A BUSINESS PROCESS PERFORMANCE MEASURE DEFINITION SYSTEM SUPPORTED BY INFORMATION TECHNOLOGIES

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A BUSINESS PROCESS PERFORMANCE MEASURE DEFINITION SYSTEM SUPPORTED BY INFORMATION TECHNOLOGIES

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ABSTRACT

A BUSINESS PROCESS PERFORMANCE MEASURE DEFINITION SYSTEM SUPPORTED BY INFORMATION TECHNOLOGIES

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There is a growing interest and research on improvement of business processes as an essential part of effective quality management. Process improvement is possible with measurement and analysis of the process performance. Process performance measurement has been studied to a certain extend in the literature, and many different approaches have been developed such as Sink-Tuttle Model, Performance Measurement Matrix, Balanced Scorecard Approach, and Performance Prism Framework. These approaches require that process owners and analysts define appropriate measures based on general guidelines for each process separately. Recently, with the advancement of information technologies, modeling and simulation of processes on a computer aided platform has become possible; standards and software support regarding such applications have been developed. Even though increasingly many organizations have been building their process models on computers, only a few manages effective use of such models for process improvement. This is partly due to difficulties in defining appropriate performance measures for the processes. The purpose of this study is to propose a method that can be used for defining performance measures of business processes easily and effectively according to specific nature of these processes. The proposed performance measure definition system is based on the idea of using generic process performance measures published by trusted business process frameworks for high level processes and adapting them for lower level ones. The system, using a search mechanism available on a computer, allows users to easily find and define appropriate performance measures for their processes. The proposed system is used for a research project management process and a creating research opportunities process of a public university and the results are discussed.

Keywords: Business Process Management, Process Performance Measurement, Performance Measure, Information Technology.

ÖZ

BİLİŞİM TEKNOLOJİLERİ İLE DESTEKLENEN BİR SÜREÇ PERFORMANS ÖLÇÜSÜ TANIMLAMA SİSTEMİ

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Etkili kalite yönetiminin önemli bir parçası olarak, iş süreçlerinin iyileştirilmesi üzerine artan bir ilgi ve araştırma vardır. Süreçlerin iyileştirilmesi, süreç performansının ölçülmesi ve analizi ile mümkündür. Süreç performansının ölçülmesi literatürde belli bir ölçüde çalışılmış ve Sink-Tuttle Modeli, Performans Ölçüm Matrisi, SMART Piramit, Dengeli Puan Kartı Yaklaşımı, Kritik Az Metodu ve Performans Prizma Çerçevesi gibi yöntemler geliştirilmiştir. Bu yöntemler, süreç sahipleri ve analistlerinin genel yönlendirmelere göre her bir süreç için uygun ölçümleri ayrı ayrı oluşturmalarını gerektirmektedir. Son zamanlarda bilgi teknolojilerindeki gelişmelerle süreçlerin bilgisayar destekli ortamlarda modellenmesi ve benzetilmesi mümkün hale gelip, bu tür uygulamaları destekleyen standartlar ve yazılımlar geliştirilmiştir. Örgütlerin birçoğunun süreçlerini bilgisayar ortamında oluşturmasına rağmen sadece bir kaçı bu modellerin süreç iyileştirmeye yönelik olarak etkin kullanımını yönetmektedir. Bu çalışmanın amacı, bu süreçlerin performans ölçülerinin süreçlerin kendilerine özgü doğasına göre kolay ve etkili bir şekilde tanımlanması için kullanılabilecek bir yöntem önermektir. Önerilen bu performans ölçüsü tanımlama sistemi, genel süreçler için güvenilir süreç referansları tarafından yayınlanmış genel performans ölçülerini kullanmak ve bunları daha alt seviye süreçler için uyarlamak fikrini temel almaktadır. Bu sistem, bir bilgisayarda bir arama işleyişini kullanarak bilgi teknolojilerinin yardımı ile kullanıcıların kendi süreçleri için performans ölçülerini kolaylıkla bulmalarını ve tanımlamalarını sağlar. Önerilen bu sistem bir kamu üniversitesinin araştırma projesi yönetimi ve araştırma fırsatları oluşturma süreçleri için kullanılmış ve sonuçları tartışılmıştır.

Anahtar Kelimeler: İş Süreç Yönetimi, Süreç Performans Ölçümü, Performans Ölçüsü, Bilişim Teknolojileri.

To My Family

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CHAPTER 1

INTRODUCTION

The fundamental aim of all organizations' existence is simply creating value. The meaning of creating value is changing and enlarging rapidly with the growing competition in the global world. The way of doing business, or business processes significantly affect the value created. A business process can be thought of a chain of interrelated activities, which are clearly definable, repeatable and measurable, done for transforming inputs to outputs with the goal of creating value for stakeholder satisfaction. Process management, on the other hand, is a systematic way of defining, maintaining, improving the processes aiming the continuity of the operations in line with the organizational mission, vision, and strategies.

Organizations are aware of the importance of process management for their success in the growing global competition. Early studies in this area focused more on process definition and modeling, and some traditional approaches were developed. Process management activities continued in 1990s with process improvement and process reengineering concepts and approaches. New approaches and standards were generated for process improvement such as Capability Maturity Model Integration (CMMI) and European Foundation for Quality Management (EFQM) Excellence Model. Similarly, measurement of business process performance has become more and more important for continuous process improvement and strategic planning. Effective business performance measurement allows companies to diagnose problems, determine main causes of them and then identify if their solution approaches have worked effectively.

Process performance measurement, in fact, has been studied for many years and relatively new approaches have been developed in line with the change in quality perception and stakeholder satisfaction. The earliest measurement studies focused more on quality of the end products and financial position of the organization. Problems of end products were detected and they were tried to be eliminated. Overall organization performance, on the other hand, was evaluated mostly using financial performance indicators. These traditional methods have become insufficient with increasing competition. Modern approaches such as Total Quality Management were developed for minimizing cost, improving overall quality and increasing the customer satisfaction. Organizations' emphasis has moved from quality control to quality planning, design and assurance parallel to this evolution. Both internal and external customers of the organizations are considered and overall stakeholder satisfaction is aimed. As a result, organizations have developed specific process performance measurement systems (PMS) for continuous process improvement in line with their missions, visions and strategies. The traditional methods for developing such systems practical realization typically suggest general guidelines for how a company should measure the performance, but they rarely help with the selection and implementation of specific measures. Organizations have been developing their own specific performance measurement systems. Those believing in the system and taking this process seriously may find the whole process exhausting and time consuming especially if they do not have enough experience with such systems. They may find it difficult to manage the terminology, levels of measurement, huge lists of suggested measures and limited time allocated for the measurement system development. For other organizations there is a danger of following a short cut and ending up with an ineffective measurement system.
Advancements in information technologies (ITs) have given a different direction to developments in process management. While the processes were being managed manually with a heavy paper work previously, today it has become possible to carry out most of the communication, data collection, control and management, in general, electronically.

Many software packages (such as ARIS Toolset, Holocentric Modeler, iGrafx, Mega Suite, ProcessWizard, Simprocess, ProVision, Process Simulator) are available, or it is possible to develop them according to needs of a company for defining, modeling and simulating business processes. Such software can accommodate user defined performance measures, and measure the performance accordingly. Process performance measurement is highly data dependent, and hence this kind of software support can help with data collection and report generation in a reasonably short time. However, there is still a difficulty in defining the performance measures themselves. There, the old way of coming up with appropriate measures seems to be the only solution. However, definition of appropriate process performance measures can also be supported by information technologies besides data collection and process performance monitoring. Such a support should be effective no matter what different needs the same or different companies have.

In summary, for effective continuous process improvement and management, having an effective process performance measurement system is essential for an organization. Data collection and performance report generation functions of such a system are currently well supported by information technologies, but not that of performance measure definition. Utilizing information technologies and computer aid it is also possible to support defining appropriate process performance measures. Our purpose in this study is to design such a system so that it allows easy access to appropriate generic key process performance measures that can be used for measuring performance of generic business processes. These measures are well studied and developed by several trusted business process frameworks. Once these measures and detailed information about them are accessed, the users can adapt them according to special characteristics of their similar processes. This system can always be kept up-to-date by updating the generic process and measure lists according to changes in the frameworks and literature. Furthermore, the system can provide the framework developers valuable feedback from the field about new development needs and insufficiencies.

In order to attain the purpose of developing such a system, first a comprehensive literature review has been performed. The past and present studies in business process management (BPM), process identification and generic process definition have been investigated. Methods and approaches used for process performance measurement and process improvement are described in detail in Section 2. Trusted business process frameworks are introduced. Performance measurement in general is investigated and research made in this area is introduced. IT relation with process management concept and usage of IT in BPM are also investigated and the proposed methods and facts are given in this section.

In Chapter 3, the needs for an effective process performance measurement system are explained. Generic process performance measure definition is made referring to generic process definition. A generic process performance measure system is defined and a methodology for developing performance measure definitions based on this system is proposed. In the generic system, the generic measures are defined for each generic process. A customization procedure for developing specific performance measures for specific user processes is defined providing flexibility and easiness to the user with the help of information technologies. The way of maintaining the system is introduced so that the system stays always up-to-date based on current needs.
In Chapter 4, the proposed process performance measure definition system is applied for a research project management process and a creating research opportunities process of a public university using the proposed customization procedure and guideline.

Finally in Chapter 5, the study is concluded by summarizing the results, commenting on possible uses, advantages and disadvantages of the proposed system and further research opportunities.

CHAPTER 2

LITERATURE REVIEW AND BACKGROUND

2.1 BUSINESS PROCESS MANAGEMENT

2.1.1 Process Identification

Process is simply transformation of inputs to outputs. The first formal description of this transformation work is made by Adam Smith. Smith (1776) described the process of manufacturing a pin step by step in his famous example of a pin factory:

> *"One man draws out the wire, another straights it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head: to make the head requires two or three distinct operations: to put it on is a particular business, to whiten the pins is another ... and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which in some manufactories are all performed by distinct hands, though in others the same man will sometime perform two or three of them."*

The first formal definition of a process is made in the Dictionary of American Heritage as "a series of actions, changes, or functions bringing about a result" in 1978 (Tenner and DeToro, 1997 as cited by Aras, 2005). This first definition focuses only on the actions and output as it is too simple. Juran (1988) made a contribution to this definition in his "Planning for Quality" book by stating a process as a series of systematic actions for achieving an objective (as cited in Aras, 2005).

A comprehensive process definition is made by Davenport (1993) as

> *"a structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus's emphasis on what. A process is thus a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs: a structure for action. ... Taking a process approach implies adopting the customer's point of view. Processes are the structure by which an organization does what is necessary to produce value for its customers."*

Apart from the traditional process definition, a "generic process" definition is used by Zhang and Rodrigues (2009) to define process families of production of a product family. They need to develop process families for production of product families in order to achieve sustainable production in an environment of many customized products minimizing the variation in the production processes. The generic processes derived from existing production data are tested by Zhang and Rodrigues (2009) using an industrial example involving electronic products. They conclude that multiple processes can be developed based on a generic process.

A similar study has been done in Middle East Technical University in order to establish a complete business process management system covering all units of the university (TEKİM, 2009). In this study, the processes of the university are designed in levels so that generic processes can be established for common operations and the generic processes can be customized to develop specialized processes at lower levels. The processes of the university are designed based on eUniversity MIS Reference Model© at four levels as in Figure 1.

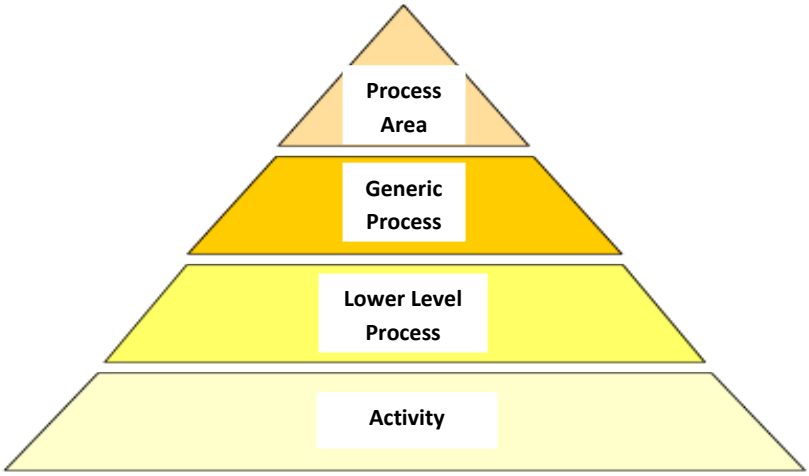

Figure 1 – eUniversity MIS Reference Model© Process Definition Hierarchy
(Source: TEKİM, 2009)

The process areas of the university are defined as in the following and generic processes are developed for each process area covering lower level processes.

- Education / Instruction
- Research
- Execution / Services
- Support Services

Generic processes are defined as in the following.

- Education / Instruction
  - Education / Instruction Programs Development
  - Education / Instruction Programs Execution
  - Utilizers Management
- Research
  - Research Environment Development
  - Research Projects Development
  - Research Projects Execution
- Execution / Services
  - Portfolio Management
  - Procurement Management
  - Providing Execution / Service
  - Relations of Utilizers
- Support Services
  - Portfolio Management
  - Procurement Management
  - Providing Service
  - Relations of Utilizers

The generic processes defined for common executions are adapted by tailoring for lower level executions. For instance, the generic process defined for development of research projects is tailored for development of different types of projects such as Scientific Research Projects (BAP in Turkish). Another example is the adaptation of execution of education / instruction programs for execution of each academic unit's education / instruction programs.

2.1.2 Business Process Frameworks

A business process framework can be defined as the structure of processes of an organization used to describe, manage, and maintain its operations at all levels. In early stages of business process management studies, each organization developed its own business process framework by defining and modeling processes based on individual specific operations. Later on some generalization studies have been made producing process frameworks composed of common processes defined based on specific industry types or specific operations. Most of these frameworks serve a comprehensive list of high level common processes in relation with process measures for the organizations. Organizations may benefit from these frameworks while developing their business processes so that it is more accurate, quicker, and easier relative to developing from scratch. The most well-known process frameworks are introduced in the following. Common features of these frameworks can be summarized as follows:

- All frameworks, except eTOM, support all industries, but many of them have a trend of providing some industry specific versions of the base format of themselves. eTOM is commonly applicable for communication industry, but they argue that the framework is used in some organizations in other industries such as banks, electric utilities, and healthcare organizations (http://www.tmforum.org/Overview/13763/home.html).
- All frameworks have a hierarchy level in the structure of processes.
- Most of the frameworks require membership which is either paid or not. Some of the services and benefits are reachable only to paid-members for some frameworks.

2.1.2.1 APQC's Process Classification Framework (PCF)

American Productivity and Quality Center (APQC) is a non-profit organization established for helping organizations to improve their productivity and quality in 1977. The PCF was developed by APQC and member companies in 1992 to facilitate improvement through process management and benchmarking regardless of industry, size, or geography. The PCF is supported by the Open Standards Benchmarking Collaborative (OSBC) database of APQC and their advisory council of global industry leaders as an open standard.

Figure 2 – APQC's Process Classification Framework (Source: www.apqc.org)

The PCF organizes operating and management processes into 12 enterprise-level categories, including process groups and more than 1,500 processes and associated activities. The PCF and associated measures and benchmarking surveys are available for download and completion at no charge at www.apqc.org/OSBCdatabase.
PCF is available for both cross-industry version and also industry-specific version for the following industries:

- aerospace and defense,
- automotive,
- banking,
- broadcasting,
- consumer products,
- education,
- electric utilities,
- petroleum downstream,
- petroleum upstream,
- pharmaceutical,
- retail,
- telecommunication.

The layout of PCF is in four levels as it is shown in Figure 3.

Figure 3 – Layout of PCF

Level 1 – Category: The highest level within the PCF (e.g., Design and Manage Operations (4.0)).
Level 2 – Process Groups: Process areas within each category (e.g., Plan for and acquire necessary resources—requisition planning (4.1)).
Level 3 – Process: Processes within each group (e.g., Manage enrollments for programs and services (4.1.1)).
Level 4 – Activity: Activities within a process (e.g., Develop baseline forecasts (4.1.1.1), Collaborate with community (4.1.1.2))

Some processes include one more level detail within activity which is named as task.

Level 5 – Task: Tasks within an activity (Develop improvement-planning and goal-setting procedures (6.3.2.1.1)).

In addition to this layout, key performance measures are included for many of the process components in PCF. The format of performance indicators includes the definition of the indicator

and description of related process components. The most recent version of PCF is V 6.0.0, available on www.apqc.org.
Main advantage of PCF relative to other process frameworks is the fact that PCF introduces cross-industry processes while serving for specific industries at the same time. On the other hand, processes introduced by the framework may be too generic for some organizations to apply and this may be considered as a disadvantage.

2.1.2.2 Control of Objectives for Information and Related Technology (COBIT)

COBIT is an IT governance framework introduced by Information Systems Audit and Control Association (ISACA) for supporting organizations to manage IT in line with business objectives and to bridge the gap between control requirements, technical issues and business risks. In other words, COBIT is a comprehensive framework providing assistance to enterprises in achieving their objectives for the governance and management of enterprise IT.

ISACA is a nonprofit global membership association for information governance, control, security and audit professionals established in 1967. ISACA states that there are more than 100,000 members from more than 180 countries covering a variety of different IT related professions in different industries. ISACA has been updating COBIT framework with improvements and best practices for years and recently released COBIT 5 in 2012.
The COBIT 5 Framework has 5 base principles, and these are shown in Figure 4.

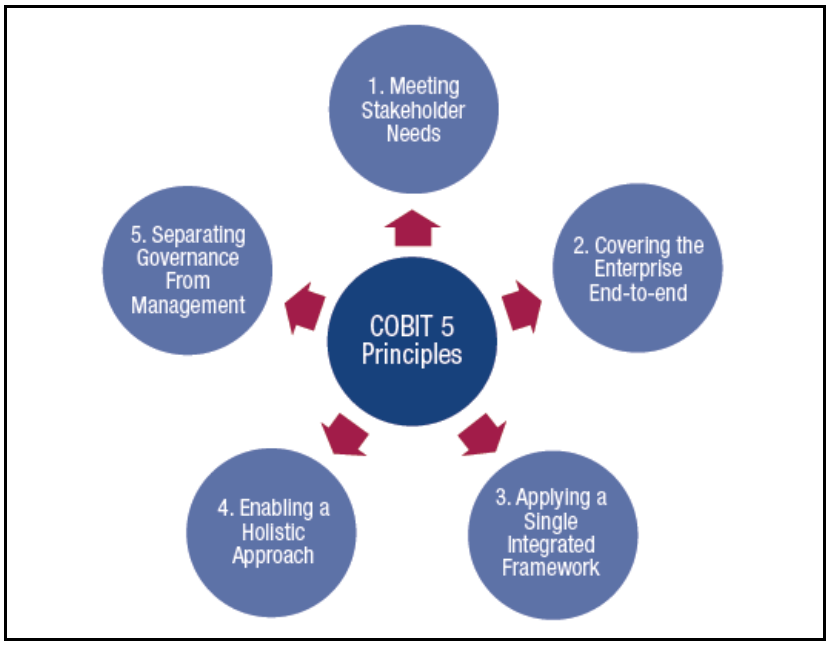

Figure 4 – Principles of COBIT 5 (Source: COBIT5, 2012)

Principle 1 – Meeting Stakeholder Needs: The COBIT 5 provides generic processes and enablers for enterprises to support their value creation for their stakeholders through use of IT. Value creation for stakeholders is fundamental existence reason of all organizations.

Principle 2 – Covering the Enterprise End-to-end: The COBIT 5 does not focus only on IT function in organizations; rather it covers all the functions and processes in organizations and considers all IT-related governance and management enablers to be enterprise wide and end-to-end.

Principle 3 – Applying a Single Integrated Framework: The COBIT 5 aims to be an overarching framework covering all IT related standards and frameworks that provide guidance for a subset of IT activities such as Information Technology Infrastructure Library (ITIL®), The Open Group Architecture Forum (TOGAF®), Project Management Body of Knowledge (PMBOK®), Projects IN Controlled Environments 2 (PRINCE2®), Committee of Sponsoring Organizations of the Treadway Commission (COSO) and the International Organization for Standardization (ISO) standards.

Principle 4 – Enabling a Holistic Approach: The COBIT 5 framework defines seven categories of enablers for providing a holistic approach covering all types of interacting components for achieving the implementation of a comprehensive governance and management system for enterprise IT.
– Principles, Policies and Frameworks
– Processes
– Organizational Structures
– Culture, Ethics and Behavior
– Information
– Services, Infrastructure and Applications
– People, Skills and Competencies

Principle 5 – Separating Governance from Management: The COBIT 5 framework makes a clear distinction between governance and management in terms of included activity types, required organizational structures and served purposes. According to the COBIT 5;

"Governance ensures that stakeholder needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved; setting direction through prioritisation and decision making; and monitoring performance and compliance against agreed-on direction and objectives. Whereas, *Management plans, builds runs and monitors activities in alignment with the direction set by the governance body to achieve the enterprise objectives."*

The processes and IT-related goals included in COBIT 5 Frameworks, and their relations are given in the following two figures.

