University of Economics, Prague
Faculty of Informatics and Statistics

DIPLOMA THESIS

2016 **Ondřej Koch**

University of Economics, Prague
Faculty of Informatics and Statistics

The role of assurance within project management standards

Thesis author: Ondřej Koch
Thesis supervisor: Ing. Václav Oškrdal, Ph.D.
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Sworn declaration:

I hereby declare that I am the author of the thesis entitled “The role of assurance within project management standards”. I duly marked out all quotations. Used literature and sources are stated in the attached list of references. All quotations were made according to ČSN ISO 690.

In ..... on ..... Signature: .....

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Thanks to my whole family I've been able to finish almost twenty years of study time without having to struggle to find both emotional and material support.

Acknowledgement goes to my girlfriend Anna for being so kind, respecting and supportive not only during the past few months, but also during every single minute I spend with her.

I am really grateful to all of you.

Abstract:

The thesis is focused on the role of assurance within project management standards. Firstly, the theoretical role of assurance was established based on the performed research. Three main areas of interest have been identified: Assurance over business, the project itself and the product. The role established in the theoretical part of the work was subsequently compared to information systems development methodologies and project management standards. From the comparison with AUP, Scrum and FDD methodologies, it seems that the better assurance is defined, the longer the feedback cycle is. During the comparison with the three most widespread project management standards – IPMA, PRINCE2 and PMBOK – various areas have been identified where these are not fully compliant with the theoretical role of assurance. Additions to IPMA and PMBOK have been created to support the compliance with the theoretically established role of assurance, fulfilling the objective set for the practical part of the work and providing benefits to IT project management professionals that struggle to deliver quality products while following one of the aforementioned standards.

Keywords:

Project Assurance, Software Quality Assurance, ERP implementation, Information Systems Implementation Projects, Project Management Standards, IPMA, PRINCE2, PMBOK, AUP, Scrum, FDD

Abstrakt:

Tato práce se zaměřuje na roli dohledu ve standardech projektového řízení. Nejprve byla ustanovena teoretická role dohledu na základě provedené rešerše. Byly identifikovány tři hlavní oblasti zájmu: Dohled nad byznysem, projektem jako takovým a produktem. Role vytvořená v části teoretické byla následně porovnána s metodikami vývoje softwaru a se standardy projektového řízení. Z porovnání s metodikami AUP, Scrum a FDD se zdá, že čím lépe je dohled definován, tím delší je cyklus zpětné vazby. V průběhu porovnání se třemi nejrozšířenějšími standardy projektového řízení – IPMA, PRINCE2 a PMBOK – byla identifikována řada oblastí, ve kterých tyto nejsou zcela v souladu s teoreticky definovanou rolí dohledu. Byly vytvořeny přídavky do IPMA a PMBOK takové, aby podpořily soulad těchto standardů s teoreticky definovanou rolí dohledu, čímž byl naplněn cíl práce stanovený pro praktickou část a taktéž podpořen přínos práce pro pracovníky, kteří k řízení IT projektů využívají jeden z výše zmíněných standardů, přesto se však potýkají s problémy znemožňujícími dodávku kvalitních produktů.

Klíčová slova:

Projektový dohled, Software Quality Assurance, Implementace ERP, Projekty informačních systémů, Standardy projektového řízení, IPMA, PRINCE2, PMBOK, AUP, Scrum, FDD

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1. INTRODUCTION

The arrival of the information age has brought various information technology issues closer to businesses all around the world. Not only the major companies, but also small and medium enterprises have to cope with digitalization and informatisation of their data, processes or workflows. Information systems help achieve those goals; nevertheless, this brings information system implementation projects inside the set of activities that most of the businesses have to cope with, even though they often do not have enough amount of experience with such projects.

During the bachelor study programme "Informatics" and major master's specialization "Information Management" we have repeatedly learnt that overwhelming majority of abovementioned information system implementation projects are over budget, do not contain all the required features, have invalid dataset, don't compy with managerial or user requirements, or simply fail completely. As all the previously mentioned and many more follow-up issues may be considered mainly as failures of project management team, question arises: Is it possible that at least some of them may have been solved using control activities that would focus on initial project requirements, implementation team, quality of the documentation or acceptance procedures? These activities, collectively described as „Project Assurance", stand at the spotlight of this diploma thesis and are to be analyzed within the theorethical background of the past years as well as within the latest project management trends.

The choice of the topic for this diploma thesis is partly a genuine interest in the topic of project management, partly a self-education activity of the author, who has been working with an information systems audit & risk assurance department for the past few months. Project assurance activities represent one of the most demanded value added services within the portfolio of the department and offer a great amount of potential for future professionals.

1.1 DEFINITION OF TERMS

It is important to pre-define main terms used inside this work to fully understand and acknowledge following chapters. The vocabulary also helps reader to identify the scope of this diploma thesis and realize the extent of issues that are out of scope of the work.

Information systems implementation project is conceived as a "planned, managed and time-limited set of activities" that "result in a delivery of a new application solution to the ordering party" [DOUCEK, 2006 p. 11]. Standalone enterprise resource planning solutions are in scope of this work, while most of the findings may be applicable also to software as a service.

Assurance is a set of activities that monitor aspects of the project's performance and products independently on the project manager. They provide "an independent assessment on risk

management, control, or governance processes for the organization. Examples may include financial, performance, compliance, system security, and due diligence engagements [CUNNINGHAM, 2016 p. 20]". These activities are to be analyzed and described in the second chapter of this work in order to establish the extent of assurance activities that are to be considered as "project assurance".

It is important to note the difference in perception of words "audit" and "assurance" for the purpose of this work. While the basic logic and activities of auditing information systems implementation projects and performing assurance work over them may overlap each other, audit is perceived as a retrospective work that evaluates the project after its completion (or completion of a stage). On the contrary, assurance work is perceived in this thesis as work that can be performed while the project is being executed, as described in ITAF - Information Technology Assurance Framework [INFORMATION SYSTEMS AUDIT AND CONTROL ASSOCIATION, 2014].

Project management standard is a document that contains guidelines for project management, published by a recognized body. For the purpose of this work, the three most widely used [MÁCHAL, et al., 2015 p. 11] international project management standards known as IPMA, PMBOK and PRINCE2 are considered as relevant. PRINCE2 is often marked as a project management methodology within the international context. For the purpose of this work, all three above mentioned documents are considered as "project management standards", as recommended by [MÁCHAL, et al., 2015 p. 11].

International Project Management Association abbreviated as **IPMA** is a federation of over 60 project management associations from around the globe, that "develop project management competencies in their geographic areas of influence, interacting with thousands of practitioners and developing relationships with corporations, government agencies, universities and colleges, as well as training organizations and consulting companies". IPMA serves as a managing body for IPMA project management certifications that are based on IPMA Individual Competence Baseline v4, IPMA Organisational Competence Baseline v1.1 and IPMA Project Excellence Baseline v1. For the purpose of certifications as well as this thesis, these three official IPMA publications are considered as definitions of the IPMA standard [INTERNATIONAL PROJECT MANAGEMENT ASSOCIATION, 2013] [INTERNATIONAL PROJECT MANAGEMENT ASSOCIATION, 2015].

A Guide to the Project Management Body of Knowledge abbreviated as **PMBOK Guide** is a standard that "provides guidelines for managing individual projects and defines project management related concepts"; and is a globally recognized standard that "has evolved from the

recognized good practices of project management practitioners" [PMI, 2013 p. 1]. For the purpose of this thesis, PMBOK Guide Fifth Edition [PMI, 2013] is to be considered as definition of the PMBOK standard.

Projects IN Controlled Environments abbreviated as **PRINCE2** is a "non-propriatery method" that has "emerged worldwide as one of the most widely accepted methods for managing projects" [AXELOS, 2009 p. 4]. For the purpose of this thesis, Managing Successful Projects with PRINCE 2: Fifth Edition [AXELOS, 2009] is to be considered as definition of the PRINCE2 standard.

1.2 OBJECTIVES OF THE THESIS

The main goal of the thesis is to analyze the role of assurance activities during information systems implementation projects using theoretical background, draw up a theoretical role of information systems project assurance, compare it with the three most used project management standards (IPMA, PRINCE2, PMBOK) and create an addition for those standards. The main focus will be put on the IPMA standard, while the comparison and possible addition to the other two standards will be slightly reduced in order to meet the recommended scope of the diploma thesis.

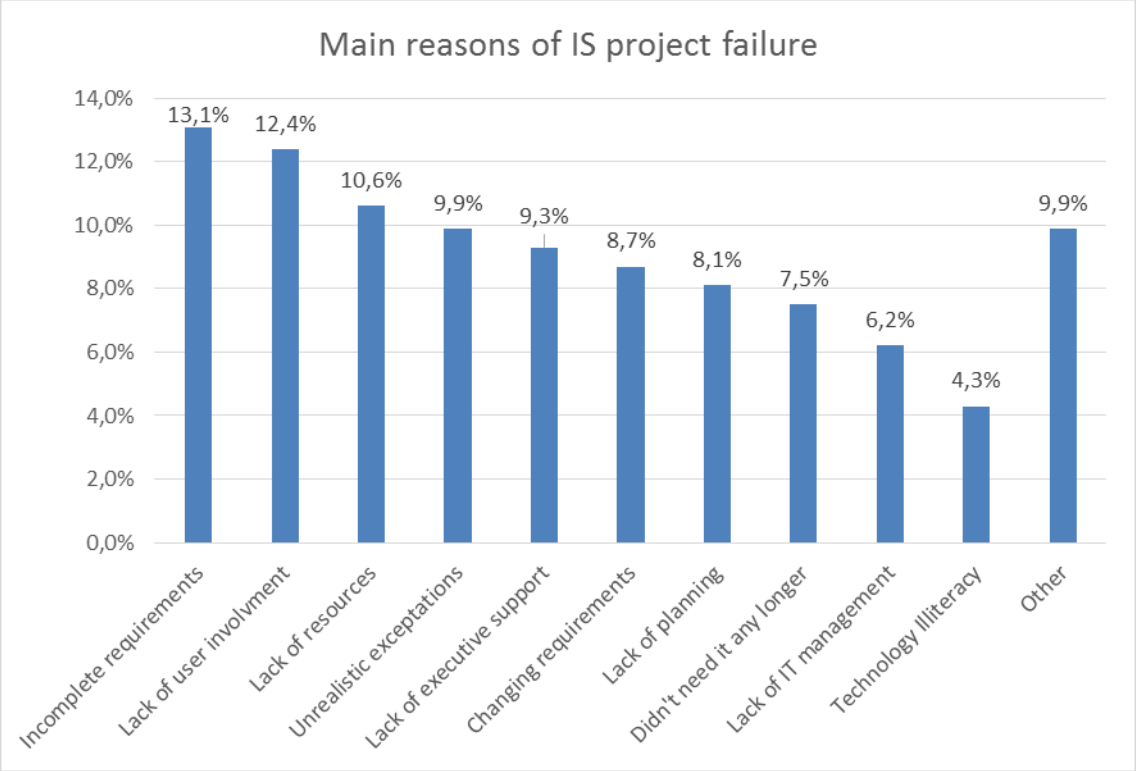
The objective mentioned above may be divided into objectives for the theoretical and practical part of the work. As for the theoretical part, the goal is to create a comprehensive and accurate role of information systems project assurance, which is a product that is widely demanded worldwide and that has been defined in various scientific literature, although named and implemented in various ways. The summary that will be created will help IT professionals to understand the importance of utilizing assurance within their information systems projects.

Objectives for the practical part of the work are as follows. Firstly, a comparison with three project management standards will be created to help understand how rightly the theoretical role is implemented within standards that are being used by project management professionals every day. The main assumption this part of the thesis is that in-scope project management standards are not fully compliant with the theoretically established role. In case this assumption confirms, an addition to the aforementioned standards (with IPMA chosen as the primary goal) will be created, so that the role of assurance within them is in compliance with theoretical background as well as with the latest trends.

1.3 MERITS OF THE THESIS

To fully understand the contribution of the work it is essential to lay emphasis on the current environment of information systems projects. Based on a research done by US National Association of Corporate Directors, only the 500 largest US firms spend 14 billion dollars a year on failed IT projects [NATIONAL ASSOCIATION OF CORPORATE DIRECTORS, 2009].

Report Chaos by The Standish Group focuses on the top ten project impairment factors as described in Graph 1. It also points out that 31.1% of IT projects are cancelled before the date they are completed, while only 16.2% of information systems implementation projects are completed on-time and on-budget [THE STANDISH GROUP, 2014].



Graph 1 - Main reasons of IS project failure
Source: [THE STANDISH GROUP, 2014]

It is important to point out that the first nine of the ten reported reasons are considerable as project management failures, with incomplete requirements topping the list. And as such, they might be prevented using adequate activities provided by project assurance teams.

The work, and the addition to project management standards in particular, may help project managers and their superiors to minimize the risk of such failures of information systems projects, provided they are managed using one of the in-scope standards and with acknowledgement of the addition provided by the author.

1.4 STRUCTURE OF THE THESIS

The first chapter of this work focuses on the introduction to the topic, on the aim and contribution of the thesis to the scientific environment, used methods and others' works that describe topics that are similar to those described in this diploma thesis.

The second chapter creates the main theoretical background for following parts of the work. It is set to establish the role of assurance during information systems implementation projects using various sources – Czech and international literature as well as data and ideas from scientific journals.

The third chapter helps to fully understand the environment of information systems development, which is an essential part of information systems project, by describing the quality assurance activities and measures that are (or are not) being followed as part of various software development methodologies, and comparing them to each other.

The fourth chapter of this thesis is a key part as it focuses on the comparison of the assurance role (that has been established during the second chapter) with the three most widely used project management standards. It has already been stated that the main assumption for the comparison part of the thesis is that the project management standards are not fully compliant with the theoretically established role and IPMA has been chosen as a primary objective.

In case the assumption at least partially confirms, a fifth part of the work shall be created: An addition to the project management standards that are not adequately compliant with the established role of project assurance. It is to be pointed out that one of the main goal of the additions is to fully follow the style, methods and format of a particular standard.

The last chapter with conclusions and generalization of knowledge and experiences gained during the execution of chapters two to five will complete this diploma thesis.

1.5 METHODS USED IN THE THESIS

The work lies on three main methods that are used among the chapters. These consist of:

- **Analysis**
  - Using analysis, the theoretical role of information systems projects assurance will be drawn up based on scientific literature from both Czech and international environment as well as the latest trends described in journals.
- **Comparison**
  - The role of assurance that has been previously established during the analysis will be compared with the three most widely used project management standards.
- **Synthesis**
  - Using the knowledge and understanding of the problematic situation gained while using the two previous methods, an addition to the project management standards that are not fully in compliance with the theoretical role of project assurance will be created by the author.

1.6 COMPARABLE WORKS

- **Managing IT projects in practice and widely used methodologies** by Ing. Soňa Matoušková is a work that focuses on "designing a proposal for managing projects in small and mid-sized companies that will be part of reference Model of Business Informatics". Although the first chapter of the thesis compares PMBOK, ICB and PRINCE2 standards, the comparison is rather high-level and no emphasis on neither project assurance nor assurance activities has been placed [MATOUŠKOVÁ, 2014].
- **Assurance tools in the IT area and their practical implementation** by Ing. Petr Hodulák is "focused on emphasizing the need of the assurance tools in IT area". The work does not describe any of the project management standards that are in scope of this work, the aim is to develop an assurance tool for a major Czech insurance company [HODULÁK, 2013].
- **Test process improvement and software quality assurance models** by Ing. Tomáš Došek is closely related to the third chapter of this thesis, as it describes quality assurance activities during the project development. The work focuses on CMMI, CTP, TPI and TMMi models instead of project or software development methodologies [DOŠEK, 2012].
- **Data migration and quality assurance and testing projects methodology of Deloitte CZ** by Ing. Marek Pospíšil is focused on data migration quality assurance, which is only a single part of the information systems project assurance issue. As the results of the work are intended for internal purposes of Deloitte company, the work has not been made available for the public [POSPÍŠIL, 2011].
- **Project management in competence centre SQA** by Ing. Michal Hendrich **"**deals with project management competence center in Software Quality Assurance, which operates the University of Economics in Prague". One of the parts of the work "focuses on project management competence center in Software Quality Assurance, which describes a modified project life cycle according to the PMBOK and project life cycle testing". The work puts accent mainly on the software quality part of assurance work and does not deal with PRINCE2 or IPMA management standards [HENDRICH, 2014].

2. THEORETHICAL APPROACHES TO IS PROJECT ASSURANCE

The purpose of the second chapter of this work is to outline the theoretical role of information system project assurance. Various scientific literature has been used while creating this chapter. It is important to note the strong accent that has been given on source selection. Since the role created within this chapter will be later used for a comparison with project management standards, no literature that would use any of those standards as a primary source has been used. Using such literature would compromise the correctness of performed work by being caught in a vicious, circular comparison.

The position of assurance team within the organizational structure of the project, choice between internal and external assurance team as well as financial and timeliness aspects of assurance work are discussed in the beginning of the chapter. Later, the set of assurance activities, which are anticipated from the assurance team, is defined. For the purpose of improvement of the future comparison, identified activities are divided into three main categories that are named as following: Assurance over business, assurance over project, and assurance over product.

2.1 ORGANIZATIONAL ASPECTS OF ASSURANCE WORK

2.1.1 POSITION WITHIN THE ORGANIZATIONAL STRUCTURE

Firstly, the position of assurance team within the project and relationship with key project groups needs to be explained. Figure 1 describes key relationships as defined in IT Assurance Guide [2007]. Stakeholders are de facto final "customers" of assurance work and project team (responsible party in the figure) is in charge of executing the project. Assurance team creates an independent report stating whether the information system implementation project (subject matter in the figure) meets the needs of the stakeholder, based on criteria approved by both stakeholder and responsible party, which are to be discussed later.

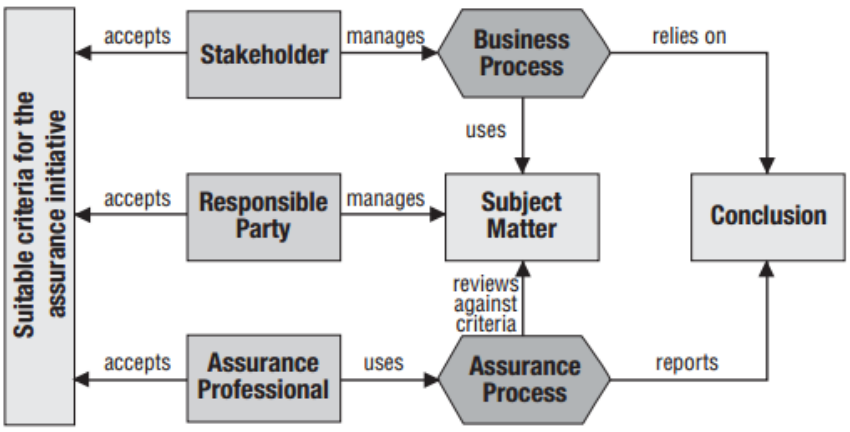


Figure 1 - Position of Assurance team within the project
Source: [IT GOVERNANCE INSTITUTE, 2007 p. 17]

The independence of assurance team is a key element that is also described in various "International Standard on Assurance Engagements" handbooks, such as ISAE 3000 and ISAE 3402, also noting that performing assurance work over transaction systems may prohibit suppliers from being able to participate during the audit of financial statements. Doucek [2011 pp. 174-175] mentions ethical behavior, fair presentation of performed procedures and results, professional approach and high competence, independence and provability of all findings as key elements of audit-type assessments. He also notes that the independence on both supplier and ordering party is "essential, because the preference of goals of any of the participating party at the expense of correct procedures of the other party will inevitably lead to the failure of the whole project" [DOUCEK, 2006 p. 51]. This does not apply only to assurance over business and project part of the implementation, but also to the development phase, Chemuturi [2014 p. 64] noting that "best practice for a software development organization that focuses on the quality of its deliverables is to have an independent, fully staffed, and robust QA department".

2.1.2 INTERNAL OR EXTERNAL ASSURANCE

During information system implementation projects, two different views on subject matter are recognizable, both with their respectful advantages and disadvantages that are to be discussed in this sub-chapter: Internal and external assurance.

There is a notable difference between the internal and external audit in the field of statutory audit and the internal and external source of experts for assurance work. Internal audit is focused mainly on business processes, is risk-based, consultative, usually requires a follow-up and its results are commonly used only for internal purposes of the company management. On the contrary, external audit of financial statements serves as an independent view that annual accounts give true and fair view of the financial situation of the respectful company, is publicly available and its aim is to give a reasonable level of assurance for stakeholders – primarily the shareholders – that the amount of risk accompanied with their investment is adequate to the state of the company [CHEMUTURI, 2014 pp. 17-18].

There are similarities with financial auditing that may be noted, but assurance over information systems projects is most likely "internal", as it serves stakeholders of projects and is not available publicly, with the exception of projects that have legal obligation to publish the report – most notably projects that gained the majority of funds from public resources. The decision that lies on project boards is different: Whether to assign the assurance work to an independent group of internal employees, or to external (usually consulting or auditing) company.

Bent Flyvbjerg [2013] focused on summarizing prior research of benefits and difficulties of internal and outside views and assessments in his paper called „Quality Control and Due

Diligence in Project Management". Noting that "forecasts of costs and benefits of major projects are generally highly inaccurate and biased" and "predicted impacts (…) are often being very different from actual ones", he addresses internal view as the one that focuses more on "constituents of the specific planned action rather than outcomes of similar actions already completed". While utilizing internal assurance experts may help to overcome difficulties of external view, which are to be discussed later on, internal experts have their own issues, with one particular to be discussed: Optimism. Assuming that the aim of the whole company that is performing the information system implementation is to sufficiently start the projects, the likelihood of meeting business goals of the implementation is to be forecasted. As Flyvbjerg [2013] states, those "forecasters may know, or have a hunch, that their forecasts are likely to be optimistic. However, they may decide not to investigate further and not to correct for possible optimism, because they assume, often for good reason, that optimistic forecasts are more likely to get projects approved than realistic ones", utilizing also an approach taken by the UK Treasury that recommends that estimates of project's costs, benefits and duration should "be based on data from past projects or similar projects elsewhere".

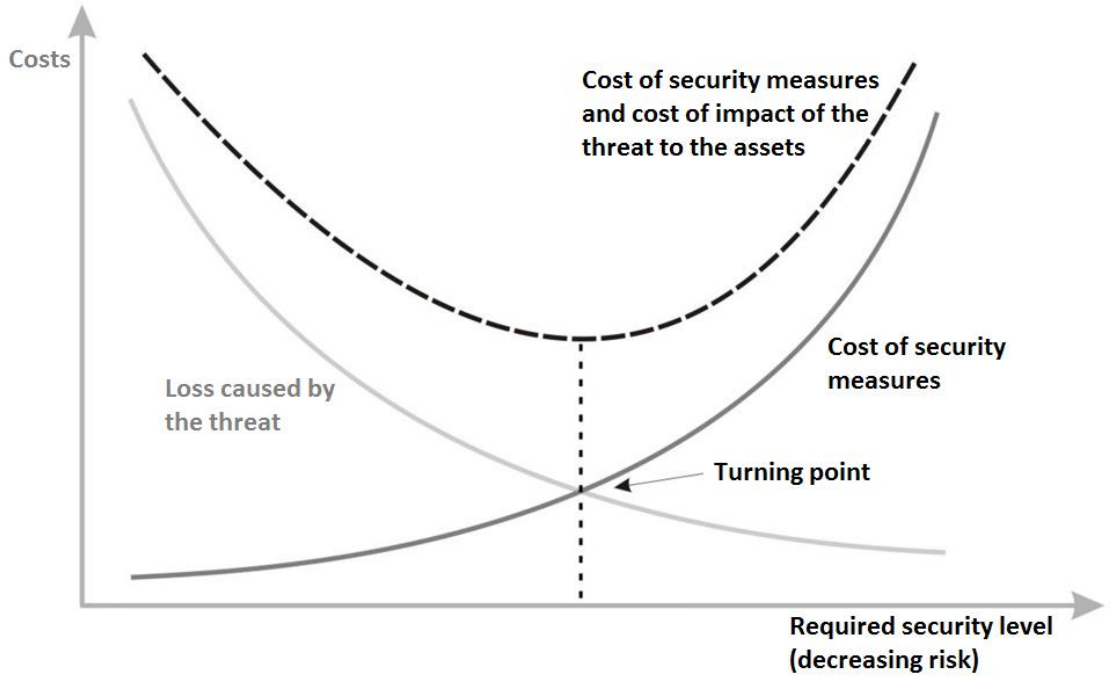
The call for an outside view on estimates may be also based on the work of Daniel Kahneman, Nobel memorial prize holder, who emphasized on psychology of judgement; he discussed the matter and noted that students, when asked how long it would take to write their thesis, usually significantly underestimated the time, trying to understand and estimate the task inside-out. "If they would simply collect data and calculate the average of how long it took 10-15 fellow students in last year's class in the same program they would arrive at a much more accurate estimate." [KAHNEMAN, 1994]

Issues connected with external view, such as rather high-level understanding of internal processes and controls by assurance team or deficiencies in sharing of information related to the project, are likely to rise and may be addressed via implementing a shared knowledge base and document server or similar software solutions that will help to provide the assurance team with all the key documents, information and decisions created and used by project team. To provide best possible results, all three parties mentioned in previous chapter need to cooperate, discuss and approve both source materials and deliverables that are to be discussed later in this chapter.

