Appendix A. GQM$^+$Strategies Process Checklist

The following checklist provides guidance for applying GQM$^+$Strategies. It aims at easy comprehensibility and lists the logical steps to be performed. More detailed descriptions of the activities in the GQM$^+$Strategies process and the GQM$^+$Strategies concepts can be found by following the pointers (in parentheses) to the respective sections in the book.

Initialize

- Define purpose (Sect. 3.1)
- Define scope (Sect. 3.2)
- Describe the organizational structure (Sect. 3.2)
- Get management commitment (Sects. 3.1 and 3.2)
- Get personnel resources (Sect. 3.3)
- Plan implementation (Sect. 3.3)
- Motivate and train personnel for GQM$^+$Strategies application (Sect. 3.4)

Characterize Environment

- Comprehend and define the environment of the GQM$^+$Strategies application (Sect. 4.1)
- Identify risks that might constrain the application of GQM$^+$Strategies (Sect. 4.1)
- Identify opportunities that might support the application of GQM$^+$Strategies (Sect. 4.1)

Define Goals and Strategies, and Measurement

- Identify existing goals, strategies, and relevant assets (Sects. 5.1 and 5.2)
- Select existing or identify new goals to start with (Sects. 5.3.1 and 5.3.2)
- Provide rationales for the goals (Sects. 5.3.1 and 5.3.2)
- Describe the goals in a structured way by using the organizational goal template (Sect. 5.3.2)
- Identify strategies that contribute to reaching the goals (Sect. 5.3.3)
- Prioritize strategies and select the most promising ones (Sect. 5.3.3)

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- Find and close gaps between goals and strategies (Sect. 5.3.3)
- Define measures for measuring goal attainment (Sect. 5.3.5)
- Define thresholds and potential explanations (i.e., interpretation models) for the success or failure of each goal and related strategies (Sect. 5.3.5)
- Iterate by refining goals and strategies until the scope is covered (Sects. 5.3.1–5.3.5)
- Review and adjust goals and strategies (Sect. 5.4)

Plan Grid Implementation

- Plan strategy deployment with stakeholders (Sect. 6.1)
- Set up measurement, analysis, and reporting procedures (Sect. 6.2)
- Organize training to prepare personnel with respect to strategy implementation (Sect. 6.3)
- Train personnel with respect to measurement, analysis, and reporting (Sect. 6.3)

Execute Plans

- Execute strategies (Sect. 7.1)
- Collect and analyze data (Sect. 7.2)
- Monitor local strategy deployment (Sect. 7.2)
- Adjust strategy implementation, if necessary (Sect. 7.3)
- Adjust measurement, analysis, and reporting procedures, if necessary (Sect. 7.3)

Analyze Outcomes

- Analyze overall strategy deployment and goal attainment (Sects. 8.1 and 8.2)
- Gather feedback from relevant stakeholders (Sect. 8.3)
- Analyze if the environment (i.e., the context) has changed (Sect. 8.3)
- Question the strategies and the assumptions they are based on (Sect. 8.3)
- Make proposals for improvement (Sect. 8.3)

Package Improvements

- Change goals or strategies, if necessary (Sect. 9.1)
- Communicate revised or new goals and strategies (Sect. 9.2)
- Store relevant information and experience from the application of GQM+Strategies for future use (Sect. 9.3)

Appendix B. GQM+Strategies Evaluation Questionnaire

The goal of this survey is to evaluate the benefits of the GQM+Strategies approach for your organization. This input will be used for improving the method in future. All questions are phrased as statements you may agree with or disagree with. There are no right or wrong answers. Your personal opinion is what matters most. All data gathered here will be analyzed anonymously and not be distributed to a third person so that no information about the respondent will be disclosed under any circumstances.

Background Information

A1: What is the name of your company?
A2: What is your current position?
A3: For how many years have you been working in this position?

