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Business Process Performance Measurement for Rollout Success

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ABSTRACT

Business process improvement for increased product quality is of continuous importance in the software industry. Quality managers in this sector need effective, hands-on tools for decision-making in engineering projects and for rapidly spotting key improvement areas. Measurement programs are a widespread approach for introducing quality improvement in software processes, yet employing all-embracing state-of-the art quality assurance models is labor intensive. Unfortunately, these do not primarily focus on measures, revealing a need for an instant and straightforward technique for identifying and defining measures in projects without resources or need for entire measurement programs.

This thesis explores and compares prevailing quality assurance models using measures, rendering the Measurement Discovery Process constructed from selected parts of the PSM and GQM techniques. The composed process is applied to an industrial project with the given prerequisites, providing a set of measures that are subsequently evaluated. In addition, the application gives foundation for analysis of the Measurement Discovery Process.

The application and analysis of the process show its general applicability to projects with similar constraints as well as the importance of formal target processes and exhaustive project domain knowledge among measurement implementers. Even though the Measurement Discovery Process is subject to future refinement, it is clearly a step towards rapid delivery of tangible business performance indicators for process improvement.

Keywords: GQM, Process Improvement, PSM, Quality Measurement

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Contents

1. Introduction

Performance of software processes characterized by expected product quality, costs, resources and development duration is crucial. Numerous management techniques and models aiding in software development exist. Yet addressing efficiency and productivity of software processes for assessment of key improvement areas remains difficult. Management needs guidance in controlling and improving software engineering projects. Founded in the conception that nothing can be improved without measuring it, Gopal *et al.* [16] highlight the significance of using measures to improve software engineering and management practices. This conforms to Bailey *et al.* [12] recognizing measurement as an effective tool assisting in management of software and system projects. Gauging a measure implies assessing business process performance in a particular area. However, introducing models of measures is not an easy task since aspects such as technical, and process- and product related are influential in addition to the target organization culture [11].

Despite extensive literature on software quality improvements, a gap between theory and practice exist, as stated by van Solingen and Berghout [4] and experienced by the thesis authors. In particular, generally recognized and accepted models do not explicitly focus on measures; rather they aim at introducing entire quality programs with measures as a subset, including high demands on resources and time, and lack concrete guidance and frameworks on how to identify and define measures appropriate to the target organization or project. In addition, programs introduce major remodeling of existing business processes, and constraints on certain kinds of projects do not allow for such impact due to timely and budgetary limitations. Consequently there is a need for a technique that instantly and straightforwardly assists in identifying and defining measures for projects without resources for introduction of entire quality programs or the need for such. Hence, this need, reflected in the shortcomings of quality improvement models with measures, composes the thesis's objective: How to introduce uncomplicated identification and definition of measures for business process performance improvement in projects without needs or resources for all-embracing quality programs.

This thesis examines and compares state-of-the-art models and techniques with measures for quality management to provide an insight into the problem domain and determine applicability of models to address it. Conformant models are parts of the Practical Software Measurement (PSM) method and parts of the Goal-Question-Metric (GQM) technique, which combined form a customized approach. This approach, the Measurement Discovery Process, instantly and straightforwardly identifies and defines measures. In order to validate the process applicability to projects associated with characteristics as of the thesis's objective, it is applied to an industry case, the Tetra Pak ISP2 project. In this project, management desires measures serving as quality indicators and base for improvement decisions in the progression of the project. A set of ISP2 case-specific measures rendered by following the Measurement Discovery Process are established and presented. Conclusively on the basis of obstacles encountered while developing the discovery process and applying it to the ISP2 scope, the process is analyzed and lessons learned form conclusions and suggestions for future work. Accordingly, issues in need of attention to ultimately arrive at a process for instant and straightforward identification and definition of measures are highlighted.

1.1 ISP2 Scope

Tetra Pak, provider of integrated processing, packaging, and distribution line and plant solutions for food manufacturing, is experiencing increased costs managing its current global, business-driven Information Systems Platform (ISP) based on SAP R/3. Accordingly, a need for a more manageable and less costly solution for smaller and medium-sized process oriented retailing sites, i.e. market companies, has initiated a program, Information Systems Platform 2 (ISP2), in order to address these issues. The derived solution is based on the commercial release of iScala, built on standard commercial technology and an externally developed database management system.

Following a pilot ISP2 project in Poland, the Czech and Slovak Republics are presently targets for a subsequent ISP2 rollout followed by worldwide implementations at other applicable market company sites. ISP2 workflow is conducted within sets and subsets of processes whereof some are documented others are not (ad-hoc). To ensure rollout process success and efficiency, and improvements for upcoming implementations, measures for quality assurance need to be defined and gauged in these processes with focus on the rollout process.

1.2 Chapter Outline

In chapter 1, an introduction and background to the thesis subject and Tetra Pak industry case has been given whereas chapter 2 introduces and assesses state-of-the-art models for quality measurement. Chapter 3 presents the Measurement Discovery Process derived from theory of the previous chapter and chapter 4 necessary Tetra Pak and ISP2 project information in order for readers to be able to understand the industry case and the application of the process, described in chapter 5. Finally, chapter 6 summarizes the composed ISP2 measures whereas chapters 7, 8 and 9 conclude the thesis by evaluating the Measurement Discovery Process, suggesting future work and presenting thesis inferences. In addition, appendices A-E and G provide material facilitating for understanding and applying the Measurement Discovery Process as well as for understanding certain details of the industry case.

1.3 Method

This thesis is research-based and industrially applied in order to evaluate results of the conducted work, serving as feedback and basis for enhancing rework. It is composed through in-depth studies and comparisons of state-of-the-art research, providing adequate insight and foundation for new model-building theories.

Informal interviews with industry personnel were used in order to elicit general organization knowledge and hard-to-acquire tacit knowledge from members of the industry case project. These were carried out ad-hoc and mainly revolved around brainstorm-based dialogues with personnel to whom the authors got acquainted or referred in the initial phase of composing the thesis. Questions addressed during these conversations embraced structure of organization, project and processes, ways of working and issues pertaining to management of quality and risk assessment. The rationale for approaching the interviewees informally was to promote their ability to express themselves freely, giving in-breadth as well as in-depth information on subjects addressed.

In addition questionnaires for information retrieval, illustrated in Appendix F, were introduced to concerned personnel. These were designed in such a way as to provide recipients with sufficient, yet concise and descriptive background material to attain understanding of what information was required. Their content consisted of a brief introduction to the questionnaire. In addition, questions with a fill-in section containing data elicited prior to questionnaire handout and a descriptive legend of abbreviations used in the questionnaire were included. The questions were designed to address issue areas where more information was required. All recipients were subjected to similar questionnaires with the fill-in sections differing with respect to each recipient in order to obtain information from those concerned with the data requested. Submission of questionnaires was done through e-mail giving recipients the option to provide the requested information by replying with the filled-in questionnaire or by requesting a meeting with the authors. In the former case, acquired data was objectively validated with respect to questions posed and information needed, and then subsequently assessed. In the latter case, i.e. meeting requests, interviews took place with the questionnaires as a basis for the conversation. Again, elicited information was objectively validated with respect to questions posed and information needed, and then subsequently assessed. The rationale for giving questionnaire recipients a choice of how to submit the requested information was four-fold: first, the number of recipients exceeded the number of questionnaire submissions estimated to be efficiently and effectively manageable through mere interviews. Second, the geographical location of several recipients made mere interviews infeasible. Third, recipients' understanding of the questionnaire and their ability to express themselves was predicted possibly limited with e-mail as the only means of dialogue with the authors. Fourth, providing recipients with a choice of how to submit questionnaires allowed them to participate at a point suiting their schedules best. The outcome of using questionnaires as an information gathering technique in the industry application is given in section 5.2.

Utilizing the described approach allowed for small preparations in terms of interviews and low-cost, fast distribution and assembly of questionnaires, fulfilling timely constraints on the thesis and the industrial project. Hence a qualitative approach to the problem domain was chosen given the exercised information retrieval techniques.

1.4 Delimitation

Surveyed state-of-the-art models for quality measurement in section 2.2 are limited to a few whereas an abundance of models exist. However, selected models are representative for techniques using measurement as part of their quality assurance concept. These provide different perspectives on the quality measurement notion and consequently represent a breadth of available models.

An evaluation of the derived Measurement Discovery Process is conducted with respect to the process itself but limited regarding evaluation of the definite measures, i.e. the final outcome of the process. Due to time constraints, gauging of definite measures has not been carried out and consequently it is infeasible to determine the measures' appropriateness to the industry case.

The thesis and its authors are bound by a non-disclosure agreement signifying that selected parts and certain keywords in the assessed information material have been left out due to the need of preserving business confidentiality or simply due to non-relevancy to the thesis's scope.

2. State-of-the-art Theory

This chapter accounts for general reflections perceived during literature and research assessment. In addition, process measurement approaches and the foundation for describing and comparing the referred approaches are given. These provide readers with an insight to state-of-the-art techniques and models for measurement as well as with a comprehension of how the thesis's objective has been addressed.

2.1 Information Retrieval

A general problem perceived by the authors during the writing of this thesis has been to retrieve information on quality assurance models and state-of-the-art research pertaining to the problem domain. Research encountered generally focus on either high-level process improvement and quality theory or low-level ditto on software development processes and do neither account for how measures are to be identified and defined nor explicitly focus on quality measures. In the absence of such literature and research theory it is fair to assume that a demand for such exists, promoting the call for this thesis.

2.2 Measurement Process Approaches

In order to achieve a deepened understanding of the problem domain, state-of-the-art and widely recognized measurement process approaches have been studied. Subsequent sections briefly introduce each approach encountered and apparently applicable to the problem domain, followed by a section discussing advantages and disadvantages of applying each to the thesis's objective.

2.2.1 Quality Function Deployment

Setting customer needs and customer expectations in focus, the Quality Function Deployment (QFD) methodology systematically identifies customer demands on product features and design parameters and transforms these into product characteristics in the manufacturing process [6]. Several product characteristics are required to fulfill these demands and several process features to accomplish these product characteristics [7]. Further, the QFD methodology facilitates organizational communication and employee participation in requiring cross-functional group meetings as part of the concept. Figure 2-1, adopted from [13], illustrates a framework for QFD.

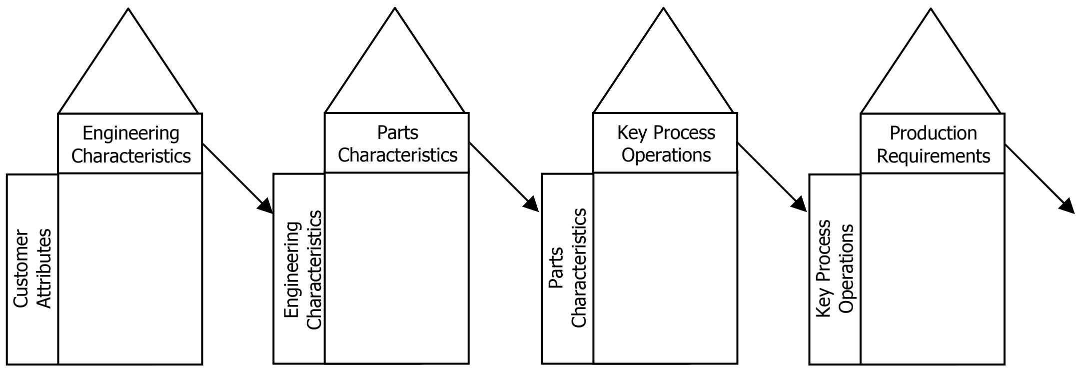

Figure 2-1 A framework for Quality Function Deployment [13].

Processing QFD embraces performing market analysis assessing customer needs and expectations, examining competitors' ability to meet customer demands, and identifying success key factors for market success of company products based on previous steps. Finally, identified key factors are translated into product and process characteristics in connection with design, development and production [6]. Generally recognized advantages gained by adopting QFD is improved inter-company communication, knowledge transfer, team unity and improved design. Yet, benefits such as improved products, customer satisfaction and shortened production times appear late and are infrequently perceived as immediate consequences of employing QFD. Bergman and Klefsjö [6], through [8], report frequent problems when implementing QFD: lack of management support, lack of project group commitment and insufficient resources. A major concern is to what extent multiple requirements can be handled simultaneously when working with QFD. [6]

2.2.2 Six Sigma

Six Sigma is an approach for fulfillment of corporations' strategic goals [2], and may be briefly described as a data-driven method for eliminating defects in any process. The term Six Sigma is used as an expression in organizations to simply refer to a measure of quality aiming at near perfection. To reach Six Sigma, a process must not produce more than 3.4 Defects Per Million Opportunities (DPMO). A Six Sigma defect is defined as anything that differs from customer specification and an opportunity is the total quantity of chances for a defect. Six Sigma may possibly, in certain cases, be used for software project as illustrated by Biehl in [17].

Focus of the Six Sigma methodology is the implementation of a measurement-based strategy that centers on process improvement accomplished through the use of two Six Sigma sub-methodologies: *DMAIC* and *DMADV*. DMAIC (Define, Measure, Analyze, Improve, and Control) is applicable to organizations already having formal processes whereas DMADV (Define, Measure, Analyze, Design, and Verify) is intended for businesses without formal processes. [2] In Figure 2-2, adopted from [2], the process flows of the DMAIC and the DMADV sub-methodologies are illustrated.