2.1.3 PRICE OF THE ASSURANCE WORK

While assurance work focuses on many monetary aspects of information system implementation projects and prevents businesses from issues such as a significant cost overrun, no direct reports on average prices for IT assurance work have been found by the author of this thesis.

As assurance is mainly considered a risk management or risk control tool that protects the project or organization against a threat, general principles of budgeting a risk-preventive tool should be used. These may be mainly described as follows: The price of implementation of a risk-preventive solution (assurance work in this case) should never exceed the potential loss of assets belonging to the organization that is performing the project. This logic is described in Graph 2.



Graph 2 - Cost based model of realization of security measures
Source: [DOUCEK, 2011 p. 93]

Knowing that most ERPs support financial statements, are a key support and control element of many organizations and for some of them they even represent a core business tool, the turning point of such investment should lie greatly behind the whole budget of the implementation, while small and medium businesses may choose to scope down the assurance to prevent significant budget interferences.

Svatá [2012 p. 20] also pinpoints the economical aspect of audit-type procedures, claiming that the existence and successful performance of such activities rise the value of assessed object.

2.1.4 TIMELINESS, THREE STAGES OF ASSURANCE WORK

It has already been stated during the definition of terms for this diploma thesis that assurance is perceived as an activity that covers the whole life cycle of an information system implementation project, and does so during its execution.

The assurance work is divided into three main parts as described in IT Assurance Guide: Planning, Scoping and Execution, each with their respective sub-parts and activities performed

[IT GOVERNANCE INSTITUTE, 2007 p. 18]. Even though the specific approach is unique for most assurance projects, three stages described in this chapter need to be performed every time. They are shown in Figure 2.

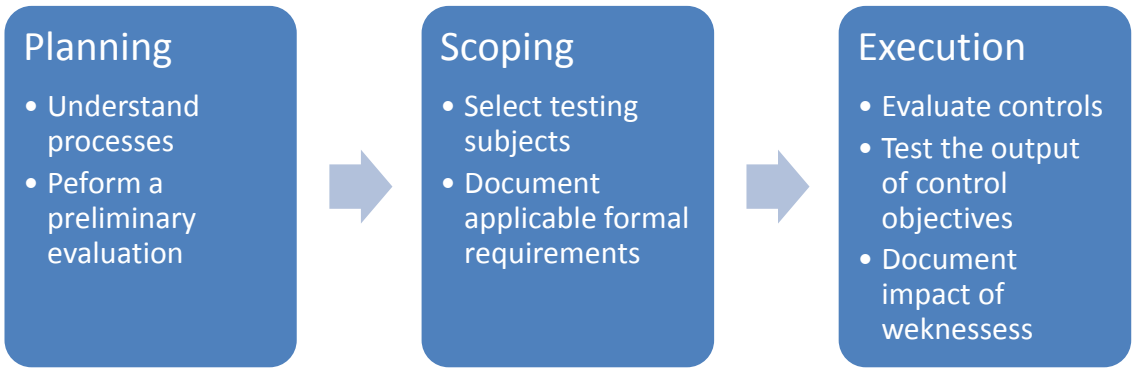


Figure 2 - Three stages of assurance work
Source: The author, [IT GOVERNANCE INSTITUTE, 2007 pp. 28-38], [SVATÁ, 2012 pp. 95-98]

The planning phase consists mostly of activities that help to gain understanding of the business environment of the client, "set the basic parameters of assurance project and perform a preliminary evaluation of maturity" [SVATÁ, 2012 p. 95]. Therefore, this part of assurance work, which must be performed before the start of the information systems implementation project, contains meetings between assurance team and IT management. During those meetings, IT assurance professionals "should obtain a good understanding of the assurance universe and the organization's business goals for IT, IT goals, and how they are planned to be realized through IT processes and IT resources. The extent of the knowledge required is determined by the nature of the organization, its environment, risks and the objectives of the assurance initiative." [IT GOVERNANCE INSTITUTE, 2007 p. 25]

The purpose of scoping stage is to "determine which IT resources and control objectives are covered within a given IT control framework in the execution stage of the initiative" [IT GOVERNANCE INSTITUTE, 2007 p. 31]. To do so, various areas of project must be documented, such as business requirements, roles, responsibilities, policies, laws, control measures, past and correct issues, as described in IT Scoping Road Map shown in Figure 3.

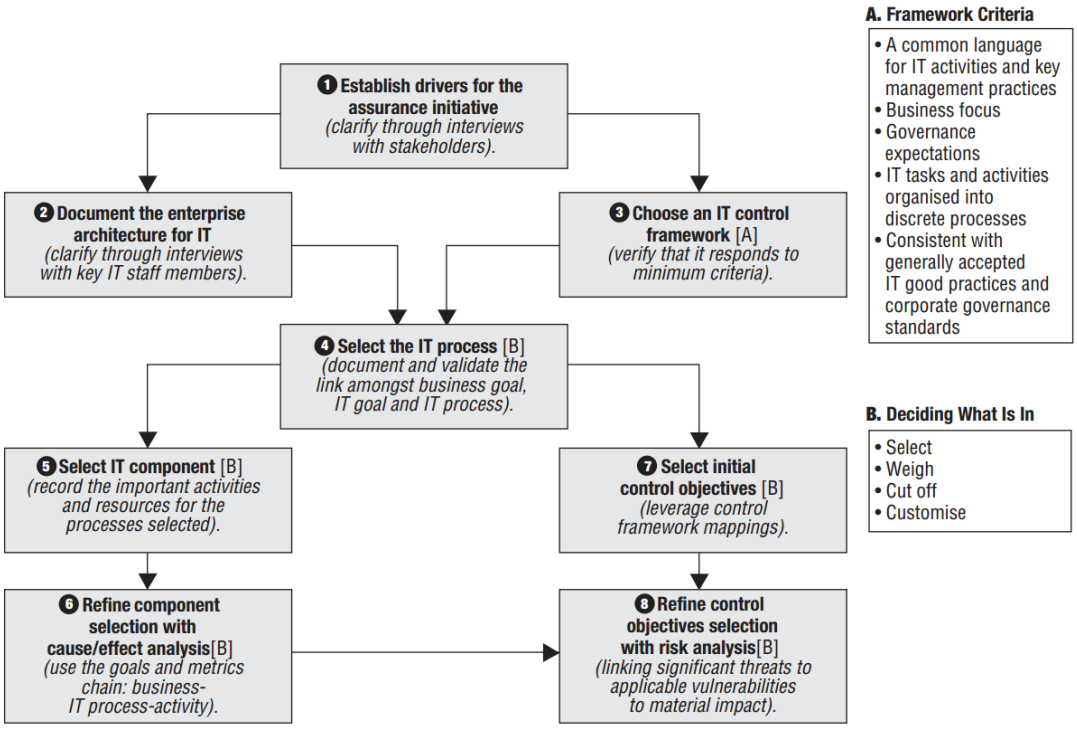


Figure 3 - IT Assurance Scoping Road Map
Source: [IT GOVERNANCE INSTITUTE, 2007 p. 31]

The assurance team should also (during the scoping) understand reasons why stakeholders created the request for assurance initiative in the first place, and perform interviews with stakeholders to understand their expectations for the assurance initiative, according to Svatá [2012 p. 97].

The most important part of scoping is to agree on an IT control framework. By its definition, assurance servers as independent statement that should assure stakeholders that the project has been executed accordingly to either:

- project management policy,
- given development methodology,
- legal obligations,
- best practice,
- or a combination of aforementioned.

Therefore, to meet expectations of stakeholders and set the framework for the whole assurance initiative, it is essential to agree upon the control framework with stakeholders of the project and tailor future procedures accordingly. Since the control framework is individual for each project, the aim of this thesis is not to focus on particular framework (as this would strongly affect the usability of outcomes), but summarize the most usual controls performed during assurance work.

The last part, execution, should "start with further investigation whether the assurance team understands the environment and defined the subject matter appropriately" [SVATÁ, 2012 p. 97]. In order to correctly start this last part, "the assurance scope and objectives need to be communicated to and agreed upon by all stakeholders" [IT GOVERNANCE INSTITUTE, 2007 p. 35].

Three crucial stages of execution are defined by Svatá [2012 pp. 97-98] as follows: Testing the design of controls, testing the output of the control objectives, and documenting the impact of control weaknesses.

Testing of the control design means that assurance team documents the process and connected controls in the particular environment and determines whether the design of the control meets criteria such as best practices, law obligations for the project, ISO or national standards, internal policies or similar formal documents. For this stages, five different types of testing may be applied, as defined in the IT Assurance Guide [IT GOVERNANCE INSTITUTE, 2007 pp. 36-37]:

- Inquiry
- Inspection
- Observation
- Reperformance
- Review of automated evidenced collection

For the second part, test of the outcomes of the control objectives, the assurance professional "needs to look for direct and indirect evidence of the control's impact on the quality of the process outputs" [IT GOVERNANCE INSTITUTE, 2007 p. 37]. According to Svatá [2012 p. 98] this stage may be skipped should the assurance professional find out satisfactory evidence that the control over the process does not exist.

If any weaknesses are noted by the assurance team during the first two parts of execution, such as no existing control, control not working as expected or control applied inconsistently among the process or organization, documentation of impact to the process and business goals shall be created by the reviewer, with emphasis on cost of errors, such as hours loss of staff time, ability to manage the process or harm to sales [IT GOVERNANCE INSTITUTE, 2007 pp. 37-38].

The creation of formal review (and/or other deliverables), handover and acceptance process with the party that ordered the assurance work concludes the whole initiative [SVATÁ, 2012 p. 98].

2.1.5 EVALUATING PROCESSES AND CONTROLS

It is important to note that while typical audit work is primarily focused on testing the design and operational effectiveness of implemented controls, part of the work performed is also focused on review of processes and high-level evaluation of the organization and environment itself.

This fact is caused by two phenomena. Firstly, understanding and assessment of the environment is needed to correctly perform all three stages of assurance work, with emphasis on planning and scoping part of the assurance project. Secondly, for some of the processes performed during information system implementation projects, no internal control may exist or the control may not be designed in compliance with best practices. Therefore, the assessment of the process provides compensating evidence for the assurance work.

For some of the activities, even the very existence of the formal process represents a certain level of control (e.g. the existence of organizational structure presents a control mechanism over performed work or access to programs and data, being a documented preventative control of the project management). Table created by Prof. Nick Gehrke may help the reader to better understand the term "internal control" and its properties.

Property	**Specification**					
Nature	Manual	Automated				
Frequency	Continuous	Daily	Weekly	Monthly	Quarterly	Other
Assertion	Completeness	Accuracy	Validity	Access	Cut off	Other
Importance	Key	Standard				
Scope	Company	Entity	Process	Activity	Transaction	
Timeliness	Preventative	Detective				
Subject	Physical Asset	Financial Asset	Data Asset	Human Asset		
Objective	Reporting	Security	Compliance			
Documentation	Documented	Informal				
Integration	Process integrated	Process Independent				
Responsibility	Top management	Business management	IT management			

Table 1 - Taxonomy of internal controls
Source: [GEHRKE, 2010]

Since control is always associated with the risk, two distinctive components of risk associated with projects as well as assurance work should be outlined. Inherent risk is a risk of a failure or misstatement that occurs if no control or mitigating action is in place for the activity. On the other

hand, control risk occurs if there is a chance that misstatement or failure "will not be prevented or detected and corrected on a timely basis by the entity's internal control" [IT GOVERNANCE INSTITUTE, 2007 p. 24], presuming the very existence of such control.

Assurance addresses, controls, mitigates or at least describes both inherent and control risks of information systems implementation projects by performing assessments that will be described in the following sub-chapters about controls over business, projects, and products.

While testing outcomes of control objectives – operational effectiveness of controls – audit sampling is usually used; with frequency of controls being the key variable for selecting the size of sample. Sampling represents "the application of audit procedures to less than 100% of items within a population of audit relevance such that all sampling units have a chance of selection in order to provide the auditor with a reasonable basis on which to draw conclusions about the entire population" [IAASB, 2009], allowing the assurance team to reduce the amount of work needed (and reduce the price for customer as a result) while keeping a reasonable level of assurance that outcomes are as expected for the whole population of controls.

For better understanding of mapping of processes and controls and audit sampling an example of simplified flowchart for project change approval process has been created by the author, along with the description of the process and example procedures – please refer to Figure 4 and Table 2.

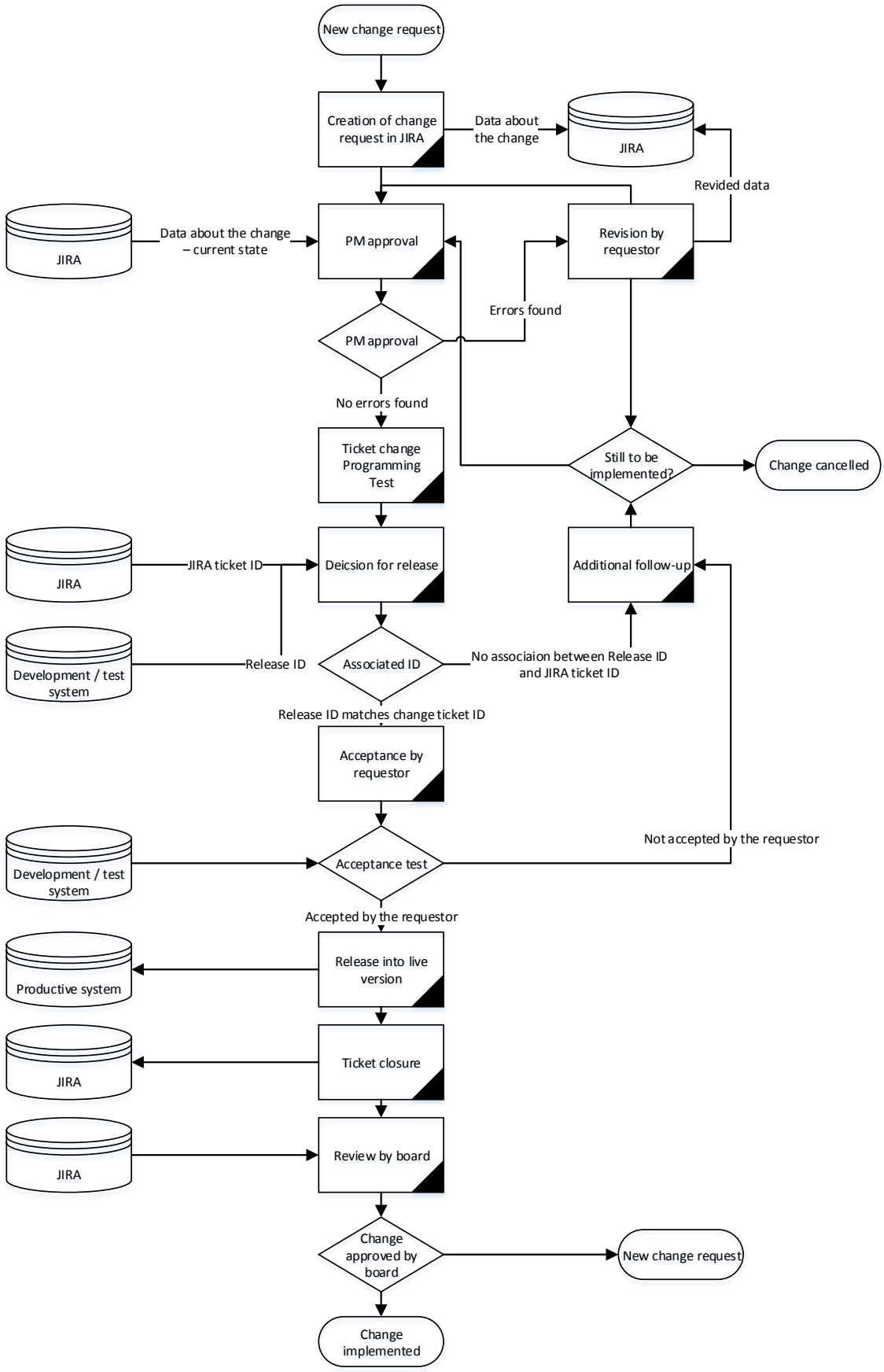


Figure 4 - Process of project change
Source: The author

DESCRIPTION OF THE PROJECT CHANGE PROCESS

Each change request is created as a JIRA ticket by the requestor. When the ticket is finalized, it is assigned to the project manager who decides if the change, as described in JIRA, should be implemented or not. In case the change is not approved, it is returned to the requestor for revision.

When the ticket is approved by PM, it is assigned to the implementation team who performs the development. There is an automatic control in JIRA that no ticket can reach the state "In development" without approval of PM **[CONTROL CH1]**.

After the development, the code is due to release. When developer assigns it to the requestor for acceptance testing, automatic control checks if the Release ID of the particular change matches Change request ID in JIRA. It is not possible to assign the change for acceptance testing if the match was not performed. [**CONTROL CH2]**.

Requestor performs the acceptance testing and decides whether the functionality meets his expectations. He either confirms the release, reviews the request ticket and adds further specifications for the development team, or terminates the change. No request may be released without the approval of requestor [**CONTROL CH3]**.

After the release, change ticket is closed in JIRA. All closed tickets are printed as a monthly summary for the project board that reviews the list and confirms it with signatures, confirming that the project change process has been followed appropriately **[CONTROL CH4]**.

At the end of every quarter, the board also checks that all changes requested in Q-2 have been released or terminated in Q-1. Additional follow-up on changes that are still in development is performed with the PM **[CONTROL CH5]**.

CONTROLS OF THE PROJECT CHANGE PROCESS

Control ID	**Short description**	**Nature**	**# in 2015**	**Frequency**	**Planned reliance & sample**
CH1	All changes in development have been approved by PM	Automated	67	Daily	Yes ~ 20

CH2	All released changes match request IDs in JIRA	Automated	46	Weekly	Yes ~ 10
CH3	All release changes have been accepted by the requestor	Automated	46	Weekly	Yes ~ 10
CH4	All changes have been confirmed by board during a formal meeting	Manual	12	Monthly	Yes ~ 2
CH5	Changes are developed in a timely manner	Manual	4	Quarterly	No (~ 2)

Table 2 - Controls over change process
Source: The author

Please note that the abovementioned control environment has been created by the author of this thesis for illustration purpose only, has been simplified for such purpose and does not represent any particular environment implemented in praxis.

2.2 ASSURANCE OVER BUSINESS OUTCOMES

The purpose of the assurance work is to assure stakeholders that risks connected to the information systems projects are mitigated. Therefore, the set of assurance activities that are connected mainly to business assurance is strongly associated with risk, described by Svatá [2012 pp. 193-194], such as:

- Missing support from company's hierarchy, leadership in particular.
- Processes within the ERP are not in alignment with business processes in the target organization.
- Preference of low initial price over aggregate cost of ownership.
- Disadvantageous contractual position of the buyer.
- ERP solution chosen without connection to company's needs.
- Unrealistic time schedules – lies on boundary between business & project.
- Unrealistic budgets – lies on boundary between business & project.

Therefore, following set of assessments, that will help the client to better understand and set the needs, budgets, schedules and contracts, should be performed by assurance team.

2.2.1 ADDRESSING THE NEEDS

Since pre-implementation project accompanies vast majority of information systems implementation projects, it presents the start point for execution of assurance. The assurance team should obtain evidence whether the implementer has placed such study and review its content.

The first part of the study should review reasons for the implementer to demand a new system, which may greatly vary and usually are combined from following list [DE BROUWER, 2013] [PLANTE MORAN, 2014] [NETSUITE, 2011]:

- Lot of different software tools for different processes.
- The current ERP is no longer supported by the vendor.
- It is not possible to access information needed by the organization (at the right time, or at all).
- There are concerns about security, data reliability, or operational risks.
- The support for current key business processes is not sufficient.
- The operation of current system(s) is too resource-consuming.

There is a very common mistake of top management of companies whose sales figures plummet: "New ERP is going to help us get through this." We have learned throughout the Information Management study programme this mind-set is destructively incorrect, causing business to spend resources they vitally need on systems they certainly need not.

The assurance team should compare the reasons stated in the pre-implementation project with the understanding they have gained during the planning and scoping part and help the implementing party to refine the needs for the system, so that formal demand for tendering process is based on those needs, and top management understands the reasons for investments into new ERP system in order to fully support them.

2.2.2 COMPLIANCE WITH STRATEGY

As information system presents a support service for the core business and information technology strategy should always be in alignment with the strategy of the whole business, the comparison between those two with acknowledgement to refinement caused by new ERP should be made by the assurance team. Both implementer and assurance team should, among other questions, ask how the new information system helps to fulfil mid- and long-term goals set by the management, and follow the fulfilment among the execution of the project, ending the assessment as part of post-implementation procedures.

2.2.3 REVIEW OF DATA AND INFORMATION BASIS

In order to create the formal demand for a new ERP, the ordering party needs to define data and information entities that are going to support the information system. Therefore, interviews with owners of data/information to understand their life cycle, accessibility, security, back-up process and further attributes shall be performed, and a prediction of changes to data environment shall be confirmed with data owners [SVATÁ, 2012 p. 197].

The assurance team should inspect that such meetings were held and be at least partially present during those meetings, as they are crucial for the ordering party to better understand the needs and the nature of changes that are going to be brought by the new system. Further controls over fully and correctly updating such data throughout the project should be assessed as well.

2.2.4 COMPLIANCE WITH BUSINESS PROCESSES

During the specification phase of information systems implementation, business users are interviewed by the project team to create an understanding of their work and requirements. Doucek [2006 p. 79] notes that strong "specification barrier" exists, causing the ordering party (being represented by middle- or top-management) being unable to specify the requirements accordingly to the actual work of employees that are on lower levels of hierarchy. This causes additional costs to both supplier and ordering party, because certain functionalities are not going to pass acceptance tests of target (business) users.

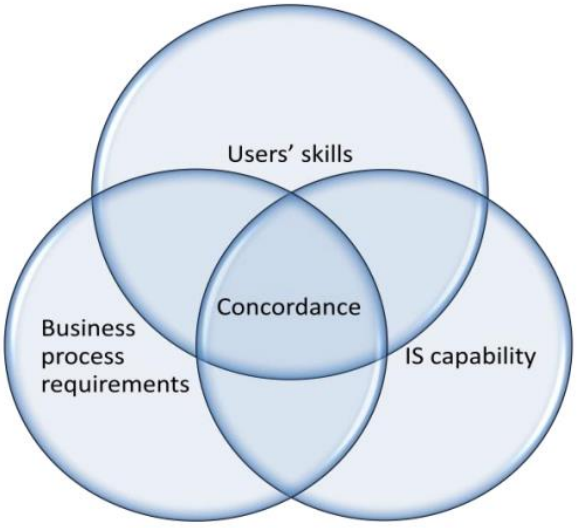


Figure 5 - Concordance of three variables
Source: [SAHASRABUDHE, et al., 2011]

Figure 5 explains that harmony between three elements – user's skills, business process requirements and capabilities of the future information systems – must be achieved to ensure proper usage of the ERP.

According to Doucek [2006 pp. 51-52], the crucial target of assurance work is to review the requirements that have been specified by the ordering party (experience with projects of similar scale are a great advantage of the assurance team, as mentioned in sub-chapter 2.1.2) and subsequently review the supplier's offer and evaluate whether the information system capabilities are in compliance with previously reviewed requirements for the system and also with user's skills.

2.2.5 REVIEW OF CONTRACTS

Management makes the final decision and chooses which of the offered ERP solutions will be implemented. Subsequently all the needed contracts will be prepared by lawyers. According to Svatá [2012 pp. 193, 198], there is a strong risk that lawyers that prepare the contracts will not understand the subject materiality, resulting in "formally perfect agreements that will degrade all previously performed steps". Project sponsor, IT specialist and a lawyer should review all contracts on behalf of the ordering party and assess whether the ERP solution will not only be the cheapest one, but also help to fulfil the ultimate goals, such as lowering the cost of existing processes or increasing productivity.