			IT-related Goal																
			Alignment of IT and business strategy	IT compliance and support for business compliance with external laws and regulations	Commitment of executive management for making IT-related decisions	Managed IT-related business risk	Realised benefits from IT-enabled investments and services portfolio	Transparency of IT costs, benefits and risk	Delivery of IT services in line with business requirements	Adequate use of applications, information and technology solutions	IT agility	Security of information, processing infrastructure and applications	Optimisation of IT assets, resources and capabilities	Enablement and support of business processes by integrating applications and technology into business processes	Delivery of programmes delivering benefits, on time, on budget, and meeting requirements and quality standards	Availability of reliable and useful information for decision making	IT compliance with internal policies	Competent and motivated business and IT personnel	Knowledge, expertise and initiatives for business innovation
			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
		COBIT 5 Process	Financial						Customer		Internal							Learning and Growth	
Evaluate, Direct and Monitor	EDM01	Ensure Governance Framework Setting and Maintenance	P	S	P	S	S	S	P		S	S	S	S	S	S	S	S	S
	EDM02	Ensure Benefits Delivery	P		S		P	P	P	S			S	S	S	S		S	P
	EDM03	Ensure Risk Optimisation	S	S	S	P		P	S	S		P			S	S	P	S	S
	EDM04	Ensure Resource Optimisation	S		S	S	S	S	S	S	P		P		S			P	S
	EDM05	Ensure Stakeholder Transparency	S	S	P			P	P						S	S	S		S
Align, Plan and Organise	AP001	Manage the IT Management Framework	P	P	S	S			S		P	S	P	S	S	S	P	P	P
	AP002	Manage Strategy	P		S	S	S		P	S	S		S	S	S	S	S	S	P
	AP003	Manage Enterprise Architecture	P		S	S	S	S	S	S	P	S	P	S		S			S
	AP004	Manage Innovation	S			S	P			P	P		P	S		S			P
	AP005	Manage Portfolio	P		S	S	P	S	S	S	S		S		P				S
	AP006	Manage Budget and Costs	S		S	S	P	P	S	S			S		S				
	AP007	Manage Human Resources	P	S	S	S			S		S	S	P		P		S	P	P
	AP008	Manage Relationships	P		S	S	S	S	P	S			S	P	S		S	S	P
	AP009	Manage Service Agreements	S			S	S	S	P	S	S	S	S		S	P	S		
	AP010	Manage Suppliers		S		P	S	S	P	S	P	S	S		S	S	S		S
	AP011	Manage Quality	S	S		S	P		P	S	S		S		P	S	S	S	S
	AP012	Manage Risk		P		P		P	S	S	S	P			P	S	S	S	S
	AP013	Manage Security		P		P		P	S	S		P				P			

Note: 'P' stands for primary relationship and 'S' for secondary relationship, i.e., a less strong relationship.

Figure 5 – IT-Related Goals and Processes included in the COBIT 5 Framework
(Source: COBIT5, 2012)

			IT-related Goal																
			Alignment of IT and business strategy	IT compliance and support for business compliance with external laws and regulations	Commitment of executive management for making IT-related decisions	Managed IT-related business risk	Realised benefits from IT-enabled investments and services portfolio	Transparency of IT costs, benefits and risk	Delivery of IT services in line with business requirements	Adequate use of applications, information and technology solutions	IT agility	Security of information, processing infrastructure and applications	Optimisation of IT assets, resources and capabilities	Enablement and support of business processes by integrating applications and technology into business processes	Delivery of programmes delivering benefits, on time, on budget, and meeting requirements and quality standards	Availability of reliable and useful information for decision making	IT compliance with internal policies	Competent and motivated business and IT personnel	Knowledge, expertise and initiatives for business innovation
			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
		COBIT 5 Process	Financial						Customer		Internal							Learning and Growth	
Build, Acquire and Implement	BAI01	Manage Programmes and Projects	P		S	P	P	S	S	S			S		P			S	S
	BAI02	Manage Requirements Definition	P	S	S	S	S		P	S	S	S	S	P	S	S			S
	BAI03	Manage Solutions Identification and Build	S			S	S		P	S			S	S	S	S			S
	BAI04	Manage Availability and Capacity				S	S		P	S	S		P		S	P			S
	BAI05	Manage Organisational Change Enablement	S		S		S		S	P	S		S	S	P				P
	BAI06	Manage Changes			S	P	S		P	S	S	P	S	S	S	S	S		S
	BAI07	Manage Change Acceptance and Transitioning				S	S		S	P	S			P	S	S	S		S
	BAI08	Manage Knowledge	S				S		S	S	P	S	S			S		S	P
	BAI09	Manage Assets		S		S		P	S		S	S	P			S	S		
	BAI10	Manage Configuration		P		S		S		S	S	S	P			P	S		
Deliver, Service and Support	DSS01	Manage Operations		S		P	S		P	S	S	S	P			S	S	S	S
	DSS02	Manage Service Requests and Incidents				P			P	S		S				S	S		S
	DSS03	Manage Problems		S		P	S		P	S	S		P	S		P	S		S
	DSS04	Manage Continuity	S	S		P	S		P	S	S	S	S	S		P	S	S	S
	DSS05	Manage Security Services	S	P		P			S	S		P	S	S		S	S		
	DSS06	Manage Business Process Controls		S		P			P	S		S	S	S		S	S	S	S
Monitor, Evaluate and Assess	MEA01	Monitor, Evaluate and Assess Performance and Conformance	S	S	S	P	S	S	P	S	S	S	P		S	S	P	S	S
	MEA02	Monitor, Evaluate and Assess the System of Internal Control		P		P		S	S	S		S				S	P		S
	MEA03	Monitor, Evaluate and Assess Compliance With External Requirements		P		P	S		S			S					S		S

Note: 'P' stands for primary relationship and 'S' for secondary relationship, i.e., a less strong relationship.

Figure 6 – IT-Related Goals and Processes included in the COBIT 5 Framework (cont.)
(Source: COBIT5, 2012)

2.1.2.3 Information Technology Infrastructure Library (ITIL)

Information Technology Infrastructure Library (ITIL) is a public framework guiding for governance of IT services by describing best practices in IT service management and focusing on the continual measurement and improvement of the quality of IT service delivered, from both a business and a customer perspective. The primary objective of Service Management is to ensure that the IT services are aligned to the business needs and actively support them; and at this point ITIL provides guidance for this purpose.

The ITIL framework has been first published in 1989 by Her Majesty's Stationery Office (HMSO) in the UK on behalf of the Central Communications and Telecommunications Agency (CCTA) – now subsumed within the Office of Government Commerce (OGC) – confined to be used by only UK and Netherlands. The recent third version of the ITIL Framework is published in 2007 consisting of five core books covering the service lifecycle.

- Service Strategy
- Service Design
- Service Transition
- Service Operation
- Continual Service Improvement

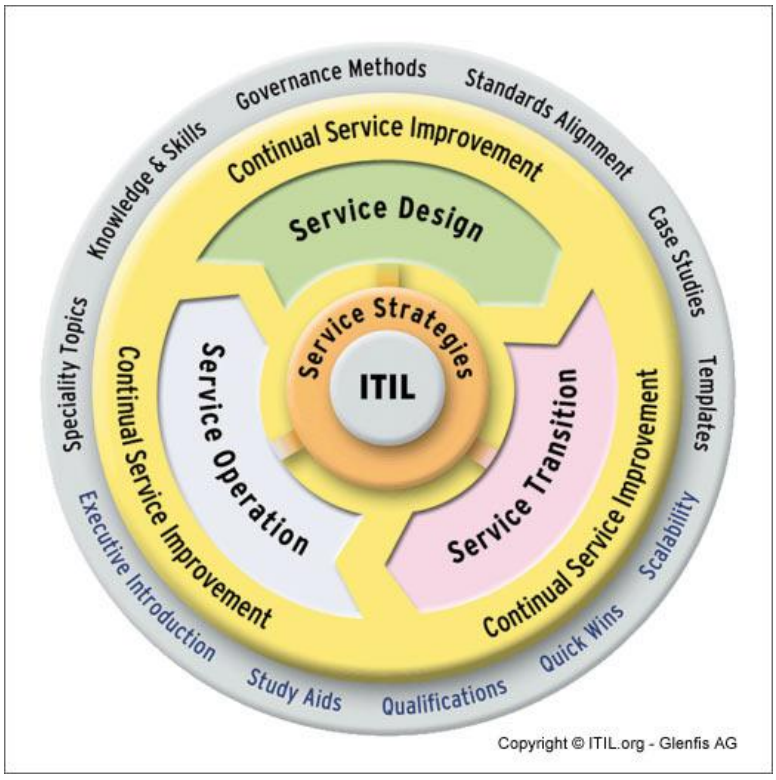

Figure 7 – ITIL Framework (Source: www.itil.org)

2.1.2.4 Enhanced Telecom Operations Map (eTOM)

The Enhanced Telecom Operations Map is a business process framework developed for telecommunication industry. The eTOM provides a library of business processes in hierarchical process decomposition at different levels. The amount of details in process definition increases as leveling down from corporate level to lower levels. The structure of the processes is composed of horizontally and vertically crossing processes. Vertical processes are separated as corporate management and supporting processes, and operational processes. These can be thought as covering lifecycles and include end-to-end activities involving customers, supporting services, resources and suppliers/partners. On the other hand, horizontal processes represent major programs or functions that cut horizontally across the vertical ones, i.e. an enterprise's internal business activities (http://www.tmforum.org/Overview/13763/home.html).

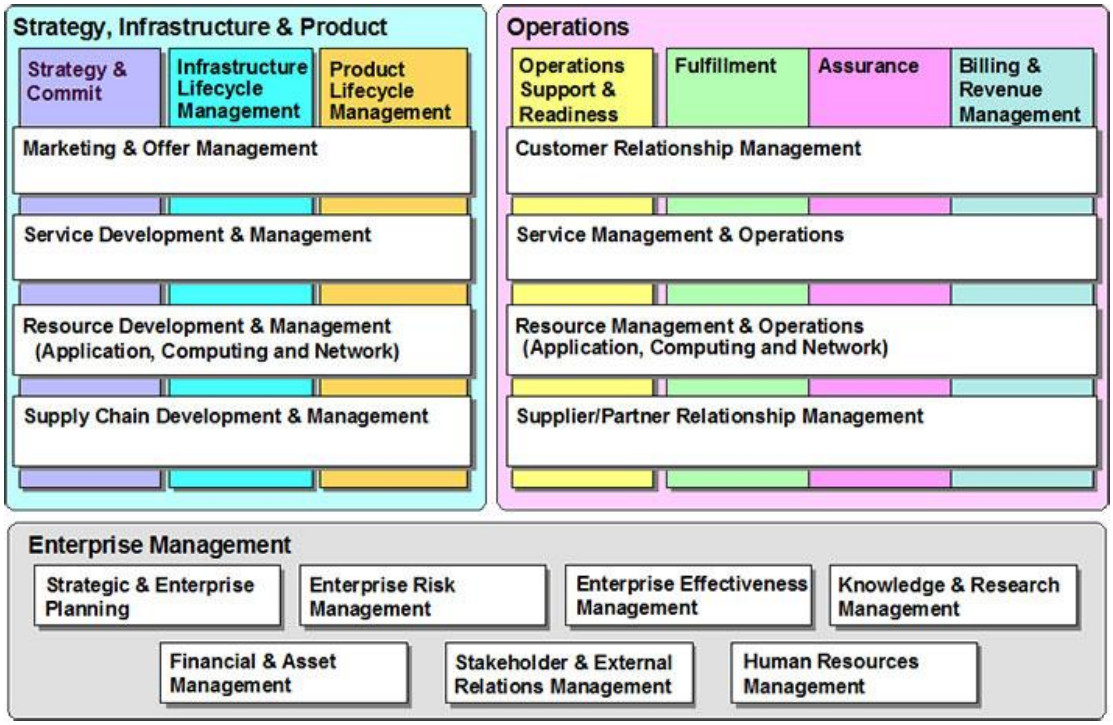

Figure 8 – eTOM Process Framework
(Source: http://www.tmforum.org/Overview/13763/home.html)

2.1.2.5 Project Management Body of Knowledge (PMBOK)

Project Management Body of Knowledge (PMBOK) is a collection of best practices in project management including knowledge, processes, skills, tools, and techniques provided by Project Management Institute. PMBOK is not a specific methodology; rather it is more like a guideline. PMBOK recognizes 5 basic process groups and 10 knowledge areas which are typical for almost all projects. The basic process groups are project initiating, project planning, project executing, project monitoring and controlling, and project closing. The processes are described

in terms of inputs, outputs, tools and techniques (Haughey, 2010). Within these process groups, ten knowledge areas are included in PMBOK and these are basics of the guidance.

A knowledge area is a complete set of concepts, terms, and activities composing a professional field, project management field, or area of specialization providing guidance. The knowledge areas included in PMBOK are (PMBOK Guide, 2012):

1. Project Integration Management
2. Project Scope Management
3. Project Time Management
4. Project Cost Management
5. Project Quality Management
6. Project Human Resource Management
7. Project Communications Management
8. Project Risk Management
9. Project Procurement Management
10. Project Stakeholder Management

The details and important aspects of knowledge areas and their integration with five process groups are defined in PMBOK Guide.

2.1.2.6 PRojects IN Controlled Environments (PRINCE2)

PRojects IN Controlled Environments (PRINCE2) is a structured project management model offering processes for effective project management. The model is established by the Central Computer and Telecommunications Agency (CCTA), renamed as the Office of Government Commerce (OGC), in 1989 with the first version PRINCE, as a project management method for using in UK Government information system projects. PRINCE2 is published in the year 1996, and its recent version is announced in 2009. Although PRINCE2 is in the public domain because of its origin, it is also widely recognized and used in the private sector (http://www.prince-officialsite.com).

The key features of this model include the fact that its focus is on business justification. The structure of the organization is defined according to the project management teams. The planning approach of the model is product-based and divided into the smaller parts for better management and control. With these features, PRINCE2 provides more control on resources, effective project and risk management. The structure of the model is based on four integrated elements of principles, themes, processes, and the project environment.

The principles are the guiding obligations and best practices indicating the project is managed by PRINCE2 model. These principles, which are obligatory for PRINCE2, are business justification, learning from experience, roles and responsibilities, managing by stages, managing by exception, focusing on products, and tailoring to suit the environment.

The themes are the guidance describing the aspects of project management that should be addresses continuously during the project life cycle for project success. These are business case, organization, quality, plans, risk, change, and progress (http://www.onlineprince2.com).
Processes describe stepwise directions for progress throughout the whole project lifecycle. Checklists are also provided with the processes. The processes are starting up a project, initiating a project, directing a project, controlling a stage, managing product delivery, managing stage boundaries, and closing a project (http://www.onlineprince2.com).

PRINCE2 is a framework that should be customized according to the project. The final element of the model describes the need for tailoring the framework for specific projects (http://www.onlineprince2.com).

2.1.2.7 Value Reference Model (Value Chain)

A Value Reference Model (VRM) is an integrating framework, established by the trade consortium Value Chain Group, supporting organizations for planning, governing, and executing with the objective of improving performance of all value chain. Value chain is a business management concept first introduced by Michael Porter in 1985 in his famous bestseller book *Competitive Advantage: Creating and Sustaining Superior Performance.* Value chain is a high-level model of how businesses receive raw materials as input, add value to them through various processes and transform them to finished products, and sell finished products to customers as outputs. The value chain categorizes the generic value-adding activities of an organization (Brown, 2009). The framework provides a semantic dictionary including processes, inputs/outputs, metrics and best practices in order to support and enable corporations to integrate their three critical domains; Global Product Developments, Global Supply Network Integration and Global Customer Success. The framework has three levels and the processes are categorized in these levels: Strategic (Level 1), Tactical (Level 2), and Operational (Level 3) (http://www.value-chain.org).

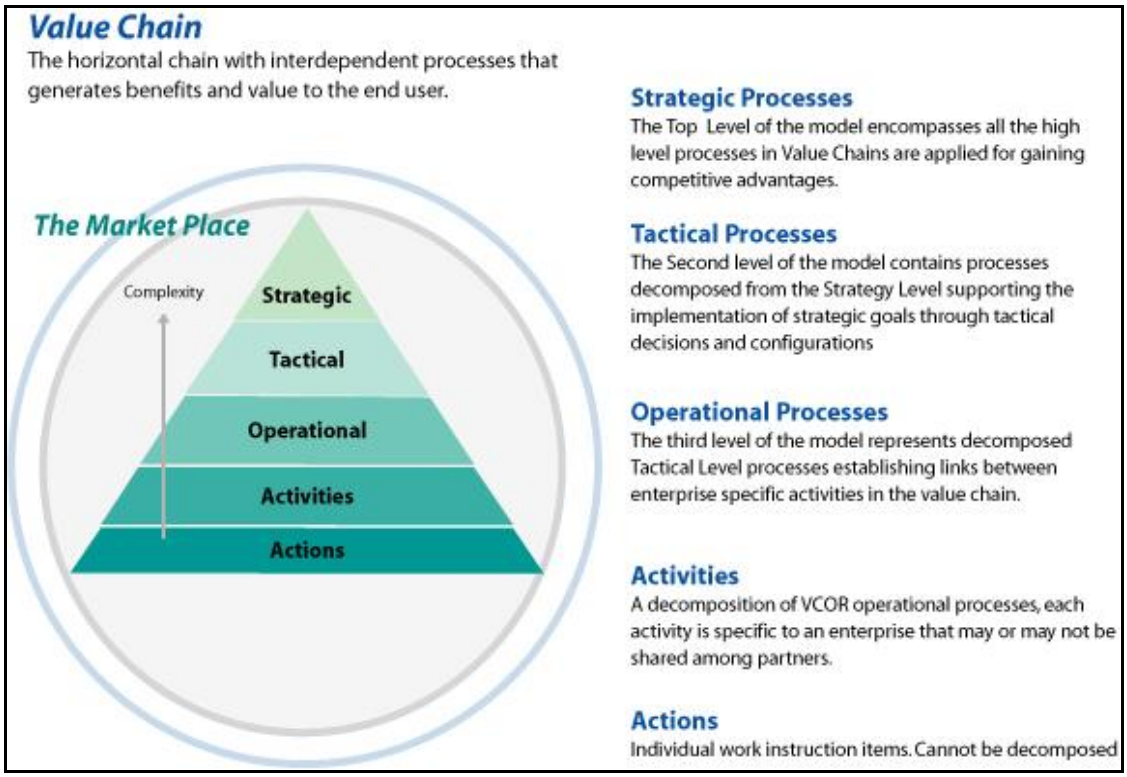

Figure 9 – Value Reference Model Framework (Source: http://www.value-chain.org)

2.1.2.8 Supply Chain Operations Reference (SCOR)

Supply Chain Operations Reference (SCOR) is established by Supply Chain Council (SCC) which is an independent, nonprofit, global corporation with membership open to all companies and organizations interested in supply chain management systems and practices. SCOR is a unique framework that links business process, metrics, best practices and technology features into a unified structure in order to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities (http://supply-chain.org/scor).

2.1.3 Business Process Improvement

There is a growing interest and research on improvement of business processes as an essential part of effective quality management. Process efficiency is questioned for assuring quality, than different approaches have been developed for improvement of quality, in other words improvement of business processes.

Business Process Improvement is defined by Harrington (1991) as *"a systematic approach to help an organization optimize its underlying processes to achieve more efficient results."* in his book "Business Process Improvement". Hammer and Champy (1993) have come up with a broader meaning for process improvement by stating that business process improvement is behind a series of incremental process changes rather it is a radical change that improves overall organizational performance. As the importance of performance increases in the competitive environment, new approaches, frameworks, standards and models have been developed for process improvement. Some of those well-known process improvement approaches are stated in the following.

2.1.3.1 Sink-Tuttle Organizational Performance Measurement Approach

A classical model for performance measurement, introduced by Sink and Tuttle (1989), introduces a systematic approach for selection, formulation, implementation, and execution of organizational performance improvement measures. An eight-step performance improvement planning process is introduced in this approach by Sink and Tuttle as it is shown in Figure 10 (Sage and Rouse, 2009).

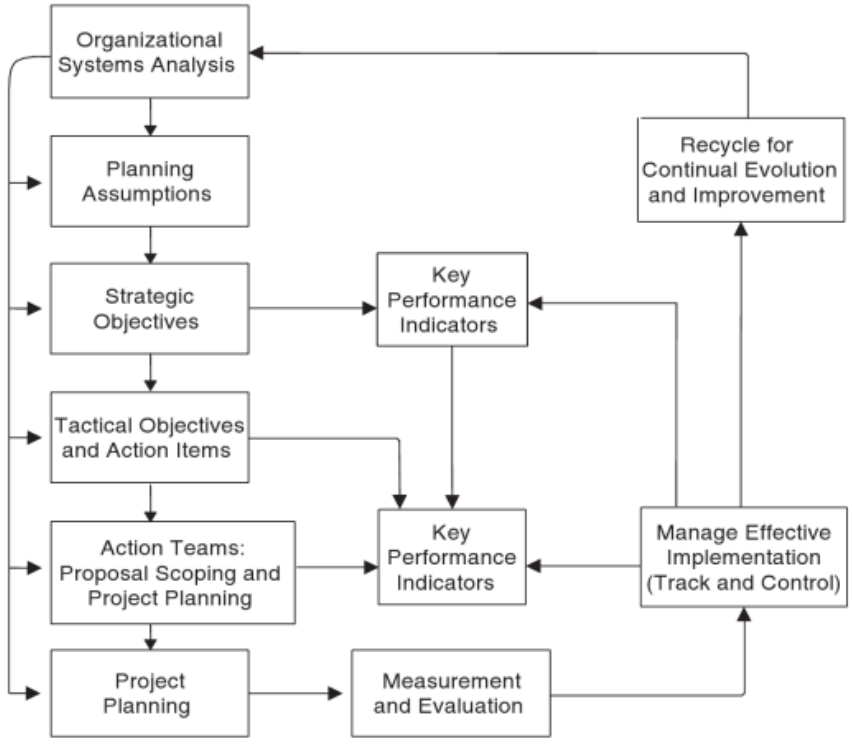

Figure 10 – Interpretation of measurement improvement planning process of Sink and Tuttle (Source: Sage and Rouse, 2009)

The performance measurement model introduced in this approach claims that performance of an organization is a complex interrelationship between seven performance criteria (Sink and Tuttle, 1989 as cited in Tangen, 2004):

- Effectiveness is the actual accomplishment of the right things, at the right time and with the right quality. It is calculated by the ratio of actual output to expected output.
- Efficiency is "doing things right", as it is the ratio of resources expected/predicted/forecasted/estimated resources to be consumed to resources actually consumed.
- Productivity is the ratio of output over input.
- Quality of Work Life represents how employees feel about various aspects of work life in the organization.
- Innovation is the creative process of changing for continuous improvement.
- Profitability/budgetability is the revenue/cost related performance.
- Quality is a very wide concept; it is defined based on five factors: upstream systems of suppliers, inputs, transformation processes, outputs, and downstream systems of customers.