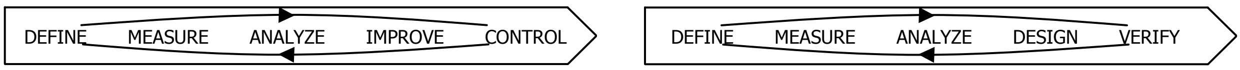

Figure 2-2 The Six Sigma improvement sub-methodologies DMAIC and DMADV [2].

Murugappan and Keeni [3] describe the steps in DMAIC where *Define* implies identifying the product or process to be improved and translate customer needs into Critical to Quality Characteristics (CTQs) as well as developing the problem/goal statement, the project scope, team roles and milestones. Finally, a high-level process is mapped for the existing process. Second, Measure involves recognizing the key internal processes that affected the CTQs and measuring the defects generated relative to the identified CTQs. Third, Analyze denotes understanding why defects are generated through brainstorming and statistical tools. This will result in key variables (Xs) that cause defects and the output will be an explanation of the variables that are most likely to affect process variation. Fourth, Improve signifies verification of the key variables and their maximum acceptable range and quantification of the effect that these have on the CTQs. Next, the existing process is modified to stay within these ranges. The final step, Control, is to use Statistical Process Control (SPC) or checklists to ensure that the modified process enables the key variables to stay within the range.

In addition, Murugappan and Keeni [3] describe the steps in DMADV where *Define* embraces equal activities as its corresponding step in the DMAIC sub-methodology. Second, *Measure* involves measuring and determining customer needs and specifications. Third, *Analyze* denotes analyzing the process options to meet the determined customer needs while the *Design* step signifies creating a detailed design of the process with these needs as its foundation. The ability to meet customer needs and performance of the design are finally validated in the *Verify* step.

2.2.3 Practical Software Measurement

The Practical Software Measurement (PSM) approach focuses on providing managers with information. Key PSM concepts are measurement planning, project estimation, feasibility analysis and status monitoring [9], providing project teams with a process selecting and applying measures for retrieval of data on project specific issues. Three processes are defined in the PSM approach: *tailor measures*, *apply measures* and *implement process* [10]. In addition, Bailey *et al.* [14] specify a fourth process, *evaluate measurement*; all are depicted in Figure 2-3 (adopted from [14]).

In the first process, based on project objectives, constraints and other planning activities, project key issues such as problems, risks and information insufficiency are identified, prioritized and mapped onto monitoring or controlling measures. Issues are classified into areas serving as the basis for mapping; Schedule and Progress, Resources and Cost, Growth and Stability, Product Quality, Development Performance and Technical Adequacy. Subsequently, a measurement plan is built. In the second process, measures are gathered, analyzed in terms of feasibility and performance and used for decision-making. Accuracy and fidelity of collected data need verification and, frequently, normalization in for facilitating combinations of data from different units. In the third process, the business implements the measurement including establishing organizational support, defining responsibilities and providing resources such as tools, funding and training. [10] In the fourth process, the measurement program is assessed and possible improvements are identified [14].

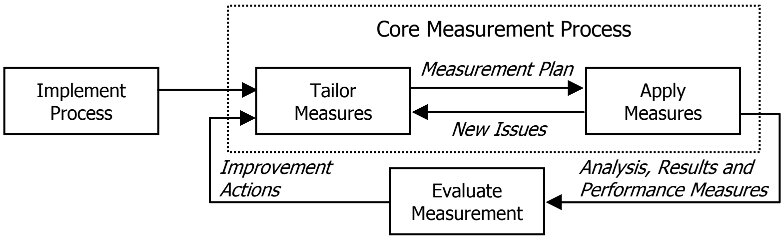

Figure 2-3 The PSM Process Scope [14].

2.2.4 Goal-Question Metric

The Goal-Question Metric (GQM) method, according to van Solingen and Berghout [4] (and originally developed by Basili and Weiss [12]), is a result of several years of practical experience and academic research. Lavazza [5] describes the GQM method as a systematic technique for developing measurement programs for software processes and products. The GQM process is founded on the concept that measurement should be goal-oriented, i.e. data collection based on an explicitly documented rationale.

Four phases are defined in the GQM method, i.e. *planning*, *definition*, *data collection* and *interpretation*. In the planning phase a project for measurement application is chosen, defined, characterized and planned, resulting in a project plan. During the definition phase goals, questions, metrics and hypotheses are defined and documented with the help of interviews. In the data collection phase data are collected upon former phases. In the last phase, the data is processed into measurement results and provide answers to the defined questions, leading to an evaluation of goal attainment. [4] Figure 2-4, adopted from [4], illustrates these phases.

The planning phase includes training, management involvement and project planning to make a GQM measurement program successful. By conducting interviews or other knowledge acquisition techniques the definition phase identifies a goal, all questions, related metrics and expectations of the measurements and the actual measurement can start. In the data collection phase data collection forms are defined, filled-in and stored in a measurement database. The interpretation phase then uses the collected measurements for answering the stated questions and to assert whether the stated goals have been attained. [4]

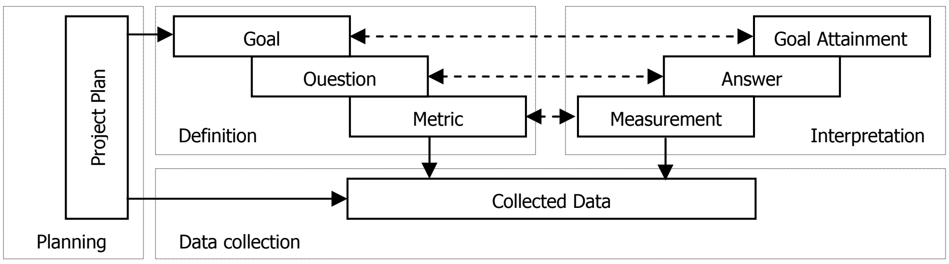

Figure 2-4 The four phases of the Goal-Question Metric method [4].

2.2.5 Balanced Scorecard

The Balanced Scorecard (BSC), described by Bianchi [11], is a technique for translating a business vision into a set of financial and non-financial perspectives that can be recognized through a set of metrics. BSC can be divided into four perspectives on which strategic goals and measurements are based. The *financial perspective* is an important measurement since both internal and external customers depend on the organization's financial result. *Customer satisfaction*, the second perspective, is vital for evaluating customer and user satisfaction, also including profits, market share and customer retention. Product/service quality and continual improvement are important for the *business process efficiency* perspective; herein internal processes can be evaluated in terms of process maturity, standards, production costs, etc. The last perspective, *innovation and training*, is essential since knowledge and competence has become critical survival factors. This can be met by assessing skills of employees, capability of information systems, speed to adopt change and technological competence. Measurements from each perspective can be combined in the BSC into a set of indicators providing the organization with valuable information for organizational improvement. [11] Figure 2-5, adopted from [15], shows the four perspectives of the BSC technique.

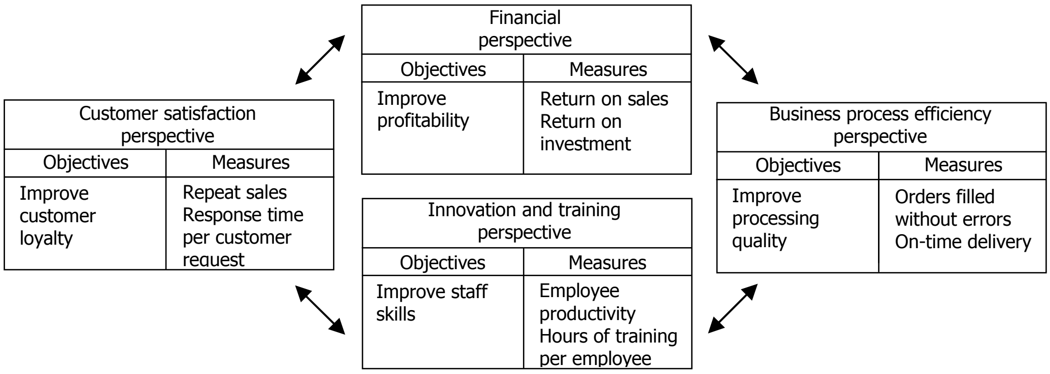

Figure 2-5 The four perspectives of the BSC technique [15].

According to Bergman and Klefsjö [6] the balanced scorecards may be viewed as a means of broadening traditional financial control with measures from other important areas, both internal and external. Furthermore, the authors highlight that in recent years balanced scorecards have been popular in both the private and the public sector. The incentive for this is, according to Bianchi [11], that BSCs have wide electronic support and are easy to learn and use.

2.3 Measurement Process Assessment

This section consider the applicability of measurement process approaches described in section 2.2, to the case of a business needing immediate process measurements as the basis of decision-making for process improvement; requisites are on project level rather than on an all-embracing process quality improvement level.

The Six Sigma sub-methodology DMAIC is attractive due to its composition of components while embracing five necessary steps to conduct when approaching the thesis's main objective. In addition, it is suitable for businesses with formally defined processes. However, Six Sigma is generally intended for businesses adopting general quality assurance in their organizations whereas this thesis's objective divert from those of Six Sigma's scope, i.e. quality management at organizational level. Consequently, Six Sigma is excluded in the light of the thesis's objective, even if it may be applicable to software projects in some cases, as seen in 2.2.2.

Focusing on information provision for managers, the PSM approach's main objective is to deliver measurements as a basis for project managerial decision-making. PSM's purpose clearly corresponds to that of the thesis's objective and the approach is equipped with easily accessible and straightforward guidelines.

A GQM measurement program involves activities occurring at several organizational levels and to fit within the thesis's objective it has to be decomposed in order to match timely constraints. Nevertheless, in addressing the development of measurement, certain parts of the method are indeed applicable, e.g. the definition phase.

Even though easily graspable and measurement focused, BSC's takeoff in corporative visions directs its use towards organizational development at a business management level. Consequently, BSC's high-level deployment makes it less suitable for implementation in a specific case since it is aiming at the development of an entire measurement program.

Out of the process measurement approaches described in section 2.2, the QFD methodology is apparently the least applicable. Despite its ability to identify and collect success key factors possibly translatable into measurements, the customer oriented approach narrows QFD's suitability in this thesis since customer demands are merely one perspective possibly impacting quality measurements in a project and therefore a wider approach is necessary.

In accordance with above considerations a measurement process embracing selected and merged parts from the PSM and GQM measurement approaches, is presented in chapter 3 since selected PSM and GQM parts are those best suitable and customizable for discovering measurements in a project needing explicit identification and definition of measures. Consequently, henceforth this thesis will exclusively focus on these measurement approaches.

3. Measurement Discovery Process

This chapter describes a process for discovering measurement opportunities in a project where emphasis is on discovering measures in a straightforward fashion. It does not primarily address implementing an entire measurement program; yet future enhancements may direct the process in this direction. The term ‘discovery’ is used to emphasize that, based on predefined questions the possible measures in a project are discovered rather than defined from scratch. In other words, a set of generally applicable measures are mapped and customized to the target project according to project characteristics.

As stated in section 2.3, this process is based on a combination of certain parts of the Practical Software Measurement (PSM) and the Goal-Question Metric (GQM) measurement methodologies, described by Bailey *et al*. [14] and van Solingen and Berghout [4] respectively. Specifically, this process has its basis in GQM where the Goal (G) approach has been removed in order to directly focus on the relationship question-metric with PSM’s predefined questions and measures for addressing this relationship. Consequently, the labor- and time-intensive process of defining business-specific goals from scratch, targeting a specific project, is avoided and allows for already in-place questions to provide guidance in the discovery of measures. Note that even though omitting the Goal approach (G) in GQM, the (Q) Question approach will shoulder the role as the area-focusing part of the derived model, avoiding measures to be scattered in terms of application areas, which would otherwise be the consequence. The requirement for straightforwardness and uncomplicatedness is indeed attained.

While PSM and GQM focus on implementing entire measurement programs, this process utilizes certain key parts of the methodologies for addressing the thesis’s objective, i.e. an approach for rapid measurement discovery is composed, giving a foundation for managerial decision-making. A process overview based on this approach is hereby rendered and given in Figure 3-1. Note that PSM’s predefined tables not are intended to represent an exhaustive or required set of project management measures. However, these measures have repeatedly proven to be effective over a wide range of projects [14].

The Measurement Discovery Process aspires to be appropriate for projects where measurement implementers have poor or no prior knowledge of the target project and its hosting organization. It is also suitable for projects and businesses demanding rapid suggestions for measures not necessarily wishing to implement measurements above project level. In addition, businesses lacking formal business goals and/or cases may profit from use of the Measurement Discovery Process in that the process does not address or require these to be defined. Subsequent sections describe the process, starting with an overview.

3.1 Process Overview

This section illustrates the Measurement Discovery Process and its possible paths, given by the overview illustrated in Figure 3-1. Discovery is the first step and embraces primary questions, measures and corresponding measure descriptions; Evaluation is the second step including stakeholder customization of discovered measures and Categorization and Presentation of measures concludes the process with labeling and presentation of measures.

In addition, Figure 3-2 provides support for measure discovery using the process and is a conjunction of PSM's predefined tables [14] found in Appendix A and B. This merge realizes the main concept of the thesis's model in that questions directly address measures. In short, the items in Figure 3-2 follow the discovery process and are to be read from left to right progressing downwards. The jagged border of the *Measure* column implies that Measure Descriptions, see section 3.2.1, are to be considered for additional selection support prior to measure approval. Remaining columns, *Measurement Category (MC)* and *Common Issue Area (CIA)* are described in section **Fel! Hittar inte referenskälla.**.

