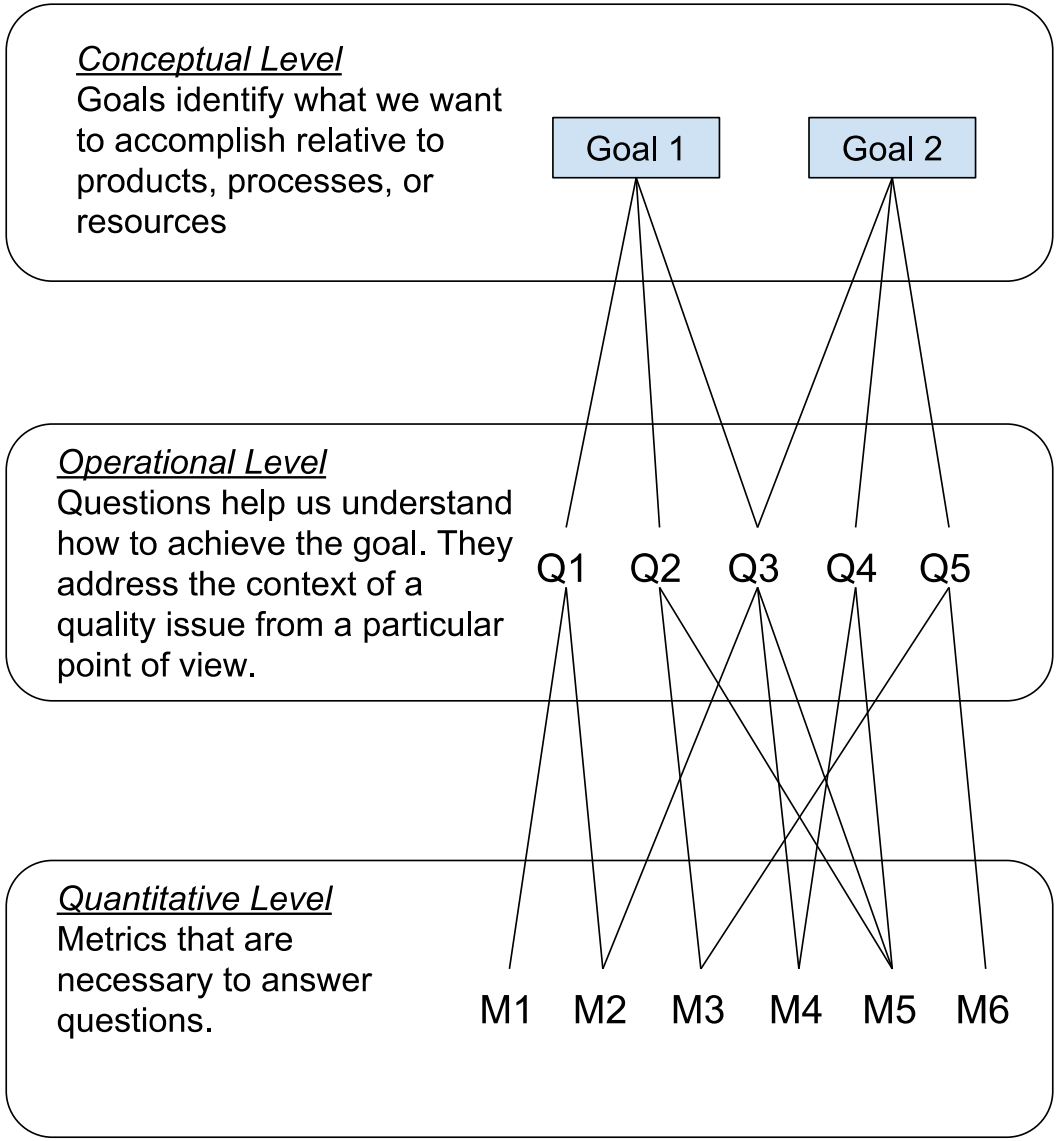
SWEN 772-Software Quality Engineering

W2-2 Measurement and Metrics Fundamentals 2 - GQM

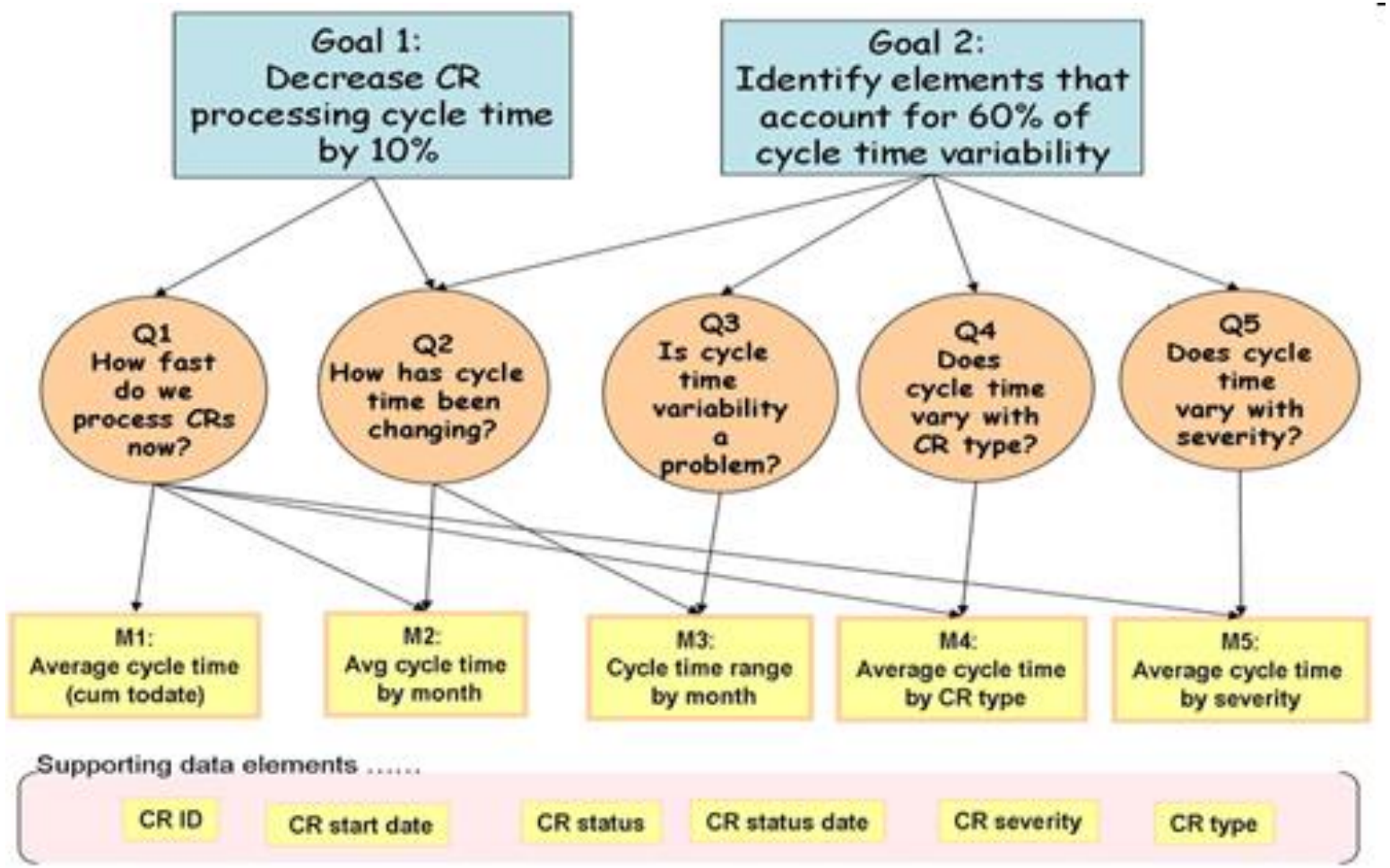
Goal, Question, and Metrics

- Origins from real world problems at NASA Goddard Space Fighter Project in 1970s: How to decide what you need to measure in order to achieve your goals?
- GQM defines a **measurement model** on three levels:
  - **Conceptual level** (Goal) A goal is defined for an object, for a variety of reasons, with respect to various models of quality, from various points of view and relative to a particular environment.
  - **Operational level** (Question) A set of questions is used to define models of the object of study and then focuses on that object to characterize the assessment or achievement of a specific goal.
  - **Quantitative level** (Metric) A set of metrics, based on the models, is associated with every question in order to answer it in a measurable way.