Since the assurance team usually comes from an audit/consulting corporation, the presence of IT specialists and lawyers that have experience with such contracts will help the ordering party during the review. Assurance team should review that price of licensing contract, implementation contract, system integration contract and maintenance contract is divided accordingly and the contractual position of the buyer is not disadvantageous. The most frequent mistake of buyer is to give preference to low initial price (for licensing and implementation) and to be blind to additional costs of ownership that will inevitably occur.

2.3 ASSURANCE OVER PROJECT OUTCOMES

This sub-chapter of the thesis is devoted to controls that are performed by assurance team to assess the project management and governance tools and procedures that have been specified by the implementing party.

2.3.1 REVIEW OF BUDGET CONTROLS

The first part that has been placed inside assurance over project lies between the project itself and business itself, since the budget is a key indicator for both. The crucial aim of this assurance control is to verify the existence of a project budget, assess its individual parts and review controls over adherence to the cost schedule.

There are two possible approaches for the creation of budget from which the implementing organization may choose: Top-down approach and bottom-up approach. The first focuses on

estimating the aggregate cost of the project and dividing it between particular activities, the second evaluates the cost of such activities and sums up for the overall budget.

Top-down approach is usually lead by senior management which creates an explanation of allocation of particular amounts for the work packages. Such explanation and allocation is subject to review of assurance professionals.

Bottom-up budgeting approach starts with business users, describing their needs, and IT professionals evaluating the cost of such needs, converted to implementation activities.

Both approaches are usually accompanied by additional estimation procedures and techniques, notably. Table 3 describes those procedures defined by Haughey [2014] and explains the role of assurance professionals during the estimations.

Technique	**Description**	**Role of assurance**
Expert judgement	Experts, with the aid of knowledge and experience, calculate the cost of project, accounting for factors not apparent to non-experts.	Assurance professionals represent such experts, having knowledge and experiences from past IS implementation projects.
Supplier bid analysis	Comparison of bids from different suppliers are used to calculate a cost estimate.	Assurance professionals may help supplier to evaluate such bids and remove unrealistic offers that would do harm to the estimation.
Analogous estimating	Estimation is created using data from historical projects.	Assurance professionals should help client in spotting differences from past projects that would compromise the accuracy of estimation.
Three-point estimating	Average of three estimates – best possible case, most likely case and worst case.	Review of the cases. While the estimation for worst case and best possible case should be close to reality, estimating the most likely case is very difficult without the expert.

Parametric estimating	Budget is calculated based on historical data (such as analogous estimating), but using parameters such as lines of code of the ERP or number of users of the system.	As very few major implementation projects take place in target organizations, access of assurance professionals to historical data of other clients will help make the estimation more accurate.

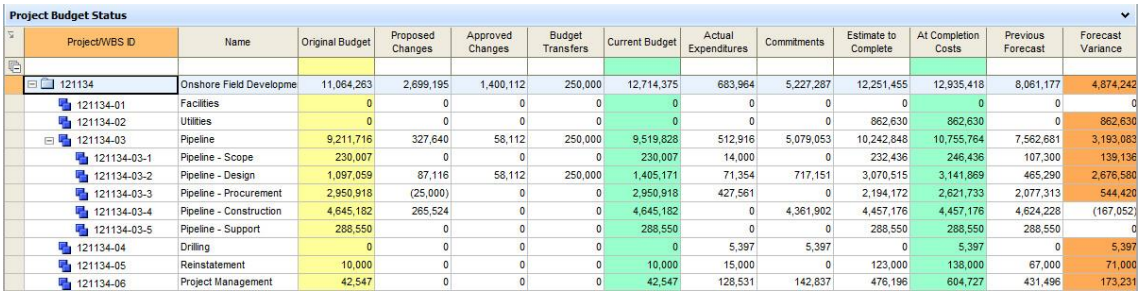
Table 3 - Budget creation techniques and possible involvement of assurance team
Source: The author, [HAUGHEY, 2014]

Successful composition of project budget is an essential kick-off activity, but the assurance team should map the process of budget controlling. Even though various techniques and computer aided automatic techniques may help to control the project budget, common signs of such controls should be assessed by assurance team. These involve at least:

- Existence of continuous control (usually aided by automated tools).
- Periodic reporting to the board.
- Existence of follow-up procedures for the cases when significant deviations from expected estimations are noted.

Svatá [2007 pp. 115-116] emphasizes that costs should always be tracked in the same structure as they have been made in the first place, should be connected to the work breakdown structure tracking and must always be conducted as a formal procedure.

Various automated tools may be used for continuous control of budgets and creation of managerial reports for the board. An example of such tool, EcoSys EPC, is shown in Figure 6.



Project Budget Status

Project/WBS ID	Name	Original Budget	Proposed Changes	Approved Changes	Budget Transfers	Current Budget	Actual Expenditures	Commitments	Estimate to Complete	At Completion Costs	Previous Forecast	Forecast Variance
121134	Onshore Field Developme	11,064,263	2,699,195	1,400,112	250,000	12,714,375	683,964	5,227,287	12,251,455	12,935,418	8,061,177	4,874,242
121134-01	Facilities	0	0	0	0	0	0	0	0	0	0	0
121134-02	Utilities	0	0	0	0	0	0	0	862,630	862,630	0	862,630
121134-03	Pipeline	9,211,716	327,640	58,112	250,000	9,519,828	512,916	5,079,053	10,242,848	10,755,764	7,562,681	3,193,083
121134-03-1	Pipeline - Scope	230,007	0	0	0	230,007	14,000	0	232,436	246,436	107,300	139,136
121134-03-2	Pipeline - Design	1,097,059	87,116	58,112	250,000	1,405,171	71,354	717,151	3,070,515	3,141,869	465,290	2,676,580
121134-03-3	Pipeline - Procurement	2,950,918	(25,000)	0	0	2,950,918	427,561	0	2,194,172	2,621,733	2,077,313	544,420
121134-03-4	Pipeline - Construction	4,645,182	265,524	0	0	4,645,182	0	4,361,902	4,457,176	4,457,176	4,624,228	(167,052)
121134-03-5	Pipeline - Support	288,550	0	0	0	288,550	0	0	288,550	288,550	288,550	0
121134-04	Drilling	0	0	0	0	0	5,397	5,397	0	5,397	0	5,397
121134-05	Reinstatement	10,000	0	0	0	10,000	15,000	0	123,000	138,000	67,000	71,000
121134-06	Project Management	42,547	0	0	0	42,547	128,531	142,837	476,196	604,727	431,496	173,231

Figure 6 - EcoSys EPC, budget monitoring tool
Source: [ECOSYS, 2013]

2.3.2 REVIEW OF TIME SCHEDULE

As time schedule of the project is inherently tied up with used project management methodology, it should always be reviewed against it by assurance professionals as part of their assessment over

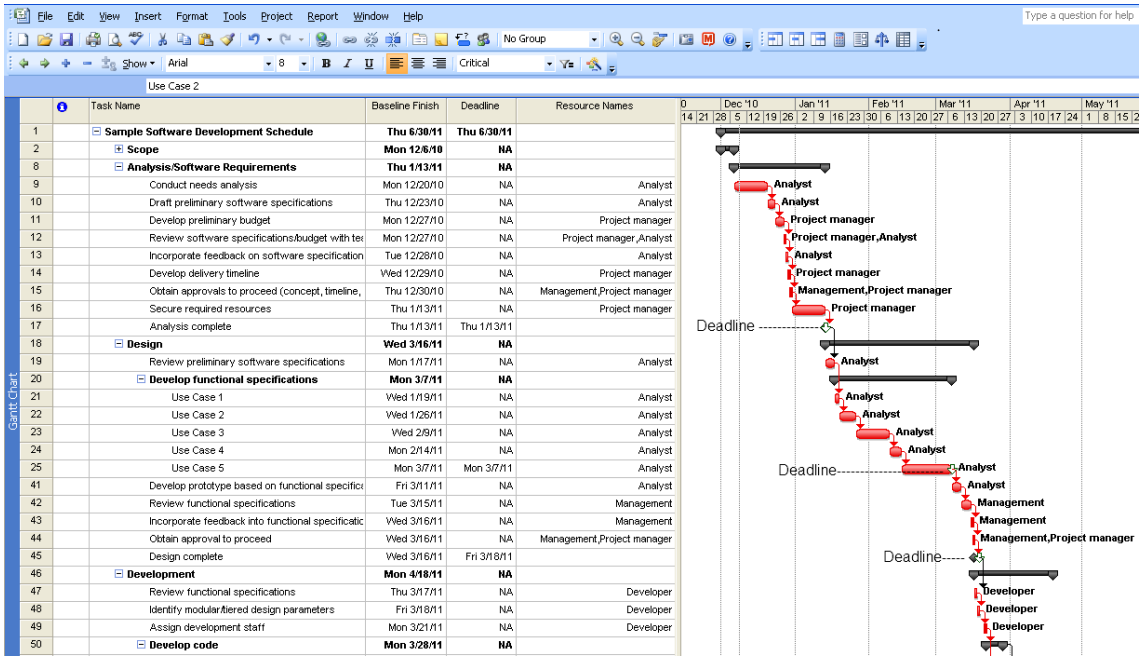
project. It is also closely connected to budgeting, cash-flow and human resource management, and thus lies on the boundary between business and project assurance.

The time line of the project is decomposed to set of activities, usually described as a Work Break-down Structure. Existence of such decomposition presents the first step of assurance assessment.

Assurance team should subsequently control following elements of the time schedule, according to Svatá [2012 pp. 209-210]

- Compliance with contractual obligations, notably milestones.
- Linkage to payment calendar.
- Filling of activities with responsible personnel.
- Time schedule change process.
- Effectiveness of automated time scheduling tools.

Most project management or GRC software solutions provide tools that help project managers to manage, control and review time schedule during the execution of projects. Figure 7 presents an example of software implementation project schedule in Microsoft Project scheduling module.



	Task Name	Baseline Finish	Deadline	Resource Names
1	**Sample Software Development Schedule**	**Thu 6/30/11**	**Thu 6/30/11**	
2	**Scope**	**Mon 12/6/10**	**NA**	
8	**Analysis/Software Requirements**	**Thu 1/13/11**	**NA**	
9	Conduct needs analysis	Mon 12/20/10	NA	Analyst
10	Draft preliminary software specifications	Thu 12/23/10	NA	Analyst
11	Develop preliminary budget	Mon 12/27/10	NA	Project manager
12	Review software specifications/budget with tea	Mon 12/27/10	NA	Project manager,Analyst
13	Incorporate feedback on software specification	Tue 12/28/10	NA	Analyst
14	Develop delivery timeline	Wed 12/29/10	NA	Project manager
15	Obtain approvals to proceed (concept, timeline,	Thu 12/30/10	NA	Management,Project manager
16	Secure required resources	Thu 1/13/11	NA	Project manager
17	Analysis complete	Thu 1/13/11	Thu 1/13/11	
18	**Design**	**Wed 3/16/11**	**NA**	
19	Review preliminary software specifications	Mon 1/17/11	NA	Analyst
20	**Develop functional specifications**	**Mon 3/7/11**	**NA**	
21	Use Case 1	Wed 1/19/11	NA	Analyst
22	Use Case 2	Wed 1/26/11	NA	Analyst
23	Use Case 3	Wed 2/9/11	NA	Analyst
24	Use Case 4	Mon 2/14/11	NA	Analyst
25	Use Case 5	Mon 3/7/11	Mon 3/7/11	Analyst
41	Develop prototype based on functional specific	Fri 3/11/11	NA	Analyst
42	Review functional specifications	Tue 3/15/11	NA	Management
43	Incorporate feedback into functional specificatic	Wed 3/16/11	NA	Management
44	Obtain approval to proceed	Wed 3/16/11	NA	Management,Project manager
45	Design complete	Wed 3/16/11	Fri 3/18/11	
46	**Development**	**Mon 4/18/11**	**NA**	
47	Review functional specifications	Thu 3/17/11	NA	Developer
48	Identify modular/tiered design parameters	Fri 3/18/11	NA	Developer
49	Assign development staff	Mon 3/21/11	NA	Developer
50	**Develop code**	**Mon 3/28/11**	**NA**	

Figure 7 - Time schedule in Microsoft Project 2007
Source: [MAKAR, 2010]

It is important to note that not only the existence of well-defined budget that is in compliance with contracts, payments or available human resources, but also the adherence to such budget and managerial controls over the adherence is in usual scope of work of assurance professionals.

2.3.3 REVIEW OF ORGANIZATIONAL STRUCTURE

Organizational structure represents an elementary and essential project management tool and its existence and effectiveness accounts for one of the most fundamental assurance control. Even though the structure is going to be reviewed against the used project methodology, for the purpose of this work, three levels of project management are considered, as described in Figure 8.

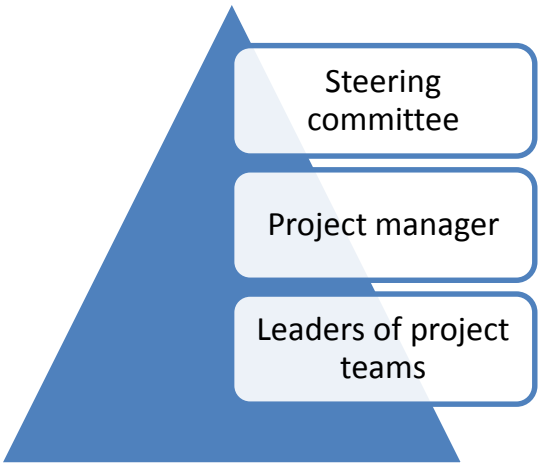


Figure 8 - Three levels of project management
Source: The author, [SVATÁ, 2012 p. 206]

Doucek [2006 p. 34] puts emphasis also on review of roles that are present in the organizational structure of the project, documentation of their responsibilities, authorizations, and relationships between such roles.

According to Svatá [2012 p. 207] assurance professionals should verify the existence of key business users and their responsibilities, as they represent essential personnel accountable for training of users, creation of user documentation and specifications for ERP customization.

Since the implementation of ERP solution will result in termination of some of work positions and user roles and establishment of new ones, a mini-project that describes both depreciated roles (e.g. controllers that perform manual controls over functionalities that are inherited in the new ERP automatically) and newly created ones (system administrators) and the process of transmission shall be created by the project team and evaluated by assurance professionals.

2.3.4 REVIEW OF ORGANIZATIONAL READINESS

As part of implementation project, the organization should evaluate its own capability to effectively implement the ERP, as it represents a great change to workflows, communication within the organization, roles, responsibilities, and other elements. Such evaluation may be executed as in Table 4 and should always be followed up by activities that eliminate or mitigate barriers for the implementation.

	ENABLERS	BARRIERS
ORGANIZATIONAL LEVEL	- Central leadership - Clear mandate - Pattern-breaking behavior - Shared understanding	- Programmatic focus & Core business - Decision making - Operational structure - Capability to work across boundaries - Ministerial constraints - Staff turnover - Misalignment of evaluation & accountability
INDIVIDUAL LEVEL	- Self-efficacy - Personal valence - Senior leader support - Organizational valence - Discrepancy - Affective commitment - Continuance commitment - Normative commitment	- Routine seeking - Emotional reaction - Short-term thinking

Table 4 - Enablers and barriers for the implementation
Source: [BLACKMAN, et al., 2013]

The aim of assurance team is to validate the existence of the evaluation and assess its individual parts, and also review follow-up procedures performed, acknowledging and describing residual risks in assurance reports.

2.3.5 REVIEW OF POLICIES

Assurance team should review that policies which accompany and define the project are existing, comprehensive, up to date and have been formally documented and communicated to all affected users. Notable project management policies, defined by Doucek [2006 p. 34] are focused on:

- Project lifecycle
- Collaboration
- Communication
- Documentation
- Acceptance procedures

- Project change process
- Contract change process
- Incident policy
- Project office
- Quality management
- Security management
- Project outcome management

In case that policies have been identified in specific areas only, the objective of assurance team is to adequately document associated risks and advise the target organization to improve the comprehensiveness of project management policies accordingly to best practices.

2.4 ASSURANCE OVER PRODUCT OUTCOMES

2.4.1 SOFTWARE QUALITY ASSURANCE

The aim of assurance within software development is to ensure its quality, which is achieved by conformance to requirements, both initial and those that arise during the development [BOURQUE, et al., 2014 pp. 174-175]. Note that following text assumes that software quality requirements have been specified and agreed between the development team and stakeholders during the pre-development phase of the project, since delivering maximum stakeholder value is the primary goal of the project.

Software quality management comprises four different subcategories [BOURQUE, et al., 2014 p. 178]:

- Software quality planning
- Software quality assurance
- Software quality control
- Software process improvement

The fundamental problem of software quality management is represented by infinitely balancing the quality and the budget, knowing that tradeoffs among cost, schedule and quality are inevitable and that designing a functional control environment over such tradeoffs is essential for every successful project. Such environment presents internal assurance itself and may be also assessed using an outside view of assurance professionals.

Cost of quality of software is usually divided into four categories [DUFFY, 2013 pp. 62-64]:

- **Prevention costs** are directly planned and serve as a precaution against future problems.
- **Appraisal costs** are related to quality monitoring and measuring activities.

- **Internal failure costs** are related to defects discovered before the final delivery of product to the customer.
- **External failure costs** that are caused by all defects that are discovered by customer after the product delivery.

In summary, cost of software quality may be transformed to potential costs of dealing with consequences of poor quality, such to be prevented by assurance. There are three complementary techniques for reducing the risk of failure: avoidance, detection and removal and damage limitation, noting that all measures should be strengthened accordingly when dealing with safety-critical systems [BOURQUE, et al., 2014 pp. 177-178].

This work aims particularly on software quality assurance and its goal: "Define and assess the adequacy of software processes to provide evidence that establishes confidence that the software processes are appropriate and produce software products of suitable quality for their intended purposes." [BOURQUE, et al., 2014 p. 178] Aforementioned statement should help the reader to understand the common misinterpretation of assurance as testing, which it is not (or not only). One of the key attributes of software quality assurance is its objectiveness, meaning it lies outside the organizational structure of the project itself, and also outside its financial ties, meaning that low development budget (inevitably leading to low quality) will not affect quality assessment work that would be even more needed and valuated.

Acknowledging previous paragraphs, it is now clear that the aim of assurance team is mainly to assess the development process and control environment quality. SWEBOK [BOURQUE, et al., 2014 p. 176] states that software engineering process ultimately affects the software quality perceived by stakeholders; thus process quality and product quality cannot be divided from each other. This approach is further described in Figure 9.

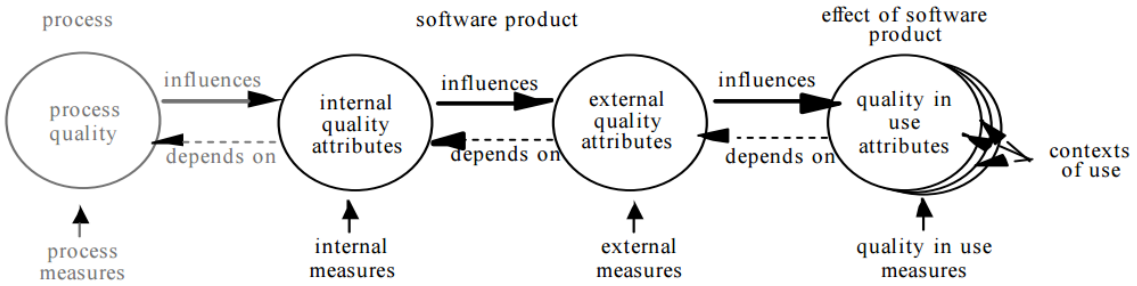


Figure 9 - Model of quality in the product life cycle
Source: [SURYN, et al., 2003]

The assumption is that combination of following quality precautions should be implemented:

- Formal definition of software development process design

    - Measurement system for the process performance
- Software life cycle process
- Fault detection and removal process
    - Process of elimination of causes of defects
- Formally defined procedures to validate appropriateness of implemented features
- Implementation of checklists to help ensure comprehensiveness of specifications and program design

The crucial aim of such precautions is the product quality, which can be divided into different quality features described in Table 5, which also explains what the representation of such features is and how to achieve them.

Feature	**How to achieve it**	**Representation**
Maintainability	Coding guidelines	Functionality may be added, removed, or modified easily. Code understandable to other coders than the original one.
Portability	Standard constructs	Software may be shifted from one platform to another, meaning machine-specific code constructs are avoided during the development.
Flexibility	Preference of parametrizing over hard coding	It is feasible to use the product even though some variables of the real world change, such as tax rate or law obligations.
Efficiency	Efficiency guidelines	Minimizing the amount of resources needed to run the system, particularly technical resources, but also other (human resources, energy, space etc.).
Modularity	Software architecture design	Software is built as stand-alone or near-stand-alone modules, meaning that the functionality is not duplicated among the system.
Reusability	Coding reusability guidelines	Source code may can be used in other similar products, lowering the overall price for particular ordering parties.
Readability	Formatting guidelines	Readable source code of the system, which is the first and elementary pre-requisite for product maintainability.
Testability	Software design guidelines	All software units can be tested independently, with other than productive data. This allows the customer to discover and fix defects easily than by revision of larger parts of source code.

Table 5 - Software quality features
Source: The author, [CHEMUTURI, 2014 pp. 38-41]

So far we have identified that main goals of software assurance is to overlook the process quality, measurement, and guidelines for quality features. The organization of quality assurance department varies project to project and is dependent on the final set of activities required by stakeholders, but it should be similar to the one presented in Figure 10.

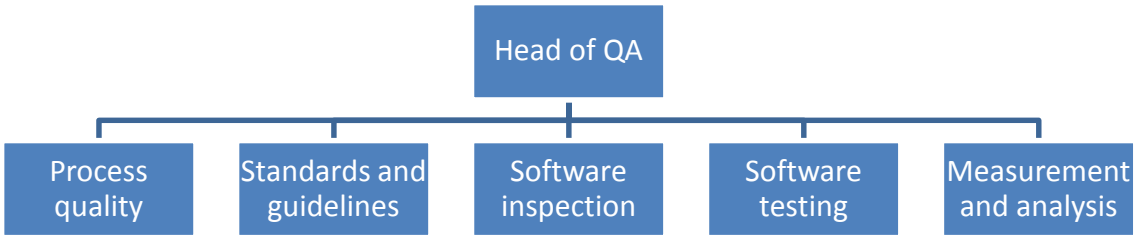


Figure 10 - Typical software quality assurance organization
Source: [CHEMUTURI, 2014 p. 75]

Following paragraphs will provide deeper perspective on abovementioned quality assurance organization structure, summarizing prior views given by the author in previous chapters and pieces of knowledge defined in a "Mastering Software Quality Assurance" handbook by Chemuturi [2014 pp. 69-74].

The **software development process** itself includes various aspect of development and quality assurance – formal measurement mechanism, analysis mechanism and improvement mechanism. Apart from the formal definition of how the development is going to be executed, it should also describe how the very process is going to be implemented to the organization, and provide analysis of anticipated results obtained from the process compliance.

The role of **standards and guidelines** is very strong during the whole development phase, as they can be seen as carriers of quality features described previously in Table 5. Standards and guidelines have, above all, following goals:

- To achieve uniformity of output from different developers coming from different environments, with different skills and coding habits.
- To ensure a minimum, standard level of quality in output from all developers, and achieve higher overall levels of quality.
- To help new entrants to the organization to effectively engage with the development team with less schooling needed.

Software inspection provides an independent review on the software itself by independent individuals, such as external assurance experts. While this may be the case for some of the information systems development products, assessment of other controls (mentioned in previous

and forthcoming paragraphs) is more usual, as the quality of development process is likely to bring quality products – this matter has also already been discussed previously.

The role of **software testing** is to verify that the developed program provides excepted behavior, based on finite set of selected test cases. To ensure this, prerequisites must be fulfilled, such as formal documentation of expected behavior, which is closely connected to pre-implementation phase of the whole project; stakeholders must be also aware that since testing is always done through finite set of test cases (for large ERPs, more test cases that are humanly possible to invent and technically possible to execute theoretically exist), testing obviously cannot provide definite assurance that the software is completely fault-free [BOURQUE, et al., 2014 p. 82].