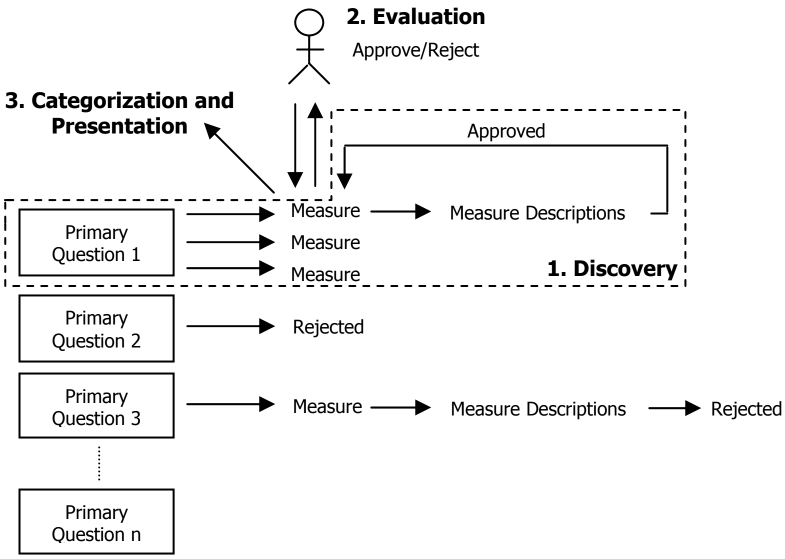

Figure 3-1 The Measurement Discovery Process.

Showing an example following Figure 3-2, the first primary question is *Is the project meeting scheduled milestones?*. This question is connected to its measure *Milestone Dates* that, in turn, is equipped with its corresponding measure description; these constitute the first step of Figure 3-1 (Discovery) if a rejection has not occurred. Secondly, the measure may be evaluated (Evaluation) and finally categorized (Categorization and Presentation) in *Milestone Performance* (Measurement Category) and *Schedule and Progress* (Common Issue Area), as of Figure 3-2. The elements and workflows of these figures are further described in section 3.2.

Primary Question	Measure	Measurement Category (MC)	Common Issue Area (CIA)
Is the project meeting scheduled milestones? Are critical tasks or delivery dates slipping?	Milestone Dates Critical Path Performance	Milestone Performance	Schedule and Progress
How are specific activities and products progressing?	Requirements Status Problem Report Status Review Status Change Requests Status Component Status Test Status Action Item Status	Work Unit Progress	
Is capability being delivered as scheduled in incremental builds and releases?	Increment Content – Components Increment Content – Functions	Incremental Capability	
Is effort being expended according to plan? Is there enough staff with the required skills?	Effort Staff Experience Staff Turnover	Personnel	Resources and Cost
Is project spending meeting budget and schedule objectives?	Earned Value Cost	Financial Performance	
Are needed facilities, equipment, and materials available?	Resource Availability Resource Utilization	Environment and Support Resources	
How much are the product's size, content, physical characteristics, or interfaces changing?	Database Size Components Interfaces Line of Code Physical Dimensions	Physical Size and Stability	Product Size and Stability
How much are the requirements and associated functionality changing?	Requirements Functional Change Workload Function Points	Functional Size and Stability	
Is the product good enough for delivery to the user? Are identified problems being resolved?	Defects Technical Performance	Functional Correctness	Product Quality
How much maintenance does the system require? How difficult is it to maintain?	Time to Restore Cyclomatic Complexity Maintenance Actions	Supportability – Maintainability	
Does the target system make efficient use of system resources?	Utilization Throughput Timing	Efficiency	
To what extent can functionality be re-hosted on different platforms?	Standards Compliance	Portability	
Is the user interface adequate and appropriate for operations? Are operator errors within acceptable bounds?	Operator Errors	Usability	
How often is service to users interrupted? Are failure rates within acceptable bounds?	Failures Fault Tolerance	Dependability – Reliability	
How consistently does the project implement the defined processes?	Reference Model Rating Process Audit Findings	Process Compliance	Process Performance
Are the processes efficient enough to meet current commitments and planned objectives?	Productivity Cycle Time	Process Efficiency	
How much additional effort is being expended due to rework?	Defect Containment Rework	Process Effectiveness	
Can technology meet all allocated requirements, or will additional technology be needed?	Requirements Coverage	Technology Suitability	Technology Effectiveness
Is the expended impact of leveraged technology being realized?	Technology Impact	Impact	
Does new technology pose a risk due to too many changes?	Baseline Changes	Technology Volatility	
How do our customers perceive the performance on this project? Is the project meeting user expectations?	Survey Results Performance Rating	Customer Feedback	Customer Satisfaction
How quickly are customer support requests being addressed?	Request for Support Support Time	Customer Support	

⟩ = Measure Descriptions supporting measure selection

Figure 3-2 Measurement discovery items.

3.2 Procedure

In order to discover the most suitable measures, it is necessary to study and get acquainted with the target project and its processes. The higher level of organizational process maturity, the easier it is to obtain and assess internal information of relevancy to measurement discovery. Process documentation, risk analysis and stakeholder interviews are key instances of sources for information retrieval. Personnel with profound knowledge in these areas are more appropriate for managing the discovery process than people required to collect this information, e.g. external consultants.

Although the Measurement Discovery Process is based on the PSM [14] and the GQM [4] measurement methodologies, it is not crucial to be familiar with these techniques, yet comprehension of their basic concepts may facilitate in running the process.

3.2.1 Discovery

Addressing primary questions given in Figure 3-2 (*Primary Question*) commences the process. The term 'primary' denotes that these are, as opposed to other questions appearing later in the process, considered at first in the Measurement Discovery Process. These offer suggestions on which areas to address for measurement discovery and are based on actual measurement experience on government and industry software and system projects [14]. Either question areas are not of relevancy to the project and hence rejected or may be further dealt with by considering their corresponding measures; again see Figure 3-2.

A measure may not be entirely assessed without considering its Measure Description Table, exemplified in Appendix E, and hence can neither be rejected nor approved without this information. These tables, provided in [14], detail measures with information on where, how and when (*Selection Guidance*) the measure is to be applied. In addition, *Specification Guidance* gives information on data and meta data associated with the measure. Particularly valuable when selecting measurers are the table sections stating detailed questions to which the measure may answer.

Based on this information, a measure may fairly effortlessly be rejected or approved by measurement implementers, i.e. determined whether suitable for the target project or not and hence subject to further evaluation as described in section 3.2.2. In order for measure evaluation to be conducted, discovered measures need documentation including the columns of Figure 3-3, which provides an example of how measure documentation may be designed. In this figure, enumeration of measures provides structure and traceability, activity application states target project area, data shows what to measure, issues addressed state which questions the measure answers to, whereas rationale gives justification for using the measure in the specific project.

Nevertheless, additional columns such as priority, responsible person etc. may be added according to project needs and characteristics. Information should consequently be extended gradually as it becomes available throughout the discovery process and in particular during evaluation, i.e. the second step of the Measurement Discovery Process.

No	Measure	Activity Application	Data	Issues Addressed	Rationale
1	Lines of Code (LOC)	Development	# lines of code # lines of code added/deleted/modified	How accurate was project size estimate on which schedule and effort plans were based?	Changes in LOC indicate development risk due to product size volatility and possible rework.

Figure 3-3 Documentation of discovered measure.

3.2.2 Evaluation

Measures selected so far reflect the target project information gathered and assessed by measurement implementers conducting the Measurement Discovery Process. However, stakeholders affected by the introduction of measurement may need to be consulted for further information and evaluation of discovered measures, e.g. through interviews, observations or questionnaires. Stakeholders are likely to be able to provide inputs determining whether selected measures are to be approved or rejected since they are now offered a foundation to base their judgments on, as opposed to when consulted in the initial step of the discovery process. Note that different stakeholders may have different opinions regarding a measure. It is then the responsibility of the implementers to resolve the conflict with whatever comprises it may imply in order to meet each stakeholder's requests.

Appendix C provides examples of electronic and hard-copy sources for measurement data and may be used to determine whether established measures are feasible in terms of available physical information. Considering sources of data for measurement discovery is likely to turn focus on measures where data is already available rather than on those measures where data needs to be collected. Thus Appendix C has not been introduced prior to measure evaluation (now).

Evaluation may as well give room for customization and concretization of discovered measures and suggestions for additional measures. Measure evaluation is vital since it facilitates organizational recognition and acceptance and accuracy of measurements, yet evaluation may be omitted if measurement implementers and target project information providers are the very same.

3.2.3 Categorization and Presentation

As seen in Figure 3-2, each measure is mapped onto a *Measurement Category* (MC) and further onto a *Common Issue Area* (CIA). These allow for classification of measures at different levels highlighting different areas targeted by the discovered measures. Note though that neither MCs nor CIAs are of vital significance in the process; they primarily serve as labels categorizing approved and definite measures.

Additional MCs may be developed and mapped onto specified or case-specific CIAs. Figure 3-4, adopted from [14], shows PSM's seven predefined CIAs which in PSM are used to map project issues to common issue areas. This thesis's process instead uses primary questions to address CIAs through MCs. Hereby, the presumptive threshold of identifying project issues and mapping these to CIAs is avoided. Instead primary questions are addressed proposing possible project issues. The seven CIAs given in Figure 3-4 are related to several MCs predefined in [14] and exemplified in Appendix D, showing the PSM Measurement Category Table *Milestone Performance* in the common issue area *Schedule and Progress*. In addition, Appendix E provides an instance of a measure, *Milestone Dates*, through a PSM Measure Description Table. A PSM Measurement Category Table provides detailed information on measurement categories and common characteristics of those measures contained within the categories. (PSM Measure Description Tables was described in section 3.2.1.)

Common Issue Area (CIA)	Description
Schedule and Progress	This issue relates to the completion of major milestones and individual work components. A project that falls behind schedule may have to eliminate functionality or sacrifice quality to maintain the delivery schedule.
Resources and Cost	This issue relates to the balance between the work to be performed and personnel resources assigned to the project. A project that exceeds the budgeted effort may recover by reducing functionality or sacrificing quality.
Product Size and Stability	This issue relates to the stability of the functionality or capability. It also relates to the system's product size or volume. Stability includes changes in scope or quantity. An increase or instability in system size usually requires increasing resources or extending the project schedule.
Product Quality	This issue relates to the product's ability to support the user's needs within defined quality or performance parameters. Once a poor quality product is delivered and accepted by the user, the burden of making it work usually falls on the operations and maintenance organization.
Process Performance	This issue relates to the capability of the supplier and the life-cycle processes to meet the project's needs. A supplier with poor management and technical processes or low productivity may have difficulty meeting aggressive project schedule, quality, and cost objectives.
Technology Effectiveness	This issue relates to the viability of the proposed technical approach, including component reuse, maturity and suitability of COTS components. It also refers to the project's reliance on advanced systems development technologies. Cost increases and schedule delays may result if key aspects of the proposed technical approach are not met, or if key technological assumptions are inaccurate.
Customer Satisfaction	This issue relates to the customer's perception of product value. Customers are likely to be satisfied when products and services are delivered on time, within budget, and with high quality. However, the customer's perceptions of cost, timeliness, and quality are influenced by marketing, historical use, and the competition.

Figure 3-4 PSM predefined Common Issue Areas (CIAs) [14].

Following the discovery, evaluation and categorization and presentation steps of the Measurement Discovery Process, a fairly significant amount of information have been established. In order to facilitate measure application and management, this information has to be summarized and represented in an intelligible form, arbitrary though suitable to the target project and information needs of personnel accountable for measure gauging. The more comprehensive and accessible information, the more attractiveness and organizational penetration of measurement can be expected.

4. ISP2 Pre-study

This chapter provides readers with sufficient background information on the Information Systems Platform 2 (ISP2) processes and infrastructure for comprehension of the case that the Measurement Discovery Process introduced in chapter 3 is applied on. It consists of information mainly retrieved internally at Tetra Pak through documentation, informal interviews and tacit knowledge of staff members. Note that selected parts and certain keywords in the assessed information material have been left out due to the need of preserving business confidentiality or simply due to non-relevancy to the thesis's. Keywords and abbreviations lacking explanation throughout the following sections are described in Appendix G.

4.1 Solution

The ISP2 solution aims at replacing current information systems at target market companies due to increased maintenance costs of existing systems and an urge to achieve a global coherent solution pertaining to selected market companies (see Figure 4-1). Preparation, implementation (rollout) and support (Hyper-Care) are the project's main phases comprising activities such as internal marketing, business analysis, risk assessment, planning, training, preparations, system implementation, validation and support. The background information detailed herein focus on rollout activities, outlined in section 4.5.

4.2 Schedule

The ISP2 rollout calendar is fairly extensive, involving 25 countries or regions chronologically partitioned in five phases as shown in Figure 4-1, referring to start of implementation period. This indicates the need of measurement for managerial decision-making and improvement opportunities in upcoming rollouts. As seen, regions presently in question for rollout are the Czech & Slovak Republics followed by Adria and the Baltics.

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Czech & Slovak	Central Asian Republics	Chile	Dubai & Yemen	Emerging Markets
Adria	Greece & Cyprus	Ecuador	Libanon & Jordan	Indonesia
Baltics	Maghreb	Peru	Egypt	New Zealand
	Romania & Bulgaria	Hoyer US	Iran	Philippines
	West Africa		Malaysia	Singapore
	Panama		Thailand	Vietnam

Figure 4-1 The ISP2 rollout calendar adopted from ISP2 internal documentation.