Goals identify what we want to accomplish; **questions**, when answered, tell us whether we are meeting the goals or help us understand how to interpret them; and the **metrics** identify the measurements that are needed to answer the questions and quantify the goal



Example



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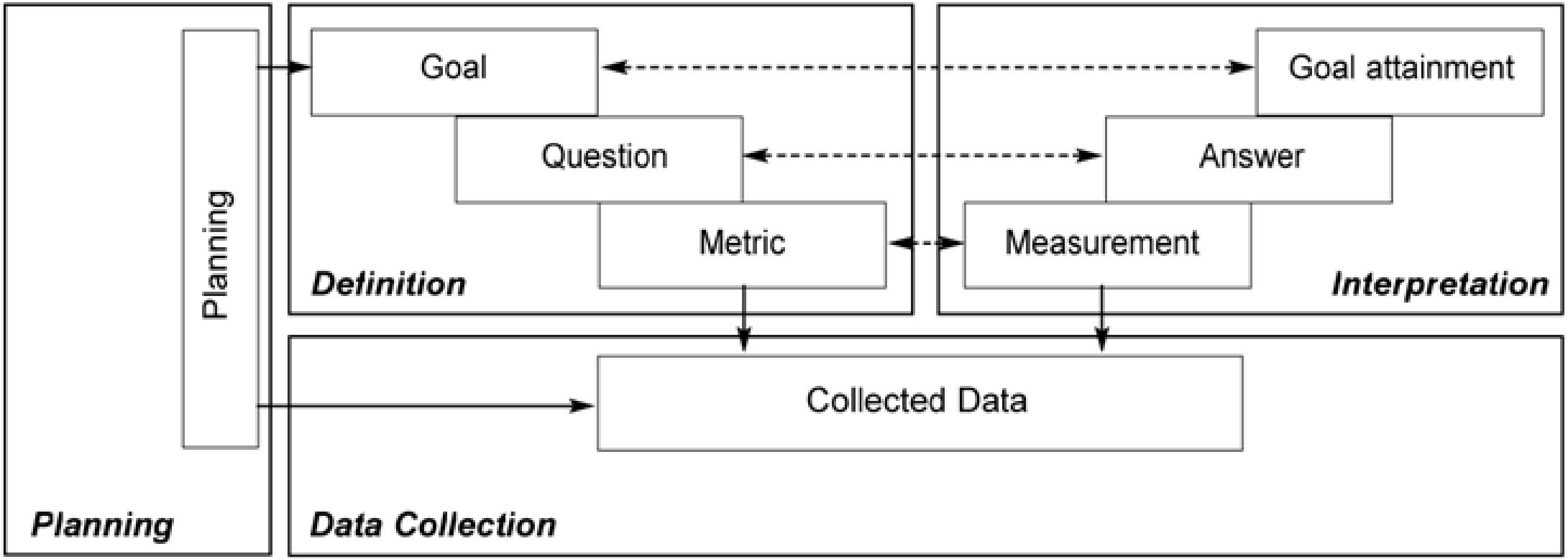
Phases of GQM Practice



Six Steps of GQM

- Steps 1-3: Definition
  - Use business goals to drive identification of the right metrics
- Steps 4-6: Data Collection and Interpretation
  - Gather the measurement data and make effective use of the measurement results to drive decision making and improvements

Six Steps of GQM-Steps 1-3: Definition

Use **business goals** to drive identification of the right metrics

1. Develop **a set of corporate, division and project business goals** and **associated measurement goals** for productivity and quality
2. Generate **questions (based on models)** that define those goals as completely as possible in a quantifiable way
3. Specify **the measures** needed to be collected to answer those questions and track process and product conformance to the goals