Training and Expertise in the GQM+Strategies Approach

B1: What GQM+Strategies training have you already obtained?	How many times?
B1.1: Motivational talk or short (<1 day) presentation	
B1.2: One-day method tutorial	
B1.3: Two-day method tutorial	
B1.4: Training for method trainers and promoters	
B1.5: Other training (please specify):	

B2: For what purposes have you already used the GQM+Strategies approach?	How many times?
B.2.1: I have employed the method in an industrial organization	
B.2.2: I have given the motivational talk	
B.2.3: I have given the 1-day method tutorial	
B.2.4: I have given the 2-day method tutorial	

(continued)

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B2: For what purposes have you already used the GQM+Strategies approach? How many times?
B.2.5: I have given the training for method trainers and promoters
B.2.6: I have moderated the 1-day exercise workshop
B.2.7: I have moderated a real-world industrial workshop
B.2.8: Other purpose (please specify):

Assessment of the GQM+Strategies Approach

	Strongly disagree	Disagree	Neither/ nor	Agree	Strongly agree	I don't know
Alignment	1	2	3	4	5	–
C1.1: Using GQM+Strategies, I'm able to harmonize goals, strategies, and measurement data	❑	❑	❑	❑	❑	❑
C1.2: GQM+Strategies supports me in tracking my goals and strategies	❑	❑	❑	❑	❑	❑
C1.3: Using GQM+Strategies, I'm able to align my work activities with the goals and strategies of the organization	❑	❑	❑	❑	❑	❑
C1.4: GQM+Strategies supports me in aligning goals and strategies across organizational units	❑	❑	❑	❑	❑	❑
C1.5: Using GQM+Strategies, gaps between goals, strategies, and measurement data become obvious	❑	❑	❑	❑	❑	❑
C1.6: GQM+Strategies supports me in closing gaps between goals, strategies, and measurement data	❑	❑	❑	❑	❑	❑
C1.7: GQM+Strategies supports me in identifying nonbeneficial goals, strategies, and measurement data	❑	❑	❑	❑	❑	❑
	Strongly disagree	Disagree	Neither/ nor	Agree	Strongly agree	I don't know
Transparency	1	2	3	4	5	–
C2.1: GQM+Strategies supports me in getting a clearer picture of the goals and strategies of my organization	❑	❑	❑	❑	❑	❑
C2.2: Using GQM+Strategies, the goals and strategies of my organization become more transparent for me	❑	❑	❑	❑	❑	❑

(continued)

Transparency	Strongly disagree 1	Disagree 2	Neither/ nor 3	Agree 4	Strongly agree 5	I don't know –
C2.3: GQM+Strategies supports me in identifying contradictory goals and strategies across different organizational units	❑	❑	❑	❑	❑	❑
C2.4: Using GQM+Strategies helps me in understanding the relationships between goals and strategies	❑	❑	❑	❑	❑	❑
C2.5: GQM+Strategies supports me in understanding the rationale for defined goals and strategies	❑	❑	❑	❑	❑	❑
C2.6: GQM+Strategies supports me in getting a consistent understanding of goals and strategies across different organizational units	❑	❑	❑	❑	❑	❑
C2.7: GQM+Strategies supports me in communicating goals and strategies across different organizational units	❑	❑	❑	❑	❑	❑

Measurability	Strongly disagree 1	Disagree 2	Neither/ nor 3	Agree 4	Strongly agree 5	I don't know –
C3.1: GQM+Strategies helps me in quantifying my organization's goals and strategies	❑	❑	❑	❑	❑	❑
C3.2: Using GQM+Strategies supports me in measuring the success/failure of goals and strategies	❑	❑	❑	❑	❑	❑
C3.3: GQM+Strategies supports me in collecting mandatory measurement data	❑	❑	❑	❑	❑	❑
C3.4: GQM+Strategies supports me in identifying superfluous measurement data	❑	❑	❑	❑	❑	❑
C3.5: GQM+Strategies helps me in optimizing the benefits from collecting measurement data	❑	❑	❑	❑	❑	❑
C3.6: Using GQM+Strategies helps me to identify unsuccessful strategies	❑	❑	❑	❑	❑	❑
C3.7: Using GQM+Strategies helps me in assessing the attainment of goals	❑	❑	❑	❑	❑	❑

General Comments to the GQM+Strategies Approach

E1: What do you like about GQM+Strategies in particular?

E2: What don't you like about GQM+Strategies at all?

Final Evaluation of the GQM+Strategies Approach

F1: What school grade would you give to the GQM+Strategies approach?

A	**B**	**C**	**D**	**F**	I don't know
Excellent	Good	Average	Low	Failed	
❑	❑	❑	❑	❑	❑

Thank you for participating in the survey!