Following list describes software testing types are usually carried out, but should not be taken as comprehensive, since various projects require tailored procedures:

- **Unit testing** serves to test developed artifacts (such as libraries, scripts, reports, screens), usually by the author of the unit or someone inside the development team.
- **Integration testing** checks that various functionalities are programmed in a way that they can be successfully organized into modules and those modules into software packages; is frequently conducted by independent peers within the development team.
- **System testing** ensures that the software may be used on different platforms (using different hardware, operating systems, and software configurations); usually conducted by independent peers within the development team.
- **Acceptance testing** is performed by customers in coordination with project manager, its aim is to ensure that developed functionality is the same as the ordered one.
- **Additional testing** consists of all other usually conducted tests, such as load and stress testing (to ensure correct performance), negative testing, etc.

We can notice that some of the tests are based on "peer reviews" that represent the first level of quality assurance: Independent members of development teams go through every line of code and documentation and provide report on how the work of colleagues has been performed.

Chemuturi [2014 pp. 72-73] strongly recommends that two particular tests are performed by the whole assurance team before presenting the output to the customer, to ensure the right product is built:

- **Functional testing** in order to gain assurance that all required features of the ERP are working as required by the customer – in fact functional testing serves as internal acceptance testing that gains comfort for the actual acceptance testing performed by the customer.

- **Negative testing** in order to gain assurance that the software is not going to be disrupted by any intended or unintended faulty use, using corrupted data that come from untrusted sources, etc.

The author of this thesis has worked in a software quality assurance department during his studies and can honestly confirm that negative testing, that basically consists of inventing cases developers would never ever think of, is a daily routine of quality assurance department and presents majority of the work performed.

Measurement and analysis is the last part of assurance and it is based on the common philosophy that if no metrics for development process (but it may be applied to all kinds of processes) exist, it can never be successfully managed. Implementation of measure-analyze-improve-monitor cycle for the development should ultimately end in a never-ending circle of continual improvement of both the software creation process and the product itself. Assigning the measurement of development to QA department helps to create valuable and reliable data about the performance for the usage of all levels of project management.

2.4.2 DATA ASSURANCE

After the development phase of the project, implementation within the environment of the customer becomes the next step. As the new ERP system serves as a data storage and processing tool, it is important to ensure the correct transmission of data has been performed. Since assurance procedures over data are a key element of the implementation phase, they have been pointed out from the overall process and are described in a standalone chapter. There's a great reason for this: Data migration is an appendix of information system implementation projects, with lot of hidden costs caused by unplanned downtime of the productive system, delays of the implementation, needs for additional storage and lack of validation procedures; with horrifying 83 % of all data migrations experiencing significant problems [IBM GLOBAL SERVICES, 2007].

There may be individual cases when the new ERP is going to use the same database as the old system, particularly when a developer has been hired to write a new package that fits the current data environment from the scratch. Acknowledging the popularity of pre-assembled software packages, most information systems implementation projects are likely not going to be such case. Therefore, a new database structure must be designed, so that data consistency among the system (meaning the same entity is represented by same data in the whole package), data integrity (resistance to corrupted data and low occurrence of such in general) and low redundancy (hosting of data that are no longer relevant, valid or needed) – with all those characteristics to be ensured by following means [CHEMUTURI, 2014 p. 308]:

- Domain experts will help to define fields in a way they can hold the data efficiently.
- Database experts will help control the redundancy and integrity by designing an optimal database schema.
- Software developers will help match the database data types with the ones inside the software package.

Having the databases and data to be migrated, the process will be performed by implementation experts. Details over the actual migration are not relevant to this diploma thesis and will not be described; the key value that is added by assurance team is the assurance over controls performed by migration team and business users that are the final responsible personnel over particular data packages.

Such procedures must comprise comprehensive comparison of summations of data as well as additional tests of details performed on sample data. Assurance professionals may help the customer on selecting a proper sample for such tests. Key activity is to gain confidence and approval over data sets that directly support financial statement lines as well as core business. These consist of (at least) following sets:

- Books (accounting)
- Property, plant and equipment
- Obligations
- Claims
- Warehouse
- Work in progress
- Supplier data
- Customer data
- Human capital data

The other part of data assurance part is a review that all data and documents created during the development of the project have been incorporated into the final product correctly.

2.4.3 IMPLEMENTATION ASSURANCE

For the implementation of developed / customized ERP system into the target organization, a crucial decision between two variants of implementation must be made, often utilizing advices and recommendations given by assurance experts:

- **Big Bang** implementation, with the live start of all modules at a given date and time.
- **Stage** implementation, allowing the target organization to launch some of the crucial modules (eg. finance) at one time and add more modules later.

Moreover, there is always a third option – combination of both approaches. Table 6 describes general principles on how to choose the right implementation variant for different organizations and environments.

ERP configuration		**International strategy**		
		Multinational	Global	Supranational
SW configuration	**Business level**	Same finances, different processes	Same finances, same processes	Same finances, different processes
	System level	Independent systems, connected reporting	Centralized architecture, interfaces to national levels	Distributed functionality
	Process description level	Detailed	Poor	Detailed
	Customization level	High	Low	High
Information architecture		Standalone databases Distributed applications Local HW Utilization of LAN	Centralized databases Centralized applications Centralized HW Utilization of WAN	Distributed databases Hybrid applications Utilization of WAN
Implementation variant		**Stage**	**Big Bang**	**Combination**

Table 6 - Recommendations for implementation variant
Source: [SVATÁ, 2007 p. 80]

Describing implementation activities in detail would greatly exceed expected range of this work; thus, simplified set of anticipated processes, activities and controls over the phase of integration into target organization has been assembled by the author.

- Integration
    - Setting up interfaces with other software packages ran by the target company
- Data migration – described in previous sub-chapter
- Configuration of parameters

- Training
    - Business user training
    - End-user training
    - Administrator training
- Creation of software documentation for all target groups
- Reengineering of current processes accordingly to standards set by the ERP
- Reengineering of networks
- Implementation of new hardware equipment
- Acceptance tests
    - Formal support for go/no-go decision

The aim of the assurance initiative, as during other phases, is to review the design of such processes, overlook the execution, map controls (correct timing of abovementioned procedures in particular) and eventually consult details of execution with the project team.

2.4.4 POST-IMPLEMENTATION ASSURANCE

After the implementation, a continual process of post-implementation assurance should be executed, in order to collaboratively enhance the operation of information system and validate that users are not using workarounds to bypass standard processes implemented together with the system. Svatá [2012 pp. 211-212] emphasizes also the verification of following controls and procedures:

- Identification of fields where the ERP does not provide expected outcomes
- Identification of processes that require unexpected support of help desk for business users
- Retraining of users
- Re-customization of system if needed
- Defined process for continuous optimization of performance
- Tracking the performance of system on transactional level
- Back-tracking the compliance of user expectations and the system functionality

A closing report on the project is the last pre-requisite for the issuance of assurance report and conclusion of the whole assurance initiative.

2.5 CONCLUSION ON THE ROLE OF ASSURANCE

Following sub-chapter concludes on the role of assurance initiative during information systems implementation projects by summarizing prior knowledge and establishing the assurance profile that will be compared to the assurance defined in in-scope project management standards.

This sub-chapter also fulfils the objective that has been set up for the theoretical part of this diploma thesis, as it creates a summary that will help IT professionals to understand the importance of utilizing assurance within their information systems projects.

2.5.1 ENHANCING THE TRADITIONAL VALIDATION APPROACH

By reading all the previous sub-chapters of second chapter, it must now be clear to the reader that assurance enhances the traditional V-model of information systems implementation with acknowledgement of soft, systematic approaches shown in Figure 11.

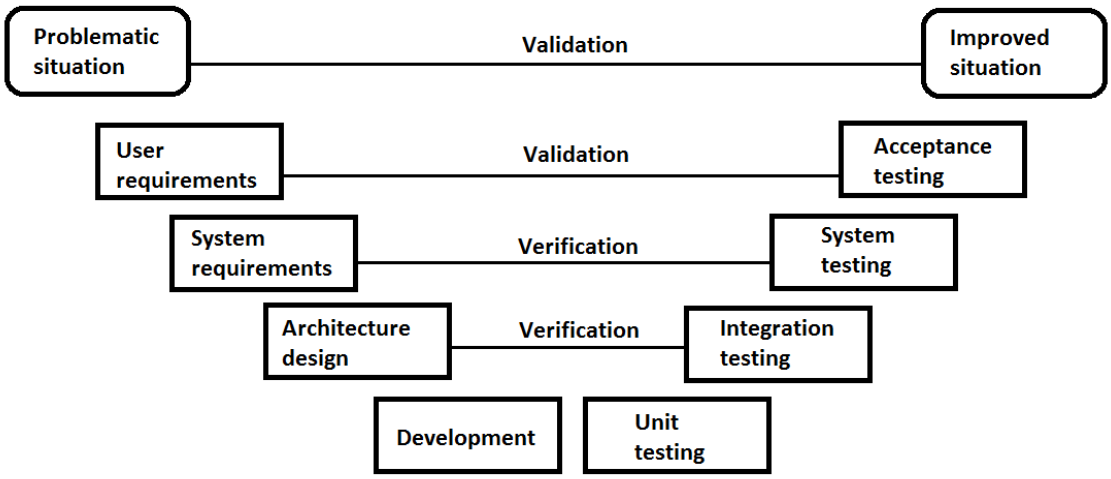


Figure 11 - Traditional V-model
Source: [SVATÁ, 2007 p. 17]

This thesis does not focus on disrupting the traditional model. We have learned, though, that validation and verification of criteria on the left side of the model after the development of the software is finished results in deficiencies, budget overruns, and dissatisfaction of both target users and stakeholders in general.

Figure 12, on the other hand, shows the theoretical approach summarized in all previous sub-chapters applied to the traditional model, to help reader understand the role of assurance. Major ERP implementation projects may last for months, or, in some cases, even years. Problematic situation or user requirements may change over the time. Users may not even remember what they have required by the time the software package arrives on their table. The aim of assurance is to prevent such situations by constantly enhancing the left side of V-model by verifying it.

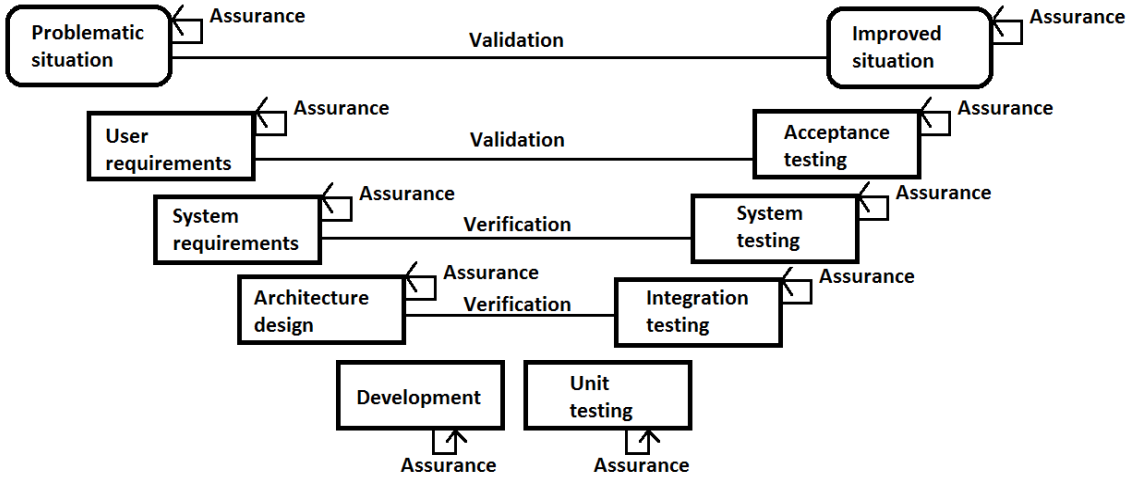


Figure 12 - Enhanced V-model
Source: The author, using [SVATÁ, 2007 p. 17]

Verification and validation present key words, since the role of assurance must never consist of creating decisions. We have already acknowledged that in some parts of information system implementation projects, assurance professionals may help the assurance customer to revise the basis for managerial decisions. But decisions themselves must always lie on the project board, since the role of assurance is to provide a report on how the project was executed. By being such an important part of its execution by creating decision, independent standpoint will never be achieved. Following sub-chapter will sum up all previously described knowledge in structured form in Table 7.

2.5.2 THE ROLE OF ASSURANCE

ASSURANCE OVER INFORMATION SYSTEMS IMPLEMENTATION PROJECTS	
OBJECTIVE	To provide assessment on risk management, control, or governance processes for the project
CUSTOMER	Stakeholders of the project
ACHIEVED THROUGH	Mapping and assessments of processes and control environment (control design and control outcomes)
POSITION	Independent Consultancy over most project stages is possible, but decision making lies on project board / teams
SOURCE	External assurance team recommended
TIMELINESS	During all stages of project
PRICE	Individual, should never exceed potential harm caused by impaired system
EXTENT	Individual, based on review criteria
REVIEW CRITERIA	Policies, standards, methodologies, legal obligations, best practices, or a combination of previously mentioned
CONCLUSTION	Assurance report
COMMON EXTENT OF ASSURANCE INITIATIVE ON ERP IMPLEMENTATIONS	
ASSURANCE OVER BUSINESS OUTCOMES	
FIELD	**PROCESSES AND CONTROLS**
Addressing the needs	Existence of pre-implementation project Mapping of business needs Feasibility study
Strategy compliance	Mapping of project outcomes to strategy goals
Data basis	Data basis specification process Formal definition of information and data basis for the information system
Process compliance	Requirement specification process Formal definition of processes covered by the information system Compliance between requirements and offered ERP solution
Contracts	Formal attributes of contracts Attributes connected to subject matter Contractual position of the ordering party

ASSURANCE OVER PROJECT OUTCOMES	
FIELD	**PROCESSES AND CONTROLS**
Budget	Budget creation process Budget management process Continuous controls over budget Periodic controls over budget
Time schedule	Time schedule creation process Time schedule change process Automated time scheduling tools usage Compliance with budget & contractual obligations
Organizational structure	Formally defined organizational structure Existence of key business users Formally defined responsibilities of users User role transmission mini-project
Organizational readiness	Formal evaluation of organizational capability for change
Policies	Formal documentation of comprehensive project policies

ASSURANCE OVER PRODUCT OUTCOMES	
FIELD	**PROCESSES AND CONTROLS**
Software	Formally defined software development process Formally defined software quality requirements Control environment over cost-schedule-quality tradeoffs Formally defined fault detection and removal process Software inspections Standards and guidelines on software development Software testing procedures (Unit, Integration, System, Acceptance) Formally defined measurement and analysis tools over development
Data	Definition of data basis for old and new ERP Data migration mini-project Data migration controls Formally confirmed confidence over data migration Incorporation of data created during the execution into the product
Implementation	Choice of data implementation variant Definition of interfaces Integration with other software solutions Training of all user groups Documentation for all user groups Reengineering of processes Reengineering of hardware and networks Formally confirmed acceptance tests Basis for the go / no-go decision
Post-implementation	Identification of misalignments Identification of performance issues Identification of workarounds Identification of user difficulties Formally defined process for continuous optimization of ERP

Table 7 – The role of assurance
Source: The author

3. ASSURANCE IN SOFTWARE DEVELOPMENT METHODOLOGIES

The third chapter focuses on what is the backbone of all software implementation projects: Software development methodologies and on the role of quality assurance within them in particular. The aim is to identify such activities, which assure stakeholders that the software product is being developed as required and accordingly to best practices, with respect to the role created in previous chapter.

This chapter is structured in the following way: Firstly, assurance techniques of three formally documented software development methodologies will be described. Secondly, comparison of the role of software development assurance with those methodologies using an evaluation table will be created.

Choosing methodologies for the comparison is based on experiences gained while finishing the university course "Introduction to Project Management" and discussion with the thesis supervisor. Three methodologies that are very different from each other have been chosen. Even though they all describe themselves as "agile", we will learn through the chapter that it may be more a word in the name than a reality. Some of the methodologies were rejected because of their complexity and parameterizability (such as Rational Unified Process), others because of non-existent assurance roles. Therefore, the final choice of three in-scope project development methodologies is as follows:

- **Agile Unified Process** (Defined by The AUP Product)
- **Scrum** (Defined by The Official Scrum Guide)
- **Feature Driven Development** (Defined by The Latest FDD Processes)

To help reader understand the environment of those methodologies and role of assurance within them, sub-chapters will provide simple characterization of particular methodologies and then focus on assurance processes.

3.1 AGILE UNIFIED PROCESS

This sub-chapter is based (as well as all quotations) on formal documentation of The Agile Unified Process (AUP) and AUP Product, created by Mr. Scott Ambler [AMBLER, 2014].

Agile Unified Process was released in September 2005 as an attempt to improve and agilize the IBM's Rational Unified Process. The lifecycle of AUP is "serial in the large, iterative in the small, delivering incremental releases over time", as described in Figure 13 and Figure 14.

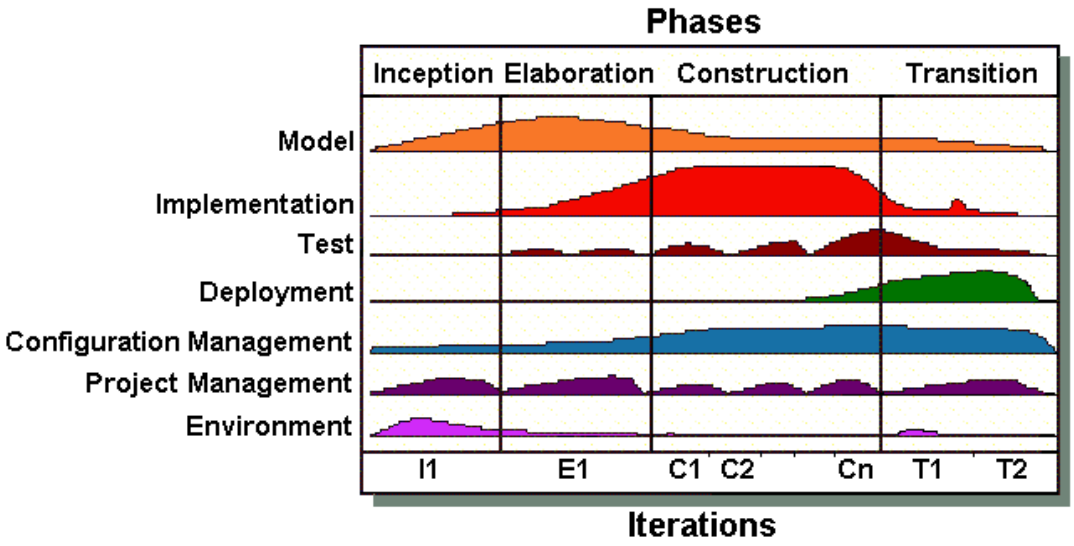


Figure 13 - AUP lifecycle
Source: [AMBLER, 2014]

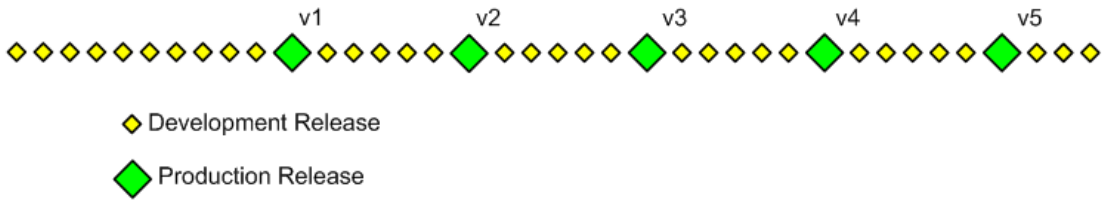


Figure 14 - AUP product delivery
Source: [AMBLER, 2014]

Indications of assurance activities may be found in provided AUP overview, as in following excerpts:

- **Phases**
  - "Inception: The goal is to identify the initial scope of the project, a potential architecture for your system, and to obtain initial project funding and stakeholder acceptance."
    - Development team gains an understanding of the target environment, followed by a formal stakeholder acceptance.
  - "Transition: The goal is to validate and deploy your system into your production environment."
    - Note that this is the approach very similar to the traditional V-model in Figure 11 – validating the software after it's been built.
- **Disciplines**
  - "Implementation: The goal of this discipline is to transform your model(s) into executable code and to perform a basic level of testing, in particular unit testing."

        - Note the unit testing being an inherent part of implementation discipline.
    - "Test: The goal of this discipline is to perform an objective evaluation to ensure quality. This includes finding defects, validating that the system works as designed, and verifying that the requirements are met."
        - Whole testing discipline is present in the methodology.
    - "Project Management: The goal of this discipline is to direct the activities that takes place on the project. This includes managing risks, directing people (assigning tasks, tracking progress, etc.), and coordinating with people and systems outside the scope of the project to be sure that it is delivered on time and within budget."
        - This is more related to project management standards; even though, one question arises: How does coordinating with people outside the project assure the team about being on time and within budget?
    - "Environment. The goal of this discipline is to support the rest of the effort by ensuring that the proper process, guidance (standards and guidelines), and tools (hardware, software, etc.) are available for the team as needed."
        - Presence of process definition, standards, guidelines and tools indicates strong focus on quality assurance.

Following roles specified by AUP participate in most activities that belong to quality assurance execution:

- Project Manager – Among other "builds relationships with stakeholders, coordinates interactions with stakeholders, plans, manages and allocates resources".
- Reviewer – "Evaluates project work products, often 'works in progress', providing feedback to the team."
- Stakeholder – "Professionals potentially affected by the development and/or deployment of a software project."
- Tester – "Responsible for writing, conducting, and logging the outcomes of testing effort."
- Test Manager – "Responsible for the success of the testing effort, including planning, management, and advocacy for testing and quality activities."

Table 8 presents a deeper extraction of assurance activities performed in AUP, sorted by phases and disciplines, assembled by the author of this thesis.