4.3 Infrastructure

In order to provide means for managing changes and issues within the ISP2 solution, several mechanisms supporting ISP2 processes exist of which those affected by the definite measures given in chapter 6 are described in sections 4.3.1-4.3.6. In addition, sections 4.3.7 and 4.3.8 describe the Tetra Pak Business Processes and components of the ISP2 solution, i.e. Business Activity Processes. Figure 4-2 gives an understanding of how the major notions for managing changes, i.e. TDR, GAP and SCR, are used and impacted by possible sources of modifications to the ISP2 solution.

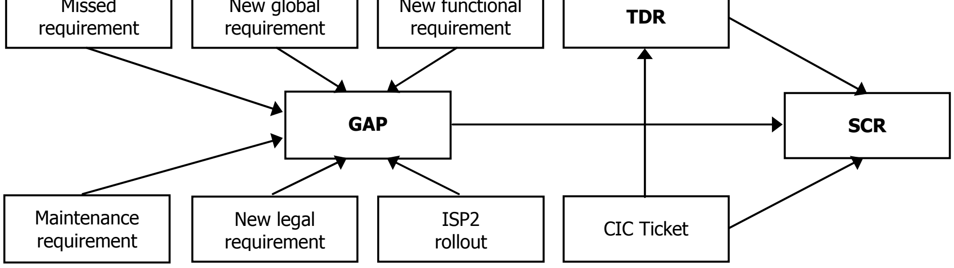

Figure 4-2 Possible flows raising a TDR, GAP or SCR.

4.3.1 eRoom

eRoom serves as a web-based repository for managing, storing and providing a variety of documentation on ISP2 processes, workflows, instructions, managerial issues etc. In addition, the notions of GAP and SCR are supported by tools accessible through eRoom; these are described in sections 4.3.3-4.3.4.

4.3.2 TDR and Test Director

A Test Discrepancy Report (TDR) is a description of a software defect discovered in the ISP2 solution and may be raised through CIC Tickets, see Figure 4-2, or through test activities. TDRs are traceable to Tetra Pak Business Processes and Business Activity Processes, described in section 4.3.7 and 4.3.8 respectively.

Test Director is a web-based commercial of the shelf (COTS) tool for managing test scripts and TDRs, e.g. priority, status, dates, estimated time for fix, CIC Ticket reference, severity, description etc.

4.3.3 GAP and GAP Tracker

A GAP (non-abbreviation) is a request for functionality not covered by the current ISP2 solution and may be raised through new functional, new global requirements, missed, maintenance or new legal requirements, or implementation issues encountered during rollout, as seen in Figure 4-2. GAPs are traceable to Tetra Pak Business Processes or MDM and Business Activity Processes, described in sections 4.3.7 and 4.3.8.

GAP Tracker, accessible via eRoom, is a database for managing GAPs, e.g. dependencies, status, dates etc.

4.3.4 SCR and SCR Tracker

A System Change Request (SCR) is a request for a change in the ISP2 solution to address a specific GAP, TDR or a CIC Ticket containing a development request, as seen in Figure 4-2. SCRs are traceable to Tetra Pak Business Processes and Business Activity Processes, described in sections 4.3.7 and 4.3.8 respectively.

SCR Tracker, accessible via eRoom, is a database for managing SCRs, e.g. owner, dependencies, status, dates, estimated time for implementation, GAP reference etc.

4.3.5 Benefit & Issue Trackers

Benefit & Issue Trackers are used at market companies for logging issues raised locally at the site, possibly progressing into GAPs when additional local or legal requirements are captured. A tracker is realized through spreadsheets, word processing documents or by other means arbitrarily decided by its manager. Logged issues constitute the ISP2 rollout source for GAP raise, as depicted in Figure 4-2.

4.3.6 CIC and Tickets

The Customer Interaction Center (CIC) is used globally within Tetra Pak Information Management, IT-supportive to the organization. It is used for logging and tracking problem issues raised during operational (after go-live) use of the ISP2 solution at market companies. Each issue raises a Ticket containing details of the reported problem and may remain a support request or propagate to a development request of the ISP2 solution, pertaining to its severity. Tickets may raise a TDR or SCR as seen in Figure 4-2 and described in sections 4.3.2 and 4.3.4 respectively.

4.3.7 Business Processes

Tetra Pak is viewed in terms of four Business Processes: Equipment and Project Sales (EQPS), Finance (FI), Packaging Material (PM) and Technical Sales (TS). EQPS sells engineered solutions to meet customer requirements on processing and packaging of food, consisting of hardware, software (drawings, specifications, programs, manuals etc.) and services (engineering, installation, support etc.). FI includes financial administration, accounting, managing of financial and legal requirements such as those pertaining to taxes and the European Union for market companies. PM is the core Tetra Pak business process and embraces packaging and its material such as carton or plastic as well as straws, sealing, corks, design, layout and paper quality. The TS business process constitutes handling of spare parts and service of packaging machines delivered by Tetra Pak.

4.3.8 Business Activity Processes

ISP2 Business Activity Processes are ways of viewing software components and interfaces comprising the ISP2 solution in terms of Business Process supporting entities.

Components include Management Information System (MIS)/Reports for fulfilling global management requirements on reports, results and statistics; Forms for satisfying market company requirements on invoices, orders etc.; iLink for connecting ISP2 with other Tetra Pak financial systems; TL-Netting for invoice set offs and reduction of currency fluctuation effects within Tetra Pak, and iScala/Global Template (GT) for considering the ISP2 solution entirety. Also included is the Master Data Management (MDM) component consisting of a Master Data Object (MDO) and a Master Data Interface (MDI). MDO is an ISP2 customized comprehensive database for storing business process data for all market companies, whereas MDI is its web-based interface for data managing.

Interfaces, termed e-business as well, denote e-business within the PM business process, i.e. e-pacs, and e-business with the TS business process, i.e. e-parts. The PM and TS business processes are described in section 4.3.7.

4.4 Roles and Responsibilities

Approximately 50-55 persons are directly or indirectly involved in the deployment of the ISP2 solution, the figure varies due to periodically hired consultants. ISP2 includes several roles and responsibilities as well, of which those affected or concerned by the application of the Measurement Discovery Process, are described in Figure 4-3.

Role	Responsibilities
Business Expert	Capture, analyze, categorize and validate local, legal and business critical requirements. Facilitate identification of needs for process alignment and internal business integration to maintain Tetra Pak trade flow. Responsible for managing Benefit & Issue Tracker and raise potential GAPs for e.g. business critical integration points between ISP2 and other systems. Handle support requests in system localization and local system validation.
Cut Over & Conversion Lead	Key responsible for managing transactions pertaining to database management system for market company production, facilitating market company go-live. Responsible for data cleansing, data loading and data validation of data contained within market company systems.
Global Design Lead	Responsible for design of a specific ISP2 component in the global template solution including configuration, parameters, tables, programs, code files etc. This role is more technical than global process leads.
Global Process Lead	Review local, legal and business critical requirements for assisting in market company localization. Control global template solution in conjunction with market company localization requirements and localization activities. Analyze GAPs and cost of resolution and assist in local system validation preparation and hyper-care.
Integration Manager	Responsible for managing ISP2 scope and supervision of GAPs. Control implementation and quality of changes in development environments in accordance with established specifications and estimated time plans.
Project Controller	Responsible for follow-ups on costs and revenues, and management of budgetary planning, payments, cost centers and contracts.
Release Manager	Manage development, planning, changes to and tests of new releases within the ISP2 implementation.
Rollout Director	Overall responsible for managing identification and resolution of market company requirements as well as alignment and integration of their needs such as risk management, go-live readiness and key stakeholder communication.
Service Delivery Manager	Establish and maintain operational standards for support service and contingency plans. Support establishment and maintenance of globally transparent operational routines for the service and technical training programs.
Technical Team Lead	Key responsible for rollout project plan, technical budget, quality assurance and requirements management. Monitor and coordinate rollout activities to identify and diminish technical risks.
Test Coordinator	Responsible for evaluation of test scripts and assurance of test procedures with follow-ups on test progression and quality of tests and deliverables. Additionally in charge of compiling test statistics and quality review of TDRs.

Figure 4-3 ISP2 Roles and Responsibilities.

4.5 Rollout Activities

The ISP2 rollout comprises several key implementation activities of which those applicable to the thesis's scope are viewed in Figure 4-4 and detailed throughout this section. Parenthesized abbreviations of rollout activity names in subsequent sections correspond to those used in the figure. The jagged end of the stripe left to the Implementation Phase stripe denotes the existence of a preceding phase (Preparation), though not of interest to the thesis. Note that this section introduces several new terms that are explained in Appendix G and/or in previous sections.

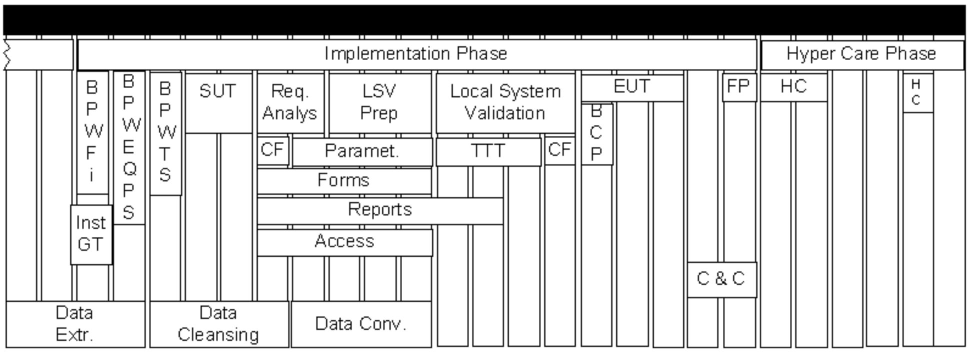

Figure 4-4 The ISP2 rollout activities adopted from ISP2 internal documentation.

4.5.1 Business Process Walkthrough

The Business Process Walkthrough Activities (BPWFi, BPWEQPS, BPWTS) intend to make super-users familiar with Tetra Pak global business processes as well as mediating knowledge of business scenarios related to iScala and its master database. In addition, super-users and other market company representatives are provided with information on how the ISP2 implementation will impact daily work. The former are also able to bring previously missed requests, i.e. legal or business critical requirements, into light.

4.5.2 Install and set-up Global Template Solution

The purpose of the Install and set-up Global Template Solution (Inst GT) activity is to ensure that the global template solution, i.e. iScala, MDM and components, is in place and localizable at a market company site.

4.5.3 Data Extract

A copy of the presently kept local database at a market company site is extracted and provided for data handling purposes in the Data Extract (Data Extr.) activity. Data handling includes evaluation, cleansing, conversion and loading of local data into the global template solution. These are detailed in sections 4.5.4-4.5.5 and 4.5.19.

4.5.4 Data Cleansing

Extracted data from the locally kept database at a market company site is cleansed in the Data Cleansing (Data Cleansing) activity. This aims at identifying, evaluating and correcting errors in extracted data in order to attain stable and reliable data as input for data conversion, see section 4.5.5.

4.5.5 Data Conversion

In the Data Conversion (Data Conv.) activity, data extracted and cleansed from the locally kept database at a market company site is converted and prepared for insertion into the ISP2 implementation, holding different requirements on data format than the market company site.

4.5.6 Super-User Training

In the Super-User Training (SUT) activity, super-users are trained for their role and responsibilities in the ISP2 market company implementation, embracing knowledge of system localization tasks and training of end-users. In addition, supplementary local and legal requirements are captured using Benefit & Issue Trackers during this activity.

4.5.7 Local/Legal Requirements Identification and Analysis

Local and legal requirements as a basis for market company localization are identified, captured and categorized during the Local/Legal Requirements Identification and Analysis (Req. Analys) activity. The identification stage is part of the Super-User Training activity (see section 4.5.6) while the analysis aims at identifying requirements to be addressed during localization activities (see section 4.5.8-4.5.11).

4.5.8 Parameter Localization

The Parameter Localization (Paramet.) activity includes establishing parameters in the global template solution according to market company local requirements, rendering a local system design. Parameters such as tax and currency settings are set in iScala to conform to market company functions.

4.5.9 Forms Localization

Addressing market company local and legal requirements, the Forms Localization (Forms) activity ensures that forms for e.g. invoice design, comply with Tetra Pak global standards while simultaneously addressing market company requirements.

4.5.10 Reports Localization

Addressing market company local and legal requirements and Tetra Pak global requirements, the Reports Localization (Reports) activity aims at providing a market company with a reporting solution, e.g. sales statistics, complying with requirements.

4.5.11 User Access

The User Access (Access) activity identifies and defines market company user access profiles and levels of authorization mapping security levels for use of the ISP2 implementation.

4.5.12 Cross-Function Session(s)

The Cross Function Session activity (CF) aims at ensuring that a market company is organized efficiently with the ISP2 implementation by asserting sufficient process alignment due to internal changes in market company processes and/or system integration points (e.g. automated integration between departments introduced to iScala). These sessions are targeted at severe issues requiring several parties' involvement (minor issues are resolved during normal implementation activities). Accordingly, clear understanding of Tetra Pak global business processes and agreed roles and responsibilities at market company site, is attained.