Appendix C. Authors

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Victor Basili is Professor Emeritus of Computer Science at the University of Maryland. He holds a PhD in Computer Science from the University of Texas, Austin and is the recipient of two honorary degrees from the University of Sannio, Italy (2004) and the University of Kaiserslautern, Germany (2005). He served as founding director of the Fraunhofer Center for Experimental Software Engineering and the Software Engineering Laboratory at NASA/GSFC. He has worked on measuring, evaluating, and improving the software development process and product using methods that include Iterative Enhancement (IE), the Goal–Question–Metric Approach (GQM), the Quality Improvement Paradigm (QIP), and the Experience Factory (EF). He has developed, tailored, evaluated, and evolved these techniques for several organizations. He has been the recipient of grants from government agencies and companies including NSF, NASA, AFOSR, ONR, AFOSR, AFRL, DARPA, IBM, Hughes, NEC, Amdahl, Coopers and Lybrand, Ricoh, Mutsuhito Panasonic, Daimler Benz, Bellcore, and Fujitsu. Dr. Basili is the recipient of several awards, including the NASA Group Achievement Award (1996), ACM SIGSOFT Outstanding Research Award (2000), IEEE Computer Society Harlan Mills Award (2003), and the Fraunhofer Medal (2007). He has authored over 250 journals and refereed conference papers and is Co-Editor-in-Chief of the Journal of Empirical Software Engineering. He is an IEEE and ACM Fellow.

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Bibliography

Accenture (2004) Managing IT investments in the high-performance business. Strategic information technology effectiveness (SITE). Report, Accenture LLP

Ambler SW (1998) Process patterns: building large-scale systems using object technology. Cambridge University Press, Cambridge, UK

Antón AI, McCracken WM, Potts C (1994) Goal decomposition and scenario analysis in business process reengineering. In: Wijers G, Brinkkemper S, Wasserman T (eds) Advanced information systems engineering. Springer, Berlin, pp 94–104

Basili VR (1981) Data collection, validation, and analysis. In: Tutorial on models and metrics for software management and engineering, IEEE Catalog no. EHO-167-7, pp 310–313

Basili V (1985) Quantitative evaluation of software methodology, keynote address. In: Proceedings of the first Pan Pacific computer conference, vol 1, pp 379–398

Basili VR (1989) Software development: a paradigm for the future. In: Presentation at the thirteenth international computer software and applications conference, Los Alamitos, CA

Basili VR (1993) The experience factory and its relationship to other improvement paradigms. In: Proceedings of the fourth European software engineering conference (ESEC), Garmisch-Partenkirchen, Germany. The Proceedings appeared as Lecture Notes in Computer Science 717

Basili VR, Caldiera G (1995) Improve software quality by reusing knowledge and experience. Sloan Manag Rev 37(1):55–64

Basili V, Green S (1994) Software process evolution at the SEL. IEEE Software 11(4):58–66

Basili VR, Rombach HD (1988) The TAME project: towards improvement-oriented software environments. IEEE Trans Software Eng 14(6):758–773

Basili VR, Weiss DM (1984) A methodology for collecting valid software engineering data. IEEE Trans Software Eng SE-10(6):728–738

Basili VR, Caldiera G, Rombach HD (1994a) The experience factory. In: Marciniak JJ (ed) Encyclopedia of software engineering, vol 1, 2nd edn. Wiley, New York, pp 469–476

Basili VR, Caldiera G, Rombach HD (1994b) Goal question metric paradigm. In: Marciniak JJ (ed) Encyclopedia of software engineering, vol 1, 2nd edn. Wiley, New York, pp 528–532

Basili V, Zelkowitz M, McGarry F, Page J, Waligora S, Pajerski R (1995) Special report: SEL's software process-improvement program. IEEE Software 12(6):83–87

Basili VR, Green S, Laitenberger O, Shull F, Sørumgård S, Zelkowitz MV (1996) The empirical investigation of perspective-based reading. Empir Software Eng 13(12):1278–1296

Basili VR, Lindvall M, Regardie M, Seaman C, Heidrich J, Münch J, Rombach HD, Trendowicz A (2010) Linking software development and business strategy through measurement. IEEE Comput 43(4):57–65

Beck K, Andres C (2004) Extreme programming explained: embrace change. Addison-Wesley, Boston, MA

Becker SA, Bostelman ML (1999) Aligning strategic and project measurement systems. IEEE Software 16(3):46–51

Boehm B (2003) Value-based software engineering. ACM SIGSOFT Software Eng Notes 2(28):3–15

V. Basili et al., *Aligning Organizations Through Measurement*, The Fraunhofer IESE Series on Software and Systems Engineering, DOI 10.1007/978-3-319-05047-8,