PHASE	DISCIPLINE	ASSURANCE ACTIVITIES
Inception	Model	Participation of stakeholders during high-level requirements modeling
	Implementation	Acceptance of User Interface Prototype by stakeholders
	Test	Initial test planning Review of initial project management work products by key stakeholders Review of initial models by stakeholders in the presence of developers
	Configuration management	Setup of a formally defined change and configuration management environment Putting all work products during all phases of project under CM control
	Project management	Feasibility study (financial, technical, operational, political aspects to be considered)
	Environment	Setup of a development process, tailoring the process, choosing the right tools to execute it
Elaboration	Model	Identification of technical risks
	Test	Validation of system architecture Validation of results of prototyping efforts with stakeholders Development of a regression test suite based on modeling and implementation activities Maintaining traceability between requirements, tests and source code
	Environment	Maintenance over development process and tools
Construction	Model	Active stakeholder participation to understand their needs on JIT basis Design model storming Writing acceptance test cases Formal documentation over critical design decisions
	Implementation	Taking a test-driven-development-based approach to all aspects of implementation Using a source-code-change-tracking tool Setting up user interface and user experience standards

	Test	Testing the software – unit tests, system tests, deployment tests, user acceptance tests (Further definition of AUP testing follows this table as Figure 15)
	Deployment	Developing a release documentation Developing a system documentation (operations, support, overview, user documentation) Creating training materials
	Project management	Identification of main dependencies involved with successful deployment of the system Planning the end user training Planning the pilot / beta test of the system
	Environment	Setting up a training environment for end users, support staff and operations staff
Transition	Model	Finalizing system overview documentation Potentially usage of JIT modeling to understand root causes of transition defects
	Test	Full scale validation of system – system testing, integration testing, acceptance testing, pilot / beta testing (Further definition of AUP testing follows this table as Figure 15) Validation of system documentation (operations, support, overview, user documentation) Validation of training materials Formalization of defect reporting and releasing it into production
	Transition	Finalization of system documentation (operations, support, overview, user documentation) Execution of the end user training
	Environment	Setting up a support environment

Table 8 - Assurance activities in AUP
Source: The author, using [AMBLER, 2014]

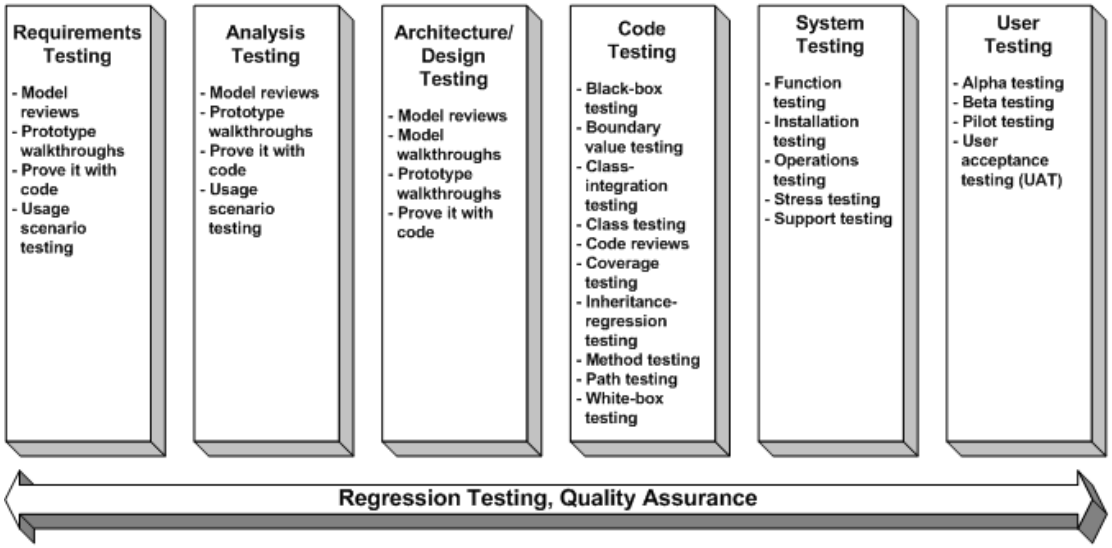
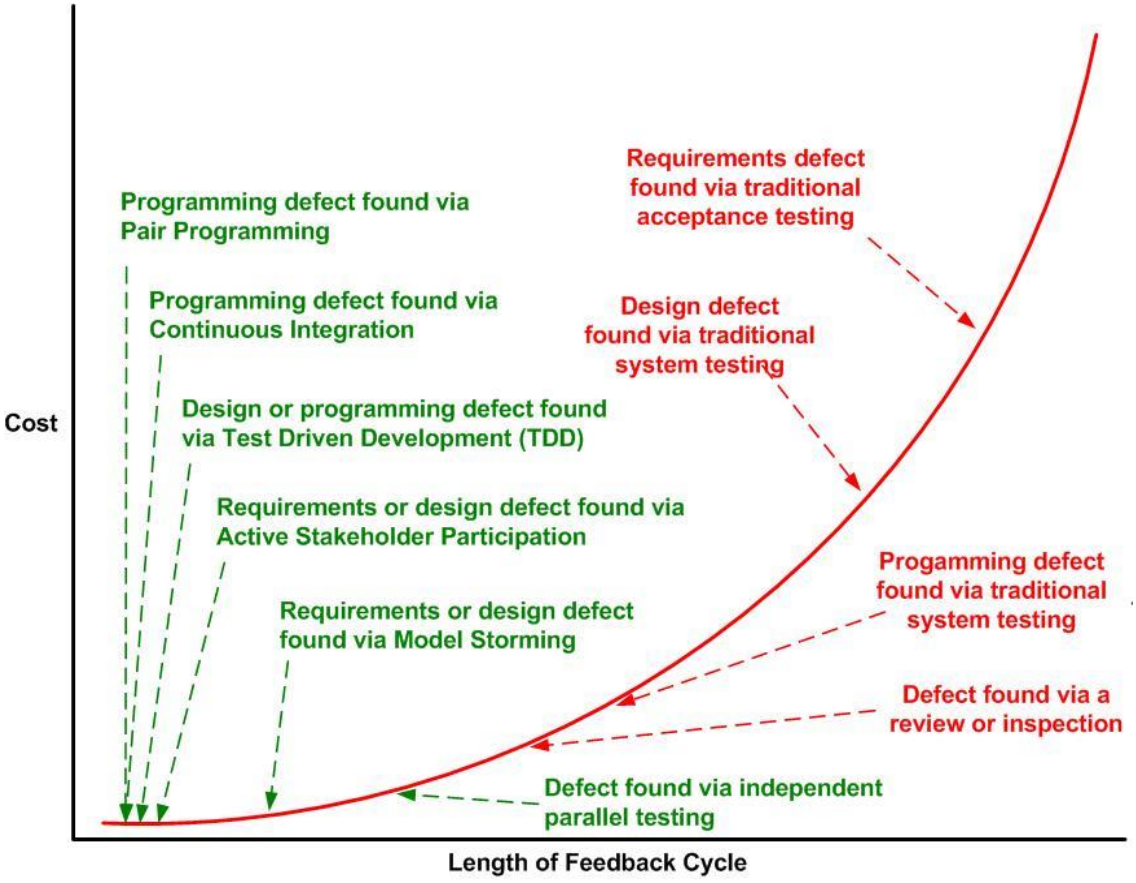


Figure 15 - Testing in AUP
Source: [AMBLER, 2014]

As we can understand from Table 8 and Figure 15, the extent of assurance activities in Agile Unified Process is quite comprehensive. Discussion may be focused on the timing, though.



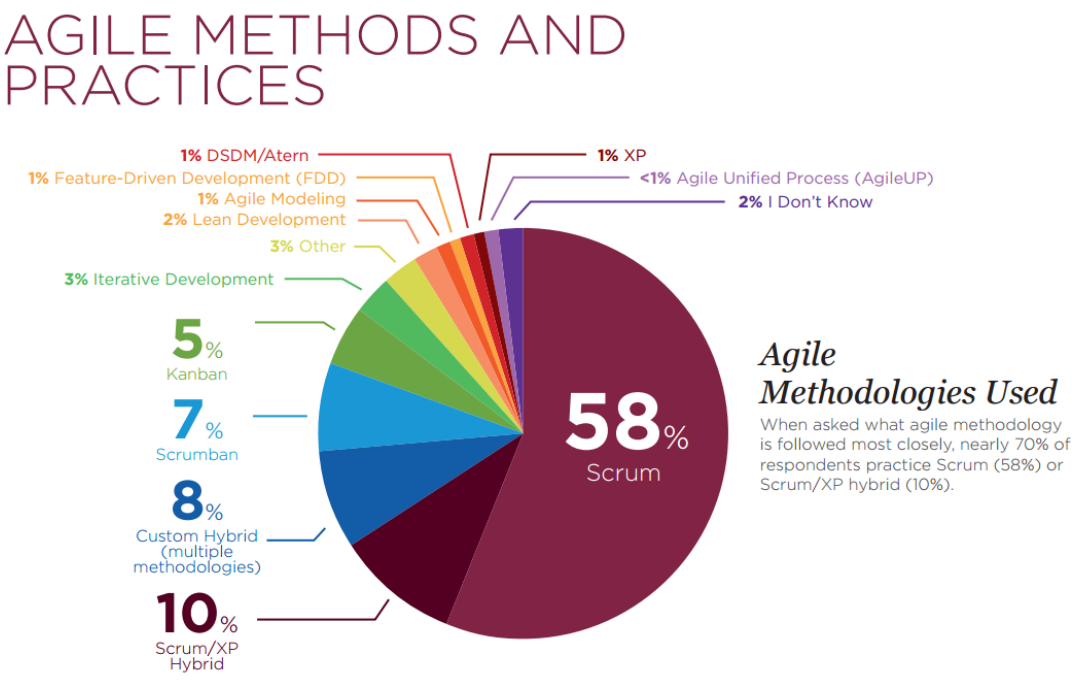
Graph 3 - The Full-Lifecycle Object-Oriented Testing
Source: [AMBYSOFT, 2012]

In Graph 3, the author of AUP and his associates discuss the impact of quality assurance timing on costs incurred by found defects and it is clear that the longer the feedback cycle is, the higher are costs. This phenomenon is reflected in AUP only partially, as most of the quality assurance activities take place during construction and delivery phases and accent on continuous requirement revision is not strong enough, causing the prolongation of feedback cycle. Being an enhancement of RUP, Agile Unified Process is in fact at least partially rigorous, with long feedback cycle and comprehensively described assurance techniques being both strong attributes of such rigorousness. Further evaluation of compliance of assurance in AUP with understanding created during the theoretical part of this work follows in the end of this chapter.

3.2 SCRUM

This sub-chapter is based (as well as all quotations) on formal documentation of Scrum, written in The Official Scrum Guide by Ken Schwaber and Jeff Sutherland [SCHWABER, et al., 2013]. While many unofficial additions to Scrum exist, this guide serves as formal documentation of the methodology; as authors emphasize, "Scrum's roles, artifacts, events, and rules are immutable and although implementing only parts of Scrum is possible, the result is not Scrum. Scrum exists only in its entirety and functions well as a container for other techniques, methodologies, and practices."

Scrum was firstly introduced in 1995 and since then, the Scrum Guide has been developed and sustained by its authors to document the learning gained over 20 years of applying Scrum.



Graph 4 - Agile methodology usage
Source: [VERSIONONE, 2016]

In Graph 4, extracted from the 10th Annual State of Agile Report, we can see clearly that Scrum is the dominant agile methodology used in software development. Numerous courses provided by the University of Economics, Prague, are focused on Scrum methodology, therefore the thesis will leave out the Scrum definition and focus will be laid on quality assurance aspects of Scrum. Naturally, understanding of Scrum roles and development process is critical for understanding of such aspects; they are – in a well arranged way – described in Figure 16.

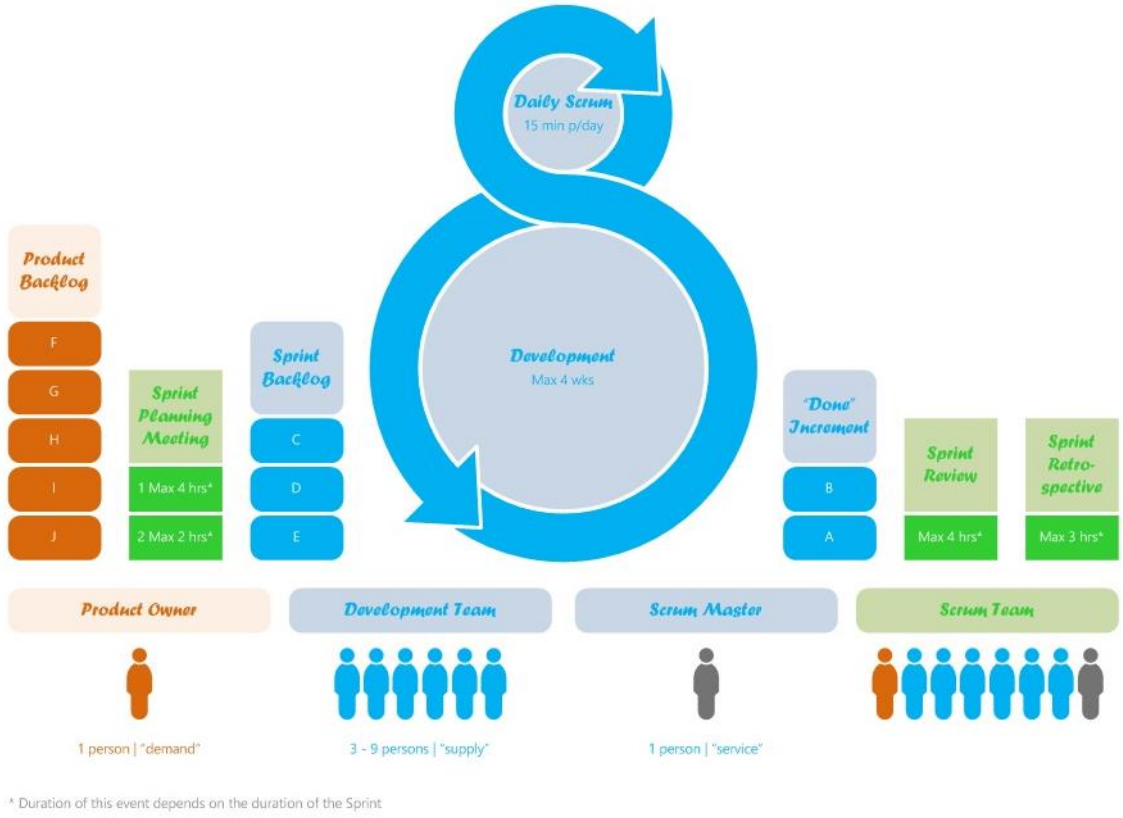


Figure 16 - Scrum overview
Source: [HOOGVELD, 2015]

Scrum describes itself as a simple-to-understand methodology with iterative and incremental approach that helps to optimize predictability and control risks. There are three pillars of Scrum defined, each with its connection with quality assurance; they are described in Table 9.

PILLAR	DEFINITION	QA CONNECTION
Transparency	Transparent development process Common standards Common definition of "done"	Understanding of process, standards and quality requirements is necessary for the high product quality.
Inspection	Scrum users must inspect artifacts to detect undesirable variances Inspections at the point of work	Short quality verification cycle helps to find defects in little to no time.
Adaptation	Assessing deviations outside acceptable limits Adjustments to development process Formal development events	Formally defined feedback procedures are necessary to correct discovered defects.

Table 9 – Three Scrum pillars
Source: The author, [SCHWABER, et al., 2013]

The short, iterative development cycle provides a lot of opportunities for feedback during team work or at Scrum events; the existence of "done" version of software at all stages of development helps stakeholders to better understand attributes of the product and provide feedback on Scrum events. "Done" version of software must be in a usable condition, whether or not the Product Owners decides to actually perform the release. As the team matures, "done" will include more stringent criteria for higher quality, according to the guide.

Development teams in Scrum are self-organized with nobody eligible to intervene into the process of turning Product Backlog items into reality. Scrum guide emphasizes that no development team members can call themselves other than "developers", even though it is clear that they may, and must, carry out activities that are not perceived as the ones that should be done by developers in the traditional understanding of the word, such as modelling, creating software architecture, or testing.

Product Backlog consists of items that are to be done and represents a key element of assurance, as it serves as a control mechanism for stakeholders to ensure that features that maximize value of the product perceived by stakeholders is developed firstly and correctly. One of the Product Owner responsibilities is to ensure that "Product Backlog is visible, transparent, and clear to all, and shows what the Scrum Team will work on next" and also that "Development Team understands items in the Product Backlog to the level needed". The Product Backlog constantly changes in order to identify "what the product needs to be appropriate, competitive, and useful", and by its definition it is never complete, since stakeholders, marketplace, technology and many other parties and matters provide reasonable feedback on its items.

The procedural functionality of development falls on Scrum Master's shoulders. The main purpose of Scrum Master is to assure that Scrum Team adheres to Scrum process, practices and rules that are defined in Scrum Guide and potentially in the internal Scrum implementation. He provides variety of services to all participants; following are notable for connection to quality assurance:

- "Finding techniques for effective Product Backlog management.
- Helping the Scrum Team to understand the need for Product Backlog.
- Coaching the Development Team in self-organization and cross-functionality.
- Helping the Development Team to create high-value products.
- Removing impediments to the Development Team's progress.
- Leading and coaching the organization in its Scrum adoption.
- Helping employees and stakeholders understand and enact Scrum and empirical product development." [SCHWABER, et al., 2013]

Sprints represent the heart of Scrum, as they serve to create a "done" increment to the product. It is important to note that even though re-negotiation of Sprint scope may be done by the Product Owner with Development Team, it is forbidden to carry out changes that would endanger the Sprint goal and, more importantly, decrease quality goals by any means. The length of Sprint, which is set to maximum of one month, greatly reduces the risk of programming non-functional, defective or unwanted product, to the risk of one calendar month of cost. According to the guide, sprint cancellations are very uncommon.

Clear Sprint Goal provides the Scrum Team with understanding of their work and reasons for creating the particular increment. It is crafted during a Sprint Planning meeting by discussing objectives and Product Backlog items that are to be developed. The selection of Product Backlog items for the Sprint and the plan for their delivery is called the Sprint Backlog. First Sprint Backlog items are de-composed to a detailed work breakdown structure before the start of the Sprint, while others later inside the Sprint. If the work that Development Team performs turns out to be unable to achieve the Sprint Goal, negotiation over trade-offs and re-scoping must be done with the Product Owner.

The assurance aim of the Daily Scrum meeting (which is a maximum 15 minutes time-boxed event) is to synchronize activities, create plan for the forthcoming day, and mainly, to inspect and revise the work done since the last Daily Scrum. Matters of contribution to the Sprint Goal and impediments that prevent developers from meeting the Sprint Goal are also discussed during the meeting. This basically shortens the internal feedback cycle to one single day.

At the end of each Sprint, two feedback meetings are being held: Sprint Review and Sprint Retrospective. Following elements are included in the Sprint Review, whose attendees include the Scrum Team and key stakeholders invited by the Product Owner.

- "The Product Owner explains what Product Backlog items have been 'Done' and what has not been 'Done';
- The Development Team discusses what went well during the Sprint, what problems it ran into, and how those problems were solved;
- The Development Team demonstrates the work that it has 'Done' and answers questions about the Increment;
- The Product Owner discusses the Product Backlog as it stands. He or she projects likely completion dates based on progress to date (if needed);
- The entire group collaborates on what to do next, so that the Sprint Review provides valuable input to subsequent Sprint Planning;
- Review of how the marketplace or potential use of the product might have changed what is the most valuable thing to do next; and,
- Review of the timeline, budget, potential capabilities, and marketplace for the next anticipated release of the product." [SCHWABER, et al., 2013]

It is clear that almost all items from the abovementioned list contribute to high process and therefore also product quality and help the entire team to understand how and why they are developing the information system product.

The Sprint Retrospective meeting takes place immediately after the Scrum Review and its aim is to enhance the development process itself, by inspecting how the last Sprint influenced the people, relationships, sub-processes and tools; identifying major achievements and failures that present field for future improvements; and subsequently creating an improvement implementation plan. The aim of the Scrum Master is to encourage the Scrum Team to improve the process and make it more enjoyable for the whole team. Such retrospective over the development process itself and also project management process is exceptional and does not take place in many other methodologies, neither rigorous nor agile.

Emphasis of the guide is laid on monitoring progress to both Sprint Goal and project goal. At any point of the time, remaining work in Sprint Goal and in the project must be able to be summarized by the Product Owner. Estimations on remaining time to reach the goal must be transparent to all stakeholders of the projects; they may be done using various forecasting techniques such as burn-ups and burn-downs described in the theoretical part of this work. In compliance to prior theoretical research described in sub-chapter 2.1, the Scrum Guide warns the reader not to replace

empiricism by such forecasts, noting that "in complex environments, what will happen is unknown; only what has happened may be used for forward-looking decision-making" [SCHWABER, et al., 2013].

We have learned in this sub-chapter that while there is a strong emphasis on feedback and its very short cycle as well as on stakeholder transparency and acceptance, tangible and specific definition of quality assurance activities is not really present in the formal definition of Scrum.

3.3 FEATURE DRIVEN DEVELOPMENT

This sub-chapter is based on formal documentation of Feature Driven Development methodology, written in The latest FDD Processes by Nebulon [NEBULON, 2003].

Feature Driven Development is a methodology invented in the late 1990's by Nebulon and it is not only feature-driven methodology, but also a model-driven. Firstly, there is a startup phase for each information systems implementation projects, which consists of development of overall model, building a features list and planning the work. The construction phase of the methodology follows and is based on multiple recurrence of designing by feature and building by feature. This approach is described in Figure 17.

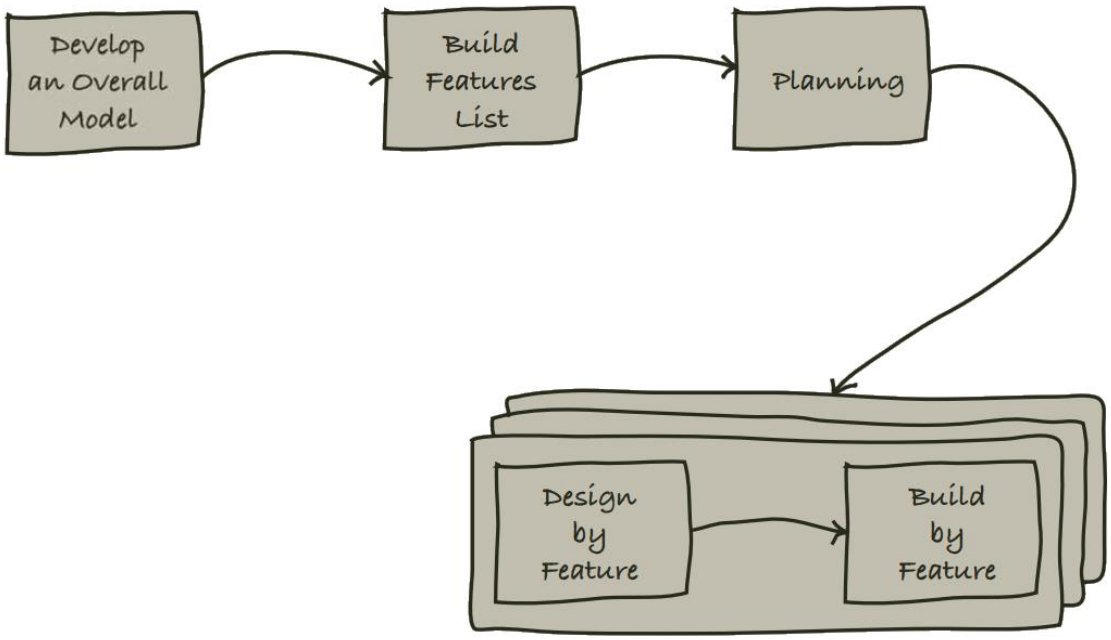


Figure 17 - Feature Driven Development approach
Source: [NEBULON, 2005]

The methodology is specified with five major processes, each with its overview, entry and exit criteria, tasks and verification activities. Assurance in each of those processes is the content of following paragraphs.

Process 1: Develop an Overall Model

During the first phase of the project, high-level walkthrough of the system scope is performed, followed by a domain walkthrough. There is a strong accent on assurance over domain models: After each domain walkthrough is performed, small teams are formed to create model for the domain. Created models are subsequently peer-reviewed and discussed, resulting in the choice of one model, or, more commonly, merging the models. Thus, model approved by consensus of majority of team members becomes the model for selected domain. Notes must be captured, allowing the team to retrospectively understand why a particular model has been chosen, in future stages.

"Study documents" is an optional activity during the phase, encouraging team members to understand object models, functional requirements, use cases, data models and user guides for the system. Such understanding, from the author's point of view, should be mandatory.

Internal verification of the phase is achieved by active participation of domain experts inside the small teams that perform the modelling. External assessment by business users is recommended (on a need-to basis), not mandatory.

Process 2: Build a Features List

In this phase, domains are functionally de-composed into subject areas, business activities within them and steps within each business activity, using the knowledge obtained from the first process. As a result, a feature list is formed; it must always have the same structure:

<action> the <result> <by|for|of|to> a(n) <object>

Such structure represents the client-value approach to development, since each feature represents a step in the process performed by the business user. Features must not take more than two weeks to develop (otherwise they must be de-composed into smaller features), but should by no means be reduced to the level of "getters" and "setters", since those do not represent any client value.

Again, internal verification of the phase is achieved by active participation of modelling team members (from the first process). On as-needed basis, ratification and clarification of issues is performed with business users.

Process 3: Planning by Feature

The objective of the third process is to produce the development plan. Based on feature, object and class dependencies, task list is created and divided between development teams, allowing the project manager to determine the class ownership and distribute key responsibilities over business

activities defined in the second process. Key goals of this phase consist of balancing the workload across developers and class owners, successful consideration of information system complexity, dependencies and also external milestones and impacts.

Verification for this process, as well as for the last two, is required. However, in this case, only a self-assessment achieved by active participation of chief programmers, development managers and project manager shall be made. FDD puts no accent on external verification of this process.

Process 4: Design by Feature

The last two processes of FDD are performed per-feature; features that use the same classes may be operationally clustered into "chief programmer work package". The outcome of this process is a sequence diagram(s), object model(s) based on the created diagram and class and method prologues.

Based on complexity of the feature, two optional activities are performed: Domain walk-through performed with the domain expert and study of referenced documentation performed by the feature team.

The specification lays strong emphasis on comprehensive documentation over design decisions, sequence diagram creation and object model refinement. Any alternative designs are recorded for the purpose of potential future use in case the chosen design has not proved its usefulness. Based on models, class and method prologues are created (this includes parameter types, return types, exceptions, messages and interfaces).

There are two options for the execution of verification phase; choice from those is that of the chief programmer. Design inspection is performed either by feature team only, or with other project team members. On acceptance, a to-do list for each programmer is created; author's view is that this should be more a task than a verification activity.

Process 5: Build by feature

The last process is also a per-feature; it consists of development, unit testing and code inspection. Unit testing is a required activity, in order to ensure that all requirements of the class are satisfied. Chief programmer also determines if any feature-level testing is going to be performed.

Code inspection with feature members is performed before or after unit testing. Chief programmer decides whether the inspection is going to be executed by feature team only, or inviting other member of the project team, and also the timeliness of the inspection. There are no other defined activities for the verification phase, other than successful performance of unit testing and code inspection. When a client-value feature is completed, it is promoted to the build.