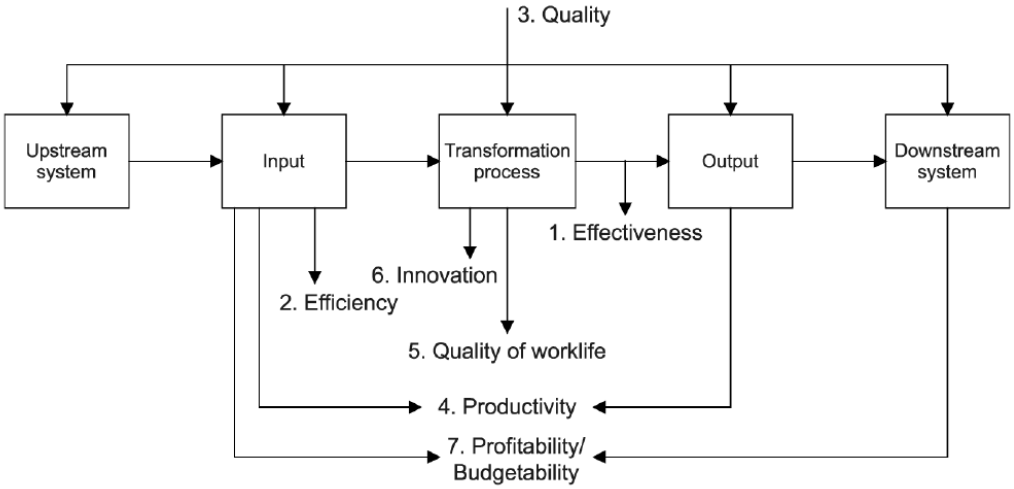

Figure 11 – Sink –Tuttle Organizational Performance Measurement Approach
(Source: Tangen, 2004)

2.1.3.2 Performance Measurement Matrix Framework

Performance Measurement Matrix framework is introduced by Keegan, Eiler, and Jones (1989) (as cited in Neely et al., 2000). Performance measures are defined in four categories in the performance matrix as cost, non-cost, internal, and external as shown in Figure 12.

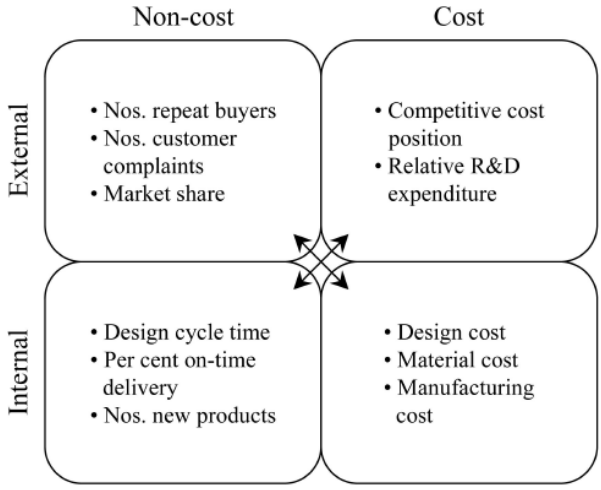

Figure 12 - Performance Measurement Matrix
(Source: Keegan et al., 1989 as cited in Neely et al., 2000)

By this categorization, it is aimed to have a balancing measurement system which also has a simple and flexible design. The performance measures are positioned in this matrix, and the management focuses on them accordingly (Neely et al., 2000).

2.1.3.3 SMART Pyramid

SMART (Strategic Measurement and Reporting Technique) pyramid developed by Lynch and Cross (1991) (as cited in Neely et al., 2002) introduces also a balanced measurement in terms of internal and external efficiency (see Figure 13).

SMART Pyramid contributes in terms of showing the need of internal and external measures and how they should cascades down the organization reflecting the corporate vision in the lower levels while considering the objectives at the same time (Neely et al., 2002)

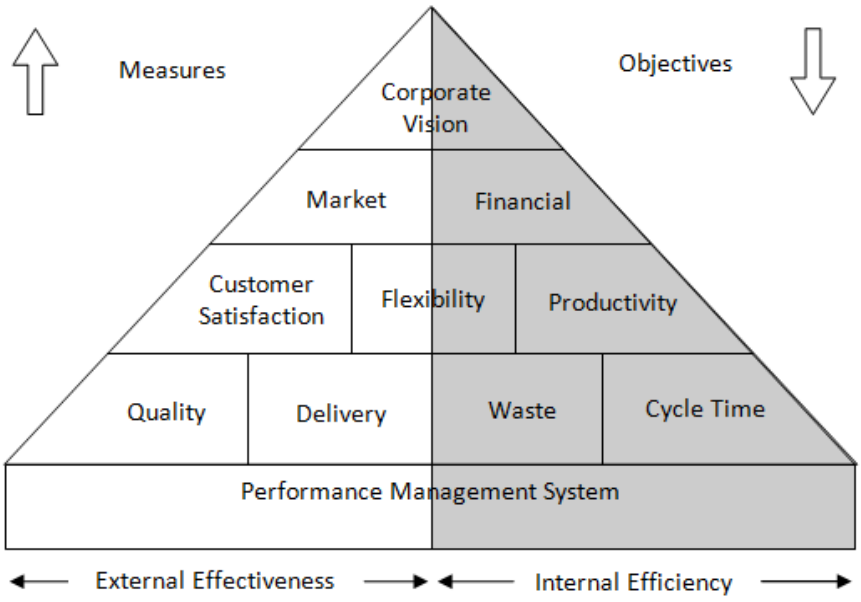

Figure 13 - SMART Pyramid (Source: Neely et al., 2000)

2.1.3.4 Results-Determinants Framework

A different classification of performance measures is introduced by Fitzgerald et al. (1991) (as cited in Neely et al., 2002) with the framework of results and determinants. Performance measures are categorized as either results related or determinants related. The results are competitiveness, and financial performance, on the other hand, the determinants of these results are quality, flexibility, resource utilization, and innovation. This model emphasizes the causal relationship between results and determinants. This framework encapsulates the theme raised in later debates about identifying performance drivers and deploying performance measurement systems in order to achieve the desired performance outcomes (Neely et al., 2002).

Results	Competitiveness
	Financial Performance
Determinants	Quality
	Flexibility
	Resource Utilization
	Innovation

Figure 14 – Results-Determinants Framework
(Source: Neely et al., 2000)

2.1.3.5 Input-Process-Output-Outcome Framework

Brown (1991) (as cited in Neely et al., 2002) introduced another framework which focuses on the concept of linking the performance measures based on cause and effect relationship. In this framework a business process is investigated in five linked stages and performance of each stage is a separate category. The five stages of a process are inputs, processing system, outputs, outcomes, and goal. It is argued that performance of each stage is affected by the previous factor in this framework, which constitutes more complex relations then the relations in previous frameworks such as internal vs. external, and results vs. determinants (Neely et al., 2000).

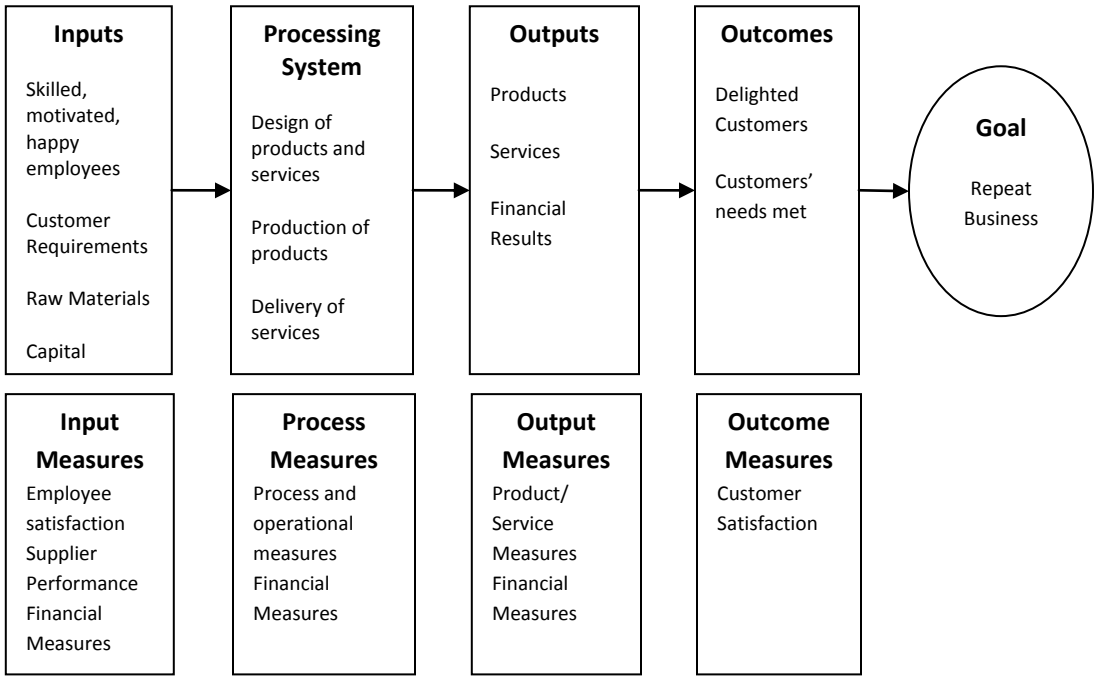

Figure 15 – Input-Process-Output-Outcome Framework. (Source: Neely et al., 2000)

2.1.3.6 Balanced Scorecard

Balanced Scorecard method may be considered as the most well-known process performance measurement reference model among others. Balanced Scorecard method is introduced by Robert S. Kaplan and David P. Norton in 1992. The introduction of this model is aroused because traditional measurement systems heavily relying on financial measures became insufficient as organizations' efforts for developing new competencies have increased. Some renewal methods were put forward such as making financial measures more relevant or leaving them away completely and taking only operational measures into consideration. At this point, Kaplan and Norton introduced Balanced Scorecard method at the end of a year-long study with 12 companies from different industries (Kaplan & Norton, 1992). With this method, it is aimed to give fast and comprehensive information about organizational performance to top management. This method focuses on four perspectives; financial, customer, internal-business-process, learning and growth, while measuring the performance. These four perspectives cover the organization's strategy and mission from all aspects. Organizations adapt this method to themselves based on their mission and objectives (Kaplan & Norton, 1992).

2.1.3.7 Critical Few Method

Critical Few Method is introduced by Murray and Richardson (1998, as cited in Franchescini et al., 2007) which propose that managing too many indicators for measuring performance brings some drawbacks such as;

- *losing sight of all the indicators' impact*
- *distracting management's focus from those indicators that are the most critical to organizational success*
- *not identifying the correlation/influence between two indicators*

Therefore, determining a few most critical performance indicators and managing those is more desirable (Franchescini et al., 2007).

2.1.3.8 Performance Prism

Performance Prism framework, which is introduced by Andy Neely, Chris Adams, and Paul Crowe, brought a stakeholder-centric approach to performance measurement (Neely et al., 2001). Performance prism focuses on stakeholder involvement separating the concepts of stakeholder satisfaction and stakeholder contribution which is a major difference from other frameworks. An organization should consider both its wants and needs (mutual exchanges) from its stakeholders in order to create value for them. In order to meet the requirements of this mutual exchange, strategies of the organization should be set accordingly. At this point, critical processes and measures become important that managers need processes for fulfillment of the strategies and measures for tracking the correct implementation of the strategies. Furthermore, organizations should consider what capabilities they need for proper operations and enhancement of critical processes.

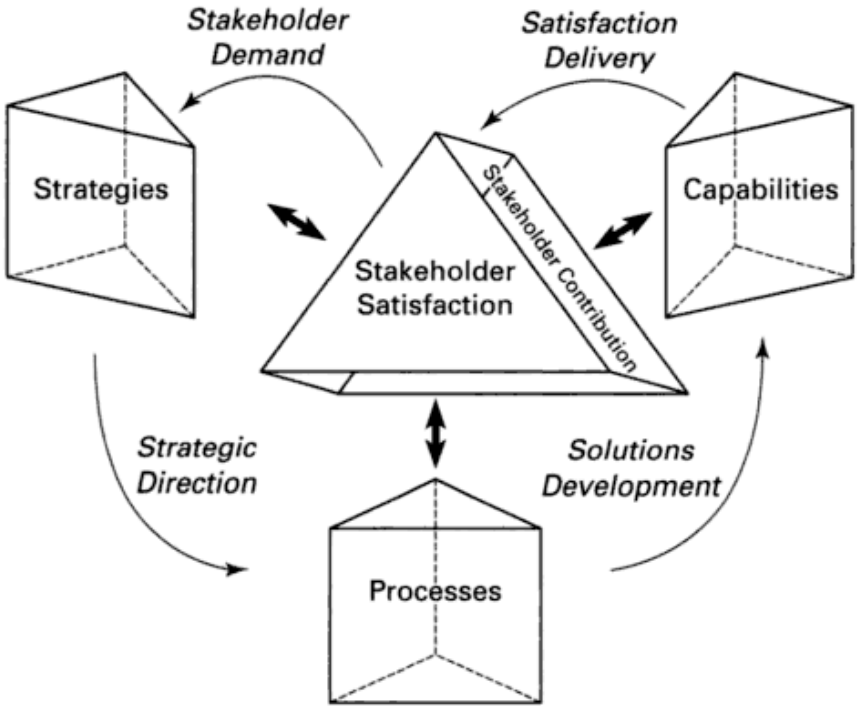

Figure 16 – Performance Prism (Source: Neely and Kennerley, 2002)

2.1.3.9 Business Excellence Model

Another approach is the Business Excellence Model introduced by The European Foundation for Quality Management (EFQM) in order to be the driving force for Sustainable Excellence in Europe concerning Quality Management (Site EFQM 2005; Premio Qualità Italia 2002 as cited in Franchescini et al., 2007). The Business Excellence Model of EFQM is a self-assessment method focusing on five "enablers" and four "results". The five "enablers" are Leadership, Strategy, People, Partnerships & Resources and Processes, Products & Services; and four "results" are Customer Results, People Results, Society Results, and Key Results. Enablers include what an organization does and results include what an organization's achievements. The relation between enablers and results is the fact that enablers help for achievement in results and feedback from results help to improve enablers (Franchescini et al., 2007). This model shows the complexity in cause and effect relationship within an organization (Neely et al., 2000).

2.1.3.10 Malcolm Baldridge National Quality Award

Another model is the one based on Malcolm Baldridge Quality Award applied by US organizations for quality improvement. This award model evaluates the organizations based on seven criteria which are leadership, information and analysis, strategic planning, human resources development and management, process management, work results, and customer focus and satisfaction. The establishment of this model is based on customer satisfaction as emphasized by Total Quality Management (Neely et al., 2005).

2.2 PERFORMANCE MEASUREMENT

The basis of performance measurement can be traced to the Measure Theory that was developed in successive stages during the late 19th and early 20th centuries by Émile Borel, Henri Lebesgue, Johann Radon and Maurice Fréchet, among others. In this concept, a measure can be defined as a systematic way to assign a number to a meaningful subset of a predefined set showing its size in the context of mathematical analysis. Measuring performance can be defined as gathering information, and making analysis and interpretations for existing outcome whether the intended outcome is achieved. The purpose of measuring performance is stated by Training Resources and Data Exchange (TRADE) Performance-Based Management Special Interest Group as in the following:

- *"performance measurement provides a structured approach for focusing on a program's strategic plan, goals, and performance;"*
- *"measurements focus attention on what is to be accomplished and compels organizations to concentrate time, resources, and energy on achievement of objectives. Measurements provide feedback on progress toward objectives;"*
- *"performance measurement improves communications internally among employees, as well as externally between the organization and its customers and stakeholders. The emphasis on measuring and improving performance (results-oriented management) creates a new climate, affecting all the organizations aspects;"*
- *"performance measurement helps justify programs and their costs. Measurements provide the demonstration of a program's good performance and sustainable impacts with positive results, in order to support the decision making process."*

In some other words; performance measurement can be defined as the process of quantifying the efficiency and effectiveness of an action. Starting from this point, a performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of an action (Neely et al. 2005). In other words, performance measures are used for determining whether an action (a process, a function, or a service) is actually performing according to the identified performance expectations and the way it was designed. A complete set of performance measures used to quantify both the efficiency and effectiveness of past actions through acquisition, collation, sorting, analysis, interpretation, and dissemination of appropriate data in order to support decision making forms a performance measurement system (Neely, 1998).
Neely et al. (1997) have made a study to determine the attributes and the features of a good performance measure. They defined a performance measure record sheet for using in designing performance measures and revised this sheet in the conclusion of their study as in Table 1.

Table 1 – Performance Measure Record Sheet Recommended by Neely et al. (1997)

1	Title	
2	Purpose	
3	Relates to	
4	Target	
5	Formula	
6	Frequency of measurement	
7	Frequency of review	
8	Who measures?	
9	Source of data	
10	Who owns the measure?	
11	What do they do?	
12	Who acts on the data?	
13	What do they do?	
14	Notes and comments	

They also have made a literature review for recommended features of a good measure, and then they evaluated these recommendations by their previously designed performance measures and eliminated the irrelevant ones which are not directly related with properties of performance measure. According to this study, recommendations for a good performance measure reached at the end of this study are shown in the following table.

Table 2 – Recommendations for a Good Performance Measure
(Source: Neely et al. 1997)

No	Recommendation
1	Performance measures should be derived from strategy
2	Performance measures should be simple to understand
3	Performance measures should provide timely and accurate feedback
4	Performance measures should be based on quantities thatcan be influenced, or controlled, by the user alone or in co-operation with others
5	Performance measures should relate to specific goals (targets)
6	Performance measures should be relevant
7	Performance measures should be part of a closed management loop
8	Performance measures should be clearly defined
9	Performance measures should provide fast feedback
10	Performance measures should have an explicit purpose
11	Performance measures should be based on an explicitly defined formula and source of data
12	Performance measures should provide information
13	Performance measures should be precise – be exact about what is being measured

In another study by Jensen & Sage (2000) which is cited by Kellen (2003), metric design attributes (goals), metric set goals, and measurement system infrastructure goals are enumerated.

The Jensen & Sage (2000, as cited in Kellen, 2003) metric goals include:

1. Cost-effectiveness
2. Strategic alignment
3. Acceptability (buy-in)
4. Usefulness
5. Acquirability and implementability
6. Consistency
7. Accuracy
8. Reliability
9. Repeatability
10. Believability
11. Timeliness
12. Responsiveness
13. Known responsibilities
14. Security

The Jensen & Sage (2000, as cited in Kellen, 2003) metric set goals include:

1. Balance across types of metrics
2. Organizational coverage
3. Completeness, minimum overlap
4. Cost-effectiveness
5. Total number, number per measurement area
6. Standardization
7. Documentation
8. Coverage of strategic thrusts
9. Current status and trend measures
10. Communications to staff

The Jensen & Sage (2000, as cited in Kellen, 2003) measurement system infrastructure goals include:

1. Automation
2. Repository, communications and other security (access to archival information)
3. Labor hour reduction
4. Information dissemination

De Haas & Kleingeld (1999, as cited in Keller, 2003) mention seven pre-existing measurement system criteria from other studies and add their concept of coherence (discussed below) to the list to make eight for a good performance measurement system as cited by Keller (2003):

1. Controllability
2. Validity
3. Completeness
4. Cost-effective measurability
5. Specificity
6. Relevance
7. Comprehensibility
8. Coherence

Neely et al. (2000) proposes that the development process of a performance measurement system can be divided into three main phases, which are:

1. design of the performance measures;
2. implementation of the performance measures;
3. use of the performance measures.

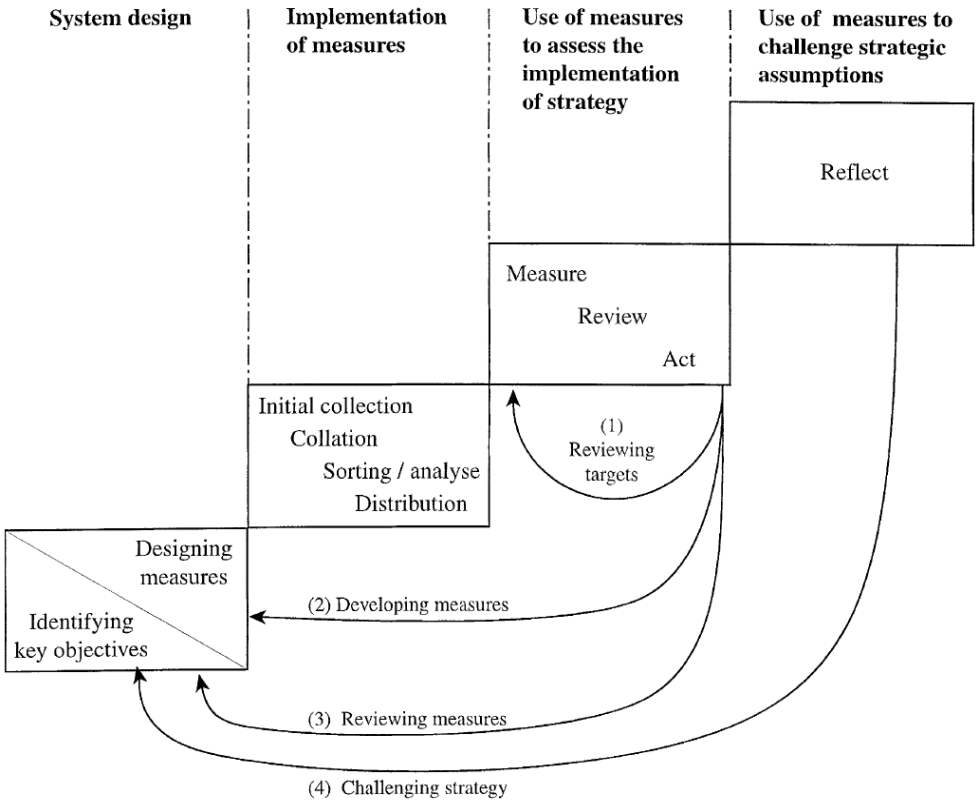

Figure 17 – Phases of Implementing a Performance Measurement System.
(Source: Neely et al., 2000)

Further, they argue that this process is not a simple linear progression from system design to the use of performance measures for challenging strategy, and the performance measurement system requires developing and reviewing at a number of different levels as the situation changes (Neely et al., 2000). For instance, a performance measurement system should include;

1. an effective mechanism for reviewing and revising targets and standards (Ghalayini and Noble, 1996, as cited in Neely et al., 2000).
2. a process for developing individual measures as performance and circumstances change (Maskell, 1989; Dixon et al., 1990; McMann and Nanni, 1994, as cited in Neely et al., 2000).
3. a process for periodically reviewing and revising the complete set of measures in use. This should be done to coincide with changes in either the competitive environment or strategic direction (Wisner and Fawcett, 1991; Dixon et al., 1990; Lingle and Schiemann, 1996, as cited in Neely et al., 2000).