4.5.13 Local System Validation Preparation

In order to reach agreement upon specified requirements for local validation of the ISP2 implementation, the Local System Validation Preparation (LSV Prep) activity is conducted. Validation scripts and guidelines are localized and changes made for local data are reflected. This session provides a foundation for Local System Validation as described in section 4.5.14.

4.5.14 Local System Validation

The Local System Validation (Local System Validation) activity, by executing validation scripts, aims at ensuring compliance of the ISP2 implementation at a market company site with local and global requirements.

4.5.15 Train-the-Trainer

The Train-the-Trainer (TTT) activity aims at preparing market company super-users for training delivery to end-users, including presentation techniques, introduction of learning styles, class room management, trainer roles and responsibilities and use of ISP2 training material.

4.5.16 Business Contingency Plan

In case the implemented system becomes inoperable or if electronic communication links between supply chain ordering parties are disrupted, a course of action is attended to. This is established in the Business Contingency Plan (BCP) activity and mainly covers stated requirements for market company-specific processes' critical areas in case of system disruption for extended periods.

4.5.17 End-User Training

In the End-User Training (EUT), market company end-users are trained by super-users to be able to operate the ISP2 solution after go-live. Super-users are responsible for training activities due to language difficulties, ownership reasons and long-term competence build.

4.5.18 Final End-User Preparation

In the Final End-User Preparation (FP) activity, market company end-users are provided with additional hands-on practice in operating the ISP2 implementation. The session aims at building competence and familiarity with the new system.

4.5.19 Cut-Over and Conversion

The Cut-Over and Conversion (C&C) activity is intended to migrate and load all relevant extracted, cleansed, converted and validated transactional data from the current market company system into the ISP2 implementation.

4.5.20 Hyper-Care 1

The Hyper-Care 1 (HC) activity aims at supporting the market company gone live with the ISP2 implementation and follow up issues to prepare for hand-over to the regional support center. Issues are logged and categorized in CIC, see section 4.3.6.

4.5.21 Hyper-Care 2

The Hyper-Care 2 (HC) activity aims at supporting the market company gone live with the ISP2 solution for first book closing. Issues are logged and categorized in CIC, see section 4.3.6.

5. ISP2 Rollout Measurement Discovery

This chapter describes how the Measurement Discovery Process introduced in chapter 3 is applied at Tetra Pak and its ISP2 rollout process detailed in chapter 4. Conducting the discovery process aims at obtaining relevant measures for this process forming a foundation for evaluation by managerial staff members. Information and material assessed and to some extent detailed in chapter 4 creates the basis for application of the process. The former, among others, embrace lessons learned from the ISP2 pilot project, ISP2 process documentation, informal meetings and brainstorming, assessed support tools and risk analysis. Comprising a pre-study, this information provides general comprehension of ISP2 of which a vast amount renders tacit knowledge. The process's implementers, i.e. the authors, are Tetra Pak external and may be considered as consultants with insufficient prior knowledge of the ISP2 rollout process and Tetra Pak. Consequently the pre-study constitutes a major part of this particular case. Due to the authors' scarce previous knowledge of Tetra Pak and the ISP2 processes and goals, following the process of chapter 3 is most likely favorable in this application; accordingly it is possible to directly focus on proposals for measures, fulfilling the thesis's objective and addressing its scope. The following sections describe how the Measurement Discovery Process has been applied to the ISP2 rollout project.

5.1 Discovery

The primary questions of Figure 3-2 were considered for initial suggestions on which measures to assess for the ISP2 rollout project. Some questions were immediately pronounced out of scope on the basis of the authors' acquired project knowledge, whereas several primary questions were indeed seemingly appropriate and hence their corresponding measures, also given in Figure 3-2, were scrutinized. As emphasized in section 3.2.1, a measure's Measure Description Table was extensively examined to determine whether it was subject to implementers' approval or rejection. The listings in Selection Guidance and Specification Guidance were assessed and compared with project specific information attained, predominantly focusing on data items and detailed questions to which the measures answer. On the basis of measure details considered, measures were rejected or approved and further submitted for evaluation to ISP2 stakeholders. The measures selected, i.e. approved for measure evaluation, were summarized in accordance with Figure 3-3 to facilitate the second process step, evaluation.

Initially discovered and documented ISP2 rollout measures are given in Figure 5-2. For instance consider measure no 5, *Staff Turnover,* in Figure 5-2; the measure was selected since the authors' assessment of the present situation in ISP2 activities recognized a strong reliance on key personnel and their competence to perform certain tasks. This kind of dependency on crucial resources is critical and must be considered a risk. Hence, measuring employee retention and losses within all activities facilitates in addressing project impact due to staff turnover. This example gives an insight on how the remaining measures of Figure 5-2 have been selected and justified. Note that in order to promote structuring and statements of applicability when mapping measures onto activities in Figure 5-2, ISP2 rollout activities (see section 4.5) were grouped as shown in Figure 5-1, the third column (*Rationale*) stating each group's incentive.

Activity Group (abbreviation)	Activities (abbreviation)	Rationale
Initiation (INIT)	Business Process Walkthrough Install and set-up Global Template System Super-User Training Local/Legal Requirements Identification and Analysis Cross-Function Session(s)	Activities commence the ISP2 rollout phase for a specific market company.
Customization (CUST)	Local System Validation Preparation Parameter Localization Forms Localization Reports Localization User Access	Activities are concerned with tasks developing and customizing the solution to approved market company requirements.
Hyper-Care (HC)	Hyper-Care 1 Hyper-Care 2	Activities are concerned with supportive tasks subsequent to market company go-live.
Data Handling (DH)	Data Extract Data Cleansing Data Conversion Cut-Over and Conversion	Activities are concerned with database management and refinement of market company data for fitting purposes to the solution.
Ungrouped	Local System Validation (LSV) End-User Training (EUT) Business Contingency Plan (BCP) Final End-User Preparation (FP) Train-the-Trainer (TTT)	Activities lack sufficient common characteristics for grouping and are consequently stand-alones.
All activities (ALL)	All	All activities included in an ISP2 rollout.

Figure 5-1 Activity Groups discerned from activities described in section 4.5.

No	Measure	Activity Application	Data	Issues Addressed	Rationale
1	Milestone Dates	ALL	Activity start & end date Project start & end date	Is the current schedule realistic? How many activities are concurrently scheduled? How often has the schedule changed? What is the projected completion date for the project? What activities are on time, ahead of schedule, or behind schedule?	Essential for decision making and follow-up of timely issues permitting schedule changes, resource reallocation and budgetary considerations. Provides information to subsequent rollouts on process duration and efficiency.
2	Change Request Status	ALL	# change requests reported & solved	How many change requests have impacted the solution? How are change requests distributed among activities? Have change requests been reduced since last project? How should resources be distributed among activities?	Provides information on how to change activity routines for decreasing change requests and an indication of amount of performed or required rework.
3	Component Status	CUST	# components # components completed successfully	What components are on time, ahead of schedule, or behind schedule? Is the planned rate of completion realistic?	Indicates activity progression within each customization activity and progression of completion of components needed by each market company. Provides information to subsequent rollouts.
4	Test Status	ALL	# test cases # test cases failed # test cases passed	What functions have been tested or are behind schedule? Is the planned rate of testing realistic?	Indicates test progress and foundation for prioritization. In addition, overall quality pertaining to test cases is indicated.
5	Staff Turnover	ALL	# personnel # personnel gained & lost per project	How many people have been added to or have left the project? What areas are most affected by turnover?	Determines how resources are utilized, personnel retained and project impact of employee turnover. Gives foundations for decisions on resource allocation and risk assessment.
6	Cost	ALL	Cost	Are project costs in accordance with budgets? Will the target budget be achieved, overruned or surplussed?	Allows for project cost comparisons and budgetary considerations.
7	Resource Utilization	ALL	# hours/units requested # hours/units allocated # hours/units scheduled # hours/units available # hours/units used	Are sufficient resources available? How efficiently are resources being used? Is availability of resources impacting progress?	Provides information on whether key resources are sufficient and used effectively.
8	Database Size	DE	# tables # records/entries/words/bytes	How much data has to be handled by the system? How many different data types have to be addressed?	Indicates amount of data for processing and degree of handling difficulty, permits for resource management, timely estimations and comparison of extraction proportions to previous and upcoming rollouts.
9	Requirements	ALL	# requirements (per classification) # requirements added/deleted/modified	Have the requirements allocated to each increment changed? Are requirements being deferred to later increments? How much has functionality changed? What components have been affected the most? Is the number of requirements growing, at what rate?	Indicates level of adherence to market company requirements and quality of requirements management, useful for scope control. Effort in requirements and change management may be compared between market companies and rollouts.
10	Defects	CUST LSV	# defects # defects per classification Average age of defects	How are defects distributed among components? Do any severity patterns exist? What components require additional testing, review or rework? Do defect reporting and closure rates support the scheduled completion date of integration and test?	Provides quantification of number, status and priority of defects reported giving information on defect handling ability. Numbers give additional information on necessary rework and overall software quality. Arrival dates indicate solution maturity, closure rates indicate progress used for completion prediction whereas defect age implies process efficiency.
11	Technical Performance	LSV	Specified technical performance level Demonstrated technical performance level	Is the system able to perform all required functions within the specified system response time? Does the system operate efficiently?	While addressing system characteristics that can be quantitatively defined and demonstrated provides information on system ability to meet non-functional requirements.

No	Measure	Activity Application	Data	Issues Addressed	Rationale
12	Time to Restore	LSV HC	Time at which system failure was observed Time at which system failure was restored Time at which permanent fix was completed (including integration and test) # components affected Effort (labor hours) to recover (restore and fix)	How long does it take to recover from a failure? How much effort is required to fix a system component after failure? Does the system design support restoration of system operation within resource constraints?	Provides information on time and resources expended to recover from system failure in terms of immediate restoration of operational capability and long term resolving of root cause, determining adequate maintenance effort to ensure operational system availability.
13	Maintenance Actions	HC	Date of maintenance action Time required to perform maintenance action Cost of performing maintenance action Effort (labor hours) to perform maintenance action # user services unavailable # users impacted # system components impacted	How often must maintenance staff work on the system? How much does maintenance cost? Which system components have the highest number of maintenance actions?	Collecting data on maintenance actions performed on the system supplies information on system supportability impact due to system changes.
14	Timing	LSV	Time of function initiation Time of function completion Maximum allowable time for function	Is the target system sufficient to meet response requirements? How long do certain services or functions take? Does the system operate efficiently?	Indicates whether target component or system respond to requirements of timely nature.
15	Operator Errors	SUT TTT EUT FP	# operator errors	Does the solution meet its intended use? Have the operators received adequate training?	Provides information on how well the global solution has been integrated into the market company in terms of end-user and super-user usability.
16	Failures	HC	Date & time of failure occurrence Date & time of failure resolve Operating time since last failure	Was the system ready for operation? How often (and how severely) will the system/component fail during operation of the system? How much support resources are required?	Provides information on reliability, e.g. mean time between failures (MTBF). Failure rates give an indication of release date accuracy and amount of supportive actions needed. Assessed information provides vital input for subsequent rollouts.
17	Requirements Coverage	REQI REQA	# requirements # requirements consistent with technology	How compatible are the requirements with the technology?	Determines whether the technology available satisfies the requirements or if requirements change management is required (given that technology is firm).
18	Survey Results	ALL	Survey Results	Is the solution meeting market company expectation? Is market company satisfaction trend static or improving? According to market company, what areas need improvement?	Provides information on how the rollout process may be improved to increase (other) market companies' satisfaction.
19	Requests for Support	HC	# requests received # reported defects Time to respond and resolve	What types of support functions are requested most often? Do components have to be recalled, redesigned, or provided with new operating procedures? How responsive is support function to market company? Are market company needs and expectations being met? On average, how long does it take to resolve a market company request?	Number of discovered defects indicates quality of delivered solution. In addition, responsiveness of support activities and their ability to maintain the solution is assessed.

Figure 5-2 Documentation of initially discovered ISP2 rollout measures.

5.2 Evaluation

The information contained within initially discovered ISP2 rollout measures presented in Figure 5-2, merely reflect the implementers' point of view and consequently needs concretization on the basis of information retrieval from stakeholders in order to explicitly fit the ISP2 project. This comprises the evaluation step of the Measurement Discovery Process, see section 3.2.2, by the consultation of ISP2 stakeholders concerned with activities addressed by the initially discovered measures.

The evaluation was initiated by scrutinizing the measures of Figure 5-2 with a representative from ISP2 integration management since this organizational function was predicted to posses the most comprehensive knowledge of ISP2 in terms of key personnel, areas of responsibilities as well as process workflows. This representative served as a sounding board throughout the evaluation step, and aided in a first-level ISP2 customization of measures by appointing personnel responsible for measure gauging by appraising rollout activity application of each measure and determine overall feasibility of proposed measures.

At this point a need for a more intelligible presentation (illustrated in Figure 5-3 and used in chapter 6) of measures became obvious; isolated from each other and leaving more space for changes and refinement, stand-alone-measures were predicted more accessible and appealing to stakeholders. In order to avoid stakeholders being bewildered, it was decided to use this presentation design, durable in the remaining execution of the Measurement Discovery Process. In addition, each measure's documentation was extended to allow information on possible electronic and hard-copy sources, supplementary information and measure categorization. Data sources are essential for determining physical location of data to be measured and supplementary information allows for stating useful information regarding a measure. Measure categorization was introduced in advance to facilitate the last process step, categorization and presentation.

