQM and BSc* [BECK99]

As can be seen, GQM is indeed a flexible technique which can be used in multiple contexts, while the BSc-type framework provides a more comprehensive context of interpretations. *More specifically, the added value in the BSc approach resides in its development of a causal relationship chain among the business goals of the various perspectives, allowing for the alignment of business and operative goals for achieving success.*

7. Summary

This paper has investigated a question frequently asked when a company needs to select a quantitative approach to support a goal-oriented SPI initiative: what are the differences between the Goal-Question-Metric (GQM) technique and the Balanced Scorecard (BSc) framework? After presenting both approaches, including their initial design and subsequent enhancements, three main points were discussed: measurement object, nature of the method and strategy. In particular, strategy is the key point differentiating the two, the added value of BSc residing in the causal relationship chain among the business goals of the various perspectives, which enables a proper alignment of business and operative goals for achieving success. It included a discussion for joint use of both approaches for richer analysis frameworks. However, a multi-level BSc seems to provide better coverage of this challenge, due to the implicit use of GDI elements in the BSc, a more robust and explicit cause and effect relationship chain and a wider vision at each level of application, each time considering multiple perspectives. Examples of research efforts on the joint use of both GQM and BSc were presented, as well as the ways in which they can contribute to improving the extensions of BSc to the IT field, such as improvements to the ESI Balanced IT Scorecard (BITS). Finally, it can be mentioned that additional perspectives can be added in BSc, such as the fifth perspective, *People* in the ESI BITS, and *Employee* in the AIS scorecard, where the human component assumes a central role, according to widely accepted quality management systems (QMS) like the Malcolm Baldridge and EFQM models. This illustrates again the larger perspective and greater contribution to business alignment provided by a BSc as compared to the GQM technique.

References

[BASI84] BASILI V.R. & WEISS D.M., *A Methodology for Collecting Valid Software Engineering Data*, IEEE Transactions on Software Engineering, Vol. SE-10 No.6, November 1984, IEEE Computer Society, pp. 728-738

[BASI85] BASILI V.R. & SELBY R.W. Jr., *Calculation and use of an Environment's Characteristic Software Metric Set*, Proceedings of the 8th International Conference on Software Engineering, 1985, IEEE Computer Society, pp. 386-391

[BASI88] BASILI V.R. & ROMBACH H.D., *The TAME Project : Towards Improvement-Oriented Software Environments*, IEEE Transactions on Software Engineering, IEEE Computer Society, Vol. 14 No. 6, June 1988, pp. 758-773

[BASI93] BASILI V.R., *Applying the Goal/Question/Metric Paradigm in the Experience Factory*, 10th Annual CSR (Centre for Software Reliability) Workshop, Application of Software Metrics and Quality Assurance in Industry, Amsterdam, Holland, 29th September - 1st October, 1993.

[BASI94] BASILI V.B., CALDIERA G. & ROMBACH H.D., *Experience Factory*, Encyclopædia of Software Engineering. Wiley, 1994, pp. 469-476

[BECK99] BECKER S.A. & BOSTELMAN M.L., *Aligning Strategic and Project Measurement Systems*, IEEE Software, May/June 1999, pp. 46-51

[BUGL99] BUGLIONE L., QUINTANO N. & REO D.A., *Balanced IT Scorecard and EFQM: A Balanced Approach to Performance Measurement for Software Intensive Organisations*, Proceedings of the 2nd European Software Measurement Conference - FESMA 1999, October 4-8, 1999, Amsterdam, The Netherlands, ISBN 90-76019-07-X, pp. 415-426

[EDBE97] EDBERG D.T., *Creating a balanced IS measurement program*, Information Systems Management, Vol. 14, Spring 1997, pp. 32-40

[EPST97] EPSTEIN M.J. & MANZONI J.F., *The Balanced Scorecard and Tableau de Bord: A Global Perspective on Translating Strategy into Action*, INSEAD Working Paper 97/63/AC/SM, 1997

[FERG98] FERGUSON P., *Connecting Process Improvement Goals to Business Objectives with a Balanced Scorecard*, SEPG 98 Conference, Chicago, Illinois, USA, March 8-10, 1998

[FERG99] FERGUSON P., LEMAN G., PERINI P., RENNER S. & SESHAGIRI G., *Software Process Improvement Works!*, SEI Technical Report, CMU/SEI-TR-99-27, November 1999

[GAO98] GAO, *Measuring Performance and Demonstrating Results of Information Technology Investments*, US General Accounting Office, GAO/AIMD-98-89, March 1998