In literature, sometimes performance measure and performance indicator are used interchangeably as they have the same meaning, but sometimes they are used differently such as, performance measure is an indicator gathered from some calculations and analysis, while performance indicator is only the raw data itself. For instance, according to this distinction, actual cost is an indicator while cost variance is a measure. In this thesis, in order to enlarge the adaptation possibility, indicator and measure are used interchangeably.

2.3 USE OF IT IN BPM

Information technology is becoming one of the major elements of business process management since its contribution to process modeling, process improvement, and process reengineering is rapidly increasing. Information technology is used for process modeling, gathering and analyzing process related data, reporting, etc.

Davenport and Short (1990) evaluates IT capabilities and their impact on organizations from business process management perspective, and their evaluations are stated in Table 3.

Table 3 – IT Capabilities and Their Organizational Impacts
(Source: Davenport and Short, 1990)

Capability	**Organizational Impact / Benefit**
Transactional	IT can transform unstructured processes into routinized transactions
Geographical	IT can transfer information with rapidly and ease across large distances, making processes independent of geography
Automational	IT can replace or reduce human labor in a process
Analytical	IT can bring to bear complex analytical methods on a process
Informational	IT can bring vast amounts of detailed information into a process
Sequential	IT can enable changes in the sequence of tasks in a process, often allowing multiple tasks to be worked on simultaneously
Knowledge Management	IT allows the capture and dissemination of knowledge and expertise to improve the process
Tracking	IT allows the detailed tracking of task status, inputs, and outputs
Disintermediation	IT can be used to directly connect two parties within a process that would otherwise communicate through an intermediary (internal and external)

Bititci, Carrie and McDevitt (1997) put information systems into the heart of performance management process by defining performance measurement system as the information system that enables the performance management process to function effectively and efficiently. The process of performance management serves for a proactive overall control during the endeavor for achieving organizational objectives, and strategies. To support performance management process, performance measurement system provides feedback for appropriate decision making by integrating all relevant information from relevant information systems.

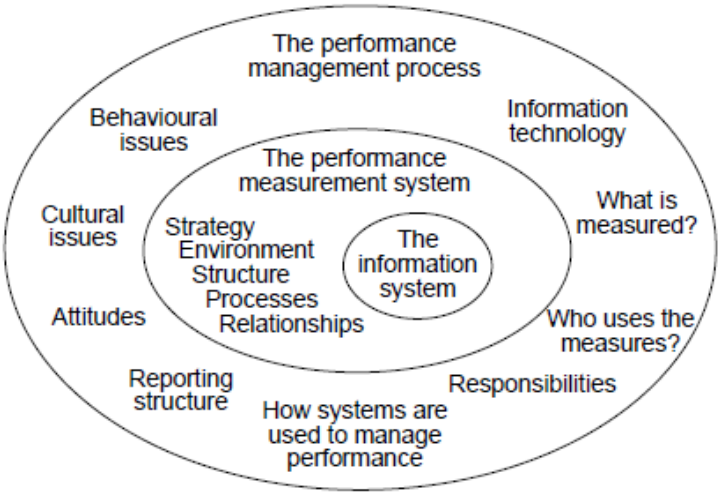

Figure 18 – The performance management process and the position of the performance measurement system (Source: Bititci et al., 1997)

2.3.1 An IT Application Example: KPI Library

An example application for process performance measurement is the "KPI Library" application which provides an online repository of process performance indicators on the web (www.kpilibrary.com). KPI library includes key performance indicators categorized by industry, by process frameworks and by process. The users can reach the library with free membership. They can search for performance measures and add new measures to the library. The measures are provided with a definition, unit of measure, formula, and direction (minimize or maximize). For some of the measures, benchmark scores provided by the users and popularity scores are provided. Users can suggest new performance measures. With premium membership with a fee, developing scorecards and dashboards by choosing measures from the library is possible. In addition, a data collector is provided for integration of dashboards and scorecards with other data sources such as Oracle, SQL Server, and SAP BW. KPI Library is a beneficial tool for its members which can be justified by the huge number of members (over 425,000) using the application. However, there are several drawbacks of KPI Library. A large number of performance indicators are provided to the users, but there is no guidance for how to select the right measures or how to define a good measure for proper performance measurement. In addition, the descriptions provided for the measures are very limited, they are not sufficient according to the research studies in the literature. The categorization of the measures is limited with only by process, by process framework and by industry. In summary, KPI Library needs to have a methodology or a guideline for describing how to develop a performance measurement system, comprehensive descriptions for the measures included in the library, and a multidimensional categorization of the measures.

2.3.2 Information Retrieval and Search Engines

Information retrieval is simply finding information, more specifically; "information retrieval is the process of matching the query against the information object that are indexed". The term was started to be used just after the invention of digital computers providing storage and retrieval of information (Goker and Davies, 2009). As the IT capabilities increased, information retrieval mechanisms are improved.

Recently, the popular term search engine is used for information retrieval systems. Search engines are software codes designed for information retrieval by searching the Web, or an intranet, or a database. Essential modules of a search engine are given below.

Table 4 – Search Engine Modules and Functionalities (Source: Liddy, 2001)

Module	**Function**
Document processor	Identifies potential indexable elements in the document, extracts index entries, and create index.
Query processor	Breaks the query, inputted by a user, down into understandable segments and creates query representation depending on how matching is done.
Search and matching capability	Searches the inverted indexed files for documents meeting the query requirements, computes a similarity score between the query and the document files creates a ranked results list based on computed scores, and presents an ordered list of documents.
Ranking capability	

2.4 GROUP DECISION MAKING: DELPHI TECHNIQUE

Delphi Technique is a structured group decision making method introduced by Helmer and Dalkey in 1950s at the RAND Corporation, in order to gain the most reliable consensus of opinion of a group of experts through sequential questionnaires or rounds (Spinelli, 1983). A group of experts answer questionnaires in two or more rounds. A facilitator collects the answers of experts and provides an anonymous summary of the answers with their reasoning. Experts revise their previous answers in the light of announced summary of other members' answers. With these sequential rounds, it is aimed that the group members converge towards the correct answer. The process is completed when a predefined completion criterion is reached or the group members reach the correct group answer. This technique has been used widely in business, industry and health care research with a variety of methodological interpretations and 'modifications' (Spinelli, 1983, and Powell, 2003). There are several studies showing the usage of this technique in determining quality measures especially in health care research (i.e. Holloway et al., 2001; Beattie et al., 2004; Lindsay et al., 2002; Normand et al., 1998). This technique is used for group decision making needs of the Performance Measure Definition System proposed in this thesis.

CHAPTER 3

THE PROPOSED PROCESS PERFORMANCE MEASURE DEFINITION SYSTEM

3.1 INTRODUCTION

Developing a complete performance measurement system is absolutely inalienable for the organizations in order to achieve continuous improvement which is a fundamental rule of today's competitive world. In the Literature Review Chapter, some studies, frameworks and methodologies about performance measurement are introduced. Process frameworks provide a comprehensive list of common processes and related key performance indicators to organizations. On the other hand performance measurement and process improvement methodologies provide guidance for developing performance measures and performance measurement systems. Both process frameworks and process improvement methodologies are used as reference for developing performance measurement systems, but still the guidance is limited. Process frameworks provide performance measures in line with the processes; however adapting these is still difficult since it may require profession in the field of corresponding process framework implementation. On the other hand, process improvement methodologies give guidance for organizations to decide on what type of performance measures they should use to measure their performance but they do not provide specific advice on how to select and implement performance measures.

Bourne et al. (2000) made a case study in three different organizations about implementation of performance measurement systems. They concluded at the end of their study that implementation and use of a performance measurement system was far from complete after the end of design phase (required 9 to 13 months to complete all phases in the case studies), which took a long time, resulting in resistance to measurement and management being distracted by other events. According to their study, reducing the time scales to ensure that companies realize the benefits of performance measurement earlier is crucial for the success of performance measurement systems. Another conclusion they make is that the speed of implementation progress should be increased by earlier involvement of IT specialists, application of data retrieval and manipulation tools and allocation of resource. Their final conclusion for improvement is the fact that skills are needed to be developed in critiquing and learning from the performance measures. An effective performance measurement system built on an information systems infrastructure, which is partly introduced in this thesis, may be a solution for these improvement needs. The performance measurement system includes generic performance measures provided by business process frameworks in a common format including necessary attributes to be a "good" performance measure and customized easily by giving detailed customization guidance to the user.

In addition, with this system organizations may gain much more value by using a tool integrating process frameworks and process improvement methodologies while giving a detailed guidance for developing process performance measures. With this perception, a structure providing generic performance measures (based on process improvement methodologies) for generic processes (included in process performance frameworks), and adapting these generic performance measures for organization specific business processes is introduced in this thesis. This structure is developed based on the capabilities supported by information technologies in order to meet the requirements of being flexible, quick and easy to implement. Without usage of information technologies, applying such a structure may be difficult and much time consuming in practice. In other words, it is aimed to have an effective performance measure definition system

which is *easy and quick to develop* and *flexible to maintain* covering all the common processes while having the process improvement methodologies as basis.

3.2 THE PERFORMANCE MEASURE DEFINITION SYSTEM (PMDS)

The primary objective of the Performance Measure Definition System (PMDS) is to support development of appropriate performance measures and provide detailed guidance on operational use of them for an effective measurement of process performance. In the core of the system, generic process performance measures provided by widely accepted process frameworks are settled within a simple approach built based on process improvement methodologies. The attributes of a generic performance measure include only those that can be generalized for organizations and exclude those that are determined based on specific characters of organizations.

The development steps of the proposed system for effective process performance measurement supported by information technologies are given in the following:

1. Determine the basic categories of performance measures that will be introduced as generic measures.
2. Determine the performance dimensions that will be basis for defining the performance measures based on process improvement methodologies.
3. Determine the attributes of a generic performance measure; prepare a Generic Performance Measure Identification Card.
4. Determine the attributes of a specific performance measure; prepare a Specific Performance Measure Identification Card.
5. Define the process of customizing generic performance measures for specific business processes.
6. Define the activities for maintenance of the process performance measure definition system.

3.2.1 Categories of Generic Performance Measures

The categories of generic performance measures in this proposed system are determined based on the arguments in different approaches introduced in the literature review. While determining the categories, it is aimed to have a performance measure categorization that is simple, applicable, and broad enough for generalization within this performance measure definition system. The categories are determined to be industry, process framework, business process, performance dimension, and stakeholder as it is shown in
Figure 19.

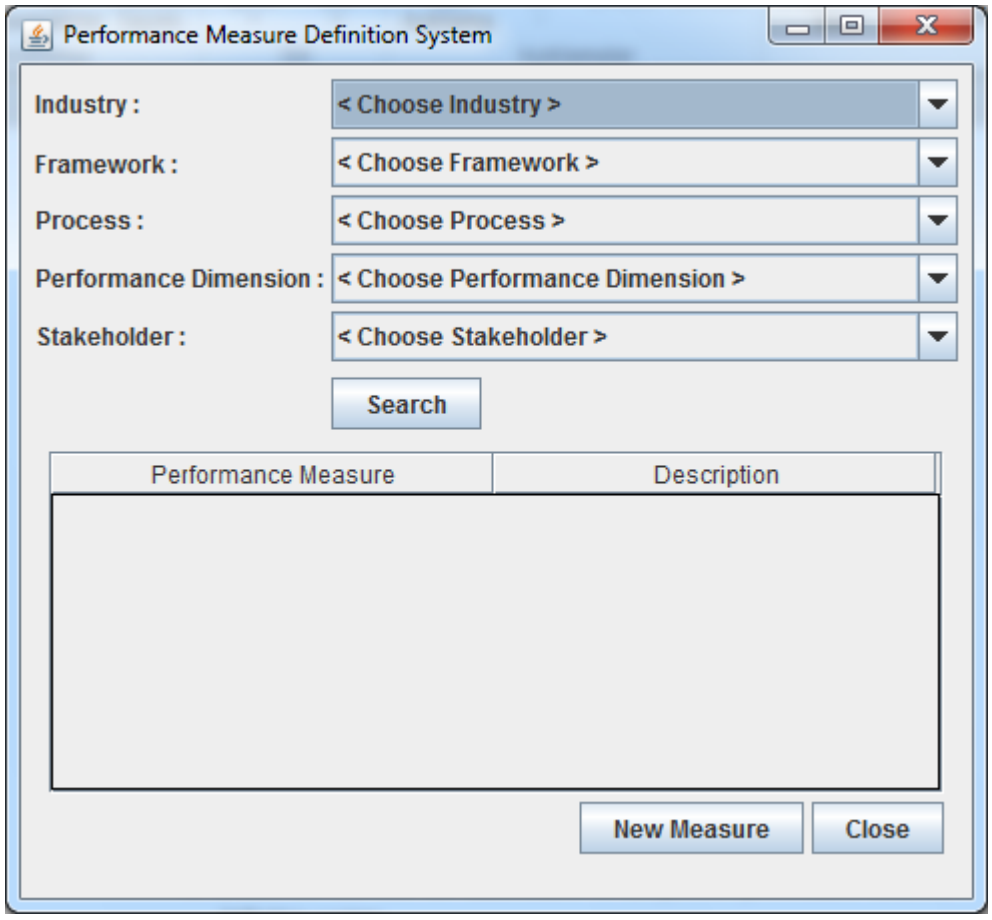

Figure 19 – Performance Measure Categories of the Proposed System

For industry classification, International Standard Industry Classification (ISIC) is used since its coverage is very large and it is a widely accepted categorization (ISIC Rev.4, 2008). The International Standard Industrial Classification of All Economic Activities (ISIC) is the international reference classification of productive activities. Its main purpose is to provide a set of activity categories that can be utilized for the collection and reporting of statistics according to such activities (ISIC Rev.4, 2008). The categories of ISIC used in this system are provided in Appendix A.

The business process frameworks introduced in the Literature Review are included in this system. They are PCF, COBIT, ITIL, eTOM, PMBOK, PRINCE2, VRM, and SCOR. In order to use these process frameworks in PMDS, licensing agreements should be done with framework authorities.

Process, in other words generic process as used in this thesis, defines common operations for a process family as it is stated in the Literature Review. In this thesis, generic process term is used to define a high level process that represent a common business process area introduced in business process frameworks meaning that organizations have an adapted version of the common process in application in a specialized form specific to themselves. For example, Customer Relationship Management Process (eTOM), Strategy Management Process (COBIT),

and Production Scheduling Process (APQC) are generic processes provided by different process frameworks.

Performance dimension is one of the fundamental attributes for performance measures and it is one of the main determinants while deciding on how to measure. The following performance dimensions are determined for this study, and their details are given in the next section.

- Effectiveness
- Productivity
- Efficiency
- Quality
- Innovativeness
- Time
- Cost
- Flexibility

The perceptions of these dimensions by different stakeholders are considered separately while defining the performance measures. As it is stated in almost all of the performance improvement methodologies, in order to have a complete and comprehensive performance measure definition system, different performance dimension perceptions should be taken into consideration. The following stakeholders are determined within this category of generic performance measures:

- Customer
- Owner/Investor
- Employee
- Regulators
- Suppliers
- Competitors
- Community

For instance, the quality perception is evaluated differently for different stakeholders such as; quality of the product or service for customers, quality of working environment for employees. A matrix is built for each generic process to show the performance dimensions and stakeholders and it is used while categorizing the generic measures as in the sample matrix in Table 5.

Table 5 – An example generic measures matrix for generic processes

	Customer	Owner/ Investor	Employee	Regulators	Suppliers	Competitors	Community
Effectiveness							
Productivity							
Efficiency							
Quality							
Innovativeness							
Time							
Cost							
Flexibility							

The relation matrix of different performance perspectives can be enlarged as being a multi-dimensional matrix including different classification attributes of the performance measures. This is explained further in Section 3.4 Maintenance of the System.

3.2.2 Performance Dimensions

Performance dimension is the key linkage between process frameworks and process improvement methodologies in this study. Performance dimensions are included in almost all process improvement methodologies while defining the performance measures included in process frameworks implicitly. In this study, effectiveness, efficiency, productivity, quality, innovativeness, time, cost, and flexibility are included in PMDS as performance dimensions in order to have a comprehensive performance perspective for process performance measurement.

Effectiveness and Efficiency are the two concepts included explicitly in some performance measurement approaches such as Sink – Tuttle Model, SMART pyramid, while included implicitly in others (Neely et al., 2005). These two terms are frequently confused with each other. There are different definitions for these terms in the literature. Tangen (2005) has collected these different definitions, which is provided in Figure 20.

Definitions of efficiency	Definitions of effectiveness	Reference
Efficiency is an input and transformation process question, defined as the ratio between resources expected to be consumed and actually consumed	Effectiveness, which involves doing the right things, at the right time, with the right quality etc., can be defined as the ratio between actual output and expected output	(Sink and Tuttle, 1989)
Efficiency is used for passive or operational activity, which is usually defined technically so that the system and its behaviour are foreseeable in advance	Effectiveness is basically used in active or innovative activity performed by a risk taker and based on a rather broad perspective	(Kurosawa, 1991)
Efficiency is the ratio of actual output attained to standard output expected, and reflects how well the resources are utilised to accomplish the result	Effectiveness is the degree of accomplishment of objectives, and shows how well a set of results is accomplished	(Sumanth, 1994)
Efficiency is a measure of how economically the firm's resources are utilised when providing the given level of customer satisfaction	Effectiveness refers to the extent to which the customer requirements are met	(Neely *et al.*, 1995)
Efficiency means how much cost is expended compared with the minimum cost level that is theoretically required to run the desired operations in a given system	Effectiveness in manufacturing can be viewed as to what extent the cost is used to create revenues	(Jackson, 2000)
Efficiency = ideal system dependent time/total time	Effectiveness = value added time/ideal system dependent time	(Jackson, 2000)

Figure 20 – Example Definitions of Efficiency and Effectiveness
(Source: Tangen, 2005)

Efficiency and effectiveness are included in PMDS as they are defined by Sink and Tuttle (1989) in the following.

Efficiency is the level of how efficient the inputs are used to get outputs. The objective is to produce the outputs with minimum resource cost at the end of the process. The common saying for efficiency is "Are we doing things right?" A generic formulation for measuring efficiency is stated below (Sage and Rouse, 2009).

$$\text{Efficiency} = (\text{Planned Input Consumption} / \text{Actual Input Consumption}) \times 100$$

Effectiveness indicates the degree of meeting the requirements and achieving the objectives at the end of a process with process outputs. A common saying “Are we doing the right things?” is used for expressing this term. A generic formulation for measuring effectiveness is stated below (Sage and Rouse, 2009).

Effectiveness = Actual Output / Planned Output

Productivity is another common term included in many different performance measurement approaches either as a performance dimension or a category or a performance measure (Neely et al., 2005). Productivity is simply the rate of outputs to inputs showing the level of input usage for acquiring output at the end of a process. International Labor Organization defines productivity as efficient and effective use, in other words utilization, of resources in the production of outputs. Productivity is a multidimensional concept within itself as its meaning may vary depending on the context it is used (Tangen, 2005). The different definitions of productivity in the literature are summarized by Tangen (2005) as in Figure 21.

Definition	Reference
Productivity = faculty to produce	(Littré, 1883)
Productivity is what man can accomplish with material, capital and technology. Productivity is mainly an issue of personal manner. It is an attitude that we must continuously improve ourselves and the things around us	(Japan Productivity Centre, 1958 (from Björkman, 1991))
Productivity = units of output/units of input	(Chew, 1988)
Productivity = actual output/expected resources used	(Sink and Tuttle, 1989)
Productivity = total income/(cost + goal profit)	(Fisher, 1990)
Productivity = value added/input of production factors	(Aspén *et al.*, 1991)
Productivity is defined as the ratio of what is produced to what is required to produce it. Productivity measures the relationship between output such as goods and services produced, and inputs that include labour, capital, material and other resources	(Hill, 1993)
Productivity (output per hour of work) is the central long-run factor determining any population's average of living	(Thurow, 1993)
Productivity = the quality or state of bringing forth, of generating, of causing to exist, of yielding large result or yielding abundantly	(Koss and Lewis, 1993)
Productivity means how much and how well we produce from the resources used. If we produce more or better goods from the same resources, we increase productivity. Or if we produce the same goods from lesser resources, we also increase productivity. By "resources", we mean all human and physical resources, i.e. the people who produce the goods or provide the services, and the assets with which the people can produce the goods or provide the services	(Bernolak, 1997)
Productivity is a comparison of the physical inputs to a factory with the physical outputs from the factory	(Kaplan and Cooper, 1998)
Productivity = efficiency * effectiveness = value adding time/total time	(Jackson and Petersson, 1999)
Productivity = (output/input) * quality = efficiency * utilisation * quality	(Al-Darrab, 2000)
Productivity is the ability to satisfy the market's need for goods and services with a minimum of total resource consumption	(Moseng and Rolstadås, 2001)

Figure 21 – Example Definitions of Productivity (Source: Tangen, 2005)

Productivity is included as a performance dimension in PMDS with its simple but general definition, a ratio of a volume measure of output to a volume measure of input use.