Briand LC, Differding CM, Rombach HD (1996) Practical guidelines for measurement-based process improvement. Software Process Improv Pract 2(4):253–280

Brindgeland DM, Zahavi R (2008) Business modeling: a practical guide to realizing business value. Morgan Kaufmann, Boston, MA

Budd CI, Budd CS (2009) A practical guide to earned value project management, 2nd edn. Management Concepts, Vienna, VA

Buglione L, Abran A (2000) Balanced scorecards and GQM: what are the differences? In: Proceedings to the third European software measurement conference, pp 18–20

Burlton R (2010) Delivering business strategy through process management. In: vom Brocke J, Rosemann M (eds) Handbook on business process management 2. Springer, Berlin, pp 5–37

Chillarege R, Bhandari IS, Chaar JK, Halliday MJ, Moebus DS, Ray BK, Wong M-Y (1992) Orthogonal defect classification – a concept for in-process measurements. IEEE Trans Software Eng 18(11):943–956

Ciolkowski M, Laitenberger O, Rombach D, Shull F, Perry D (2002) Software inspections, reviews and walkthroughs. In: Proceedings of the 24rd international conference on software engineering, May 2002, pp 641–642

CMMI Product Team (2010) CMMI for development, version 1.3. Technical report CMU/SEI-2010-TR-033, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA

Conradi R, Fuggetta A (2002) Improving software process improvement. IEEE Software 19(4):92–99

Damiani E, Mulazzani F, Russo B, Succi G (2008) SAF: strategic alignment framework for monitoring organizations. In: Proceedings to the eleventh international conference on business information systems, Innsbruck, Austria. Springer

Deming WE (1986) Out of the crisis. Massachusetts Institute of Technology, Center for Advance Education Services, Cambridge, MA

Eckerson WW (2005) Performance dashboards: measuring, monitoring, and managing your business. Wiley, Hoboken, NJ

Epstein M, Manzoni J-F (1998) Implementing corporate strategy: from Tableaux de Bord to balanced scorecards. Eur Manag J 16(2):190–203

Fagan M (1976) Design and code inspections to reduce errors in program development. IBM Syst J 15(3):182–211

Gamma E, Helm R, Johnson R, Vlissides J (1994) Design patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, Boston, MA

Gartner (2010) Gartner executive programs CIO survey. Press release, Gartner, Inc.

Gartner (2011) Forecast alert: IT spending, worldwide, 2008–2014, 4Q10 update. Press release, Gartner, Inc.

Gresse C, Hoisl B, Wüst J (1995) A process model for planning GQM-based measurement. Technical report STTI-95-04-E, Software Technology Transfer Initiative, University of Kaiserslautern

Hammer M (1990) Reengineering work: don't automate, obliterate. Harv Bus Rev 68(4):104–112

Hammer M (2010) What is business process management? In: vom Brocke J, Rosemann M (eds) Handbook on business process management, vol 1. Springer, Heidelberg

Hammer M, Champy JA (1993) Reengineering the corporation: a manifesto for business revolution. Harper, New York

Humphrey A (2005) SWOT analysis for management consulting. SRI Newsletter: History Corner, SRI International, pp 7–8

ISO (2009) ISO/IEC 20926 – IFPUG functional size measurement method 2009, 2nd edn. International Standardization Organization, Geneva

Kaplan RS, Norton DP (1992) The balanced scorecard: measures that drive performance. Harv Bus Rev 70(1):71–79

Kaplan RS, Norton DP (1996) Balanced scorecard: translating strategy into action. Harvard Business School Press, Boston, MA

Kaplan RS, Norton DP (2004) Strategy maps: converting intangible assets into tangible outcomes. Harvard Business School Press, Boston, MA

Kaplan RS, Norton DP (2008) Execution premium: linking strategy to operations for competitive advantage. Harvard Business School Press, Boston, MA

Kerth NL (2001) Project retrospectives: a handbook for team reviews. Dorset House, New York

Laitenberger O (2002) A survey of software inspection technologies. In: Chang SK (ed) Handbook on software engineering and knowledge engineering. World Scientific, Singapore, pp 517–556

Mandić V (2012) Measurement-based value alignment and reasoning about organizational goals and strategies: studied with ICT industry. Doctoral dissertation, University of Oulu, Finland