Prior to progressing with evaluation concerning further stakeholders, Appendix C was assessed for suggestions on possible measure data sources as described in section 3.2.2. Unfortunately, these sources proved too high an abstract level to be applicable to the ISP2 project and despite the authors' organizational knowledge, these were not possible to concretize for ISP2 use. Progression of measure evaluation included composing a questionnaire for each measure for submission to concerned ISP2 stakeholders. Appendix F contains the questionnaire design omitting measure-specific information where the middle section, during evaluation, comprised hitherto collected measure documentation. The questionnaires were designed to provide stakeholders with sufficient background information to attain understanding of what information was required. Its content embraced questions, a documented measure concerning the appointed stakeholder and the legend depicted in Figure 5-1 with abbreviations and groupings of activity applications. Questionnaires were submitted to stakeholders through e-mail with the option to reply via the questionnaires or by requesting a meeting.

Questionnaires were used since the number of stakeholders amounted as much as 25 persons, realistically eliminating other means of information retrieval than questionnaires due to stakeholders' geographical location, since stakeholders' understanding of the questionnaire and their ability to express themselves was predicted limited with e-mail and since it allowed them to participate in a less time consuming activity, i.e. e-mail reply. The questionnaires rendered four different outcomes: response through the questionnaire (2), response via requested meeting (11), stakeholders being excluded due to their lack of time, geographic impediments or referral to other stakeholder(s) (7), or stakeholders not responding even after a reminder (5). The meetings were conducted with the questionnaire(s)'s current measure documentation as a basis for conversation implying an unreserved dialogue resulting in ISP2 customization of measures and their documentation as well as additional measures, following section 3.2.2. Information attained from notes taken during these meetings and information from questionnaire replies via e-mail, was validated with respect to the information required and applicability to each measure, and subsequently used to refine and enhance measure documentation.

As stated, some questionnaire recipients did not reply at all. Nevertheless, due to comprehensive information about measure-concerned stakeholders obtained from ISP2 integration management, sufficient measure information from stakeholders was indeed acquired since several questionnaires/measures had more than one recipient. Thus it was possible for the replying stakeholders to approve or reject measures previously approved by measurement implementers in the discovery step. Reliability of the received information was further improved since stakeholders were carefully and representatively allocated to all measures and consisted of almost half of all ISP2 personnel (see section 4.4); several groups of stakeholders were concerned during the evaluation of measures when the latter could not be related to a single responsible. Hence it is reasonable to assume that the responses were fairly typical of the population. No prioritization regarding the significance of a certain stakeholder's opinion was made, i.e. every stakeholder was regarded equally important and certain compromises were made in order to satisfy conflicting stakeholders' requirements.

The outcome of the measure evaluation was propagated through the categorization and presentation step, detailed in section 5.3, to the definite ISP2 rollout customized measures given in chapter 6.

5.3 Categorization and Presentation

Subsequent to measure evaluation and following 3.2.3, the measures approved by concerned stakeholders were mapped onto a Measurement Category (MC) and further onto a Common Issue Area (CIA). The latter labels measures with respect to addressed project issue areas within ISP2 in order to provide measure responsibles or readers of measure documentation with information on the measurement domain covered. MCs detail which family of measures a certain ISP2 rollout measure belongs to, i.e. to which part of an ISP2 CIA. As section 3.2.3 suggests, supplementary MCs and CIAs may be developed to address a specific project. However in the ISP2 project, measures raised apart from those predefined in PSM were determined to fit within existing MCs and consequently within their corresponding CIAs. Mapped measure categories, i.e. CIAs: MCs, were put into each measure's documentation.

Following the discovery, evaluation and categorization of ISP2 measures the presentation layout, see Figure 5-3, of measures designed during evaluation and used in chapter 6, was utilized to document each measure's specifics and suited to fit the needs of the ISP2 project and its personnel accountable for measure gauging.

No Measure Name	**Responsible** *ISP2 Role*
Rationale with purpose and implications of the measure	
Activity Application	**Data**
Single or multiple ISP2 rollout activities to which the measure is applicable, using the notion of activity groups in Figure 5-1	*The explicit data items to be measured*
Issues Addressed	**Data Sources**
Questions answered by gauging the measure	*Where to collect explicit data items*
Supplementary Information	**Categorization**
Additional noteworthy information such as risks, gauging-facilitating information and measure prerequisites	*Labeling of the measure with Common Issue Area and Measurement Category*

Figure 5-3 Measure documentation design and field explanations.

The application of the Measurement Discovery Process to the ISP2 project provides an understanding of how to identify and define measures in an industrial project but also indicates the feasibleness of the process. The ISP2 case illustrates the uncomplicatedness and straightforwardness of the process and verifies the possibility of succeeding in using predefined measures for project-specific customization. Since the Measurement Discovery Process indeed proved possible to apply in this case, its applicability to similar projects as well is presumed. Chapter 6 presents the result of the Measurement Discovery Process, i.e. the definite ISP2 rollout measures. The presentation layout is designed in concordance with the theory of section 3.2.3 and Figure 5-3, and custom to ISP2, but may be equally as applicable to any other measurement implementation project.

6. ISP2 Rollout Measures

This chapter summarizes definite measures of the Measurement Discovery Process applied to Tetra Pak ISP2 rollout. Each of 15 measures is documented using the design of Figure 5-3 that explains how to interpret the measures. The measures are ordered by common issue area and measurement category, which in turn are ordered as they appear in Appendix A, i.e. PSM's predefined CIAs and MCs. The measure summary gives an illustration of possible results generally attainable when applying the process to projects with similar characteristics as those of ISP2.

1 Milestone Dates

Responsible
Rollout Director

Essential for decision making and follow-up of timely issues permitting schedule changes, resource reallocation and budgetary considerations. Provides information to subsequent rollouts on process duration and efficiency.

Activity Application	Data
ALL	Activity start & end date Project start & end date

Issues Addressed	Data Sources
Is the current schedule realistic? How many activities are concurrently scheduled? How often has the schedule changed? What is the projected completion date for the project? What activities are on time, ahead of schedule, or behind schedule?	eRoom: version control

Supplementary Information	Categorization
The ISP2 project being in its infancy, rollout activities are presently fairly dynamic and their content and occurrence may vary between rollouts. This must be taken into consideration when the gauged measure is assessed.	Schedule and Progress: Milestone Performance

2 Component Status

Responsible
Integration Manager/Release Manager

Indicates activity progression within each customization activity and progression of completion of components needed by each market company. Provides information to subsequent rollouts.

Activity Application	Data
CUST LSV	# components # components completed successfully

Issues Addressed	Data Sources
What components are on time, ahead of schedule, or behind schedule? Is the planned rate of completion realistic? How many TDRs, GAPs and SCRs are raised in a component?	Test Director Measure: GAP Status Measure: SCR Status

Supplementary Information	Categorization
Components are current business activity processes.	Schedule and Progress: Work Unit Progress

3 Validation Status

Responsible
Global Process Lead

Indicates test progress and foundation for prioritization. In addition, overall quality pertaining to test cases is indicated.

Activity Application	Data
LSV	# test cases # test cases failed # test cases passed

Issues Addressed	Data Sources
What functions have been tested or are behind schedule? Is the planned rate of testing realistic?	Visual Source Safe Test Director: LSV

Supplementary Information	Categorization
Test cases can only be run by their designers or people working within the process. TDRs are not kept in Test Director for all business processes. Test cases currently run by global process leads are to be delegated, to who is not decided. Scripts are global automated tests cases.	Schedule and Progress: Work Unit Progress

4 GAP Status

Responsible
Integration Manager

Provides information on how to improve routines for decreasing GAPs and an indication of amount of performed or required rework distributed among business processes and business activity processes.

Activity Application	Data
ALL	# GAPs per period # GAPs opened per period # GAPs closed per period # GAPs approved per period # GAPs rejected per period Estimated time for GAP implementation

Issues Addressed	Data Sources
How much functionality apart from Global Template does a market company site desire? How many GAPs have impacted the solution? How are GAPs distributed among business processes and periods? Have GAPs been reduced since last project? Which business processes have been affected the most during a certain period?	GAP Tracker

Supplementary Information	Categorization
GAPs herein refer to those raised during rollout, yet GAPs may also be raised through new legal requirements, new functionality or new global requirements. A GAP is related to a single or all business processes or MDM and a business activity process, driven by a single business process. Current GAP Tracker provides facilities for GAP traceability to rollout (but not its activities). Estimated time for GAP implementation may be compared with time between GAP approval and GAP closure for cost considerations.	Schedule and Progress: Work Unit Progress

5 SCR Status

Responsible
Global Process Lead/Business Expert

Provides information on how to improve routines for decreasing system change requests (SCRs) and an indication of amount of performed or required rework distributed among business processes and business activity processes.

Activity Application	**Data**
ALL	# SCRs per period # SCRs opened per period # SCRs closed per period # SCRs rejected per period
Issues Addressed	**Data Sources**
How many SCRs have impacted the solution? How are SCRs distributed among business processes and periods? Have SCRs been reduced since last project? How should resources be distributed among business processes? Which business processes have been affected the most during a certain period?	SCR Tracker
Supplementary Information	**Categorization**
SCRs herein refer to those raised through GAPs, TDRs or CIC Tickets (Hyper-Care). A SCR is related to a single or all business processes or MDM and a business activity process. Current SCR Tracker does not provide facilities for SCR traceability to rollout activities. Data is additionally collected for business process and business activity processes where possible.	Schedule and Progress: Work Unit Progress

6 Staff Turnover

Responsible
Rollout Director

Determines how resources are utilized, personnel retained and project impact of employee turnover. Gives foundations for decisions on resource allocation and risk assessment.

Activity Application	**Data**
ALL	# personnel # personnel gained per project # personnel lost per project
Issues Addressed	**Data Sources**
How many people have been added to or have left the project? What areas are most affected by turnover?	eRoom
Supplementary Information	**Categorization**
Promotion delayed when Global Process Leads unavailable.	Resources and Cost: Personnel

7 Cost

Responsible
Rollout Director/Project Controller

Allows for project cost comparisons and budgetary considerations.

Activity Application	**Data**
ALL	Cost

Issues Addressed	**Data Sources**
Are project costs in accordance with budgets? Will the target budget be achieved, overruned or surplussed?	Mercur Business Control eRoom: Finance

Supplementary Information	**Categorization**
Routines for cost measuring is presently well defined and in use, yet strictly confidential.	Resources and Cost: Financial Performance

8 Resource Utilization

Responsible
Technical Team Lead/Rollout Director

Provides information on whether key resources are sufficient and used effectively.

Activity Application	**Data**
ALL	# hours/units requested # hours/units allocated # hours/units scheduled # hours/units available # hours/units used

Issues Addressed	**Data Sources**
Are sufficient resources available? How efficiently are resources being used? Is availability of resources impacting progress?	

Supplementary Information	**Categorization**
	Resources and Cost: Environment and Support Resources

9 Database Size

Responsible
Cut Over & Conversion Lead

Indicates amount of data for processing and degree of handling difficulty, permits for resource management, timely estimations and comparison of extraction proportions to previous and upcoming rollouts.

Activity Application	**Data**
DH	# tables # records/entries/words/bytes

Issues Addressed	**Data Sources**
How much data has to be handled by the system? How many different data types have to be addressed?	MDO: Scala upload

Supplementary Information	**Categorization**
	Product Size and Stability: Physical Size and Stability

10 Requirements

Responsible
Integration Manager

Indicates level of adherence to market company requirements and quality of requirements management, useful for scope control. Effort in requirements and change management may be compared between market companies and rollouts.

Activity Application	**Data**
ALL	# requirements # requirements added # requirements deleted # requirements modified

Issues Addressed	**Data Sources**
Are requirements being deferred to later implementations? To what extent has functionality changed? Which business processes have been affected the most? Which business activity processes have been affected the most? Is the number of requirements growing compared to other rollouts, at what rate? Are requirements of sufficient quality?	Visual Source Safe Scope Control: GT Requirements Specification

Supplementary Information	**Categorization**
Measure requires full requirements specification embracing global requirements and all market company requirements as well as elaborated routines for requirements management.	Product Size and Stability: Functional Size and Stability

11 Defects

Responsible
Test Coordinator

Provides quantification of number, status and priority of defects reported giving information on defect handling ability. Numbers give additional information on necessary rework and overall software quality. Arrival dates indicate solution maturity, closure rates indicate progress used for completion prediction whereas defect age implies process efficiency.

Activity Application	Data
CUST LSV	# defects # defects per business activity process # defects per business process Average age of defects

Issues Addressed	Data Sources
How are defects distributed among components and business processes? Do any severity patterns exist? Do defect reporting and closure rates support the scheduled completion date of integration and test?	Test Director

Supplementary Information	Categorization
Defect age is dependent on level of documentation in Test Director. Defect = Bug in ISP2 solution causing abnormal software behavior, occurring before go-live.	Product Quality: Functional Correctness

12 Technical Performance

Responsible
Service Delivery Manager

While addressing system characteristics that can be quantitatively defined and demonstrated provides information on system ability to meet non-functional requirements. In addition, when performance baselines are established and most important business processes defined, permits for performance comparison between market companies.