Quality is another concept generally included in performance measurement approaches as the level of meeting the requirements and expectations of stakeholders. Philip B. Crosby (1979) defines quality as conformance to requirements. His approach is based on achieving quality by

prevention rather than appraisal and the standard for performance is zero defects. The measurement of quality is measuring the cost of quality through price of conformance and price of nonconformance in his approach. W. Edwards Deming (1986) defines quality in terms of quality of design, quality of conformance, and quality of the sales and service functions. He argues that quality measurement should be done by direct statistical measures of manufacturing performance against specifications. He does not accept the measurement by cost of quality as he argues that major quality cost is cost of delivering defective product to customers and it is not measurable in real life. On the other hand, Armand V. Feigenbaum, who is the originator of the term "total quality control", defines the cost of quality in three categories as appraisal cost, prevention cost, and failure cost (1962 as cited in Neely et al., 2005). Based on these different definitions, common point is the fact that quality is a multidimensional concept.

Quality is included in PMDS as a performance dimension with its attributes under three topics: product quality (Garvin, 1987), service quality (Parasuraman et al., 1988), and quality of life (Sink and Tuttle, 1989). Product quality is considered based on its eight dimensions: performance, features, reliability, durability, conformance, serviceability, aesthetics, and perceived quality (Garvin, 1987). Service quality is considered based on SERVQUAL dimensions (reliability, assurance, tangibles, empathy, and responsiveness) (Parasuraman et al., 1988). Quality of life is considered as affective or emotional response or reaction of people in the organizational system (Sink and Tuttle, 1989).

Table 6 – Definitions of Product Quality Dimensions (Source: Garvin, 1987)

No	Dimension	Definition
1	Performance	The primary operating characteristics of a product.
2	Features	The "bells and whistles" of a product (i.e., those characteristics that supplement the basic functions).
3	Reliability	The probability that a product will fail within a specified period of time.
4	Conformance	The degree to which the design or operating characteristics of a product meet pre-established standards.
5	Durability	The amount of use a product can sustain before it physically deteriorates to the point where replacement is preferable to repair.
6	Serviceability	The speed, courtesy, competence, and ease of repair.
7	Aesthetics	The look, feel, taste, smell, and sound of a product.
8	Perceived Quality	The impact of brand name, company image, and advertising.

Table 7 – Definitions of SERVQUAL Dimensions (Source: Parasuraman, 1988)

No	Dimension	Definition
1	Reliability	The ability to perform the promised service dependably and accurately.
2	Assurance	The knowledge and courtesy of employees and their ability to convey trust and confidence.
3	Tangibles	The appearance of physical facilities, equipment, personnel and communication materials.
4	Empathy	The provision of caring, individualized attention to customers.
5	Responsiveness	The willingness to help customers and to provide prompt service.

Innovativeness is another dimension included in process performance measurement approaches. Sink and Tuttle (1989) defines innovation as creative process of changing. Innovation is a collection of change, improvement, creativity, flexibility, risk, and entrepreneurship achieved for meeting the current requirements better and responding the new requirements, serving for continuous improvement and learning. Innovation is considered based on its four dimensions (product innovation, product development, process innovation, technology acquisition) in the process of benchmarking innovation in the literature. Innovation is included as innovativeness in PMDS as a performance dimension representing the ability of learning and continuous improvement in order to have sustainable improvement in organizational performance.

Time, cost, and flexibility are other common dimensions included in performance measurement approaches. These three concepts are also multi-dimensional so that they are used for different expressions in the literature (Neely et al. 2005).

In PMDS, time is used as a dimension of representing performance of timeliness and cost is used as a dimension of representing performance of profitability in operations. Flexibility is different from cost and time and it is included in the system with its two dimensions of range flexibility and response flexibility. Range flexibility is the ability to cope with a wide range of specifications, and response flexibility is the ability to change quickly, giving response fast to changing needs (Slack, 1983 and 1987 as cited in Neely and Austin, 2000).

The coverage of performance dimensions included in the system is quite large but there are still other dimensions for performance such as cycle time, resource utilization (Harbour, 1997); and safety (Performance-Based Management Special Interest Group, 1993) used in different frameworks. During the maintenance of the PMDS, additional performance dimensions may be included by the managing committee with arising needs. The generic measures may be included in more than one category of different performance dimensions since their coverage may intercept.

3.2.3 Attributes of a Generic Performance Measure

The attributes of a generic performance measure are determined based on literature considering the specifications a performance measure should have to be a good one. The following sources

have been keys in developing these attributes provided in Generic Performance Measure Identification Card in Table 8:

- Designing Performance Measures: A Structured Approach by Neely et al. (1997)
- Performance measurement system design: developing and testing a process-based approach by Neely et al. (2000)
- The Metric Reference Model by Chaudhuri et al. (2010), who are members of BI Working Group of CAM- I (CAM-I is an international consortium of manufacturing and service companies, government organizations, consultancies, and academic and professional bodies who work to solve management problems and critical business issues.)

Table 8 – Generic Performance Measure Identification Card

Generic Performance Measure Identification Card	
Name	
Description (Purpose)	
Process Framework(s)	
Related Objective	
Advantages	
Drawbacks	
Interpretation	
Unit of Measure	
Calculation Method*	
Data Elements and Sources*	
Data Collection Frequency	
Frequency of Update*	
Analysis Method*	
Related Process(es)*	
Derived or Related Measures*	
Benchmark Value	

* May be more than one alternative.

Most of the attributes of a generic measure come from literature and their use are obvious. Some of them may need to be explained and some of them are new to the literature. The related explanations and an example are provided below.

- Title and definition identify the measure; they provide the reasoning and the purpose in usage of this measure.
- Related objective is the reasoning of defining this measure, which is compatible with the objective of corresponding process.
- Advantages and drawbacks are the clues for the users to take into consideration while choosing the measures for customization. The users may decide on the applicability of a measure by looking at these attributes while adapting the system. The Metric Reference Model introduced by Chaudhuri et al. (2010) defines Strengths/Opportunities and Weaknesses /Problems /Risks for the performance metrics. These are included in PMDS as advantages and drawbacks for the generic measures.
- Interpretation is an attribute that is rarely considered in the literature to the best of our knowledge, but it is necessary for deciding on choosing which generic measures to customize. Interpretation gives clue to the user about how to use the results of the measure.

OECD has included definition, interpretations, purpose, advantages, drawbacks and limitations for explaining each of the most widely used productivity measures in the Manual of Measuring Productivity (OECD, 2001).

- Data collection frequency is for defining the data collection points in and during the related process. This may be customizable for some measures whereas unchangeable for some others. Frequency of update is the time of measuring the collected data and updating the value of measure.
- Related processes include the process that the measure belongs to and other processes that the measure may be in relation.
- Derived or related measures include the other measures that are derived from this measure or used in calculation of this measure or measures in relation with this one.
- Benchmark value is a representation of the measure in real applications which is defined based on benchmark studies made by the framework authorities or made within the PMDS with feedbacks from the users. This value may not be available for each generic performance measure at the beginning, but it is provided and improved as the measure is used through customization and feedbacks are provided by the users. The users provide benchmark value in Specific Performance Measure Identification Cards and New Performance Measure Identification Cards as the measures are used and real data is acquired.

Table 9 – An example generic performance measure identification card

Generic Performance Measure Identification Card	
Name	Sales Turnover Rate
Description (Purpose)	An effectiveness measure that shows the progress of actual sales relative to sales plans
Process Framework(s)	VRM
Related Objective	Achieving annual sales targets
Advantages	Easy to collect from actual sales
Drawbacks	Shows past performance based on historical data, may be insufficient for proactive planning alone
Interpretation	A low percentage indicates that the actual sales have been less than the planned sales. The higher the percentage, the better it is.
Unit of Measure	Percentage
Calculation Method*	The percentage of actual cumulative sales (in terms of sales income) in the planned cumulative sales in a period
Data Elements and Sources*	Invoiced sales records
Data Collection Frequency	Weekly
Frequency of Update*	Weekly
Analysis Method*	This figure should be monitored to see if it is low or if there is a decreasing trend, in which case causes of discrepancies between sales plans and realizations need to be found and corrective actions need to be taken
Related Process(es)*	Sales Management Process
Derived or Related Measures*	Sales Income, Planned Sales Income
Benchmark Value	75 %

Related processes and derived/related measures are used to create a relationship map within the whole process performance measure definition system. This map is used while interpreting the results of performance measures by considering the effects of relations in the results. For example, in the project management process, schedule performance index (SPI) and cost performance index (CPI) are the two performance measures derived from earned value measure, and cost schedule index (CSI) is another measure derived from SPI and CPI, as it is explained in the following.

Earned Value: The budgeted (planned) cost of work that has actually been performed in terms of carrying out a scheduled task during a specific time period

SPI: The rate of budgeted cost of work performed to the planned cost of the work that has been allocated to be performed during a specific time period (Earned Value / Planned Value)

CPI: The rate of budgeted cost of work performed to the actual cost spent for performed work during a specific time period.

CSI: Cost Performance Index times Schedule Performance Index (CPI $\times$ SPI).

In this example, the user should consider Earned Value, SPI and CPI while analyzing and interpreting CSI, since these are derived from each other, meaning that they depend on each other.

Generic performance measures for each generic process defined in process frameworks are taken and their attributes are determined based on best practice applications and field professions. The attributes of these measures can be validated by experts using a method similar to the Delphi Method.

The performance measures provided by process frameworks do not include the attributes defined in Generic Performance Measure Identification Card in their definitions. Therefore, each performance measure coming from process frameworks are defined in the form of Generic Performance Measurement Identification Card.

3.2.4 Attributes of a Specific Performance Measure

Attributes of generic performance measures can be revised and enlarged to have specific performance measures in application. With this issue in mind, attributes of specific performance measures are determined as in Table 10.

Table 10 – Specific Performance Measure Identification Card

Specific Performance Measure Identification Card		
Name		
Description (Purpose)		
Related Objective		
Unit of Measure		
Target Value		
Threshold Value*		
Preference Value*		
Calculation Method		
Data Elements and Sources		
Data Collection Frequency		
Frequency of Update		
Analysis Method		
Responsible Parties	Owner	
	Data Providers	
	Data Collector	
	Measured by	
	Analyzed by	
	Reported by	
	Reported to	
Related Process(es)		
Derived or Related Measures		
Benchmark Value		

* Threshold value and preference value may be used interchangeably depending on the measure.

New attributes different from those of a generic performance measure are explained in the following. Target value and threshold value are necessary fields for customizing generic measures. Target value is the level of performance that is needed to be achieved to satisfy the

related objective of the measure. Threshold value is the minimum/maximum tolerable level of performance that may require taking of corrective actions when its value is achieved. Preference value also acts as a threshold value as it shows the level of performance where the above/below levels of performance are preferred to have. Responsible parties should be identified precisely for successful implementation of the performance measure definition system. Some responsible parties may be the same for some measures. These attributes are necessary for implementation of the measures during performance measurement process (Neely et al., 1997).

3.3 ADAPTATION OF GENERIC MEASURES

Establishing a process performance measure definition system using an adaptable system is easier and quicker with the support of information technologies provided that organization's mission, vision and strategies are known.

The proposed system includes common generic processes and corresponding generic process performance measures. A responsible end user can develop specific performance measures for organization's specific processes by customizing these generic measures considering the organizational objectives, strategies and needs. At the end of the customization, a specific process performance measure can be defined using specific performance measure identification card.

Before starting the adaptation process, the end user should have the knowledge of measurement needs and objectives in advance, and then follows the steps below.

1. Choose the most appropriate industry for the organization.
2. The frameworks applicable for the selected industry are listed. Choose the appropriate ones from the list according to the process which is subject to measurement.
3. The generic business processes provided by the frameworks are listed. Choose the generic processes that are most related to the specific process for performance measurement.
4. Choose the performance dimension(s) from the given list.
5. Choose the stakeholder(s) from the given list.
6. Available generic performance measures are listed; choose and select an appropriate one for the specific purpose of measurement.

   If no performance measure is listed or existing measures in the list are not appropriate for the end user's specific purpose, then the end user can define a new performance measure as a suggested one. At this point, he or she can follow the guidance for defining a good performance measure included in Appendix D.

7. Define a specific performance measure by customizing the selected generic measure.
   7.1. Update the name and description of the generic measure if needed.
   7.2. Define the objective of the measure based on the organizational objectives.
   7.3. Determine the target value based on the related objective.
   7.4. Determine the threshold and preference values.
   7.5. The possible calculation method and/or methods are given for the generic measure. Choose the most appropriate one.
   7.6. Possible data elements and sources are given by the system according to the selected calculation methods in the previous step. Define the appropriate data elements and sources based on the ones given for generic measure.
   7.7. Define the frequency of data collection, i.e. determine that in which phase of the process and at what frequency the data will be collected.
   7.8. The update frequency of measurement data is determined based on needs. Suggested frequencies of update are provided by the generic measure, choose the appropriate one or define a different frequency.

7.9. Choose the analysis method.
7.10. Determine the responsible parties. Determine the owner of the specific measure. The owner is responsible for determination, execution and maintenance of the measure. Data providers, collectors, measurement responsible and analyzer are the responsible of these activities.
7.11. Related processes are provided by generic measure, update this field if necessary.
7.12. Derived or related measure, if there is any, is provided by generic measure, update this field if necessary.

3.4 MAINTENANCE OF THE PERFORMANCE MEASURE DEFINITION SYSTEM

Maintenance of a performance measure definition system is crucial for successful continuity of the system. For ensuring continuous process improvement, the measurement system should always be up to date satisfying the current needs of the organization. Artley and Stroh (2001) states well the fact of maintenance need of a measurement system in *The Performance Based Management Handbook Volume 2*.

"If It Ain't Broke, Don't Fix It!"
If your performance measurement system is meeting your organizational needs, is effective, and is driving improvement, don't think that you have to change it. You don't. However, you still need to go through the maintenance checks outlined in this section. The object is to maintain your successful measurement system and possibly improve it. Giving your system a "check-up" will ensure that you meet this objective.

"If It's Broke, Don't Ignore It!"
If your performance measurement system isn't meeting your organizational needs, isn't effective, and isn't driving improvement, then you have to change it! Don't ignore that fact. Don't assume that miraculously it will get better. It won't. A system that isn't driving improvement is driving in the opposite direction and toward ultimate failure! Another way of putting this "truth" is, "If it's broke, fix it! And do it fast!"

In order to keep a measurement system always up to date, it should be flexible, easy and quick to make changes. The maintenance process of the process performance measure definition system is designed based on the usage of information technologies which support the system for being flexible and easy to update. Update of the system is possible through the following alternative ways:

- Defining new performance measures for new measurement needs.
- Updating current performance measures existing in the measurement pool.
- Eliminating the unused or useless measures from the system.

These solutions can be applied any time in the system with the help of information technologies but determining the need of update for measurement system is the key point for keeping the system up to date. These needs may come from updates in the frameworks or individual measurement needs of the users when the generic measure lists are inadequate for them. An authority should be responsible from these updates. This authority is the managing committee of the system which is introduced in Section 3.2.3. The referenced business process frameworks are periodically checked and when there is an update the proposed system should be revised. On the other hand, if a new measure is identified by any user and given as a suggested measure for the improvement of the system, this measure is tagged as a pending generic measure and included in the list as a temporary generic measure. During this pending period, the temporary generic measure is evaluated by the managing committee according to the

following acceptance criteria in order to determine if it is appropriate for being a generic performance measure.

Acceptance criteria for a generic process performance measure:

1. Performance of at least one of the generic processes included in the system can be measured based on any of the performance dimensions defined in the system with the newly identified measure.

2. It is possible to fill out Generic Performance Measure Identification Card for the new measure, in other words the new measure can be defined based on the mandatory attributes of generic process performance measures.

If the temporary generic measure is evaluated as appropriate, it is included in the list of generic performance measures as a permanent one. Generic Performance Measure Identification Card is filled for this new measure by the managing committee. The appropriate performance dimension, related stakeholders and related business processes for this new measure are determined by the committee, and it is categorized accordingly. Otherwise, the measure is categorized as "user identified specific measure".

All the revisions and updates are announced to the current users. Moreover, feedback for process frameworks are also shared with related organizations, and support the frameworks to be improved.

In addition to these update processes, periodic checks of the system are also required for keeping the system up to date as it is sated by Artley and Stroh (2001). The way of these checks is crucial so that the determination of the needs is made objectively as much as possible. The objectivity is achieved by a systematic review of the system which is based on the data accumulated from the system. A periodic status report of the measure definition system may help achieving this purpose. The content of the report is designed for determining whether a measure still serves for the current needs or not, meaning that if it is chosen by the users for customization or not. A report for all generic performance measures, which shows how many times a measure is chosen and customized by users, is produced quarterly by the system for review of the managing committee. The status of generic performance measures are reviewed by the managing committee at the end of each quarter, four times a year. If a measure is not resulted in any customization process several years after the system has been put in use, then it should be checked whether its attributes are set correctly, and necessary updates are done. Any measure that is not selected for customization by the users even after it is updated, and then the committee evaluates to remove the generic measure from the system. The generic performance measures are rated according to the results of these reports, the most customized ones are ranked high meaning that they are most preferred, and the generic measures are listed according to these rankings in search results.

With these updates and revisions, the performance measure definition system can always be kept up to date and it can support better continuous improvement of the user processes.

3.5 GENERIC MEASURE CATEGORIZATION AND SEARCHING MECHANISM

As the performance measure definition system is used, there may be additions to the list of generic measures. A catalog of generic measures will be in use supporting the performance management system. The categorization of generic measures is possible with the following attributes and determinants.

a. Performance Dimension
b. Stakeholder
c. Related Process
d. Related Objective
e. Description (Purpose)

The system can also serve as a search mechanism, which is based on key words, attributes, and determinants, for the users so that they can find the right generic measures easily. Generic measures can be listed according to their rankings in search results, and search lists can be narrowed down by entering additional attributes and determinants. Pairwise comparison matrices are used for searching the generic measures and narrowing the search lists, some of them are provided in the following.

Table 11 – Performance Dimension – Stakeholder Pairwise Comparison Matrix

		Stakeholder					
		Customer	Employee	Investor/ Owner	Community	Suppliers	Others
Performance Dimension	Productivity						
	Quality						
	Effectiveness						
	Efficiency						
	Time						
	Cost						
	Innovation						
	Flexibility						

Table 12 – Performance Dimension – Business Process Pairwise Comparison Matrix

		Business Process				
		Generic Process 1	Generic Process 2	Generic Process 3	Generic Process 4	Generic Process 5
Performance dimension	Productivity					
	Quality					
	Effectiveness					
	Efficiency					
	Time					
	Cost					
	Innovation					
	Flexibility					

Table 13 – Stakeholder – Business Process Pairwise Comparison Matrix

		Business Process				
		Generic Process 1	Generic Process 2	Generic Process 3	Generic Process 4	Generic Process 5
Stakeholder	Customer					
	Employee					
	Investor/Owner					
	Regulators					
	Suppliers					
	Community					
	Competitors					

Performance measures identified by users and not accepted as generic measures stay in the category of “user identified specific measure” and these are also available for searching based on key words.

3.6 DEMONSTRATION SOFTWARE

A prototype software tool for demonstration of PMDS is developed for showing the contributions of IT usage. Java programming language is used for coding in Eclipse Juno platform, and a database is created in SQLite in the scope of this thesis. The database tables are included in Appendix E. An executable application of the demo software is included in the attachment as an electronic copy.

The generic measures are included in the database of the software tool based on the industry, process framework, process, performance dimension, and stakeholder categorization.

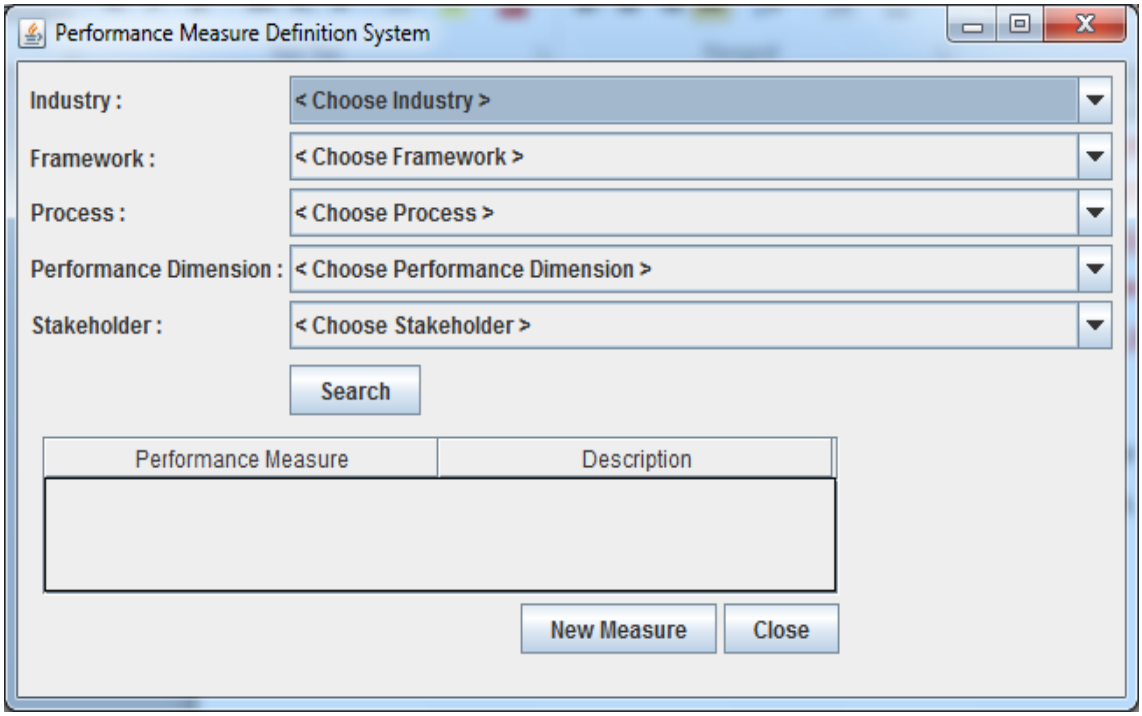

Figure 22 – Main Window of PMDS

The user can develop specific performance measures by customizing generic performance measures using specific performance measure identification cards, or by identifying new performance measures using the guidance provided with new performance measure identification card. The user chooses an industry from the scroll down list provided which his/her organization belongs to (Figure 23).