Six Steps of GQM-Steps 4-6: Data Collection and Interpretation

Gather the **measurement data** and make effective use of the **measurement results** to **drive decision making and improvements**

4. Develop **mechanisms for data collection**
5. **Collect, validate and analyze the data** in real time to provide feedback to projects for corrective action
6. Analyze the data in a **postmortem fashion** to assess conformance to the goals and to make recommendations for future improvements

Defining Goals—PPE Template

- **Purpose**: Analyze some (objects: processes, products, other experience models) for the purpose of (why: characterization, evaluation, prediction, motivation, improvement)
- **Perspective**: with respect to (what aspect: cost, correctness, defect removal, changes, reliability, user friendliness, etc.) from the point of view of (who: user, customer, manager, developer, corporation, etc.)
- **Environment**: in the following context: (where: problem factors, people factors, resource factors, process factors, etc.)

IEEE-STD-1061-1998 Standard for Software Quality Metrics Methodology

Goal Example

- **Analyze** the (system testing method) for the **purpose** of (evaluation) with respect to a model of (defect removal effectiveness) from the point of view of the (developer) in the following **context**: the standard NASA/GSFC environment, i.e., process model [e.g., Software Engineering Laboratory (SEL) version of the waterfall model], application (ground support software for satellites), machine (running on a DEC 780 under VMS), etc.

IEEE-STD-1061-1998 Standard for Software Quality Metrics Methodology

Key Practices of GQM (p. 1 of 3)

- Get **the right people** involved in the GQM process
- Set **explicit measurement goals** and **state them explicitly**
- **Don’t create false measurement goals** (for example, matching metrics you already have or are easy to get)
- **Acquire implicit quality models** from the **people involved**

Key Practices of GQM (p. 2 of 3)

- Consider **context**
- Derive **appropriate metrics**
- Stay **focused on goals** when analyzing data
- Let the **data be interpreted** by the **people involved**
- **Integrate the measurement activities** with **regular project activities**

Key Practices of GQM (p. 3 of 3)