Progress-tracking

The authors of FDD laid strong emphasis on progress-tracking issue of the methodology by developing a "Nebulon FDD Implementation", which is basically a Project Tracking System that comes with the methodology. This allows the project manager to track the progress towards the final delivery. Progress summary and visualization are shown in Figure 18 and Figure 19.

ID	Description	Walkthrough		Design		Design Inspection		Development		Code Inspection		Promote to Build	
		Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
XP077	determine *the diversity requirement for* a Pathing Step Context	05/12/2000	05/12/2000	06/12/2000	11/12/2000	07/12/2000	12/12/2000	13/12/2000		14/12/2000		15/12/2000	
XP078	determine *the diversity category of an IPPC for* Diversity Constraints	05/12/2000	05/12/2000	06/12/2000	11/12/2000	07/12/2000	12/12/2000	13/12/2000		14/12/2000		15/12/2000	
XP079	determine *other end of* an IPPC	05/12/2000	05/12/2000	06/12/2000	11/12/2000	07/12/2000	12/12/2000	13/12/2000		14/12/2000		15/12/2000	

Figure 18 - Progress summary by feature
Source: [NEBULON, 2002]

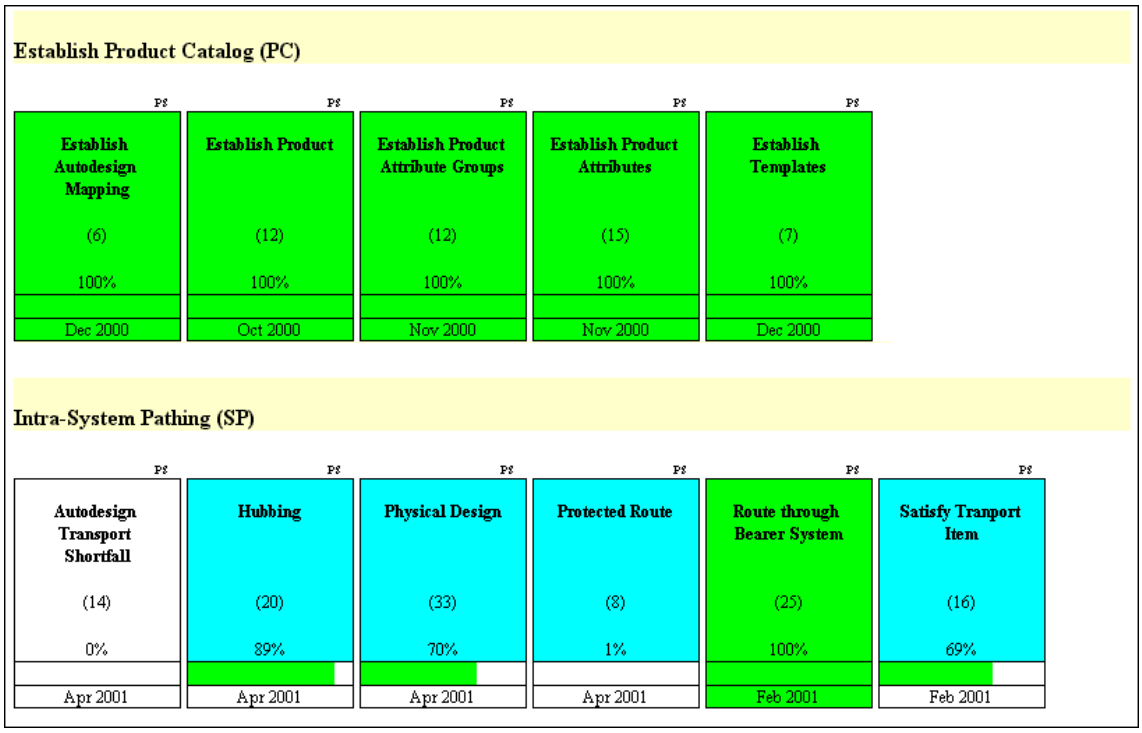


Figure 19 - Progress summary visualised
Source: [NEBULON, 2002]

By reading this sub-chapter, the reader should gain an understanding how assurance is implemented in Feature Driven Development. While the feature-driven approach helps shorten the feedback cycle to not more than two weeks, it is clear that the amount and variety of control activities, stakeholder participation and fault detection and removal process are clearly insufficiently defined in the methodology. This is mirrored in a comparison with other methodologies that follows this sub-chapter in Table 10.

3.4 COMPARISON AND CONCLUSION

LEGEND	WELL DEFINED	ADEQUATELY DEFINED	INSUFFICIENTLY DEFINED
SOFTWARE ASSURANCE ATTRIBUTES	**AUP**	**SCRUM**	**FDD**
Formally defined software development process			
Formally defined software quality requirements			
Control environment over cost-schedule-quality tradeoffs			
Formally defined fault detection and removal process			
Software inspections			
Standards and guidelines on software development			
Software testing procedures			
Formally defined measurement and analysis tools			
Stakeholder participation			
ADDITIONAL ATTRIBUTES	**AUP**	**SCRUM**	**FDD**
Validation of documentation			
Validation of user training			
Validation of data migration			
Validation of integration			
Validation of post-implementation phase			
LENGTH OF THE ASSURANCE CYCLE	**LONG**	**SHORT**	**MIDDLE**

Table 10 - Comparison of SW Assurance in theory and Assurance within project development methodologies. Source: The Author

The objective of Table 10 is to provide the reader with comprehensive summary and comparison of the three in-scope software development methodologies. Some interesting facts have emerged from the comparison; these are described further in following paragraphs.

Firstly, it is clear that the extent of assurance activities and the very understanding of quality assurance varies greatly among the methodologies. Most areas are covered by Agile Unified Process, even though it insufficiently describes areas that other methodologies define well, measurement and analysis being one of them. The only thing that has been assessed as comprehensively formally defined in all three methodologies is the development process itself, which comes as no surprise, since the development process definition is a key objective of a development methodology.

Agile Unified Process also covers some of the post-development processes, such as documentation creation, user training, integration or data migration, and validation of those processes. These are areas that are covered using very minimalistic approach, or not at all, by the other two methodologies.

The length of assurance cycle represents other very interesting variable. Even though Agile Unified Process puts strong emphasis on assurance activities, most of them happen at later stages of development, at the point when cost of change greatly increases. On the other hand, most assurance processes in Feature Driven Development are performed no later than after two weeks of development. Using Scrum, some of the impairments may be found even on the morning of the following day. But it is important to note that processes that gain confidence over fault detection and removal are much less robust than the ones accompanying AUP.

There's one last thing to discuss – a hypothesis that arises from the table above. Presumably there is some level of connection, in form of indirect proportion, between the scale and level of detail of assurance activities defined inside the methodology, and the length of the feedback cycle. Feedback cycle is generally shorter in agile methodologies; we must remember manifestations such as "responding to change over following a plan" or "interactions over processes". So, is it true that the more the methodology is agile, the less defined quality assurance is? Answering such question must not be based on a comparison of three methodologies that at least partially deem themselves agile. It would also greatly exceed the extent of this work. The question instead represents a possible field for future work of fellow colleagues at informatics-related study programme, possibly finding ways how to accept or reject the hypothesis and assumedly create ways how to improve the QA implementation into methodologies like Scrum or Extreme Programming.

4. ASSURANCE IN PROJECT MANAGEMENT STANDARDS

4.1 IPMA

The purpose of this chapter is to compare the theoretical role of assurance with IPMA project management standard that is defined by the three following official IPMA publications:

- IPMA Individual Competence Baseline v. 4.0 [IPMA, 2015] - **ICB**
- IPMA Organisational Competence Baseline v. 1.1 [IPMA, 2016a] - **OCB**
- IPMA Project Excellence Baseline v. 1.0 [IPMA, 2016b] - **PEB**

The role of ICB is to describe individual competences for project management in three areas: People, Practice and Perspective. The OCB introduces the approach of organizational competence to manage projects and meet the demanding expectations of stakeholders. The desire of PEB is to promote excellence in managing projects. Together, these three standards form the IPMA standard.

The structure of IPMA standards relies on competences – defined as "ability to apply knowledge and skills to achieve intended results" or "the application of knowledge, skills and abilities in order to achieve the desired results" [IPMA, 2016a p. 37]. They do not provide the reader with comprehensive and particular measures on how to manage a project, portfolio, or programme. Instead, core competences of individuals (project managers, senior executives, reviewers, consultants or internal educators) working in the project environment are described (in ICB), as well as organizational competences of groups (project teams, departments etc.) (in OCB) and excellence baselines (in PEB), noting that project excellence is based on "continuous competence development throughout the lifetime of a project" [IPMA, 2016b], connecting the PEB to ICB and OCB.

The objective of following sub-chapters is to provide the reader with comprehensive comparison of concepts, baselines and competences described in abovementioned paragraphs, with the theoretical role of assurance over information systems implementation projects established in the second chapter of this work; all of this understanding the structure and objective of IMPA standard while performing the comparison.

IPMA standard covers project management, programme management and portfolio management. Only the project management related chapters and competences of IPMA standards will be covered by the comparison.

4.1.1 ORGANIZATIONAL ASPECTS OF ASSURANCE IN IPMA

By reading the opening parts of all the three IPMA standards, it must be clear to the reader that since the approach of IPMA is to describe competences, knowledge and abilities of people related to projects, the organizational establishment of assurance in IPMA is not defined clearly.

All three documents that form the IPMA standard describe intended users, and also their approach to the usage of particular standard, in introductory chapters. IPMA ICB states that it can be used by assessors as "a baseline for assessment", by consultants as "individual standard to be applied to clients" [IPMA, 2015 p. 17]. IPMA OCB states that internal and external consultants "can use the standard to work with the organisation's top managers, senior executives, project, programme and portfolio managers and their staff to develop organisational competence in managing projects in a holistic way. Consultants may offer benefits such as specific expertise, independent views and additional capacity and provide services such as benchmarking, training and development" [IPMA, 2016a p. 24]. IPMA PEB states that both internal and external consultants can "use the baseline to provide consultancy to an organisation's senior managers, project managers and staff to develop the project management competences necessary for managing excellent projects. Consultants may offer benefits such as specific expertise in a certain relevant project management or results area, an independent view and additional capacity" and that the baseline itself may be "used as a reference for conducting an assessment" [IPMA, 2016b p. 29].

As we will learn in following sub-chapters, IPMA standards sometimes encourage individuals or the organization to assure themselves over particular project management area or field of knowledge by searching for and outside view of an assessor or a consultant, but the nature of the assurance work is not specified very clearly. IPMA states that the success of a project is dependent on right decisions made and right information delivered for such decisions, calling for periodic reporting which is essential for stakeholder trust and traceability of the project [IPMA, 2015 p. 48]. An individual, project management ability should lie in understanding that "the parent organization will have different forms of quality assurance which relate to projects (e.g. system assurance, project assurance, finance assurance, technical assurance, security assurance, etc); for the individual it is important to take these into account in devising a quality assurance plan for his or her project, to decide which project areas could become quality assurance objects and to know which members of the project team should be involved in project assurance activities" [IPMA, 2015 p. 48].

Also, there is an entire chapter called "Quality" present in IPMA ICB that describes skills and abilities of project management in relation to quality. Notably, following knowledge, skills and abilities that have been established during the theoretical part of this diploma thesis are described in IPMA ICB [IPMA, 2015 pp. 119-120]:

- Validation and verification
- Cost of quality
- Organisational quality analysis
- Policies implementation
- Design for testing
- Inspection methods and techniques
- Risk-based testing
- Testing techniques, including, for example, automated testing
- Continuous integration
- Software application for handling and managing tests and defects

IPMA ICB puts great emphasis on quality and describes following key indicators of project management that are related to quality and quality assurance [IPMA, 2015 pp. 120-122]:

- "Develop and monitor the implementation of and revise a quality management plan for the project."
    - We have previously understood that it is impossible to control quality, when there are no criteria against which it would be reviewed. Implementation of a quality management plan implies establishment of clear needs and goals for the project.
- "Verify the achievement of project quality objectives and recommend any necessary corrective and/or preventive actions."
    - This relates closely to the traditional V-model and enhanced assurance V-model described while concluding the theoretical part of this thesis. IPMA ICB states following: "It has been proven that it is more cost-efficient to perform verification at early stages of the development of the project, instead of leaving verification to the end of the project." [IPMA, 2015 p. 121] This clearly confirms assumptions of the enhanced V-model for assurance.
- "Plan and organise the validation of project outcomes."
    - This competence indicator puts focus mainly on conducting validation exercises and obtaining acceptance terms from the client. We already know that such terms are step one in achieving customer satisfaction.
- "Ensure quality throughout the project."
    - The competence indicator describes that "regular check-ups and improvements need to take place to maintain the fitness for purpose" and "special attention should be paid to quality awareness" among people participating on the project.

Another Practice competence that is closely related to assurance is “Plan and control”. Its aim is to establish a project management mainframe and subsequently implement functioning monitoring processes that “gather information regularly on progress, finances and utilisation of resources compared with baselines, adherence to quality and other standards, stakeholder satisfaction” [IPMA, 2015 p. 136].

One of key competence indicators in this area is named “Control project performance against the project plan and take any necessary remedial actions”. It points out that “an integrated project controlling and reporting system that covers all project objectives and the corresponding success criteria for the relevant project phases and requirements of all stakeholders” [IPMA, 2015 pp. 138-139] must be established within the project.

Apart from individual competences, organizational competence assessment can be made based on IPMA Organisational Competence Baseline. Competence elements of the organization are closely linked to competence elements of individuals; where relevant, they will be described in following sub-chapters. The approach of IPMA OCB is easily understandable with the help of Figure 20.

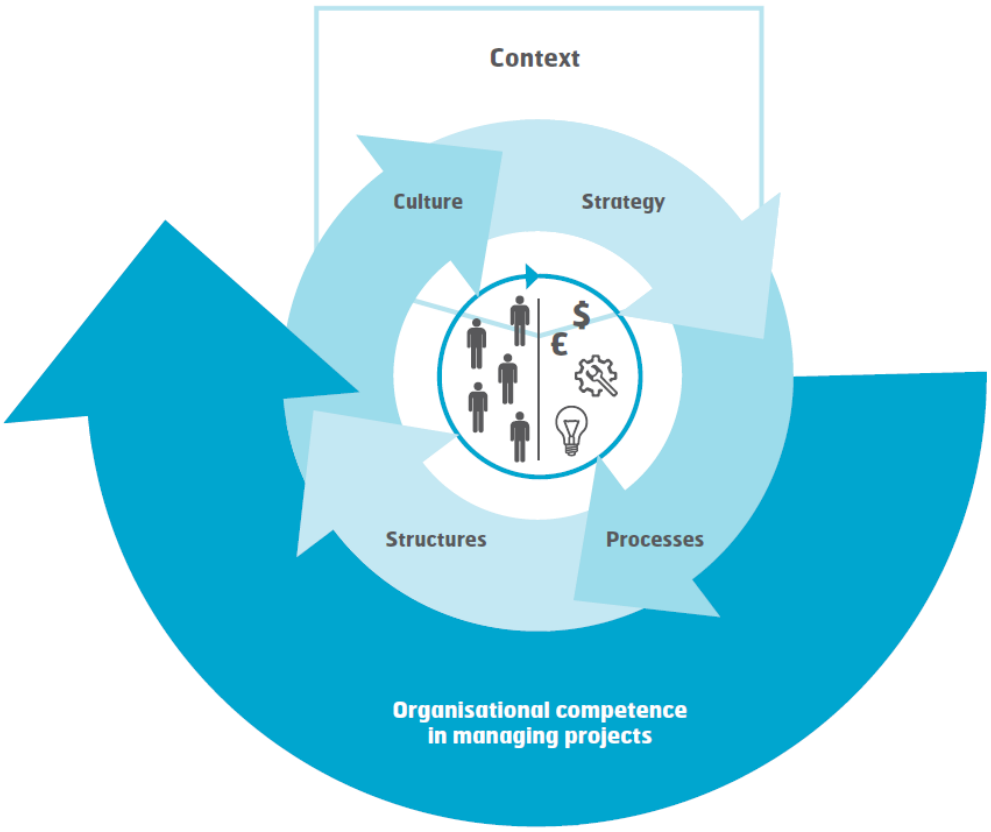


Figure 20 - IPMA OCB approach
Source: [IPMA, 2016a p. 63]

Very similar approach is presented in IPMA Project Excellence Baseline. IPMA PEB introduces PEM – Project Excellence Model. It aims to help "project teams to identify areas for improvement, to align the project objectives accordingly, to create skills and resources to launch and integrate improvements into a culture of strategic execution" [IPMA, 2016b p. 67]. Elements of the Project Excellence Model are closely linked to individual competences and organizational competences defined in IPMA ICB and OCB.

Project Excellence Baseline puts great emphasis on continuous improvements during both project lifecycle and lifecycle of the organization. Past experience from projects allows organization to execute projects more effectively, as described in Figure 21.

Figure 21 - Continuous improvement of projects
Source: [IPMA, 2016b p. 70]

We already know that the very existence of audit-type tools – project excellence baseline in this case – helps project team to improve the quality of the product by having a tool for self-assessment. PEM is mainly used for continuous improvement and benchmarking purposes; it assesses People & Purpose and Processes & Resources areas based on PDCA cycle [IPMA, 2016b p. 79]. This is reflected in IPMA ICB's competence indicator "Review, apply and exchange lessons learned from and with other projects" [IPMA, 2015 p. 103].

4.1.2 ASSURANCE OVER BUSINESS IN IPMA

Addressing the needs

The ability of meeting the needs of stakeholders lies on the shoulders of project management, which should, according to IPMA ICB, be able to:

- "Provide a formal document which states the official reasons for a project, including the business or organisational benefits that the project has to deliver;
- develop and ensure the ongoing validity of the business / organisational justification;
- explain integration aspects with new elements in the project and should be the basis for the success criteria and benefits the project should deliver (the scope)." [IPMA, 2015 p. 42]

To be able to meet the needs of the stakeholders, it is important that the project management is able to "identify stakeholders and analyse their interests and influence" and "develop and maintain a stakeholder strategy and communication plan" – both being key competence indicators of "Stakeholder" Practice competence [IPMA, 2015 pp. 145-147].

There is one more, important thing associated with the needs: Success criteria. IPMA lies great emphasis on ability to "acknowledge, prioritise and review success criteria" [IPMA, 2015 p. 102] (it is a sole competence indicator), so that the stakeholder acceptance is documented accordingly to best practices. "Requirements and objectives" is a Practice competence described as follows: "Every project is undertaken because internal and external stakeholders want to achieve something. This competence element describes the 'why' of the project – which goals are to be achieved, which benefits are to be realised, which objectives are to be reached and which stakeholders' requirements are to be fulfilled." [IPMA, 2015 p. 107] Needs are closely related to requirements, that are closely related to the product and its acceptance criteria – therefore, additional requirements of this competence are described in assurance over product part.

"Objectives & Strategy" area of IPMA PEB aims on assessment whether the project objectives are in alignment with stakeholder's needs and requirements; in general it states that excellent projects are the one that follow individual competences in this area such as ability to identify, describe, record, agree on and fulfil the needs of stakeholders. "Customer satisfaction" area notes that excellent projects are those during which "representatives consistently express their satisfaction throughout the entire project lifecycle" [IPMA, 2016b p. 96].

Strategy compliance

Competence "Strategy" describes the needs for the alignment of project with long-term as well as short-term strategy of the organization; the assessment whether project goals are in sync with the mission and values of the organization is a responsibility of project management. It controls at least following areas (with possible help of independent specialists):

- Whether the project's objectives and benefits are in sync with the mission, vision and strategy;
- whether the project's organisation is delivering benefits to the organization;
- and also "develops and implements measures of strategic alignment (e.g. critical success factors, key performance indicators, etc.)" [IPMA, 2015 p. 41].

We already know and understand that strategy changes – and IMPA reflects that: "The individual needs to reflect not only the pre-set strategic goals, but also the tools and methods of questioning these goals and influencing the board to make the necessary improvements." [IPMA, 2015 p. 42]

Such controls make sense assuming that organization did implement strategy accordingly to IPMA OCB's "Project, programme and portfolio mission, vision and strategy" competence and IPMA PEB's "Objectives & Strategy" area.

Data basis

IPMA does not put great emphasis on assurance over data basis of the project, it instead advises to exchange all necessary information "accurately and consistently to all relevant parties" [IPMA, 2015 p. 69], with existing competence indicator named "Provide clear and structured information to others and verify their understanding" [IPMA, 2015 p. 70].

During a discussion over People indicator called "Leadership", following statement is present in the standard: "Sometimes the information quality is so poor that decisions are based on intuition. Reviewing and being prepared to change prior decisions based on new information is an essential part of the ability to take decisions." [IPMA, 2015 p. 78] The issue is not addressed adequately in other parts of the standard, though, and it is surely one thing that should be outlined in the addition to the standard.

Process compliance

Since IPMA is not mainly an information systems development methodology, but rather a general project management standard, there is no direct focus on compliance of processes with the workflows of the ERP. Interesting emphasis is put on compliance of project management processes the business itself, though, noting that "the governance, structures and processes competence element defines the understanding of and the alignment with the established structures, systems and processes of the organisation that provide support for projects and influence the way they are organised, implemented and managed" and "a key challenge is to balance the use of compulsory and optional structures and processes for optimal effect and benefit to the project" [IPMA, 2015 p. 44].

The area is further described in IPMA OCB: "Process alignment" organizational competence exists. The competence recommends organizations to describe, formalize and maintain procedural standards with help of independent consultants, to align processes with best practices around the world [IPMA, 2016a pp. 84-85]. "Structural alignment" competence advises to align projects with internal and external units of the organization, "Cultural alignment" puts emphasis on social interactions and is closely linked to organizational readiness for change.

Contract

Assurance over contractual agreements is described in Practice competence named "Procurement", notably as a competence indicator called "Contribute to the negotiation and agreement of contractual terms and conditions that meet project objectives". It clearly describes that project management is responsible for overseeing the contract arrangement process and "making sure that the negotiators have a clear mandate, in close cooperation with purchasing and/or legal specialists". It also notes that while particular contracts may vary in different aspects, the project manager takes care that the contract "closely relates to and serves the objectives of the project and the organization" [IPMA, 2015 p. 134].

IPMA ICB goes even beyond the contractual assurance defined by the theoretical part of this diploma thesis by establishing individual competences that aim on assuring that the project itself is in compliance with current law obligations. Perspective competence "Compliance, standards and regulations" describes that the PM "needs to analyse the scope and configuration of the project and seek out the relevant standards and regulations that will have a direct or indirect influence on it"; these "should be considered as potential risks and opportunities that need management attention" [IPMA, 2015 p. 50].

4.1.3 ASSURANCE OVER PROJECT IN IPMA

The first Practice competence of all, "Project design", describes the need for a formalized project design in general as follows: "Design describes how the demands, wishes and influences of the organisation(s) are interpreted and weighed by the individual and translated into a high-level design of the project to ensure the highest probability of success." [IPMA, 2015 p. 101]

Competence indicator "Select and review the overall project management approach" further describes the area, calls for "a high-level definition (or modification) of scope, quality aspects, organisation, communication, documentation, planning and stakeholder approach, choice of resources, risk tolerance, management and performance criteria" to be created and reviewed by independent assurance team periodically, because "many of the contextual and social influences may change over the lifecycle of the project" [IPMA, 2015 p. 104].

"Project management" competence of IPMA OCB describes that project management standards shall be developed "with the help of internal or external experts" to meet best practices and successfully manage complex projects [IPMA, 2016a p. 78].

Budget

Assurance over budget is described mainly in Practice competence named "Finance". Initial definition of project costs and establishment of a project budget is deemed necessary; securing appropriate funding of such budget follows. Subsequently, assurance procedures must be maintained according to IPMA ICB – following competence indicators are set:

- "Develop, establish and maintain a financial management and reporting system for the project."
    - The very existence of reporting system provides decent level of control over project budget.
- "Monitor project financials in order to identify and correct deviations from the project plan."
    - This is in full compliance with the recommendation of continuous, computer-aided control over budget from the theoretical part of the diploma thesis.

IPMA also states one important thing that many managers don't know or don't want to see: That personal relationships are a key prerequisite for successful funding of the project. And good personal relationships can be rarely achieved by force.

"The finance and control function of an organisation is often established as a line function providing mandatory rules, procedures and guidelines. Knowing these rules and how to utilise them effectively and efficiently are crucial for the individual for successful funding, monitoring and/or reporting on financial topics. To ensure the necessary support from the finance and control function, the individual can benefit from establishing and maintaining relationships with the relevant contact people within the finance and control function." [IPMA, 2015 p. 49]

An individual ability, according to ICB, lies in "applying analytic techniques to analysing situations, financial and organisational data and trends" [IPMA, 2015 p. 90], enabling the project management to clearly report on financial data and reports accompanying the work.