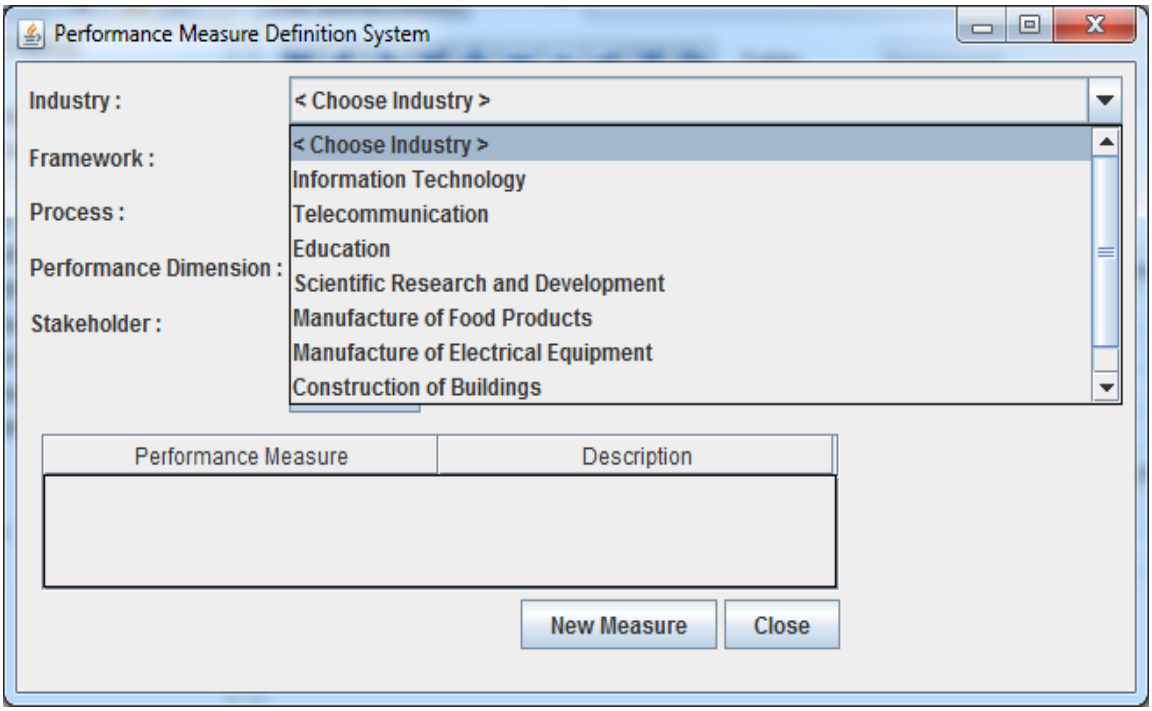

Figure 23 – “Industry” Selection in PMDS

Then the user chooses a framework from the scroll down list according the process area that he/she intends to measure, and the processes provided by the selected framework are listed in a scroll down list at the process button (Figure 24). In order to guide the user for choosing the frameworks, a brief introduction for each framework is provided in the help of the PMDS. The user may decide on which process framework to choose based on this introductory information, furthermore she/he can also reach more information about the frameworks from the related web sources provided in the PMDS.

The process frameworks included are used as reference for generic performance measures in demo software for the purposes of demonstration within the scope of this thesis. Any of these frameworks will not be used in PMDS without taking necessary permissions for licensing from related authorities.

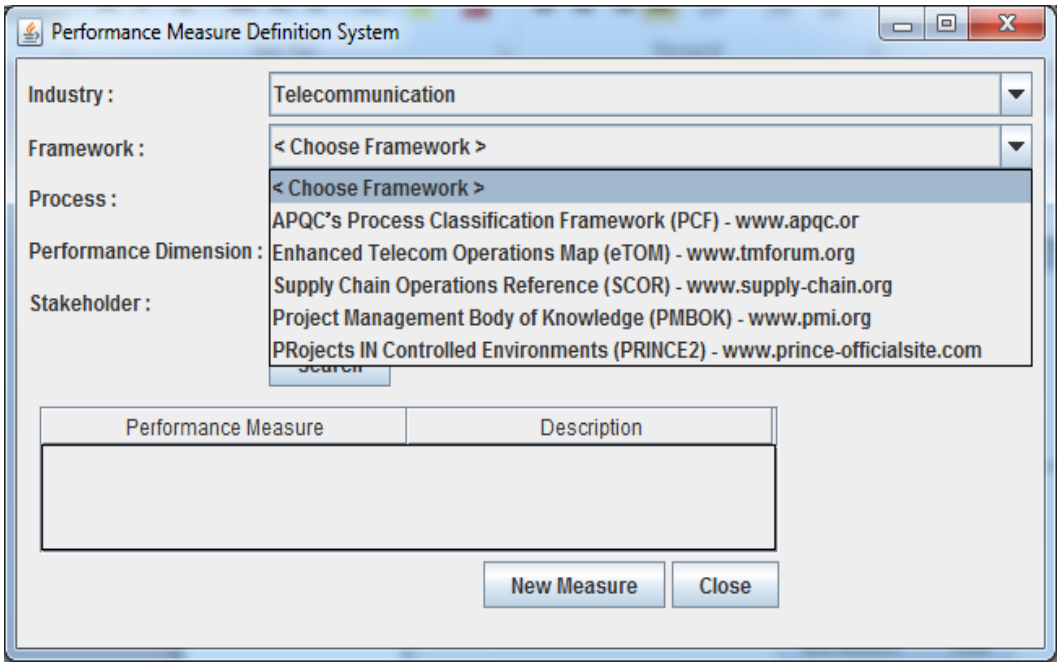

Figure 24 – "Framework" Selection in PMDS

Then the user selects a process which represents his/her specific process for measurement from the provided list (Figure 25).

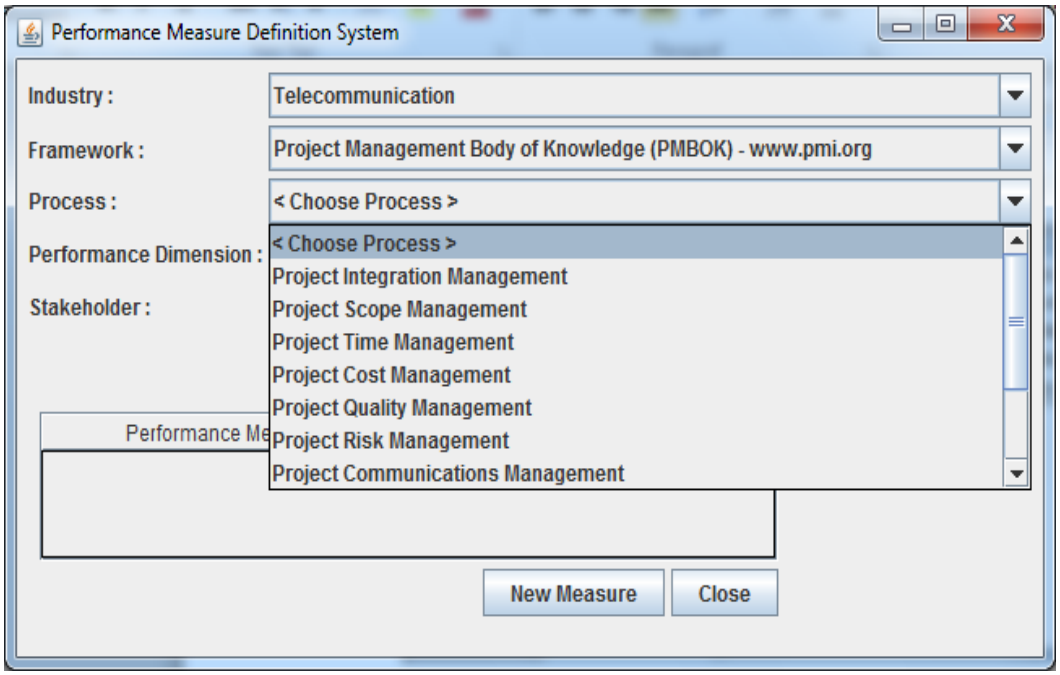

Figure 25 – "Process" Selection in PMDS

The user may select performance dimension and stakeholder in order to filter the generic performance measures provided by the framework for the selected process (Figures 26 and 27).

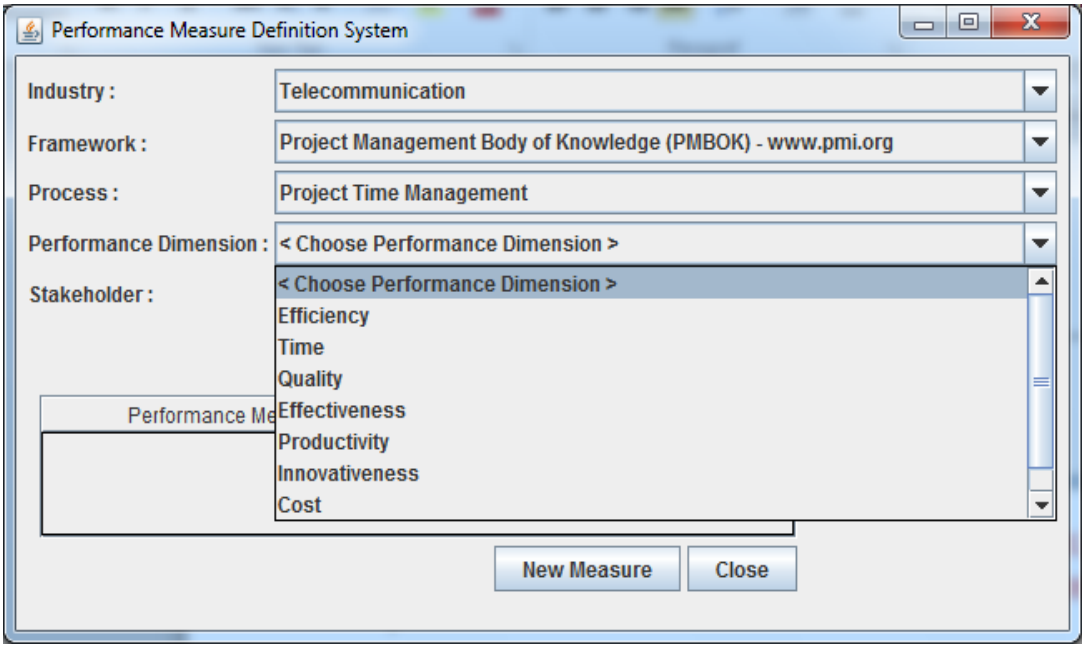

Figure 26 – “Performance Dimension” Selection in PMDS

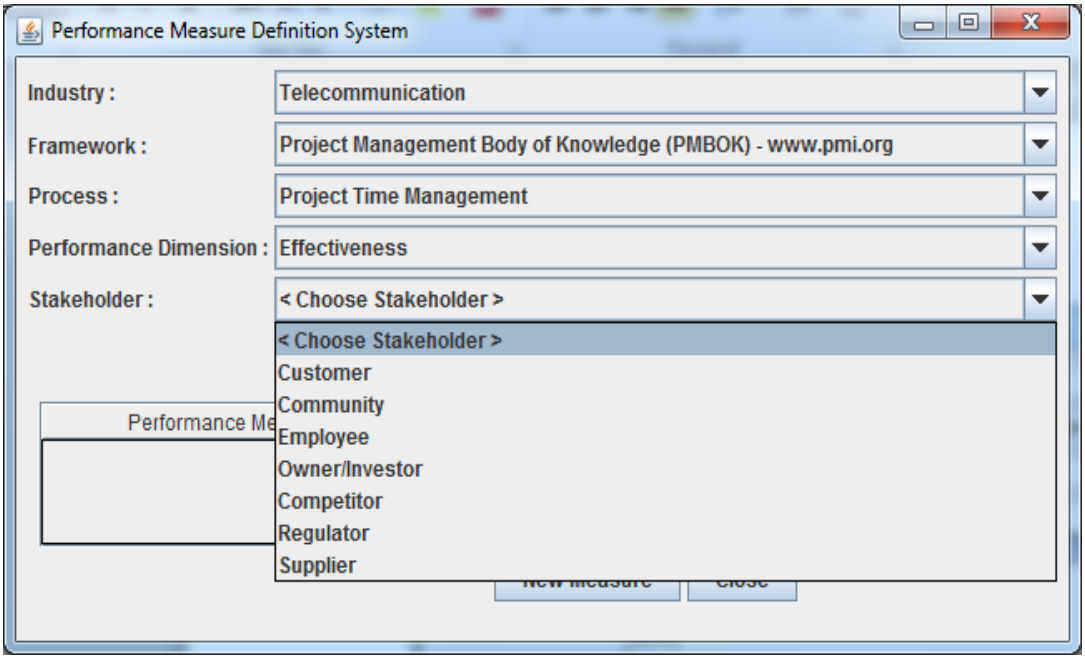

Figure 27 – “Stakeholder” Selection in PMDS

The generic performance measures are listed based on the selections of the user (Figure 28).

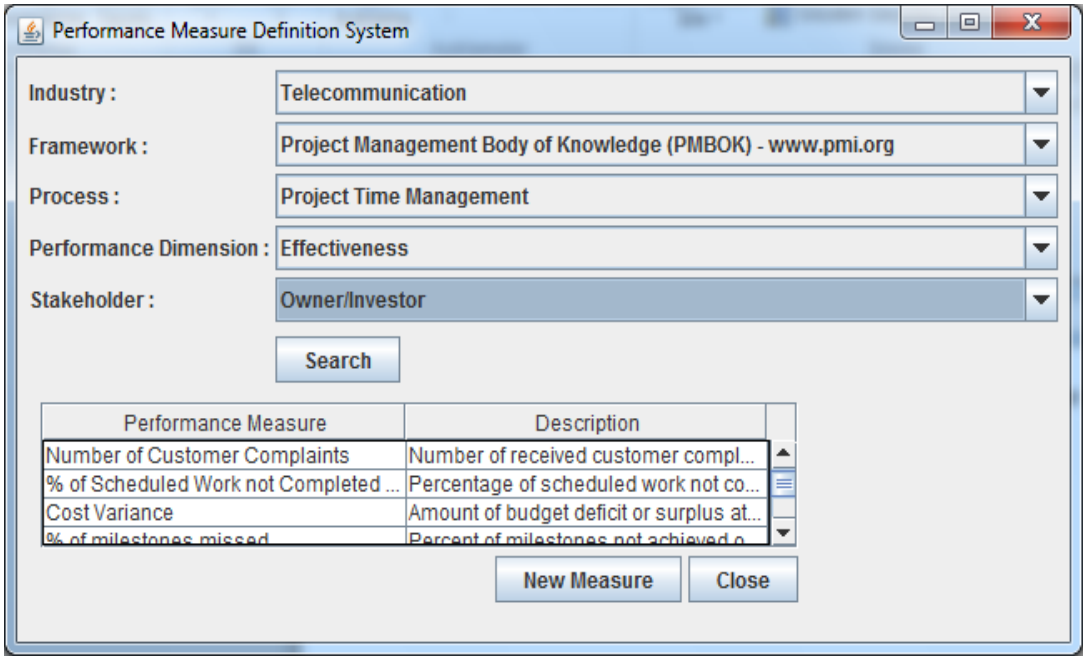

Figure 28 – Generic Performance Measure List in PMDS

The user clicks on any of the generic measures included in the list in order to see the details of the measure. After clicking on a performance measure, generic performance measure identification card of the measure is opened in a pop-up screen (Figure 29).

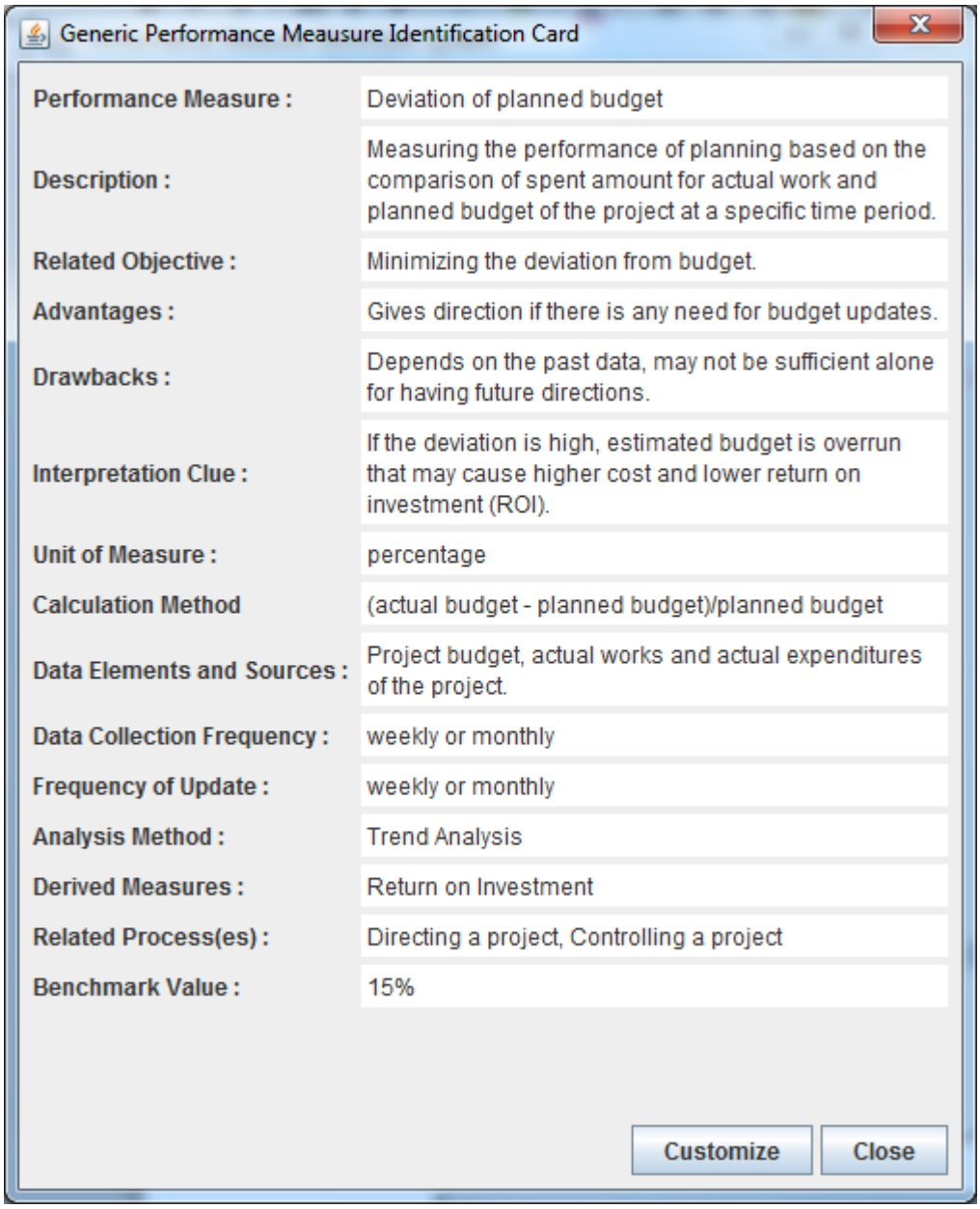

Figure 29 – Generic Performance Measure Card in PMDS

If the user wants to adapt this measure, he/she can define a specific version of it. She/he clicks on “customize” button. A specific performance measure identification card, including some information coming from the generic performance measure card, is opened in a pop-up screen (Figure 30).

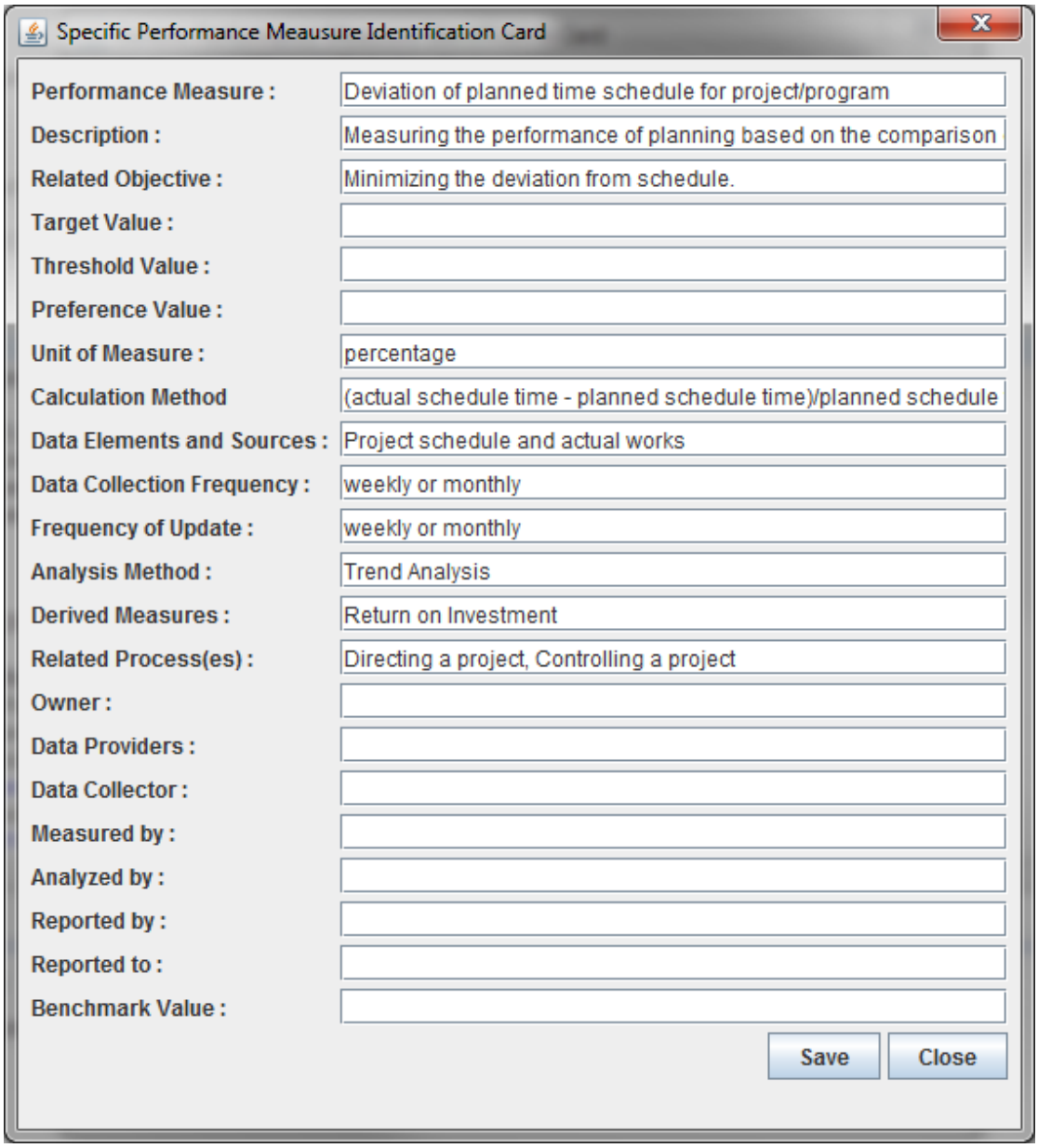

Figure 30 – Specific Performance Measure Card in PMDS

The user fills out the required fields and defines the specific performance measure for his/her process. This application steps are the recommended use of the system, however the user may also get the list of generic process performance measures by only selecting a performance dimension or a stakeholder.