Activity Application	Data
LSV	Specified technical performance level Demonstrated technical performance level

Issues Addressed	Data Sources
Is the system able to perform all required functions within the specified system response time? How long do certain services or functions take? Does the system operate efficiently in each market company? What is the availability rate of the system at each market company?	Hewlett Packard Performance Monitoring Availability Monitoring iScala performance MDM performance

Supplementary Information	Categorization
Explicit ISP2 performance requirements are presently not stated for market company sites. Performance baseline required for measuring technical performance. Specifications on most important business processes required for prioritization. Hewlett Packard are able to measure performance and availability but not able to perform follow-ups.	Product Quality: Functional Correctness

13 Failures and Recovery

Responsible
Service Delivery Manager

Serving as input to subsequent rollouts, provides information on system reliability and time and resources expended to recover from system failure in terms of immediate restoration of operational capability and long term resolving of root cause, determining adequate maintenance effort to ensure operational system availability.

Activity Application	Data
HC	Date, time & severity of system failure occurrence Date & time of system failure restoration Date & time of system failure resolve (permanent fix) Estimated time of system failure recovery Effort (labor hours) to recover (restore and resolve) # user functions unavailable due to system failure # users impacted due to system failure

Issues Addressed	Data Sources
Is/was system ready for operation? What types of support functions are requested most often? Does the system design support restoration of system operation within resource constraints? How much do system failures cost in terms of efforts and resources? How long does it take to recover from a system failure? How frequent are system failures? How severe are system failures?	CIC

Supplementary Information	Categorization
Failure = Malfunctions in ISP2 solution experienced by users during HC due to single or multiple software defects. CIC: Failure issues through tickets after market company go-live. A failure is related to a single or all business processes or MDM and a business activity process.	Product Quality: Reliability – Maintainability

14 Operator Errors

Responsible
Rollout Director/Business Expert

Provides information on how well the global solution has been integrated into the market company in terms of end-user and super-user usability. In addition, indicates whether users are able to carry out steps within ISP2 solution as required for business, i.e. capture business critical information and produce necessary forms and reports to meet local and legal requirements.

Activity Application	Data
SUT TTT EUT FP	# operator errors

Issues Addressed	Data Sources
Does the ISP2 solution meet its intended use? Have Super-Users received adequate training? Have End-Users received adequate training?	Super-User Surveys

Supplementary Information	Categorization
Super-User gathers local operator error information from End-Users.	Product Quality: Usability

15 Survey Results

Responsible
Rollout Director

Provides information on how the rollout process may be improved to increase (other) market companies' satisfaction.

Activity Application	Data
ALL	Survey Results

Issues Addressed	Data Sources
Is the solution meeting market company expectation? Is market company satisfaction trend static or improving? According to market company, what areas need improvement?	Management Meetings Surveys

Supplementary Information	Categorization
Surveys render Lessons Learned.	Customer Satisfaction: Customer Feedback

7. Measurement Discovery Process Analysis

This chapter accounts for experiences and reflections perceived by the authors during composition and application of the Measurement Discovery Process, i.e. the attempt to introduce uncomplicated identification and definition of measures for business process performance improvement in projects without needs or resources for all-embracing quality programs. Even though the analysis reflects the process's application to a specific industry case, the experiences and reflections highlighted herein pertains to strengths and weaknesses of the Measurement Discovery Process itself. This implies strengths and weaknesses not of the target project but arisen due to it, reflecting the process's first-time application. The process is appraised in subsequent sections, corresponding to each process step.

7.1 Discovery

During the ISP2 rollout application of the discovery step, commencing the Measurement Discovery Process, it soon became apparent that measurement implementers have an evident advantage when eliciting measures if fairly knowledgeable of the target organization, project and processes; the more acquainted implementers are the easier measure discovery becomes. Being external to Tetra Pak and ISP2, the measurement implementers (i.e. the authors) required a significant amount of time to get familiar with the target for process application and experienced difficulties in eliciting tacit knowledge of ISP2 stakeholders, mainly due to the complex structure of the organization and its processes. In addition, limited process documentation made the target domain less comprehensible.

Regarding the abstractional level attained in measures raised through the discovery step, ISP2 stakeholders apprehended the level as too high when involved in the evaluation step. The incentive is predicted two-fold in that the discovery of measures has its origin in PSM's predefined measures designed for application to general software processes and once again, implementers' comprehension of ISP2 was inadequate for obtaining a sufficient concretization level. The lack of measure concretization and customization to ISP2 conditions eventually implied more work in later steps than initially expected.

Despite insufficient target knowledge and abstract measures, employing predefined measures made the discovery step insignificantly resource demanding and effortlessly conducted since using predefinitions avoided the labor-intensive process of defining measures and corresponding documentation from scratch.

7.2 Evaluation

In general, the second step of the Measurement Discovery Process, evaluation, demonstrated the difficulty of receiving sufficient and relevant information concerning measures allocated to stakeholders in consequence of the latter's lack of time and the high level of abstraction in measures previously discovered. The absence of key stakeholders, i.e. in this case due to the lack of time, may result in measures maintaining their abstract level from the discovery step. However, this does not imply that these measures are to be discarded.

The measure questionnaires proved difficult for stakeholders to understand which reduced the amount of textual replies and increased the amount of meeting requests. Addressing the necessity of meetings presumably inferred a significant amount of additional work as opposed to when data was assessable on textual basis. Thus it is reasonable to assume that the additional work imposed by the implementers, resulted in that the stakeholders may have been able to carry out less work than when replying textual. In addition, stakeholders' difficultly in assimilating the questionnaire content may have caused them to neglect answering in either reply option, even after a reminder. Note however, that workload of the ISP2 personnel at the time of the evaluation step was extensive and consequently may have contributed as much to the amount of left out replies.

Appointing relevant and concerned ISP2 stakeholders for evaluation of measures was challenging; the appointment of stakeholders was based on project knowledge acquired by the implementers and provided by an ISP2 integration management representative. This rendered either stakeholders correctly appraised as concerned of a specific measure, or stakeholders being dismissive or referring to other(s), better suited for evaluation of a specific measure. This, once again, indicates the extent of deficiency in transferring organizational, process and project knowledge of ISP2 to the implementers.

The original ISP2 scope for this thesis's industry case was to identify and define measures for rollout. Yet, during evaluation and increased concretization of measures, the mapping of measures to explicit rollout activities was partly infeasible; the rollout phase had to be considered as a sub process of other ISP2 processes and hence not detachable from the ISP2 project entirety which made the explicit mapping impractical. Conversely, certain measures required mapping onto processes with the rollout embraced.

PSM data sources listed in Appendix C were too general to be directly applicable to the target project; naturally, the subject to measurement adopted in-house naming and abbreviations of supportive tools and infrastructure, i.e. sources of measure data, though terminology of system types in PSM data sources and ISP2 differed, causing impediments in mapping them to each other. Nonetheless they did for some measures, offer suggestions on where to dig for data repositories.

It is noteworthy to highlight the impact of having several attendees in meetings rendered by the questionnaires with measures concerning more than one ISP2 stakeholder; personnel having similar responsibilities but within different business processes demonstrated diversified conceptions of the workflow of certain processes, i.e. pertaining to workflows formally being uniform. Consequently, a coherent view of the processes' workflow was not effortlessly attained. On the other hand, the discrepancy stimulated an unreserved dialogue revolving the business processes and where, to, how and why measures were implementable in the ISP2 project and related activities. Tacit knowledge of issues other than directly related to measures was hereby stimulated.

7.3 Categorization and Presentation

Concluding the Measurement Discovery Process, the categorization part of the categorization and presentation step may be considered somewhat redundant in the application to the ISP2 project. These are of little significance to measure gauging and of low contribution to measure documentation in terms of stating project issue area and measurement category to which the measure belongs, since the measure itself address these. However, stating CIA and MC in measure documentation may facilitate lucidity for users of measures in projects where the amount of measures is extensive. On the other hand, it may limit the use of measures while tying them to a specific area when, in reality, a certain measure may address several areas simultaneously.

The design of the measure presentation was fully manageable while facilitating for modification of each measure‘s documentation and even when introducing entirely new measures, apart from PSM's predefined, these could be represented without effort by using the design.

8. Future Work

In this chapter, suggestions for future work with focus on the composed Measurement Discovery Process, are presented with its basis in lessons learned during development and application of the process as well as in the analysis given in chapter 7.

It is desirable to investigate whether primary questions during the discovery step may be omitted or not. These serve as indicators for identifying measures yet introduce a certain overhead in terms of the time-consuming activity scrutinizing each question when instead, implementers may assess measures and their descriptions directly leaving the primary questions out. Though tempting, this approach conversely may lead to implementers disregarding the suggestions given by the primary questions. Such an investigation would need to be conducted empirically, e.g. through case studies.

Additional case studies may also embrace assessing if the outcome, i.e. definite and approved measures of the Measurement Discovery Process, possibly will defer if measurement implementers are internal rather than external, to the target organization. As argued, these possess exhaustive tacit knowledge that most likely will impact the process result. The discovery step in particular will hence be affected due to increased tacit knowledge, since concretization and target customization of measures unquestionably will be augmented and facilitate upcoming evaluation.

Attending to means of information retrieval in the evaluation step, other than questionnaires with associated interviews, may become fruitful. The appropriateness of questionnaires is likely to vary between target projects and whether implementers are external or internal and thus, retrieval techniques such as brainstorming, formal meetings, observations and other contextual studies need to be considered. Nevertheless, target project personnel is likely to benefit from thoroughly prepared questionnaires in terms of easier assimilation of information request content, which will also reduce the risk of stakeholders neglecting to reply to measure detail inquiries.

As to the categorization and presentation step of the Measurement Discovery Process, categorization has to be extended to cope with the case when a new measure, i.e. not predefined in PSM, belongs to more than one measure category and its correlated common issue area. Rather than considering removing the categorization and presentation step of the process, it is instead justified to move/merge the entire step to/with the discovery step. This implies the advantages of introducing measurement categories and common issue areas early, preserving consistent measure documentation design throughout the entire process. Hence identified and defined measures are better prepared for evaluation. Note that such move or merge is fairly easily accomplished since the proportion of the categorization and presentation step in the process is minor.

The Measurement Discovery Process does not account for continuous refinement of approved measures and development of measures addressing areas previously overlooked; as of now, when measures are approved and the process has been iterated once, measures are subject to the risk of becoming static. A strategy for the ever-continuing work of employing measures as a decision-making instrument should consequently be formulated for the Measurement Discovery Process, embracing documented guidelines for managing refinement of measures. Such strategy may prove to have implications on the process as well in addition to possible improvements of measures alone.

Perfection of the process is achieved no sooner than identified, defined and approved measures are equipped with theory on how to perform measure gauging and when these are in fact gauged. Gauging is not covered by this thesis but is evidently an obvious progression of the Measurement Discovery Process. Accordingly, attention must be given to this area since without gauging, the process is deficient and management will not obtain concrete figures, and consequently is deprived of improvement opportunities for measures and the process's eternity as well. Additional work pertaining to process perfection includes establishing a business improvement plan addressing how to interpret and incorporate measurement gauging results into the organization and targeted project. This will allow measures to be enhanced with boundaries stating valid and required values of business process performance gauged by a measure.

Although neither in the objective nor in the industrial scope of this thesis, it is essential to stress the significance of anchoring the Measurement Discovery Process within the target organization and project in order to gain personnel's support and confidence in the process and to successfully be able to qualitatively improve the business processes. The latter is dependant on the fundamental issue of how sufficient and effective the Measurement Discovery Process is, explicitly focusing on measurement, in comparison with other processes having similar objectives or with entire quality improvement programs partly including measurement. The question of whether equal levels of quality is achieved when adopting either of these remains open.

9. Conclusions

In order to facilitate implementation of the Measurement Discovery Process, implementers need extensive knowledge of the target organization and project since successful definition of measures is highly dependant on the extent to which this comprehension is attained among implementers. It is consequently believed that keeping measurement implementation in-house and hence avoiding external resources reduces timely effort, particularly in the evaluation step, by exploiting existing internal tacit knowledge. External measurement implementers instead require a considerable amount of documentation and means of recognizing knowledge sustained within the target and its domain; the higher level of formal processes, the easier task for external implementers. Further, external implementers face an increased risk of overlooking possibilities for measure identification in comparison with internal dittos. This is due to that the foundation for measure identification is predefined and hence externals challenge a greater difficulty in including and excluding predefined measures. Nevertheless, if external implementers are presumed impartial, a degree of objectiveness to measurement is achieved which in its absence may generate measures only considering areas where performance already is satisfactory and where improvements accordingly are less vital. Less is achieved when measures are applied to areas in which the target is known to perform well. Yet, it may be the case that those responsible for measurement in certain areas, performing well or not, are the only ones familiar with the specific area and consequently a certain level of partiality cannot be avoided.

Even if predefinitions signify reduced effort in identifying measures during the discovery step, an increased amount of concretization work can be expected during evaluation since measures are fairly abstract when entering this step; measure identification may be considered as merely postponed to definition, i.e. evaluation. This implies the temptation of identifying numerous measures in discovery causing implementers taking on more than manageable if not approaching identification wisely and carefully. An additional implication of measure's abstractional level when entering the discovery step is the risk of encountering reduced understanding among stakeholders, rendering reluctance to measure introduction in terms of stakeholders not realizing its purpose and their roles in and contribution to the Measurement Discovery Process. Avoiding reluctance is also a matter of implementers choosing an appropriate technique for information gathering in measure evaluation. In this industrial application, the questionnaires used during definition of measures proved fairly insufficient due to an unfortunate balance between avoiding an overload in background information and keeping questionnaires short and concise to its recipients. Considering the amount of returned questionnaires in comparison with the amount of requested meetings clearly proved questionnaires' inadequacy in this context. Moreover, it further appeared as if stakeholders were not appealed by replying textually, i.e. through the questionnaires. On the other hand, conducting evaluation meetings require implementers to be considerably knowledgeable within the target domain in order to maintain a meaningful dialogue with stakeholders; these meetings are accordingly practically infeasible to conduct too early in the process.