Budget and time schedule is also mentioned in Practice competence called "Plan and control", namely in the indicator called "Report on project progress" that puts emphasis on existence of reporting structure that assures stakeholders over the overall progress, costs, time, resources, risks, and forecasts these areas.

Budget and time schedule is also linked to IPMA OCB's "Performance" competence that puts emphasis on the need of existence of such controls for all projects maintained by the organization [IPMA, 2016a pp. 76-77].

Time schedule

There are several competences associated with time scheduling – the most obvious one is a Practice competence named "Time". The purpose of Time competence is to "enable the individual to define, sequence, optimize, monitor and control all components necessary to delivering the agreed outcomes of the project" [IPMA, 2015 p. 112]. IPMA ICB notes that "a project plan may be subject to many disturbances, resulting in necessary adjustment; these may come from various sources (changes in deliverables, requirements, scarcity of resources or money or late or off-spec deliveries) and may demand re-planning. Periodically, the schedule should be compared against the baseline and, if necessary, adjustments should be made." [IPMA, 2015 p. 112]

Another competence connected to the time schedule is "Power and interest", which aims on encouraging the project management to "use power and interest techniques to achieve stakeholder satisfaction and deliver the agreed outcomes within the constraints of time and budget" [IPMA, 2015 p. 55].

To be able to deliver on time (and budget) effectively, PM should, according to IPMA, perform following assessments (possibly with an independent review):

- "Assess the personal ambitions and interests of others and the potential impact of these on the project.
- Assess the informal influence of individuals and groups and its potential impact on the project.
- Assess the personalities and working styles of others and employ them to the benefit of the project." [IPMA, 2015 pp. 56-57]

We have learned during the theoretical part of this work that not only establishment, but also continuous control over time schedule is part of assurance work. IPMA reflects on that with competence indicator named "Monitor progress against the schedule and make any necessary adjustments" [IPMA, 2015 p. 114].

Organizational structure

Practice competence "Organisation and information" focuses on how the project is organized. It describes that organizational structure must be established on at least three level model (that's in compliance with the theoretical model); notes that formal informational flow must be established between the levels.

Key competence indicators include [IPMA, 2015 pp. 116-117]:

- "Assess and determine the needs of stakeholders relating to information and documentation.
- Define the structure, roles and responsibilities within the project.
- Establish infrastructure, processes and systems for information flow.
- Implement, monitor and maintain the organization of the project."

Project manager's responsibility is to establish Project supporting functions (a project office, a project management office or similar) to "provide multifaceted support to the project and/or the individual managing the project in relation to organization, planning, reporting, meeting management, documentation, etc.". He must "ensure the necessary support from the project supporting function" and also "know relevant contact people within the project supporting function and how to establish and maintain good relationships with them" [IPMA, 2015 p. 47].

Based on IPMA ICB, it is an individual competence to build the right team that adheres to specific conditions of an organization. Project manager should ensure that "the right resources for the team are selected" and selected team members "have the right chemistry to work together as a team", shall "promote cooperation and networking between team members" and "support, facilitate and review the development of the team and its members" [IPMA, 2015 pp. 81-82].

The matter is further described in "Project Results" area of IPMA PEB – namely in "Project Team Satisfaction" that puts emphasis on the fact that satisfaction of the project team implies greater value of the developed product [IPMA, 2016b p. 98].

Organizational readiness

There are several very important key competence indicators in IPMA ICB that relate to the organizational readiness – as follows [IPMA, 2015 pp. 147-148]:

- "Engage with the executive, sponsors and higher management to gain commitment and to manage interests and expectations."
    - Commitment of the executives and sponsor represents great benefit to the success of the project, according to the text.
    - Expectation management is even "of the utmost importance" and great value can be created by employing executives as ambassadors of the change that is brought by the product – new ERP in our case.

- "Engage with users, partners, suppliers and other stakeholders to gain their cooperation and commitment."
    - The name says it all. End user cooperation is essential to gain confidence over deliverables and achievement of project outcomes. People hold the knowledge, people hold the power, and senior users are usually present during steering committee meetings. Project management must always assure that they are helping to create a product that users want.

New ERP represents a great change to the organization, therefore, Practice competence "Change" must be held. Following indicators are present in IPMA ICB:

- "Assess the adaptability to change of the organization.
- Identify change requirements and transformation opportunities.
- Develop change or transformation strategy.
- Implement change or transformation management strategy." [IPMA, 2015 pp. 151-153]

IPMA PCB describes "Project Results and Impact on the environment" as one of the excellence points, noting that clear positive impact on the organizational environment as well as environment outside the company accompanies excellent projects [IPMA, 2016b p. 100].

Policies

Previously mentioned Perspective competence called "Compliance, standards and regulations" does also focus on policy awareness. Project management should "know the legal policies of an organisation and be able to implement them in a project" and "know which parts of law regulations (e.g. civil, criminal, labour, intellectual property, etc) and common good practices are relevant to the project" [IPMA, 2015 p. 51]. Though, indirect focus on review of such policies and practices is laid; approach to policies is more of a compliance one in IPMA. According to the aforementioned competence, project management must identify and ensure (using work of specialist possibly) that the project complies with:

- "All relevant health, safety, security and environmental regulations (HSSE);
- all relevant codes of conduct and professional regulation;
- all relevant sustainability principles and objectives." [IPMA, 2015 pp. 52-53]

4.1.4 ASSURANCE OVER PRODUCT IN IPMA

Since the IPMA Standards are general project management standards and are not directly linked to information systems development, the author of this thesis has decided to follow general principles of product quality assurance instead of specific defined areas of software, data,

implementation and post-implementation, that have helped to create the comparison with IS development methodologies in Chapter 3.

There is an entire Practice competence named "Quality" in IPMA ICB that is in partial compliance with the approach defined in theoretical part of this work. We have previously understood that the quality of the products is greatly connected with the quality of the process that accompanies the very creation of such product. The purpose of Quality competence in IPMA is to "enable the individual to establish and manage the quality of the service/product to be delivered and the delivery process being managed; and to recognize quality as an invaluable tool for the benefits realisation management process" [IPMA, 2015 p. 119].

Competence named "Results orientation" in People area of IPMA ICB describes that results orientation "is the critical focus maintained by the individual on the outcomes of the project"; project management should continuously place results "at the forefront of the discussion and the team drives toward these outcomes" and "plan and deploy resources efficiently to realise the agreed results and be effective" [IPMA, 2015 p. 96]. Indicators of such competence are as follows:

- "Evaluate all decisions and actions against their impact on project success and the objectives of the organisation.
- Balance needs and means to optimise outcomes and success.
- Promote and 'sell' the project, its processes and outcomes.
- Deliver results and get acceptance." [IPMA, 2015 pp. 97-99]

"Project design" competence describes that quality processes, quality reviews and assurance are key elements of quality of the final product [IPMA, 2015 p. 103]. Quality reviews must be conducted against requirements that "must be defined (e.g. a requirement specification which can be more or less detailed or a product-backlog containing user stories); requirements should be translated into acceptance criteria against which the deliverables can be tested" [IPMA, 2015 p. 107] – this quote from "Requirements and objectives" competence helps the reader realize that even in information-systems-unrelated fields, acceptance tests exist and must be maintain to be able to measure and assess the project and subsequently also the product maturity and excellence.

Another project management competence of IPMA lies in Scope – ability to define what does the project focus on and understand the boundaries; understand constraint; design deliverable. To be able to deliver, project manager must "define the project deliverables", "define the work packages of the project" and divide them into the work breakdown structure. "With an iterative (e.g. agile) approach, a work package in a software development project is typically referred to as a user story. The same guidelines may apply to the definition of a user story as to a work package.

Control accounts are groups of work packages typically used for reporting." [IPMA, 2015 pp. 109-111]

Changes to the information systems implementation project will, in majority of cases, have subsequent impact on the product itself. Competence indicator "Assess, get agreement on and implement project changes" encourages the project management to establish a formal process for managing changes, noting that approval process is very important and all relevant stakeholders must remain at least informed, if not responsible [IPMA, 2015 pp. 139-140].

Closely related to project development methodologies, competence indicator "Close and evaluate a phase or the project" encourages project management to divide the development of the product, which is the core activity of the project, to multiple phases, and assure that all phases are adequately planned, scoped, executed and, most notably, closed. In a close-out, project management must assure that "objectives have been achieved and customer expectations met" [IPMA, 2015 p. 140].

4.2 PRINCE2

Projects IN Controlled Environments (abbreviated as PRINCE2) represents a structured project management method defined in Managing Successful Projects with PRINCE2 (Fifth Edition) [AXELOS, 2009]. It is an entirely generic project management standard that is not focused on any particular industry (information systems development in the case of this diploma thesis), hence it is clear that industry-specific or type-specific activities are excluded from the standard [AXELOS, 2009 p. 6].

The pillars upon which the standard stands are following [AXELOS, 2009 p. 5]:

- The principles (Guiding obligations and good practices)
- The themes (Aspects of project management)
- The processes (Representing a step-wise progression through the project lifecycle)

This approach is further described in Figure 22:

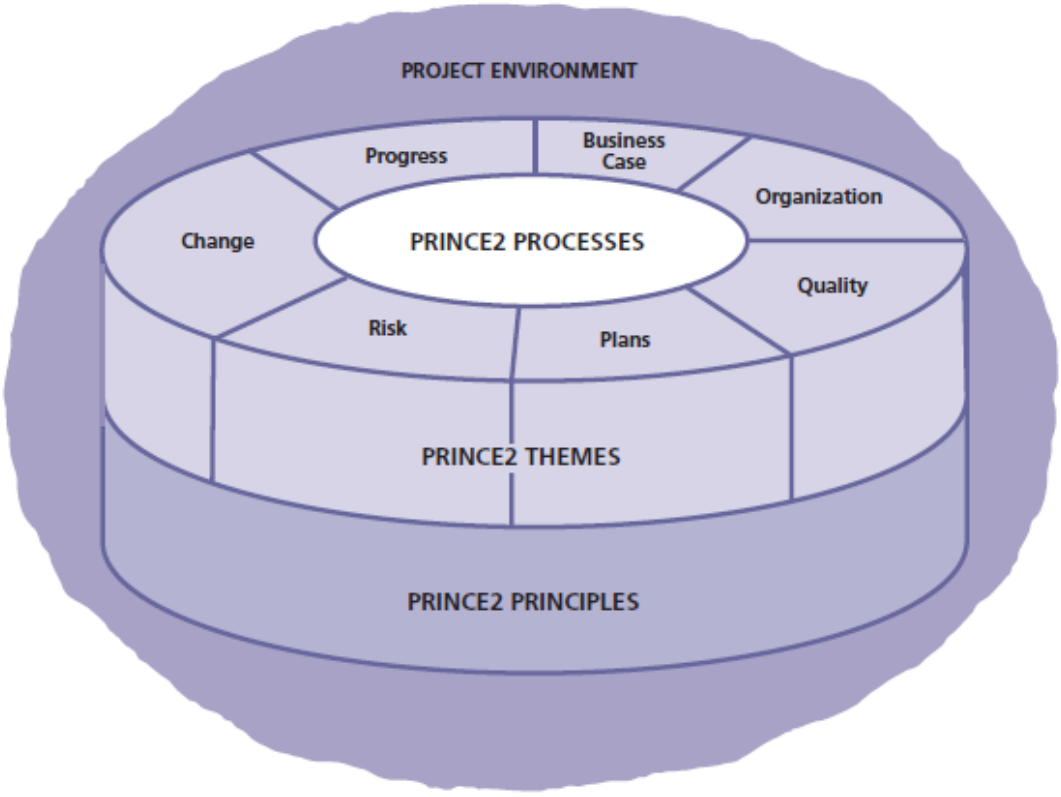


Figure 22 - The structure of PRINCE2
Source: [AXELOS, 2009 p. 6]

4.2.1 ORGANIZATIONAL ASPECTS OF ASSURANCE IN PRINCE2

The first step how to organizationally define assurance in PRINCE2 is the very definition of the Project management term – PRINCE2 describes that it "is the planning, delegating, monitoring and control of all aspects of the project, and the motivation of those involved, to achieve the

project objectives within the expected performance targets for time, cost, quality, scope, benefits and risks" (note the emphasis on control aspects of the project), which is an approach further described in Figure 23.

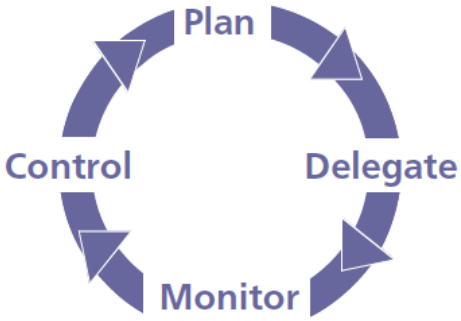


Figure 23 - Project management as understood in PRINCE2
Source: [AXELOS, 2009 p. 5]

Certain level of internal assurance is achieved through PRINCE2 Principles that open the whole standard. They advise the PRINCE2 project to have continues business justification, learn from experience, define roles and responsibilities, be managed by stages and exceptions, focus on products and be tailored to suit the project environment [AXELOS, 2009 pp. 11-14]. But this is not where PRINCE2 assurance ends.

The term "Project Assurance" is directly defined in PRINCE2 standard (in opposition to PMBOK and IPMA). According to the standard, Project Assurance "covers the primary stakeholder interests (business, user and supplier)" and "has to be independent of the Project Manager" [AXELOS, 2009 p. 273]. Particular responsibilities of Project Assurance are defined both in the "Roles and responsibilities" summary part in the standard as well as in the list of role responsibilities inside each of the PRINCE2 Themes. Relationships between Project Assurance and other organizational structures of the project are described in Figure 24.

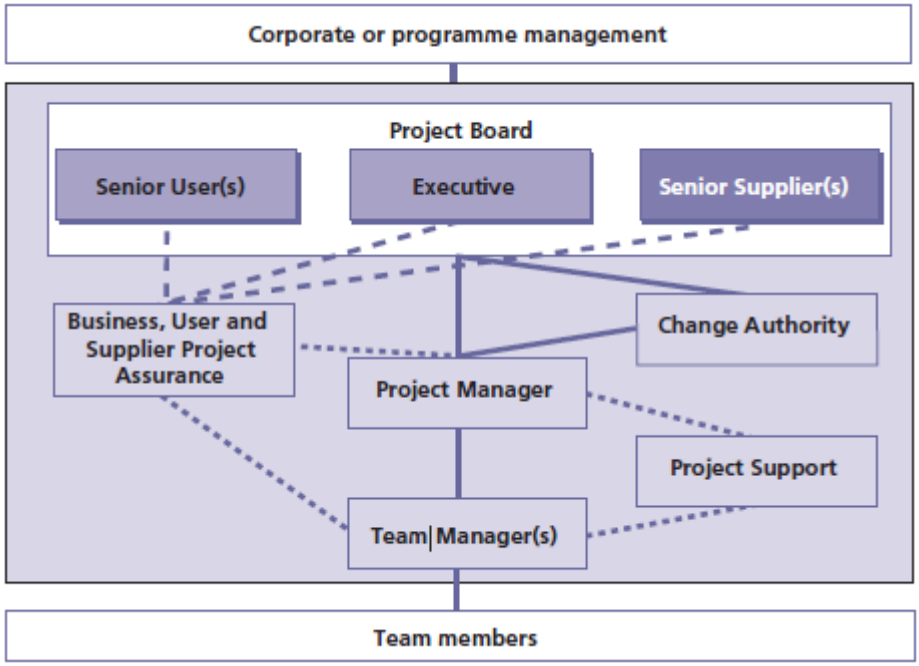


Figure 24 - Project management team structure in PRINCE2
Source: [AXELOS, 2009 p. 33]

There is another role associated with assurance in PRINCE2: "Quality assurance." The role of this independent structure is to check that "the organization and processes are in place for quality planning and control", meaning quality assurance does not actually "perform the quality planning or control, which will be undertaken by the project management team" [AXELOS, 2009 p. 49]. Quality Assurance and Project Assurance overlap each other, however, the objective of both is different: PA assures the project's stakeholders about correct conduction of the project; QA assures the wider organization that the project complies with wider corporate standards and assures over the quality of the product. As quality assurance activities are generally outside the scope of the PRINCE2 standard and the definition of Project Assurance is closer to the one this thesis works with, following sub-chapters will focus mainly on the Project Assurance roles and responsibilities; QA will be mentioned particularly in connection with assurance over product.

4.2.2 ASSURANCE OVER BUSINESS IN PRINCE2

Addressing the needs

PRINCE2 addresses the topic with development of a Business Case that is subsequently continually updated and verified (as described in Figure 25). It comprises of reasons for the project initiation, expected benefits (mapped from the outputs and outcomes provided by the project; with accent to measurability) and dis-benefits or major risks [AXELOS, 2009 p. 25].

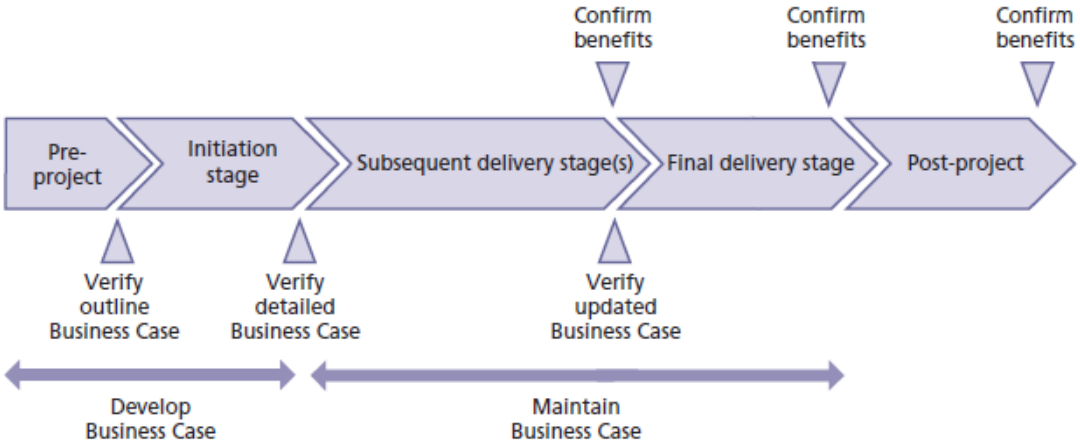


Figure 25 - Business Case in PRINCE2
Source: [AXELOS, 2009 p. 23]

Overall, the content and role of Business Case is similar to the one of Project Charter in PMBOK standard. The role of Project Assurance in this field is to "assist in the development of the Business Case", "verify and monitor the Business Case against external events and project progress", "monitor changes to the Project Plan to identify any impact on the needs of the business or the Business Case" [AXELOS, 2009 p. 28] and to assure that "the right people are involved in writing Product Descriptions" and check that "the Business Case is being adhered to throughout the project" [AXELOS, 2009 p. 273].

Strategy compliance

The board should assure that expected benefits are "aligned to corporate objectives and strategy" [AXELOS, 2009 p. 25]. The formally defined role of Project Assurance in this field is to "ensure the project fits with overall programme or corporate strategy", "verify and monitor the Benefits Review Plan for alignment to corporate or programme management" [AXELOS, 2009 p. 28] and "check that the project remains aligned to the corporate or programme strategy" throughout its execution [AXELOS, 2009 p. 273].

Data basis

PRINCE2 puts great amount of emphasis on the review of Project Initiation Documentation. The role of Project Assurance is to review following project board confirmations [AXELOS, 2009 p. 138]:

- Project definition is accurate and complete.
- Lessons learned from previous projects have been reviewed and incorporated.
- Procedures defined in the Risk Management Strategy are appropriate.
- Stakeholder Communication Management system has been set adequately.

- Roles have been established; Control environment set; Product description written.
- The Business Case demonstrates a viable product.

Even though accountability for the review lies on the Project Board, Project Assurance remains responsible for reviewing the review [AXELOS, 2009 p. 139].

Process compliance

As PRINCE2 is a general project management methodology, no direct focus is put on the matter of compliance between the ERP product and processes within the target orientation.

Assurance over procedural compliance is indirectly achieved through (at least) following measures:

- As we have previously learned, PRINCE2 emphasized assurance over choosing the right personnel from the target organization to participate in requirements documentation activities.
- As we will learn in the following sub-chapter, PRINCE2 puts great amount of focus on the product acceptance, measurability of acceptance criteria and compliance to initial requirements and involvement of Project Assurance in those procedures.
- Assurance over product is, by its PRINCE2 definition, performed in cooperation with the customer.

Additionally, to create an End Project Report, project management is required to assess and review how did the project (and its output) performed against the user requirements for quality, scope, benefits and risks [AXELOS, 2009 p. 243].

Contracts

Assurance over contracts should be gained by the fact that contractual agreements, feasibility reports and service level agreements are necessary parts of the Business Case [AXELOS, 2009 p. 127], which is inherently reviewed by the Project Assurance initiative. Additional emphasis is put on contracts with suppliers and mainly on service level agreements as part of product delivery – to be discussed later. No further direct emphasis on contractual review is laid in PRINCE2, but the level of assurance gained by inherent review is deemed satisfactory by the author of this thesis.

4.2.3 ASSURANCE OVER PROJECT IN PRINCE2

Budget

In the PRINCE2 standard, the budget is derived from the time schedule based on the cost of all needed resources, as well as cost of PM activities, risk budget, change budget and cost tolerances

[AXELOS, 2009 p. 71]. Estimations are going to be utilized (and should be assessed by a review) – already defined approaches such as top-down, bottom-up, comparative, parametric or three-point estimating are advised to be used by the standard [AXELOS, 2009 p. 68].

The role of Project Assurance in this field is to "monitor project finance on behalf of the customer" and "ensure the value-for-money solution is constantly reassessed" [AXELOS, 2009 p. 28].

Time schedule

Project time schedule establishment is comprehensively described mainly in the PRINCE2 theme "Plans". The standard advises PM to prepare the schedule either manually or using computer aided tools, start with an activity sequence, find resources, assign them, manage and monitor the resource usage, agree on control points and milestones, and thus deriving the schedule.

The main role of Project Assurance is to "monitor stage and project progress against agreed tolerances" and also "monitor changes to the Project Plan to see whether there is any impact on the needs of the business or the project Business Case". [AXELOS, 2009 p. 73].

Organizational structure

PRINCE2 approach to the organizational structure of the project is similar with theoretical approaches, with addition of the corporate or programme management role. This has already been described using Figure 24. Roles and responsibilities are described in a very comprehensive way inside the Organization theme. The role of Project Assurance is mainly the advisory one, to help the organization effectively select project team members [AXELOS, 2009 p. 43].

Organizational readiness

We have understood during the theoretical part that organizational readiness consists mainly of the organization's readiness to change. The PRINCE2 approach of Project Assurance in this field is to advise on stakeholder engagement and ensure that communication strategy with stakeholders takes place [AXELOS, 2009 p. 43]. The role of stakeholder engagement is to identify people or groups upon which the project's outcome (the product) will have the biggest influence and effectively communicate with them, noting that "effective communication with key stakeholders, both internal and external to the corporate organization, is essential to the project's success" [AXELOS, 2009 p. 41]. Project Assurance's responsibility is also to "constrain user and supplier excesses", "advise on the impact of potential changes from the user's point of view", "monitor risks to the user" and finally "ensure that user liaison is functioning effectively" [AXELOS, 2009 pp. 273-274].

Policies

The field of policy compliance is one of the few that are assured by Quality assurance in PRINCE2. According to the standard, QA "provides a check that the project's direction and management are adequate for the nature of the project and that it complies with relevant corporate or programme management standards and policies" [AXELOS, 2009 p. 48]. The definition of applicable formal guidelines happens during the Risk management phase – "A starting point for all projects will be to identify whether there are any corporate or programme policies and processes that need to be applied." [AXELOS, 2009 p. 78] Discussions over such policies (with possible adjustments as a result of the review) should happen as part of the Project Brief [AXELOS, 2009 p. 254].

4.2.4 ASSURANCE OVER PRODUCT IN PRINCE2

We have already learned that PRINCE2 is a general project management standard that is not directly connected to any industry field (information systems development in case of this thesis). Thus, the author of this thesis has decided to follow general principles of product quality assurance instead of specific defined areas of software, data, implementation and post-implementation, that have helped to create the comparison with IS development methodologies in Chapter 3.