If the generic performance measures provided by the tool are not satisfactory, the user can identify a new performance measure by using the new performance measure identification card through the provided guidance (Figure 31 and Figure 32).

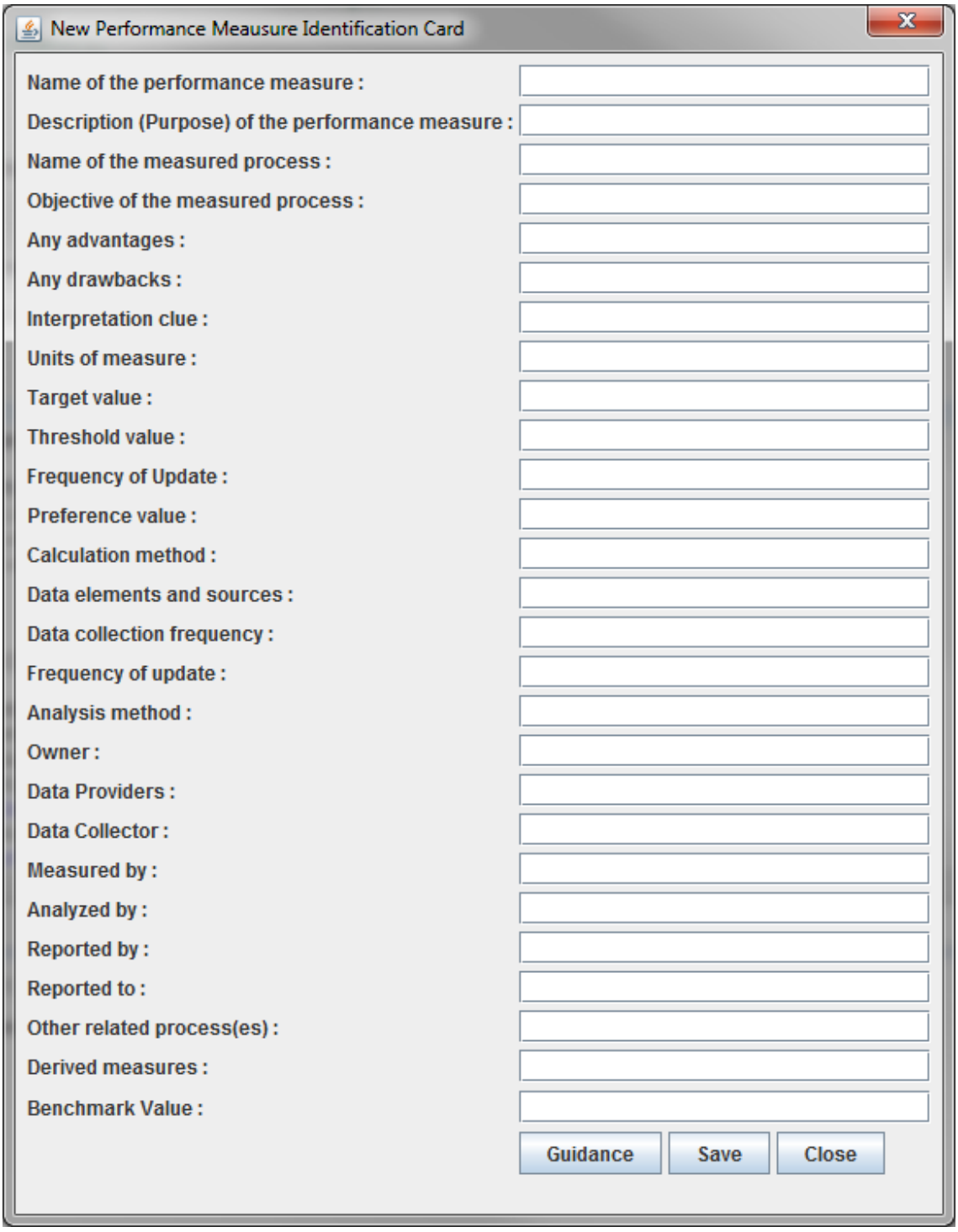

Figure 31 – New Performance Measure Identification Card

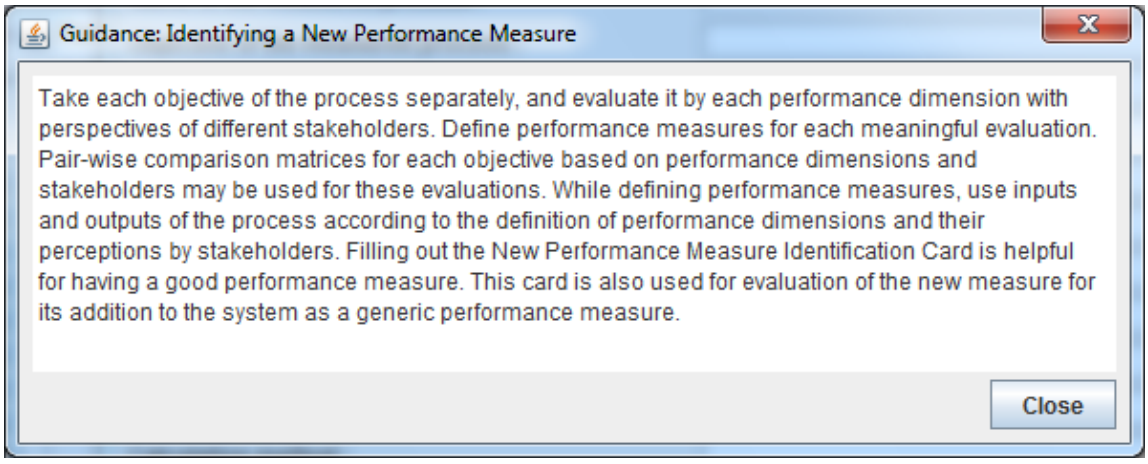

Figure 32 – Guidance for Identifying a New Performance Measure in PMDS

The minimum system requirements to run this demo software tool are;

1. Java SE Development Kit (JDK) should be installed.
2. For 32 bit windows, the JDK requires a minimum a Pentium 2 266 MHz processor.
3. For 64 bit windows, the JDK requires a minimum a Pentium 2 266 MHz processor.
4. Disk Space Requirements: The JDK features available for 64-bit platforms are the same as those for Windows 32-bit operating systems. The disk requirement for development tools for 64-bit platforms is 181 MB.

When the system requirements are met, the demonstration software can be run from the CD, which includes the demo of PMDS and is provided in the back of the cover of the document, by clicking on “PMDS.bat” file. No installation is required for running the demo of PMDS. It is possible to copy the content of the CD to the local disks in order to run the PMDS from local computers instead of CD.

Since the tool is only for demonstration, it does not include all applications needed for PMDS. The database of the software tool should be improved for serving all the needs of searching alternate generic measures. A data collection mechanism should be developed for collecting benchmark value from users for including in generic performance measure identification cards. In addition, the interface of the tool can be improved to be more user-friendly. Moreover, a database application should be developed for the users to define and keep their specific performance measures derived by customization of generic measures or identification from scratch. Integration may be possible to export specific performance measure cards saved by the user to business process management (BPM) software tools for further applications such as automatic data collection and data analysis. Finally, for the maintenance of the system, a reporting mechanism should be developed for the software tool for usage in periodic system reviews.

CHAPTER 4

APPLICATION

4.1 SELECTED PROCESSES FOR APPLICATION

The fundamental objective of developing an effective performance measure definition system is to provide detailed guidance for organizations to develop their own performance measures by finding and customizing appropriate generic measures defined for generic processes according to the organization's specific needs in an easy, quick and flexible way. In order to show this capability of the system, sample processes from a public university, Middle East Technical University (ODTÜ), are chosen and performance measures for these processes are defined by using the proposed process performance measure definition system.

Research Project Management Process and Creating Research Opportunities Process of the public university are selected for the application. These two processes are lower level processes according to the business process management structure of university. The generic process covering Research Project Management Process is the Research Project Execution Process, and the generic process covering Creating Research Opportunities Process is Research Project Development Process. The list of all generic processes of ODTÜ is provided in Section 2.1.1. The details of the two selected processes are provided in the following.

1. Research Project Management Process:

Process Purpose: Managing research projects sponsored internally or externally according to widely accepted project management principles and practices, and collecting necessary information for corporate management.

Process Objectives:

1. Initiating the sponsored research project according to the contract between the sponsored and sponsoring parties.
2. Updating the original project plan included in the proposal considering current circumstances and establishing the current plan of the research project, executing and monitoring the project according to the current plan.
3. In case of deviation from the current plan, making necessary improvements and updating the plan based on the improvements.
4. Closing the research project on the date that is agreed on for completion by the related parties.
5. Collecting lessons learned from completed and on-going research projects.

Process Stakeholders: Research Executive, Research Project Team, Scientific Research Projects Coordinator, Arbitrators, Research Responsible (vice-president), Department Manager, Research Sponsorship Authority.

Sub-process: Risk Management Process

2. Creating Research Opportunities Process:

Process Purpose: Announcing the information of the university's support programs and other national/international research support programs compatible with the university's research objectives to the researchers and keeping the information up-to-date.

Process Objectives:

1. Composing a portfolio of national/international scientific and technological research studies support programs.
2. Creating and managing internal research opportunities.
3. Announcing the research opportunities to the related departments.

Process Stakeholders: Portfolio Owner, Portfolio Manager, Research Coordinator, Research Politics Commission, academic staff, research projects owners, departments of the university.

The reason for selecting the first process for application as the Research Project Management Process is its complexity implied by its several stages and a sub process, many different inputs, outputs, and stakeholders. If the proposed process performance measure definition system can be applied to this process, it can be applied to simpler ones. The reason for selecting the second process is to show the case of inadequacy of generic process measures provided by the system. In this application, new performance measures are defined as suggested measures for the system.

4.2 APPLICATION DETAILS AND RESULTS

As the first step of the application the appropriate industry is chosen for the university considering the selected processes (Figure 33). Universities are education and research organizations; hence they belong to industry categories related to both education and research. In this application, since the selected processes are related to research, the industry category of "Scientific Research and Development" in the list of ISIC is found more appropriate for the university.

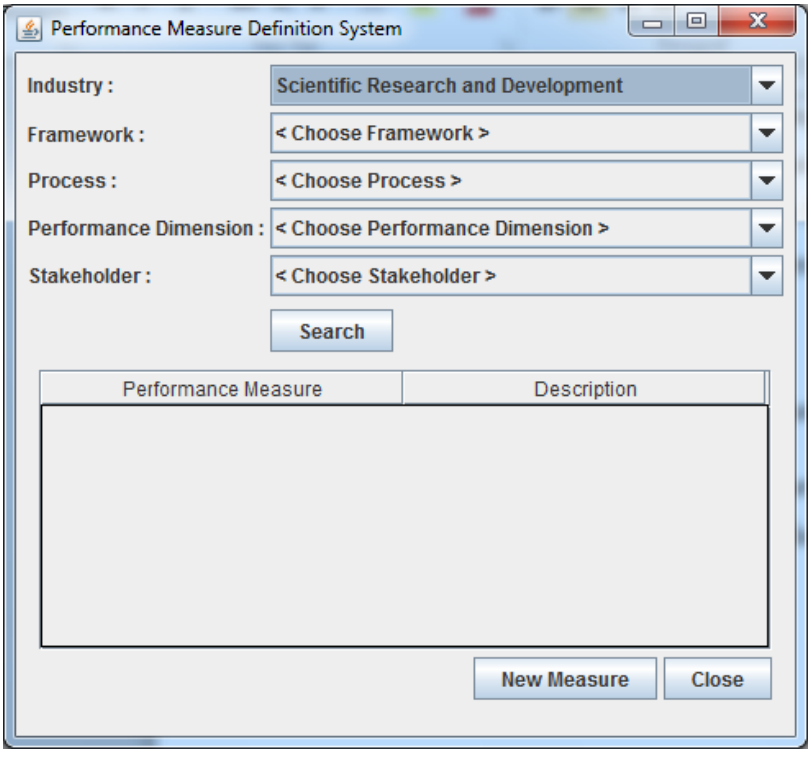

Figure 33 – Demonstration Application: Selecting the industry

Then the business process frameworks listed based on the Scientific Research and Development industry category are selected for determining the list of appropriate generic measures (Figure 34).

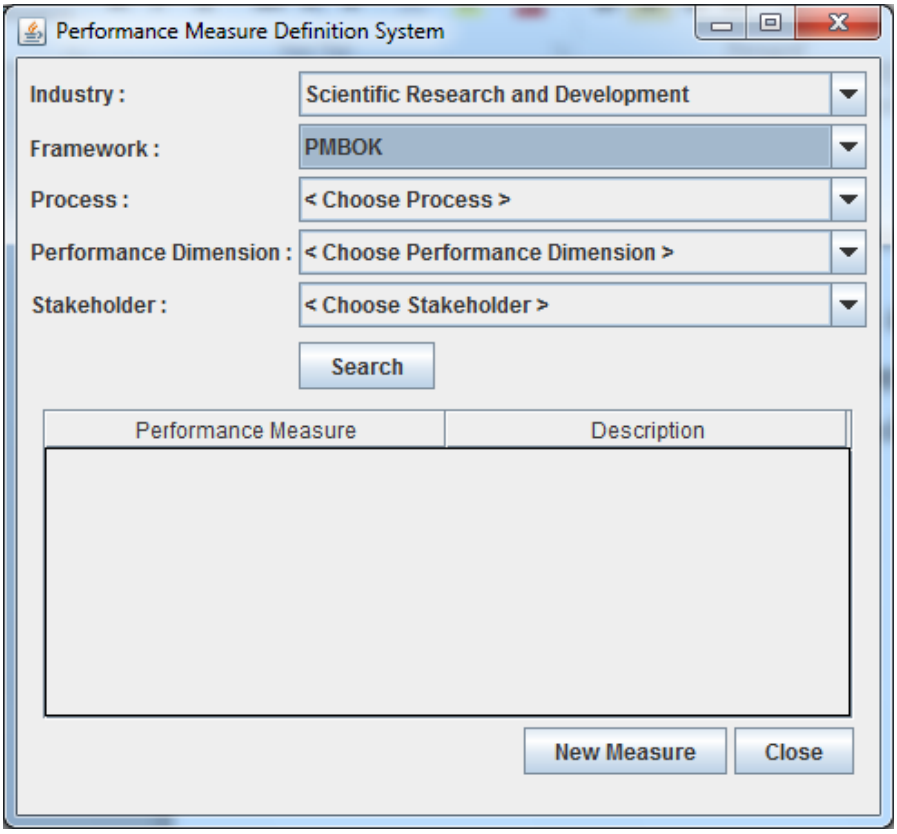

Figure 34 – Demonstration Application: Selecting the process framework

Each process framework has its own generic process list and generic performance measure list separately. The applicable frameworks are chosen one-by-one and their generic process lists are checked whether there is an appropriate process for the university's processes (Figure 35). The selection of frameworks is done considering their inclusion of project management related processes. For instance PMBOK and PRINCE2 frameworks have primary focus on project management concept, therefore they are selected. In addition, PCF and VRM frameworks have also been selected since they include project management related processes.

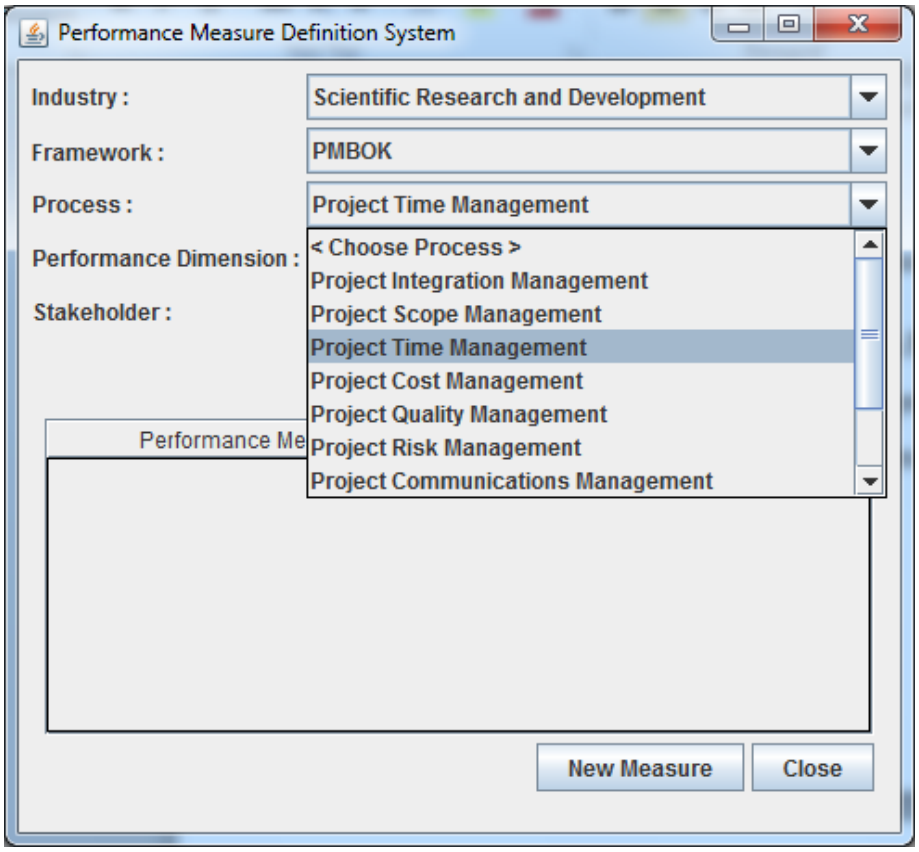

Figure 35 - Demonstration Application: Selecting the process

Related processes for Research Project Management Process exist in these frameworks but there is no directly related process for Creating Research Opportunities Process. The generic performance measures introduced by project management related generic processes are listed in Appendix B. From these generic measure lists, appropriate measures for Research Project Management Process are chosen based on performance dimensions and stakeholders for the university, and selected measures are customized according to the process objectives.

Since the stakeholders defined in the system do not exactly match with the university's stakeholders, a modification need has arisen for stakeholder categorization. The university's stakeholders are matched with the defined ones in the system as in the following based on the selected process area.

- Customer: Research Executive, academic staff, research project owners, departments of the university
- Owner/Investor: Research Responsible (vice-president), Research Sponsorship Authority, Portfolio Owner, Portfolio Manager
- Employee: Research Project Team
- Regulators: Scientific Research Projects Coordinator, Arbitrators, Research Responsible (vice-president), Department Manager, Research Sponsorship Authority, Research Coordinator, Research Politics Commission
- Suppliers: Research Sponsorship Authority

- Competitors: N/A
- Community: N/A

The categorization of stakeholders depends on the roles of the stakeholders in different processes. Therefore a stakeholder of a process can be included in more than one stakeholder category at the same time.

The list of customized specific measures is provided in Appendix C. The results are discussed with the related authority in ODTÜ and her comments are received. In addition, the specific measures which are developed by adaptation are evaluated based on the approval criteria. Finally, the measures developed by adaptation are compared to the actual measures defined for the corresponding process by ODTÜ participants. It is seen that using the PMDS made some improvement in the performance measure set of the selected process by introducing new measures compatible with the process objectives.

On the other side, since there is no matching generic process for Creating Research Opportunities Process within the effective process performance system, a new performance measure, “portfolio coverage ratio” is identified for this process based on the guidance available in Appendix D. The objective of the process is considered based on the performance dimensions and stakeholder perspectives as it is told in the guidance during defining of the new measure. The new measure is identified based on the new performance measure identification card. This new measure is also compared with the actual measures included in the process and comments of related authority in ODTÜ are taken. It is also seen for this process that the newly identified measure made some positive contribution to the current performance measure list of the selected process.

In conclusion, all these evaluation results are summarized to conclude the applicability of the proposed system.

CHAPTER 5

CONCLUSION

Process performance measurement is a fundamental component of business process management and a rigid requirement for process improvement. Organizations need to measure the performance of their processes in order to track the operational progress whether it is compatible with their mission, vision, objectives and strategies. There are many research studies for organizational performance measurement and process improvement in the literature. The traditional frameworks and methods introduced in the literature for process performance measurement have indeed solved some of the limitations of the traditional way of measuring performance, but reviews show that they still have several limitations and weaknesses (Tangen, 2004). They provide guidance on how a company should measure the performance and design its unique PMS, but they rarely help with the practical realization of specific measures at an operational level, in other words little guidance is provided for the actual selection and implementation of selected measures (Medori and Steeple, 2000). A process performance measure definition system is proposed in this thesis in order to provide a comprehensive guidance for identification and implementation of process performance measures. The PMDS is developed based on IT capabilities which bring flexibility and easy use to the system.

The PMDS is an IT based structure providing generic performance measures (based on process improvement methodologies) for generic processes (included in trusted process performance frameworks), and adaptation of these generic performance measures for organization specific business processes. The primary objective of the PMDS is to support development of appropriate performance measures and provide detailed guidance on operational use of them for an effective measurement of process performance.