Considering where measures are to be gauged, the authors faced the predicament of isolating measure applicability areas to not embrace more than one process for certain measures; it was arduous to map measures onto processes being sub processes of other processes, which shows the absence of a fixed one-to-one correspondence between measures and processes. Consequently a measure may be vital enough to maintain, even if focus is not entirely on the process or function to be measured.

As for quality processes of any kind, the Measurement Discovery Process requires anchorage and a hearing among people in the business to which the process is applied. However, rapidly and straightforwardly delivering tangible indicators of business process performance, decision-making management is able to directly spot improvement possibilities while deploying the Measurement Discovery Process; consequently management's diminished reluctance to accept and adopt the process is presumed. In addition, the process by utilizing predefined measures entails scarce use of resources and hence makes plain identification and definition of measures feasible, especially favorable in projects without need or prerequisites for entire quality programs.

The Measurement Discovery Process is considered generally applicable to software industry projects since it uses universal predefinitions for addressing measure identification and since project customization in the evaluation step constitute the major measure definition part; the basic concept of the process in its initial step is indeed generalization. Considering the thesis's scope and industrial application, it is reasonable to assume that a set of ISP2 project characteristics is common to other industrial software projects with similar prerequisites, regardless of business domain. This constitutes the Measurement Discovery Process's wide perspective on how to identify and define measures for projects sharing stated constraints.

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Appendix A – Measurement Categories and Related Questions [14]

Common Issue Area	Measurement Category	Questions Addressed
Schedule and Progress	Milestone Performance	Is the project meeting scheduled milestones? Are critical tasks or delivery dates slipping?
	Work Unit Progress	How are specific activities and solution progressing?
	Incremental Capability	Is capability being delivered as scheduled in incremental builds and releases?
Resources and Cost	Personnel	Is effort being expended according to plan? Is there enough staff with the required skills?
	Financial Performance	Is project spending meeting budget and schedule objectives?
	Environment and Support Resources	Are needed facilities, equipment, and materials available?
Product Size and Stability	Physical Size and Stability	How much are the solution's size, content, physical characteristics, or interfaces changing?
	Functional Size and Stability	How much are the requirements and associated functionality changing?
Product Quality	Functional Correctness	Is the solution good enough for delivery to the user? Are identified problems being resolved?
	Supportability – Maintainability	How much maintenance does the system require? How difficult is it to maintain?
	Efficiency	Does the target system make efficient use of system resources?
	Portability	To what extent can functionality be re-hosted on different platforms?
	Usability	Is the user interface adequate and appropriate for operations? Are operator errors within acceptable bounds?
	Dependability – Reliability	How often is service to users interrupted? Are failure rates within acceptable bounds?
Process Performance	Process Compliance	How consistently does the project implement the defined processes?
	Process Efficiency	Are the processes efficient enough to meet current commitments and planned objectives?
	Process Effectiveness	How much additional effort is being expended due to rework?
Technology Effectiveness	Technology Suitability	Can technology meet all allocated requirements, or will additional technology be needed?
	Impact	Is the expended impact of leveraged technology being realized?
	Technology Volatility	Does new technology pose a risk due to too many changes?
Customer Satisfaction	Customer Feedback	How do our customers perceive the performance on this project? Is the project meeting user expectations?
	Customer Support	How quickly are customer support requests being addressed?

Appendix B – Issue-Category-Measure Table [14]

Common Issue Area	Measurement Category	Measures
Schedule and Progress	Milestone Performance	Milestone Dates Critical Path Performance
	Work Unit Progress	Requirements Status Problem Report Status Review Status Change Requests Status Component Status Test Status Action Item Status
	Incremental Capability	Increment Content – Components Increment Content – Functions
Resources and Cost	Personnel	Effort Staff Experience Staff Turnover
	Financial Performance	Earned Value Cost
	Environment and Support Resources	Resource Availability Resource Utilization
Product Size and Stability	Physical Size and Stability	Database Size Components Interfaces Line of Code Physical Dimensions
	Functional Size and Stability	Requirements Functional Change Workload Function Points
Product Quality	Functional Correctness	Defects Technical Performance
	Supportability – Maintainability	Time to Restore Cyclomatic Complexity Maintenance Actions
	Efficiency	Utilization Throughput Timing
	Portability	Standards Compliance
	Usability	Operator Errors
	Dependability – Reliability	Failures Fault Tolerance
Process Performance	Process Compliance	Reference Model Rating Process Audit Findings
	Process Efficiency	Productivity Cycle Time
	Process Effectiveness	Defect Containment Rework
Technology Effectiveness	Technology Suitability	Requirements Coverage
	Impact	Technology Impact
	Technology Volatility	Baseline Changes
Customer Satisfaction	Customer Feedback	Survey Results Performance Rating
	Customer Support	Request for Support Support Time

Appendix C – Examples of Data Sources [14]

Measurement Category	Electronic Source	Hard-copy source
Milestone Performance	Project Management System Project Scheduling Tools	Schedule
Work Unit Progress	Project Schedule Tools Configuration Management System	Status Report
Incremental Capability	Configuration Management System	Build Reports Status Accounting Records
Personnel	Cost Accounting System Time Reporting System Estimation Tools	Time Sheets
Financial Performance	Performance Management System Financial System	Earned Value Reports Financial Records
Physical Size and Stability	Static Analysis Systems Configuration Management System Computer Models Parts Management System	Product Listing Product Specification Sheets Laboratory Test Records Bill of Materials
Functional Size and Stability	Function Point Counting Systems Change Request Tracking System Configuration Management System Computer-Aided Software Engineering (CASE) Tools	Requirements and Design Specifications Change Requests
Functional Correctness	Defect/Problem Tracking System Configuration Management System Case Tools Test Automation Tools	Test Incident Reports Review/Inspection Reports Design Review Notes and Actions
Supportability – Maintainability	Static Analysis Tools Corrective Action Reporting Problem or Failure Tracking System	Review/Inspection Reports Problem Reports Maintenance Reports Corrective Action Reports
Efficiency	Dynamic Analysis Tools System Monitoring Tools	Performance Analysis Reports
Usability & Dependability	Problem or Failure Tracking System Time Reporting System	Operator Problem Reports
Process Compliance	Process Enactment Tools	Assessment Findings Audit Findings
Process Efficiency	Project Management System Time Reporting System	Time Sheets Process Review Findings
Process Effectiveness	Defect/Problem Tracking System Time Reporting System	Test Incident Reports Review/Inspection Reports Time Sheets
Customer Feedback	On-line Feedback System	Survey Results Comment Forms

Appendix D – Measurement Category Table Example

(with permission from Jones *et al.* [14])

Milestone Performance

Common Issue Area: Schedule and Progress

The Milestone Performance measures provide basic schedule and progress information for key development activities and events. The measures also help to identify and assess dependencies among development activities and events. Monitoring schedule changes helps to assess the risk in achieving future milestones.

Project Application

- Applicable to all sizes and types of projects
- Applicable to all process models

Measures Included in this Category

- Milestone Dates
- Critical Path Performance

Limitations

- The measures in this category do not address the degree of individual activity completion, or the amount of effort to complete a scheduled activity or task.
- These measures do not address the relative importance of key activities, except for the identification of critical path activities.

Related Measurement Categories

- Work Unit Progress
- Incremental Capability

Additional Information

- An important objective in tracking milestone performance is to determine if schedule changes are realistic. This assessment is usually based on a comparison of planned versus actual dates, and an evaluation of the time allocated to complete future activities.

Example Indicator(s)

- Development Milestone Schedule (PSM Part 5, Section 2.1)
- Milestone Progress - Maintenance Activities (PSM Part 5, Section 2.1)

Appendix E – Measure Description Table Example

(with permission from Jones *et al.* [14])

Milestone Dates	Category: Milestone Performance Issue: Schedule and Progress

Milestone Dates measures the start and end dates for activities, events, and products. The measure provides an easy-to-understand view of scheduled activities and events. Comparison of plan and actual milestone dates provides insight into significant and repetitive schedule changes at the activity level.

Selection Guidance

Project Application
- Applicable to all sizes and types of projects.
- Included in most government and industry measurement practices.

Process Integration
- Required data is generally obtained from project scheduling systems and/or documentation. Data should be focused on major activities and events, particularly key items affecting the critical path performance or risk items.
- Detailed milestones provide a better indication of progress and allow earlier identification of problems.
- If dependency data is collected, slips in related activities can be projected and assessed.
- If activities or events are re-planned to occur at a different time, the original dates should be retained (with a unique plan identifier) to observe planned schedule changes.
- Some operations and maintenance projects are considered level-of-effort tasks and may not have detailed milestones. Such projects may only track increment release date and change request closure dates.

Usually Applied During
- Project Planning (Estimates)
- Requirements Analysis (Estimates and Actuals)
- Design (Estimates and Actuals)
- Implementation (Estimates and Actuals)
- Integration and Test (Estimates and Actuals)
- Operations and Maintenance (Estimates and Actuals)

Specification Guidance

Typical Data Items
- Start date of activity or event
- End date of activity or event

Typical Attributes
- Activity or event name
- Version of the plan
- Increment
- Organization

Typical Aggregation Structure
- Component
- Activity

Typically Collected for Each
- CI or equivalent
- Key activity

Count Actuals Based On
- Customer sign-off
- Action items closed
- Documents baselined
- Milestone review held
- Successful completion of tasks

This measure answers questions such as:

Is the current schedule realistic?

How many activities are concurrently scheduled?

How often has the schedule changed?

What is the projected completion date for the project?

What activities, events, or products are on time, ahead of schedule, or behind schedule?

Appendix F – Evaluation Questionnaire

The measure description below contains the number and name of the measure, a responsible within ISP2, a rationale for its establishment, area(s) of applicability (denoted according to below table), data stating what is to be measured, issues addressed by the measure and possible sources for measure retrieval. In addition, fields for supplementary information and measure classification are available. Please consider the following:

- Are you correctly appointed as responsible? If not, try to suggest a more suitable person.
- Is the measure application area correct or should it be narrowed or widened?
- Is the measure feasible, i.e. measurable in terms of data considered?
- Are issues stated possible to address given measured data? May further issues be addressed?

- In data sources, how may given data items be collected in order to address issues, i.e. where and how do we measure data?
- Supplementary information may be used for providing additional details concerning the measure, e.g. associated risks or specifics of another description field.

No Measure Name	**Responsible** *ISP2 Role*

Measure rationale

Activity Application	**Data**

Issues Addressed	**Data Sources**

Supplementary Information	**Categorization**

Activity Group (abbreviation)	Activities (abbreviation)	Rationale
Initiation (INIT)	Business Process Walkthrough Install and set-up Global Template System Super-User Training Local/Legal Requirements Identification and Analysis Cross-Function Session(s)	Activities commence the ISP2 rollout phase for the specific market company.
Customization (CUST)	Local System Validation Preparation Parameter Localization Forms Localization Reports Localization User Access	Activities are concerned with tasks developing and customizing the solution to approved market company requirements.
Hyper-Care (HC)	Hyper-Care 1 Hyper-Care 2	Activities are concerned with supportive tasks subsequent to market company go-live.
Data Handling (DH)	Data Extract Data Cleansing Data Conversion Cut-Over and Conversion	Activities are concerned with database management and refinement of market company data for fitting purposes of the solution.
Ungrouped	Local System Validation (LSV) End-User Training (EUT) Business Contingency Plan (BCP) Final End-User Preparation (FP) Train-the-Trainer (TTT)	Activities lack sufficient common characteristics for grouping and are consequently stand-alones.
All activities (ALL)	All	All activities included in an ISP2 rollout.

Appendix G – Glossary

End-User	Personnel at market company sites using the implemented ISP2 solution in their daily work.
Global requirements	An ISP2 solution requirement pertaining to Tetra Pak business processes, included in the Global Template Solution.
Global Template (GT) Solution	The ISP2 solution with iScala excluding local market company customization to legal and local requirements.
Go-live	The point at which the localized ISP2 solution is stable and put into operation at a market company site.
iScala/Scala	iScala is the core information system in ISP2 whereas Scala is its manufacturer.
ISP (Information Systems Platform)	The information system based on SAP/R3 in use worldwide at Tetra Pak and being replaced at certain market company sites.
ISP2 (Information Systems Platform 2)	The information system based on iScala being deployed at certain market company sites, replacing its current information system.
Legal requirement	An ISP2 solution requirement pertaining to local legislation of a market company region.
Local requirement	An ISP2 solution requirement pertaining to market company business demands.
Market Company	A smaller or medium-sized Tetra Pak retailing site subject to replacement of current information system.
Rollout	A process embracing several activities aiming at localizing and implementing ISP2 at a market company site.
SAP R/3 (Systems, Applications and Products in Data Processing)	An information system used worldwide within Tetra Pak.
Super-User	Personnel at market company sites (one per site) using the implemented solution, representative and trainer for End-Users and accountable for locally implemented ISP2 solution.

Appendix H – Figure Index