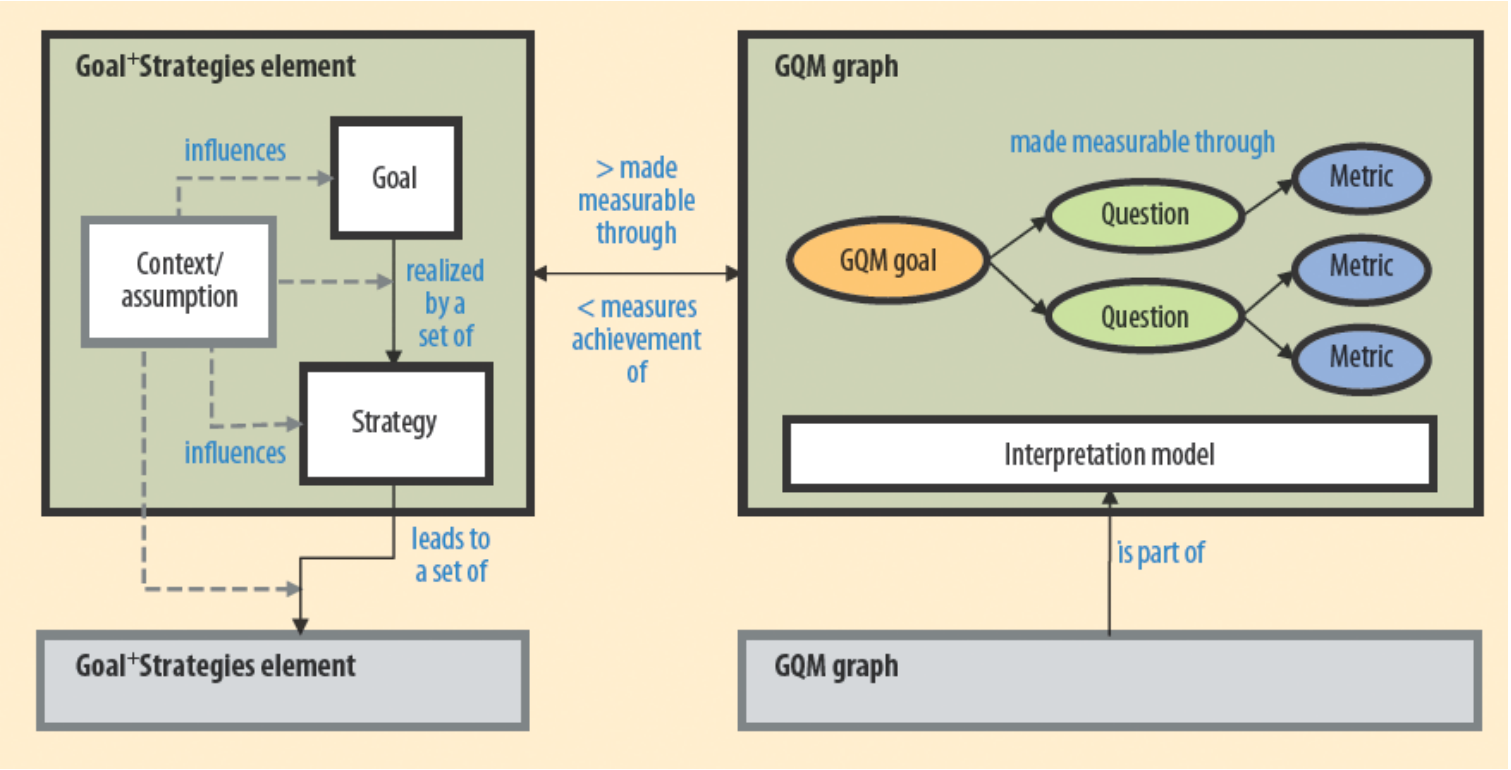
- Do **not use measurements for other purposes** (such as to assess team member productivity)
- **Secure management commitment** to support measurement results
- **Establish an infrastructure** to support the measurement program
- Ensure that **measurement is viewed as a tool**, not the end goal
- **Get training in GQM** before going forward

GQM Recent Development: GQM+

- GQM+: **extends** the goal/question/metric paradigm for measuring the success or failure of goals and strategies, **adding enterprise-wide support for determining action on the basis of measurement results**. An organization can thus integrate its measurement program across all levels
- Provides solutions to achieve **Business Alignment**
- May be applied in other non-software development domains (e.g., professional training)