[GRAY97] GRAY A. & MACDONELL S.G., *GQM++ A Full Life Cycle Framework for the Development and Implementation of Software Metrics Programs*, University of Otago, Dunedin, New Zealand, Technical Report, 1997

[IBAÑ98] IBÁÑEZ M., *Balanced IT Scorecard Generic Model Version 1.0,* European Software Institute, Technical Report, ESI-1998-TR-009, May 1998

[ISO95] ISO/IEC JTC1/SC7/WG10, WD 15504-1, *Software Process Assessment - Part 1:Concepts and Introductory Guide ,* v 1.00, 1995

[KAPL92] KAPLAN R.S. & NORTON D.P., *The Balanced Scorecard – Measures that Drive Performance*, Harvard Business Review, Volume 70 No. 1, January-February, 1992, pp. 71-79

[KAPL93] KAPLAN R.S. & NORTON D.P., *Putting the Balanced Scorecard to Work*, Harvard Business Review, Volume 71 No. 5, September-October, 1993, pp. 134-147

[KAPL96] KAPLAN R.S. & NORTON D.P., *The Balanced Scorecard: Translating Strategy into Action*, Harvard Business School Press, 1996

[KUNT97] KUNTZMANN-COMBELLES A., *The Business Performance Perspective*, ESSI g-r-a-m, No. 3, August 1997, p.4

[NASA95] BASSMAN M.J., MCGARRY F. & PAJERSKI R., *Software Measurement Guidebook*, Revision 1, SEL-94-102, NASA/GSFC, June 1995

[OFFE97] OFFEN R.J. & JEFFERY R., *Establishing Software Measurement Programs*, IEEE Software, IEEE Computer Society, Vol. 14 No.2, March/April 1997, pp. 45-53

[PAUL93] PAULK M.C., CURTIS B., CHRISSIS M.B. & WEBER C.V., *The Capability Maturity Model For Software Version 1.1*, Software Engineering Institute/Carnegie Mellon University, CMU/SEI-93-TR-24, February 1993

[PFLE94] PFLEEGER S.L. & ROMBACH H.D., *Measurement-based process improvement*, IEEE Software, IEEE Computer Society, Vol. 11 No. 7, July 1994, pp. 8-11

[POLL] POLLAR D. & BUCKLE R., *Multi-level Balanced Scorecards: Aligning Performance Measurement for Infividuals, Teams, Business Units and Whole Organizations,* Ernst & Young Canada, URL: http://www.pbviews.com/pollard.htm

[PORT85] PORTER M.E., *Competitive Advantage,* The Free Press, NY, 1985

[PYZD92] PYZDEK T., *To improve your process: keep it simple*, IEEE Software, IEEE Computer Society, Vol. 9 No. 9, September 1992, pp. 112-113

[REO99a] REO D., QUINTANO N. & IBÁÑEZ M., *ESI Balanced IT Scorecard Process Perspective V 1.1*, European Software Institute, Technical Report, ESI-1999-TR-016, February 1999

[REO99b] REO D., QUINTANO N. & BUGLIONE L., *ESI Balanced IT Scorecard Infrastructure & Innovation Perspective*, European Software Institute, Technical Report, ESI-1999-TR-043, December 1999

[REO00] REO D., *Applying the Balanced Scorecard for process improvement - A case study by the European software industry,* Presentation, Measuring The Business Value Of IT With The Balanced Scorecard, February 23 & 24, 2000 • Phoenix, AZ

[ROCH97] ROCHE J.M., JACKSON M.S. & SHEPPARD M., *Business Process Measurement: A Measurement Application Method*, Proceedings of the ASME ETCE 97 Computers in Engineering Symposium, 1997, pp. 196-203

[SEI99] SOFTWARE ENGINEERING INSTITUTE, *Capability Maturity Model â - Integrated – Systems/Software Engineering (CMMI – SE/SW) Continuous Representation,* version 0.2, August 1999

[SOLI99] VAN SOLINGEN R. & BERGHOUT E., *The Goal/Question/Metric Method. A practical guide for Quality Improvement of Software Development*, Mc-Graw Hill, 1999, ISBN 0-07-709553-7

[SZYM96] SZYMANSKI D.J. & NEFF T.D., *Defining Software Process Improvement*, Crosstalk, STSC, Hill Air Force Base, Utah, February 1996

[THOM94] THOMAS M. & MCGARRY F., *Top-down vs. Bottom-up Process Improvement*, IEEE Software, IEEE Computer Society, Vol. 11 No. 7, July 1994, pp.12-13