In the core of the system, generic process performance measures provided by widely accepted process frameworks are settled within a simple approach built based on process improvement methodologies. The generic performance measures are categorized based on performance dimensions of effectiveness, efficiency, productivity, quality, innovativeness, time, cost, and flexibility. This categorization provides guidance for having a balanced list of performance measures and deciding on how and what to measure while developing a performance measurement system. This categorization is very helpful for the organizations but categorizing the generic performance measures provided by the process frameworks based on these categories, and filling out generic performance measure identification cards for each generic performance measure is a difficult task which should be managed and coordinated carefully.
In addition to this categorization, the concept of stakeholder perspectives is also included in the system. Organizations' existence is based on creating value for stakeholders. Organizations can track and monitor their progress for achieving stakeholder satisfaction through proper performance measurement systems. As a result, stakeholder perspectives are very important and steering for performance measurement systems. Stakeholders included in the PMDS are customer, investor/owner, employee, supplier, regulator, competitor, and community.

The generic performance measures are evaluated based on the performance dimensions and stakeholder perceptions for proper selection meeting the requirements of measuring process performance based on process objectives and also organizational strategies. The framework introduced in this thesis, provide detailed guidance for how to evaluate the generic measures, select the appropriate ones, and define proper specific performance measures.

The framework is applied for categorizing the generic measures and adapting them for Research Project Management Process and Creating Research Opportunities Process of ODTÜ. Specific performance measures are defined for these processes. The framework has provided an easy and quick application for defining performance measures properly, and the defined measures are complete in terms of attributes and proper implementation.

The PMDS is an infrastructure providing a well-structured library of performance measures with the mechanisms of searching for appropriate measures through industry, process framework, process, performance dimension, and stakeholder; and customizing the generic measures for specific purpose. The system is currently in the concept exploration stage, but it is open to development due to the nature of its structure. Such a system with a similar framework is not included in the literature to the best of our knowledge. A preliminary example of the PMDS is found on the web, which is available on www.kpilibrary.com. This is a key performance indicators library providing performance indicators classified by industry, by process framework, and by process. It is possible to search for performance indicators based on these categories and some key words. However, there is no guidance or framework for selecting appropriate performance measures, identifying new measures, or implementing selected/identified measures.

The PMSD can be a supportive tool for the users during process performance measurement system development and maintenance. Moreover, this system can also be used as a reference or guidance for preparing strategy plans and improvement plans. The applicability area of the system is very large since many industries and several widely accepted process frameworks are included. Using the PMDS may be also a solution for organization facing with resistance to measurement since it includes trusted frameworks which provides experienced processes and widely accepted best practices.

The system can also be a good feedback provider for process frameworks. The limitations, changes in needs can be useful feedbacks for improvement of process frameworks. However, since some of the information included in frameworks may be subject to fee, licensing agreement may be required for usage of them. This may be an issue that should be managed.
The PMDS can be improved by adding new capabilities further from performance measure definition in future studies. The system can be used as a complete performance measurement system with addition of data collection, data analysis, and reporting functionalities for the selected performance measures. Moreover, the system can be used for problem diagnoses in the processes through some process mining applications based on the results of analysis with additional functionalities.

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APPENDIX A

INTERNATIONAL STANDARD INDUSTRY CATEGORIZATION (ISIC)

A - Agriculture, forestry and fishing
- 01 - Crop and animal production, hunting and related service activities
- 02 - Forestry and logging
- 03 - Fishing and aquaculture

B - Mining and quarrying
- 05 - Mining of coal and lignite
- 06 - Extraction of crude petroleum and natural gas
- 07 - Mining of metal ores
- 08 - Other mining and quarrying
- 09 - Mining support service activities

C - Manufacturing
- 10 - Manufacture of food products
- 11 - Manufacture of beverages
- 12 - Manufacture of tobacco products
- 13 - Manufacture of textiles
- 14 - Manufacture of wearing apparel
- 15 - Manufacture of leather and related products
- 16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- 17 - Manufacture of paper and paper products
- 18 - Printing and reproduction of recorded media
- 19 - Manufacture of coke and refined petroleum products
- 20 - Manufacture of chemicals and chemical products
- 21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
- 22 - Manufacture of rubber and plastics products
- 23 - Manufacture of other non-metallic mineral products
- 24 - Manufacture of basic metals
- 25 - Manufacture of fabricated metal products, except machinery and equipment
- 26 - Manufacture of computer, electronic and optical products
- 27 - Manufacture of electrical equipment
- 28 - Manufacture of machinery and equipment n.e.c.
- 29 - Manufacture of motor vehicles, trailers and semi-trailers
- 30 - Manufacture of other transport equipment
- 31 - Manufacture of furniture
- 32 - Other manufacturing
- 33 - Repair and installation of machinery and equipment

D - Electricity, gas, steam and air conditioning supply
- 35 - Electricity, gas, steam and air conditioning supply

E - Water supply; sewerage, waste management and remediation activities
- 36 - Water collection, treatment and supply
- 37 - Sewerage
- 38 - Waste collection, treatment and disposal activities; materials recovery
- 39 - Remediation activities and other waste management services

F - Construction
- 41 - Construction of buildings
- 42 - Civil engineering
- 43 - Specialized construction activities

G - Wholesale and retail trade; repair of motor vehicles and motorcycles
    45 - Wholesale and retail trade and repair of motor vehicles and motorcycles
    46 - Wholesale trade, except of motor vehicles and motorcycles
    47 - Retail trade, except of motor vehicles and motorcycles
H - Transportation and storage
    49 - Land transport and transport via pipelines
    50 - Water transport
    51 - Air transport
    52 - Warehousing and support activities for transportation
    53 - Postal and courier activities
I - Accommodation and food service activities
    55 - Accommodation
    56 - Food and beverage service activities
J - Information and communication
    58 - Publishing activities
    59 - Motion picture, video and television programme production, sound recording and music publishing activities
    60 - Programming and broadcasting activities
    61 - Telecommunications
    62 - Computer programming, consultancy and related activities
    63 - Information service activities
K - Financial and insurance activities
    64 - Financial service activities, except insurance and pension funding
    65 - Insurance, reinsurance and pension funding, except compulsory social security
    66 - Activities auxiliary to financial service and insurance activities
L - Real estate activities
    68 - Real estate activities
M - Professional, scientific and technical activities
    69 - Legal and accounting activities
    70 - Activities of head offices; management consultancy activities
    71 - Architectural and engineering activities; technical testing and analysis
    72 - Scientific research and development
    73 - Advertising and market research
    74 - Other professional, scientific and technical activities
    75 - Veterinary activities
N - Administrative and support service activities
    77 - Rental and leasing activities
    78 - Employment activities
    79 - Travel agency, tour operator, reservation service and related activities
    80 - Security and investigation activities
    81 - Services to buildings and landscape activities
    82 - Office administrative, office support and other business support activities
O - Public administration and defence; compulsory social security
    84 - Public administration and defence; compulsory social security
P - Education
    85 - Education
Q - Human health and social work activities
    86 - Human health activities
    87 - Residential care activities
    88 - Social work activities without accommodation
R - Arts, entertainment and recreation
    90 - Creative, arts and entertainment activities
    91 - Libraries, archives, museums and other cultural activities
    92 - Gambling and betting activities

93 - Sports activities and amusement and recreation activities

S - Other service activities

94 - Activities of membership organizations

95 - Repair of computers and personal and household goods

96 - Other personal service activities

T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

97 - Activities of households as employers of domestic personnel

98 - Undifferentiated goods- and services-producing activities of private households for own use

U - Activities of extraterritorial organizations and bodies

99 - Activities of extraterritorial organizations and bodies

APPENDIX B

GENERIC PERFORMANCE MEASURES FOR ODTÜ APPLICATION

The generic performance measures listed for Research Project Management Process:

Generic Performance Measures by APQC Process Framework:

1. Actual cost of projects as percentage of budgeted cost
2. Percentage of projects completed in budget
3. Amount organization spends on project management as a percentage of total project costs
4. Percentage of projects completed on time
5. Average time ahead of schedule
6. Average time behind schedule
7. Actual hours required to complete projects as a percentage of hours budgeted
8. Average hours worked per week on project activities per FTE

Generic Performance Measures by PMBOK Process Framework:

1. Deviation of Planned Budget
2. Budgeted Cost of Work Scheduled
3. Actual Cost of Work Performed
4. Schedule Variance
5. Estimate at Completion
6. BCWP (or Earned Value)
7. Cost Performance Index
8. Schedule Performance Index
9. Cost Schedule Index
10. Cost Variance
11. % of lessons learnt sessions per registered projects before project close outs completed
12. Deviation of NPV
13. % of assigned FTE actually working on project
14. % of milestones missed
15. % of overdue project tasks
16. % of FTE actually working on project that were not initially assigned
17. Project issue queue rate
18. % of time coordinating project
19. # of milestones missed
20. number of new project/program issues

Generic Performance Measures by PRINCE2 Process Framework:

1. % of milestones missed
2. Deviation of planned time schedule for project/program
3. Deviation of planned budget
4. Deviation of planned hours of work
5. % of overdue project tasks
6. % of FTE actually working on project that were not initially assigned
7. Deviation of planned ROI
8. Average number of milestones per project plan
9. % of assigned FTE actually working on project

10. % of time coordinating project
11. Deviation of planned break-even time
12. Deviation of net present value (NPV)
13. Cost of managing processes
14. Budgeted Cost of Work Scheduled (BCWS)
15. Actual Cost of Work Performed (ACWP)
16. Number of milestones missed
17. # planned hours per task
18. Estimate at Completion (EAC)
19. Number of unstaffed hours
20. Cost Schedule Index (CSI)
21. Budgeted Cost of Work Performed (BCWP) or Earned Value
22. Schedule Variance (SV)
23. Cost Variance (CV)
24. Cost Performance Index (CPI)
25. Schedule Performance Index (SPI)
26. Number of new project/program issues

Generic Performance Measures by Value Chain Process Framework:

1. Time-to-market of new products/services
2. Milestone Achievement Ratio
3. Break-even time
4. Cost per PTI Update
5. Engineering Change Notice Cycle Time
6. Design Effort
7. Project Completion vs Plan
8. Design Development Schedule Adherence
9. Engineering Change Order Impact
10. Value of Process Improvements
11. Number of Engineering Changes
12. On Schedule Task Start Rate
13. Phase Cycle Time vs. Plan
14. Schedule, Program Performance
15. Development Cycle Trend
16. Actual Staffing vs. Plan, Corporate
17. Actual Staffing vs. Plan, Customer Relations
18. Actual Staffing vs. Plan, Product Development
19. Actual Staffing vs. Plan, Supply Chain
20. Time to Value
21. Time to Volume
22. Engineering Change Notice Cost
23. Total Number of Implemented Changes
24. Number of Designs Initiated
25. Number of Market Projects
26. Value of Approved Projects

APPENDIX C

SPECIFIC PERFORMANCE MEASURES FOR ODTÜ APPLICATION

Generic measures selected from the lists given in Appendix B for Research Project Management Process of METU:

1. Deviation of planned time schedule for project/program
2. Deviation of planned budget
3. Deviation of planned hours of work
4. % of overdue project tasks
5. Project Completion vs Plan
6. % of lessons learnt sessions per registered projects before project close outs completed
7. Number of new project/program issues
8. Percentage of projects completed on time

Sample generic performance measure identification cards for some of the selected measures are given in Table 14, Table 15, and Table 16 in the following pages. These cards and their contents are provided as sample work, they should be established by the managing authority of the system for accurate completeness.

Table 14 – Generic Performance Measure 1

Generic Performance Measure Identification Card	
Name	Deviation of planned time schedule for project/program
Description (Purpose)	Measuring the performance of planning based on the comparison of actual work and planned schedule of the project.
Process Framework(s)	PRINCE2
Related Objective	i.e. Directing the project so that it is completed on time within budget.
Advantages	
Drawbacks	
Interpretation	If the deviation is high, estimated time schedule is overrun that may cause higher cost and lower return on investment (ROI).
Unit of Measure	Percentage
Calculation Method*	(Actual Schedule Time – Planned Schedule Time) /Planned Schedule Time
Data Elements and Sources*	Project schedule, actual works
Data Collection Frequency	Weekly or monthly
Frequency of Update*	Weekly or monthly
Analysis Method*	Monitoring
Related Process(es)*	Directing a project
Derived or Related Measures*	Not Applicable (N/A)
Benchmark Value	N/A

Table 15 – Generic Performance Measure 2

Generic Performance Measure Identification Card	
Name	Deviation of planned budget
Description (Purpose)	Measuring the performance of planning based on comparison of actual cost and planned budget of the project.
Process Framework(s)	PRINCE2
Related Objective	i.e. Directing the project so that it is completed on time within budget.
Advantages	
Drawbacks	
Interpretation	If the deviation is high, estimated budget is overrun that may cause higher cost and lower return on investment (ROI).
Unit of Measure	Percentage
Calculation Method*	(Actual Budget– Planned Budget) /Planned Budget
Data Elements and Sources*	Project budget, actual works and actual expenditures of the project.
Data Collection Frequency	Weekly or monthly
Frequency of Update*	Weekly or monthly
Analysis Method*	Monitoring
Related Process(es)*	Directing a project
Derived or Related Measures*	N/A
Benchmark Value	N/A

Table 16 – Generic Performance Measure 3

Generic Performance Measure Identification Card	
Name	Deviation of planned hours of work
Description (Purpose)	Measuring the performance of planning in terms of individual works (or tasks) in the project schedule.
Process Framework(s)	PRINCE2
Related Objective	i.e. Directing the project so that it is completed on time within budget.
Advantages	
Drawbacks	
Interpretation	If the deviation is high, estimated time is overrun that may cause higher cost and lower return on investment (ROI).
Unit of Measure	Percentage
Calculation Method*	(Actual Time of Work– Planned Time of Work) /Planned Time of Work
Data Elements and Sources*	Project schedule, actual works
Data Collection Frequency	Weekly or monthly
Frequency of Update*	Weekly or monthly
Analysis Method*	Monitoring
Related Process(es)*	Directing a project
Derived or Related Measures*	N/A
Benchmark Value	N/A

The selected generic measures are customized and specific process performance measure cards are provided in Table 17, Table 18, and Table 19 in the following pages.

Table 17 – Specific Performance Measure 1

Specific Performance Measure Identification Card		
Name		Deviation of planned time schedule for project/program
Description (Purpose)		Measuring the performance of planning based on the comparison of actual work and planned schedule of the project.
Related Objective		i.e. Directing the project so that it is completed on time within budget.
Unit of Measure		Percentage
Target Value		%1
Threshold Value*		%10
Preference Value*		N/A
Calculation Method		(Actual Schedule Time – Planned Schedule Time) /Planned Schedule Time
Data Elements and Sources		Project schedule, actual works
Data Collection Frequency		Monthly
Frequency of Update		Monthly
Analysis Method		Monitoring
Responsible Parties	Owner	Process owner
	Data Providers	Project team
	Data Collector	Project Assistant
	Measured by	Project Assistant
	Analyzed by	Project Manager
	Reported by	Project Assistant
	Reported to	Project Manager
Related Process(es)		Directing a project
Derived or Related Measures		N/A
Benchmark Value		N/A

Table 18 – Specific Performance Measure 2

Specific Performance Measure Identification Card		
Name		Deviation of planned budget
Description (Purpose)		Measuring the performance of planning based on comparison of actual cost and planned budget of the project.
Related Objective		i.e. Directing the project so that it is completed on time within budget.
Unit of Measure		Percentage
Target Value		%1
Threshold Value*		%10
Preference Value*		N/A
Calculation Method		(Actual Budget– Planned Budget) /Planned Budget
Data Elements and Sources		Project budget, actual works and actual expenditures of the project.
Data Collection Frequency		Monthly
Frequency of Update		Monthly
Analysis Method		Monitoring
Responsible Parties	Owner	Process owner
	Data Providers	Project team and accounting department
	Data Collector	Project Assistant
	Measured by	Project Assistant
	Analyzed by	Project Manager
	Reported by	Project Assistant
	Reported to	Project Manager
Related Process(es)		Directing a project
Derived or Related Measures		N/A
Benchmark Value		N/A

Table 19 – Specific Performance Measure 3

Specific Performance Measure Identification Card		
Name		Deviation of planned hours of work
Description (Purpose)		Measuring the performance of planning in terms of individual works (or tasks) in the project schedule.
Related Objective		i.e. Directing the project so that it is completed on time within budget.
Unit of Measure		Percentage
Target Value		%1
Threshold Value*		%5
Preference Value*		N/A
Calculation Method		(Actual Time of Work– Planned Time of Work) /Planned Time of Work
Data Elements and Sources		Project schedule, actual works
Data Collection Frequency		Monthly
Frequency of Update		Monthly
Analysis Method		Monitoring
Responsible Parties	Owner	Process owner
	Data Providers	Project team
	Data Collector	Project Assistant
	Measured by	Project Assistant
	Analyzed by	Project Manager
	Reported by	Project Assistant
	Reported to	Project Manager
Related Process(es)		Directing a project
Derived or Related Measures		N/A
Benchmark Value		N/A

Creating Research Opportunities Process:

Objective 1: Composing a portfolio of national/international scientific and technological research studies support programs.								
	Effectiveness	Efficiency	Productivity	Quality	Innovativeness	Time	Cost	Flexibility
Customer								
Investor/Owner	Portfolio coverage ratio							
Employee								
Regulator								
Supplier								
Competitor								
Community								

Table 20 - New Performance Measure Identification Card

New Performance Measure Identification Card		
Name of the performance measure		Portfolio coverage ratio
Description (Purpose) of the performance measure		Performance of portfolio coverage based on announced national/international scientific and technological research support programs.
Name of the measured process		Creating Research Opportunities
Objective of the measured process		Composing a portfolio of national/international scientific and technological research studies support programs.
Any advantages?		Indicates improvement needs for portfolio coverage.
Any drawbacks?		It may be difficult to reach and keep the data of all announcements.
Interpretation clue		If the coverage ratio decreases any improvement or corrective action is needed within the related process.
Units of measure		Percentage
Target value		% 90
Threshold value		% 75
Preference value		% 90
Calculation method		number of support programs included in portfolio / number of support programs announced
Data elements and sources		Support programs portfolio, announcements of the programs
Data collection frequency		quarterly
Frequency of update		annually
Analysis method		monitoring
Responsible Parties	Owner	Portfolio Owner
	Data Providers	Research Coordinator
	Data Collector	Portfolio Manager
	Measured by	Portfolio Manager
	Analyzed by	Portfolio Manager, Portfolio Owner
	Reported by	Portfolio Manager
	Reported to	Portfolio Owner
Other related process(es)		N/A
Derived or Related measures		N/A
Benchmark Value		N/A

APPENDIX D

GUIDANCE – IDENTIFYING A NEW PERFORMANCE MEASURE

This guidance is prepared for describing the process of identifying new process performance measures when generic performance measures provided by the proposed process performance measure definition system are inadequate for the users. This guidance is prepared based on the structure introduced in this thesis and it can be used with the assumptions of the proposed process performance measure definition system.

In order to have a proper process performance measure, first the attributes of the process are checked. The purpose, objectives, inputs, outputs, and related stakeholders of the process are included as inputs of this performance measure identification process. The performance dimensions that will be considered in this process are effectiveness, efficiency, productivity, quality, innovation, time, cost, and flexibility; and their definitions are given in Section 3.2.2.
Take each objective of the process separately, and evaluate it by each performance dimension with perspectives of different stakeholders. Define performance measures for each meaningful evaluation. Pairwise comparison matrices, such as the one given in Table 21, may be used for these evaluations.

Table 21 – Pairwise comparison matrix

Objective 1:								
	Effectiveness	Efficiency	Productivity	Quality	Innovativeness	Time	Cost	Flexibility
Customer								
Investor/Owner								
Employee								
Regulator								
Supplier								
Competitor								
Community								

While defining performance measures, use inputs and outputs of the process according to the definition of performance dimensions and their perceptions by stakeholders. Filling out the New Performance Measure Identification Card provided in Table 22 is helpful for having a good

performance measure. Moreover, this card is used for evaluation of the new measure for its addition to the system as a generic performance measure.

Table 22 – New Performance Measure Identification Card

New Performance Measure Identification Card		
Name of the performance measure		
Description (Purpose) of the performance measure		
Name of the measured process		
Objective of the measured process		
Any advantages?		
Any drawbacks?		
Interpretation clue		
Units of measure		
Target value		
Threshold value		
Preference value		
Calculation method		
Data elements and sources		
Data collection frequency		
Frequency of update		
Analysis method		
Responsible Parties	Owner	
	Data Providers	
	Data Collector	
	Measured by	
	Analyzed by	
	Reported by	
	Reported to	
Other Related Process(es)		
Derived or Related Measures		

APPENDIX E

DATABASE TABLE TEMPLATES OF PMDS

The templates of database tables used in PMDS are provided below.

Table 23 – Industry Database Table Template

ID	Industry Name

Table 24 – Process Framework Database Table Template

ID	Framework Name

Table 25 – Industry and Process Framework Link Database Table Template

ID	Industry ID	Framework ID

Table 26 – Process Database Table Template

ID	Process Name	Framework ID

Table 27 – Performance Dimension Database Table Template

ID	Performance Dimension Name

Table 28 – Stakeholder Database Table Template

ID	Stakeholder Name

Table 29 – Generic Performance Measure Database Table Template

ID	Performance Dimension ID	Process ID	Stakeholder ID	Name	Description	Objective	Advantages	Drawbacks	Interpretation	Unit of Measure	Calculation Method	Data Source	Data Collection Frequency	Frequency of Update	Analysis Method	Derived Measures	Related Processes	Benchmark Value

APPENDIX F

GLOSSARY

Generic performance measure: A performance measure defined for a generic process.

Generic process: A high level process defining common operations and representing a common business process area.

Business process framework: the structure of processes of an organization used to describe, manage, and maintain its operations at all levels

Performance measure: A metric used to quantify the efficiency and/or effectiveness of an action.

Performance measurement: The process of quantifying the efficiency and effectiveness of an action

Process: A structured, measured set of activities designed to produce a specific output for a particular customer or market by transformation of inputs.

Specific performance measure: A performance measure adapted from a generic performance measure by customization.

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