Mandić V, Basili V, Oivo M, Harjumaa L, Markkula J (2010a) Utilizing GQM^{+}Strategies for an organization-wide earned value analysis. In: Proceedings of the 36th EUROMICRO conference on software engineering and advanced applications, 1–3 Sept 2010, pp 255–258

Mandić V, Oivo M, Rodríguez P, Kuvaja P, Kaikkonen H, Turhan B (2010b) What is flowing in lean software development? In: Proceedings of the first international conference on lean enterprise software and systems, Helsinki, Finland, October 2010

Mandić V, Basili V, Harjumaa L, Oivo M, Markkula J (2010c) Utilizing GQM+Strategies for business value analysis: an approach for evaluating business goals. In: Proceedings of the fourth international symposium on empirical software engineering and measurement, Bolzano-Bozen, Italy, pp 1–10

Münch J, Heidrich J (2004) Software project control centers: concepts and approaches. J Syst Software 70(1):3–19

Münch J, Armbrust O, Kowalczyk M, Soto M (2012) Software process definition and management, Fraunhofer IESE series on software and systems engineering. Springer, New York

Neely A, Gregory M, Platts K (1995) Performance measurement system design: a literature review and research agenda. Int J Oper Prod Manag 15(4):80–116

Nudurupati SS, Bititci US, Kumar V, Chan FTS (2011) State of the art literature review on performance measurement. Comput Ind Eng 60(2):279–290

Offen RJ, Jeffery R (1997) Establishing software measurement programs. IEEE Software 14(2):45–53

OGC (Office of Government Commerce) (2009) Managing successful projects with PRINCE2 2009 edition manual. The Stationery Office, UK

OMG (Object Management Group) (2010) The business motivation model (BMM) V. 1.1. Object Management Group

PMI (2013) A guide to the project management body of knowledge (PMBOK guide), 5th edn. Project Management Institute, Newtown Square, PA

Porter ME (1996) What is strategy? Harv Bus Rev 74(6):61–78

Porter ME (2008) The five competitive forces that shape strategy. Harv Bus Rev 86(1):78–93

Rombach HD, Verlage M (1995) Directions in software process research. In: Zelkowitz MV (ed) Advances in computers, vol 41. Academic, Boston, MA

Rosemann M, vom Brocke J (2010) The six core elements of business process management. In: vom Brocke J, Rosemann M (eds) Handbook on business process management, vol 1. Springer, Heidelberg

Sarcia SA (2010) 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, Bolzano-Bozen, Italy, pp 1–4

Schwaber K (2004) Agile project management with scrum. Microsoft Press, Redmond, WA

Selby RW (2005) Measurement-driven dashboards enable leading indicators for requirements and design of large-scale systems. In: Proceedings of the 11th international software metrics symposium, Como, Italy, 19–22 September, pp 1530–1435

Shewhart WA (1939) Statistical method from the viewpoint of quality control. The Graduate School of the Department of Agriculture, Washington, DC. Reprinted by Dover Publications in the Dover Books on Mathematics series in 1986

Trendowicz A, Heidrich J, Shintani K (2011) Aligning software projects with business objectives. In: Proceedings of the joint conference of the 21th international workshop on software measurement (IWSM) and the 6th international conference on software process and product measurement (Mensura), Nara, Japan, 3–4 Nov 2011, vol I. IEEE Computer Society Press, pp 142–150

van Solingen R, Berghout E (1999) Goal/question/metric method. McGraw-Hill, New York

The Fraunhofer Institute for Experimental Software Engineering (IESE)

Fraunhofer IESE in Kaiserslautern is one of the worldwide leading research institutes in the area of software and systems engineering. A major portion of the products offered by its customers is defined by software. These products range from automotive and transportation systems via automation and plant engineering, information systems, healthcare and medical systems to software systems for the public sector. The institute's software and systems engineering approaches are scalable, which makes Fraunhofer IESE a competent technology partner for organizations of any size—from small companies to major corporations.

Under the leadership of Prof. Dieter Rombach and Prof. Peter Liggesmeyer, the contributions of Fraunhofer IESE have been a major boost to the emerging IT hub Kaiserslautern for more than 15 years. In the Fraunhofer Information and Communication Technology Group, the institute is cooperating with other Fraunhofer institutes to develop trendsetting key technologies for the future.

Fraunhofer IESE is one of the 60 institutes of the Fraunhofer-Gesellschaft. Together they have a major impact on shaping applied research in Europe and contribute to Germany's competitiveness in international markets.

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