GQM+ Strategies components

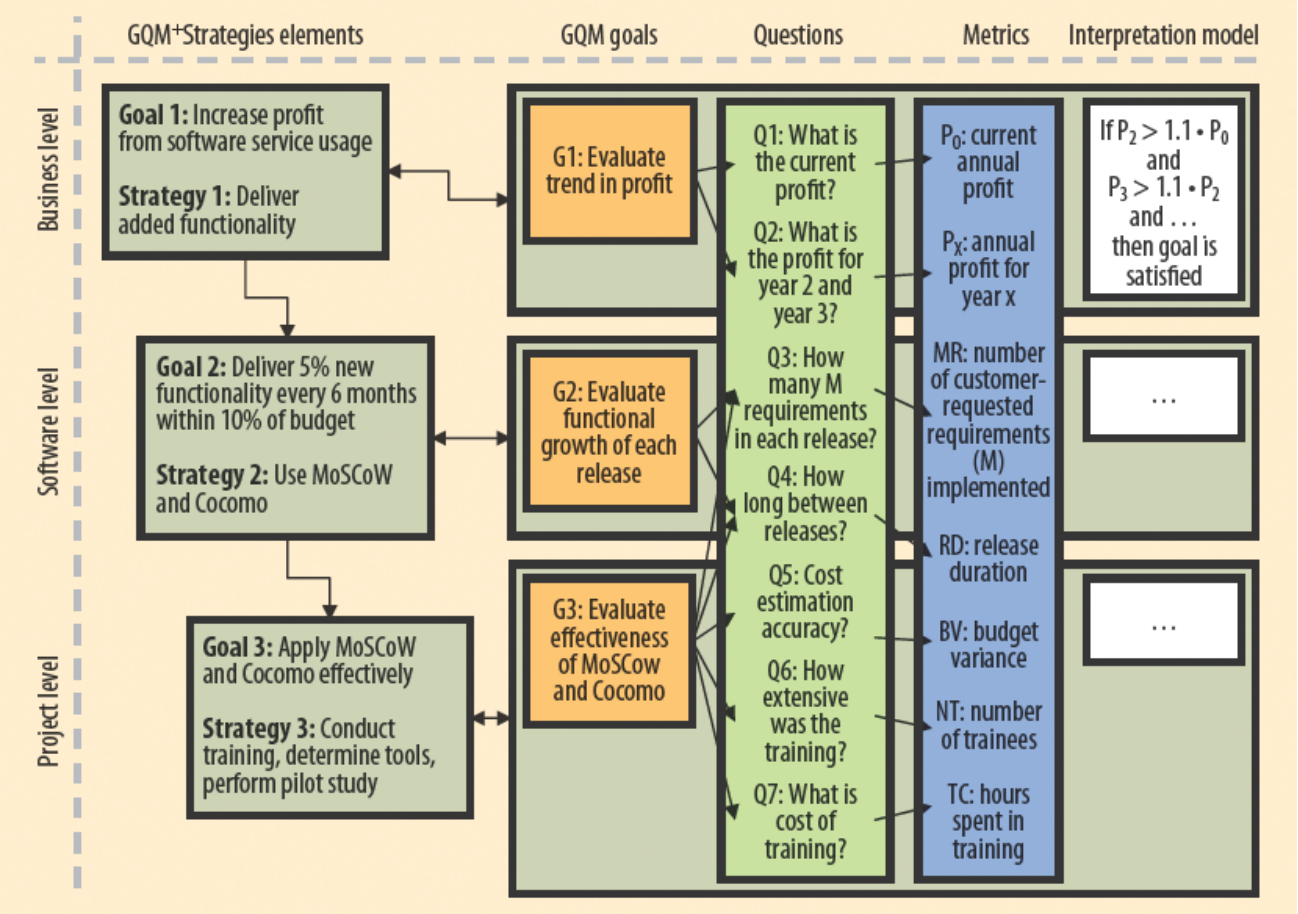
The primary components are the **Goal+ Strategies element** and the **GQM graph**. The Goal+ Strategies element includes **a single goal and derived strategies**, as well as **all context information and assumptions** that explain how goals and strategies link. **The GQM graph reflects a single GQM goal, the corresponding questions and metrics, and an interpretation model.**



GQM+ Example

GQM+Strategies enforces **the explicit documentation** of the relevant context factors and assumptions that are necessary for understanding and evaluating each goal.

A Goal+ Strategies element consists of **a goal and an associated strategy (bottom of each goal box).** Each element, in turn, is associated **with a GQM graph (green rectangle to the right of the goal)** representing questions and metrics as well as an interpretation model that evaluates if the goal was achieved.



More about GQM+ and Its Applications

- Original Paper
  - Basili, V. R., Lindvall, M., Regardie, M., Seaman, C., Heidrich, J., Münch, J., ... & Trendowicz, A. (2010). Linking software development and business strategy through measurement. Computer, 43(4), 57-65.
- Application in Non-Software Development Domains
  - Sarcia, S. A. (2010, September). Is GQM+ Strategies really applicable as is to non-software development domains?. In Proceedings of the 2010 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement (p. 45). ACM.

Discussion

- Take an everyday context, such as coursework, commuting to school, research.
  - Identify one or more quality objectives you would like to achieve, such as "improve grades", or "publish a paper".
  - Use the GQM framework to design two metrics that relate to the objective.
  - Identify the measurements that you need to compute the metric.
  - What are the reliability and validity limitations of the metrics you have identified?
- What are the problems with GQM and GQM+?