PRINCE2 advises to use quality inspections, described as "a systematic, structured assessment of a product carried out by two or more carefully selected people (the review team) in a planned, documented and organized fashion" [AXELOS, 2009 p. 310] as one of the key manners how to assure over the product created.

The role of Project Assurance in planning phase is to "assist the Project Board and Project Manager by reviewing the Product Descriptions", "advise the Project Manager on suitable quality reviewers/approvers", and "assure Project Board members on the implementation of the Quality Management Strategy" [AXELOS, 2009 p. 58].

During the execution, the formally defined Project Assurance's responsibility is to "advise on the selection of the development strategy, design and methods", "assess whether quality control procedures are used correctly, so that products adhere to requirements", assure that "right people are planned to be involved in quality inspection at the correct points in the products' development", "quality methods are being correctly followed", "follow-up actions are dealt with correctly" and "acceptable solution is being developed". [AXELOS, 2009 pp. 273-274].

Product audits are defined as part of "Change" theme in PRINCE2, describing that a "series of reviews and configuration audits" should be performed at the end of each stage and at the end of

the product to “compare the actual status of the products” to the required ones [AXELOS, 2009 p. 94]. For every stage, the role of Project Assurance is to “confirm stage and project progress against agreed tolerances” [AXELOS, 2009 p. 110].

Contrary to IPMA and PMBOK standards, PRINCE2 also focuses on the project delivery, by describing a process named “Managing Product Delivery”. The role of the process is (apart from others) to ensure that each product meets its quality criteria or its quality is in tolerable limits, project manager has approved the product can be delivered, reporting documents are created and understood, products are formally handed over to all of the involved parties and approvals have been obtained. PM should consult with Project Assurance “as to whether any extra reviewers are required and ensure that the Quality Register is updated accordingly”, capture lessons learned, update risk register, update documentation and possibly move on to the next phase [AXELOS, 2009 pp. 185-190].

Emphasis is put on the formal acceptance process. PRINCE2 notes that “products are approved throughout the life of the project and ownership may even be transferred to the customer as part of a phased handover. But, during the Closing a Project process, it is important to check that all forms of approval have been obtained and records kept for audit and/or contractual purposes.” [AXELOS, 2009 p. 57] PRINCE2 also discusses post-implementation – “Where concessions have been granted by the Project Board, it may be necessary to recommend follow-on actions for later improvements or remedies for the products concerned.” [AXELOS, 2009 p. 57]

Contractual part of post-implementation phase is discussed in the “Closing a Project” process, with PRINCE2 noting that “where a product requires a lot of potentially expensive support and maintenance, the Project Manager should ensure that a suitable service agreement or contract has been drawn up between the operations and maintenance organizations and the end-users. In such instances, the service agreement should be included as a product to be delivered as part of the plan.” [AXELOS, 2009 p. 210]

4.3 PMBOK

The purpose of this sub-chapter is to compare the theoretical role of assurance created as a result of Chapter 2 with the PMBOK standard that is defined by the "Guide to the Project Management Body of Knowledge (PMBOK® Guide) —Fifth Edition" [PMI, 2013]. The main content of the standard is described in Sections 4 through 13 that guide manager through the project management body of knowledge and describe activities, their inputs and outputs, tools and techniques.

Chapter 1.4 of the book describes relationships among Program, Portfolio, Project and Organizational Project management. As this diploma thesis focuses on information system implementation projects, the approach of the work is to consider information related to Program and Portfolio management as redundant. The same approach has been used during the IPMA standard comparison.

The Project Management Body of Knowledge is distinguished into ten separate Knowledge Areas. These are further separated into 47 interconnected project management processes. By the very first glimpse into the table of contents of PMBOK Guide the reader should understand that assurance is described in the standard to some extent. The very existence of knowledge area named "Project quality management", processes such as "Control Quality", "Control Costs" or "Control Schedule" and others suggest the level of coverage to anticipate. They will be further described in following sub-chapters.

4.3.1 ORGANIZATIONAL ASPECTS OF ASSURANCE IN PMBOK

The introductory part describes that the "project manager works closely and in collaboration with other roles, such as a business analyst, quality assurance manager, and subject matter experts" [PMI, 2013 p. 17].

Key terms are defined by PMBOK as follows:

"Perform Quality Assurance: The process of auditing the quality requirements and the results from quality control measurements to ensure that appropriate quality standards and operational definitions are used." [PMI, 2013 p. 549]

"Validation: The assurance that a product, service, or system meets the needs of the customer and other identified stakeholders. It often involves acceptance and suitability with external customers." [PMI, 2013 p. 566]

From abovementioned lines, we can assess that PMBOK understands and defines key terminology in compliance with theory; note the accent on assurance as a result of validation procedures.

The role of quality assurance within the project is mostly described in the project management process called "Perform Quality Assurance", part of knowledge area "Project quality management". Assurance is described as "the process of auditing the quality requirements and the results from quality control measurements to ensure that appropriate quality standards and operational definitions are used" [PMI, 2013 p. 242]; the inputs, tools and outputs of this process are described in Figure 26.

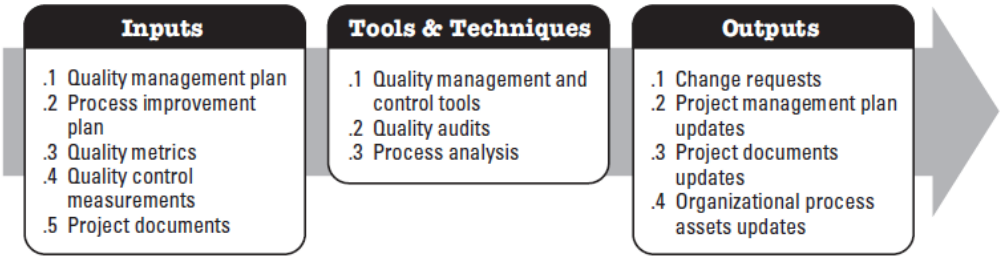


Figure 26 - Inputs, Tools and Outputs of assurance in PMBOK
Source: [PMI, 2013 p. 243]

Assurance is closely connected to other processes defined by PMBOK such as development of Project Management Plan, which is a process that establishes the product creation process. Please note that PMBOK puts strong emphasis on the connection between assurance and documentation – as described in Figure 27.

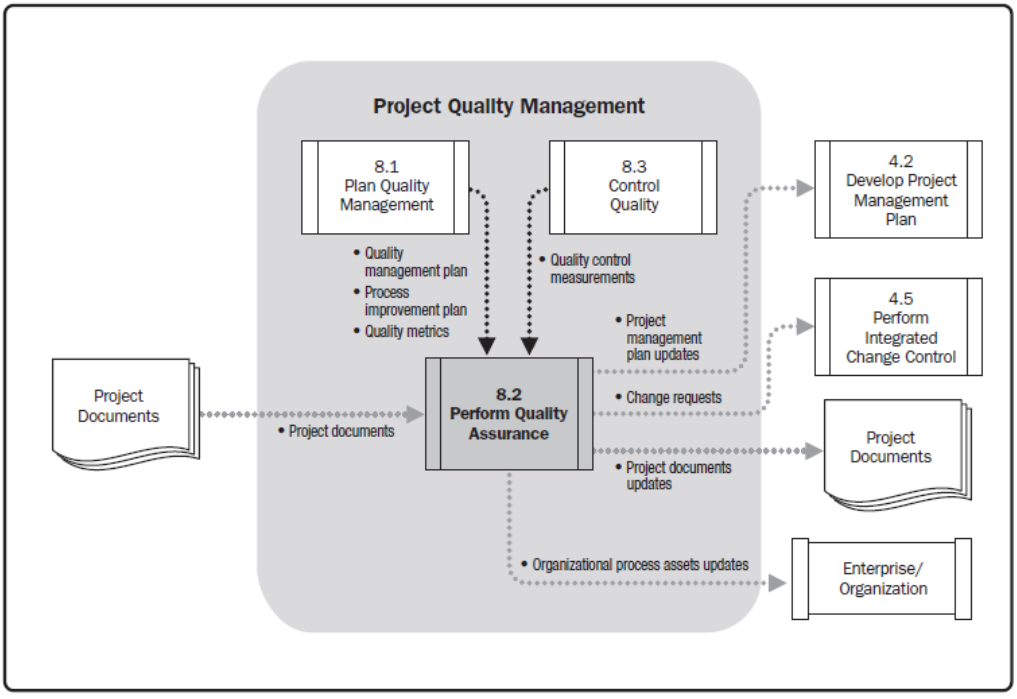


Figure 27 - Data flow diagram of assurance in PMBOK
Source: [PMI, 2013 p. 243]

It has been numerously stated in this diploma thesis that the very existence of audit-type procedures brings the quality, and PMBOK reflects on that, noting that "prevention and inspection aspects of quality assurance should have a demonstrable influence on the project" [PMI, 2013 p. 244]. PMBOK also urges all personnel directly or indirectly participating in the project to support assurance procedures and understand them as drivers of continuous process improvement.

The purpose of the "Perform quality assurance" process is also to execute the results of "Plan Quality management" and "Control Quality" – fundamental relationships are described in form of swim lanes in Figure 28.

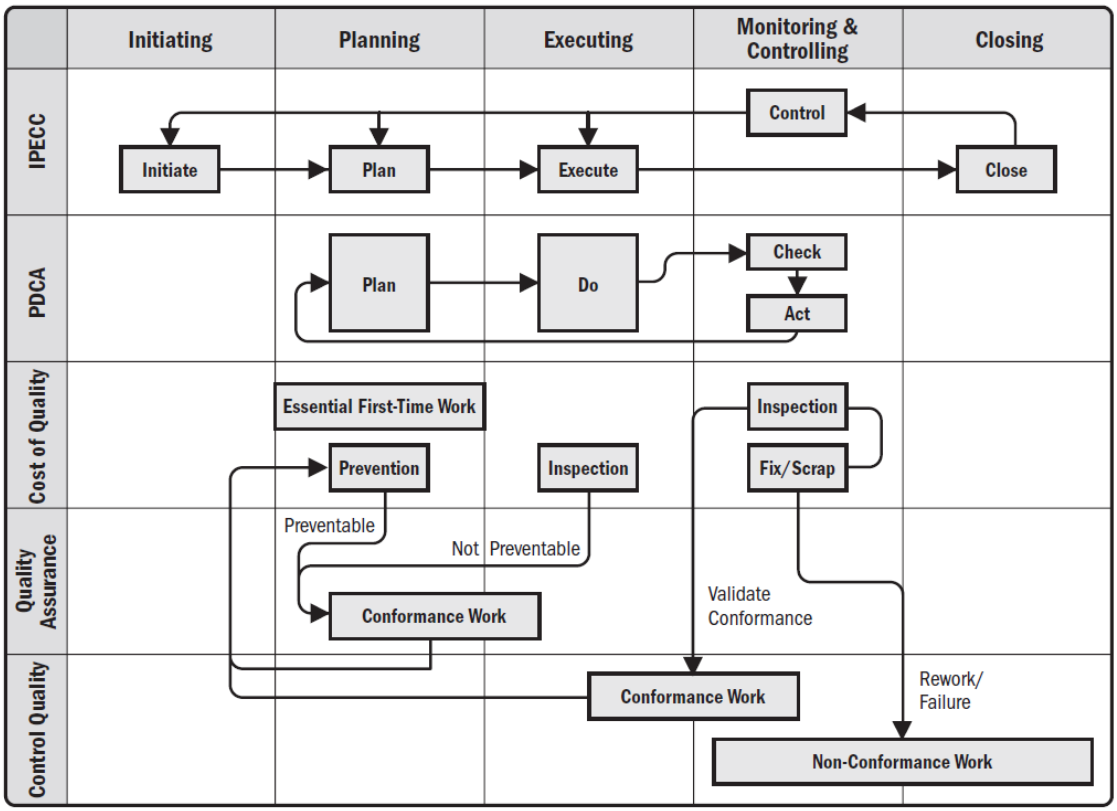


Figure 28 - Fundamental relationships of assurance in PMBOK
Source: [PMI, 2013 p. 231]

"Control quality" is described as the process of "monitoring and recording results of executing the quality activities to assess performance and recommend necessary changes" [PMI, 2013 p. 248] in PMBOK. It is much more connected to the actual controls performed during the execution of the projects that are connected to both project itself and the subject matter. Documentation, deliverables, organizational process, change management, project management plan, quality metrics – all of those directly connected to gaining confidence over the result of the work. The information flow of this process is described in Figure 29.

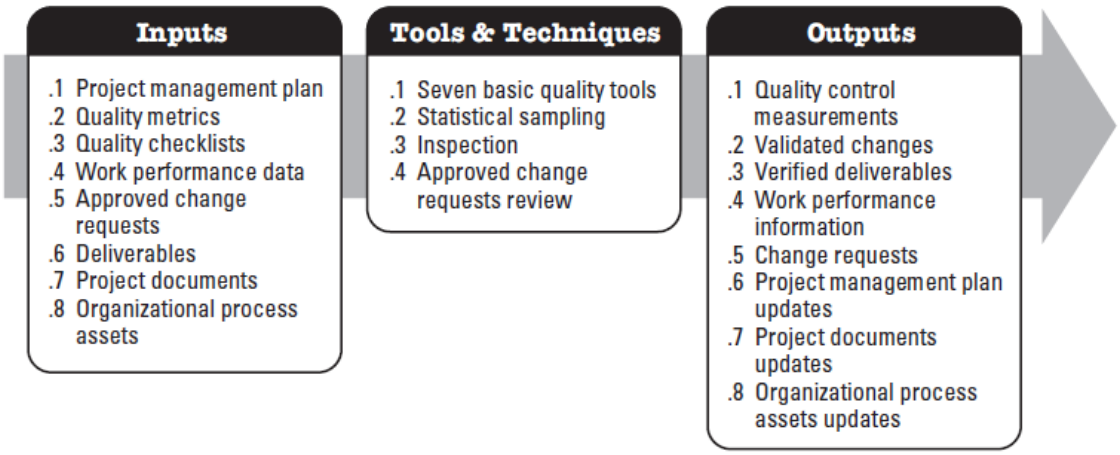


Figure 29 - Inputs, Tools and Outputs of "Control Quality" in PMBOK
Source: [PMI, 2013 p. 249]

As we already know, assurance mainly consists of assessment of design and operational effectiveness of internal controls. From the abovementioned paragraphs, it is clear that the assurance effort is strong in PMBOK. Following sub-chapters will further describe internal controls described in the standard and their connection to the assurance initiative.

4.3.2 ASSURANCE OVER BUSINESS IN PMBOK

Addressing the needs

Assurance over the needs and requirements of the project generally happens during the "initiating" process group defined by PMBOK. The normative is that sponsors, customers and other key stakeholders create a shared understanding of what they need. Such understanding "improves deliverable acceptance, customer satisfaction, and other stakeholder satisfaction" [PMI, 2013 p. 55].

PMBOK also suggests other assurance procedures – review of project needs against high-level requirements of the organization and creation of clear description of why a specific project is the best way how to meet such requirements.

The result of aforementioned procedure is the Project Charter which is a document that formally establishes the partnership between performing and requesting organization, stating business needs, scope and strategic plan. The existence of such documentation is essential for the understanding and evaluation of external assessor. Initiating processes are further described in Figure 30.

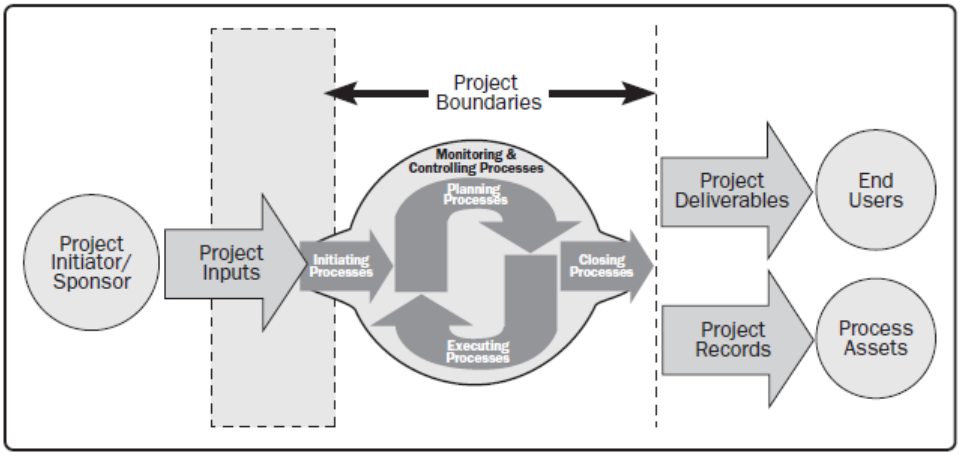


Figure 30 - Initiating processes in PMBOK
Source: [PMI, 2013 p. 54]

PMBOK urges the PM conduct such procedures and agree on a "Scope Baseline" that defines the requirements of stakeholders, amount of work that will be done, traceability matrix, result acceptance criteria, milestones, responsibilities and much more [PMI, 2013 pp. 131-132].

PMBOK further advises to "Control Scope" (which is a discreet process) and, more importantly, "Validate scope" by a review, walkthrough, examination, audit, or a combination of these [PMI, 2013 pp. 134-136].

As we already know, the needs of stakeholders usually change over time, and project change management controls should reflect on that. PMBOK defines a "Perform Integrated Change Control" process that strongly recommends the formalization of change management process (usually in form of Change Control Board) and utilization of expert judgement provided by external consultants and subject matter experts [PMI, 2013 pp. 96-99].

Strategy compliance

PMBOK in its initial part defines a Organizational project management (OPM) which is a "strategy execution framework utilizing project, program, and portfolio management as well as organizational enabling practices to consistently and predictably deliver organizational strategy producing better performance, better results, and a sustainable competitive advantage" [PMI, 2013 p. 7]. PMBOK defines an informal responsibility of project sponsor to "identify alignment or potential conflicts between organizational strategies and project goals and then communicates these to the project manager" [PMI, 2013 p. 15]. PMBOK adds that project are de facto means how to achieve the organizational strategy and objectives and the final responsibility of aligning projects (e.g. the portfolio) with organizational strategy lies on governing boards [PMI, 2013 p. 34].

Data basis

Data basis for the project should be inserted into the Project Charter, which is subject to evaluation by experts as stated in PMBOK. Expert judgement of consultant should be applied to all technical and management inputs to the project, assumptions, constraints [PMI, 2013 pp. 71-72].

PMBOK puts great amount of emphasis on the continual collection, evaluation and utilization of project data. It states that "project data are continuously collected and analyzed during the dynamic context of the project execution" [PMI, 2013 p. 58] and reused for the management of the project – please refer to Figure 31 for the explanation.

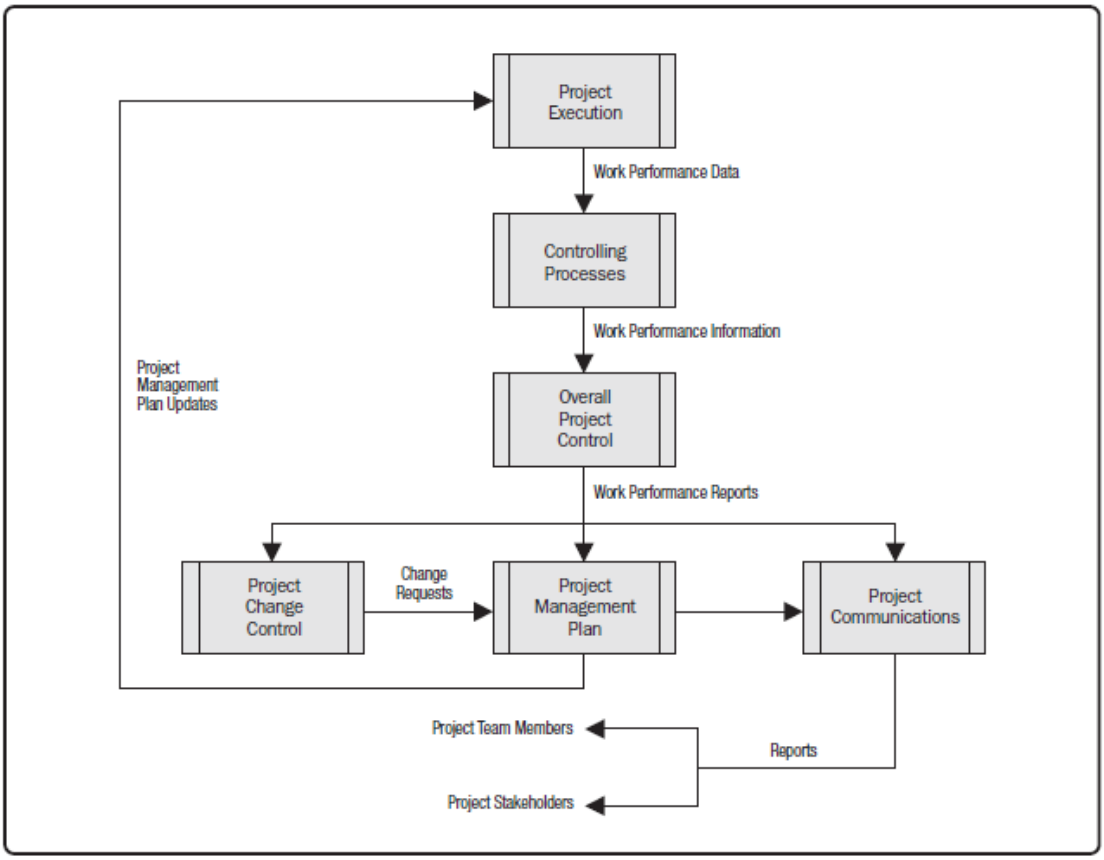


Figure 31 - Project data flow in PMBOK
Source: [PMI, 2013 p. 59]

Additionally, the organization should retain a "Lessons Learned Knowledge Base" allowing walkthroughs of previous decisions and providing positive impact on future ones.

Process compliance

PMBOK is not a methodology specifically designed to support information systems implementation projects. Therefore it naturally does not put enough accent on compliance of ERP with the target organization. But even the effort put on compliance of general product created by

the process with the target environment or alignment of project processes with the organization ones are not described sufficiently in PMBOK. This will be reflected in the addition to the standard created in Chapter 5.

Contracts

In the field of contractual controls, PMBOK standard describes following assurance procedures:

- Utilization of Contract templates during "Project Initiating and Planning". [PMI, 2013 p. 27]
- Utilization of "supporting experts" for contracting or legal control; depending on the size of the project these can be full-time advisors or work only ad-hoc. [PMI, 2013 p. 36]
- Description of agreements accompanying the project in the Project Charter that is inherently audited by expert judgement. [PMI, 2013 pp. 70-71]
- Review of compliance of all requests for changes and the change management process itself with contractual attributes. [PMI, 2013 pp. 85-91]
- Documented review of contracts during "Project or phase closure". [PMI, 2013 p. 104]
- Documentation of contractual and legal implications for the "Scope Baseline" that is inherently audit by expert judgement. [PMI, 2013 p. 203]
- Transferring risks associated with the project to another party in possible cases; review of contractual terms related to liability. [PMI, 2013 p. 344]
- Audit of significant procurement contracts and compliance between the real state and the state defined by the contract. [PMI, 2013 p. 388]
- Possible implementation of "Contract Change Control System" that is used to "collect, track, adjudicate, and communicate changes to a contract". [PMI, 2013 p. 533]

4.3.3 ASSURANCE OVER PROJECT IN PMBOK

Budget

There is an entire knowledge area named "Project Cost Management" present in the PMBOK standard, describing various controls over budget comprehensively. Cost management in PMBOK consists of following processes [PMI, 2013 pp. 195-226]:

- "Plan Cost Management"
    - Establishment of policies and procedures that accompany costs is essential for the organization to be able to manage and measure them successfully and effectively. Expert judgement is utilized in the process.

- "Estimate Costs"
    - We have learned about different ways how to estimate costs in the theoretical part of this work. Most of them are identified and described in PMBOK – expert judgement, analogous estimating, parametric estimating, bottom-up estimating and three-point estimating. PMBOK puts emphasis on the need of documentation that describes the basis of the estimation, assumptions made, and indication of confidence level.
- "Determine Budget"
    - Combination of cost aggregation, reserve analysis and expert judgement suggested for the final budget documentation. Cost baselines and description of funding requirements are deemed necessary.
- "Control Costs"
    - The final process; its objective is to control all outputs of aforementioned procedures, recognize and manage variations to project costs, take corrective actions, minimize risk. Utilization of automated measurement and forecasting tools is greatly recommended by the standard.

Time schedule

PMBOK utilizes similar approach to time as it does to budget, with "Control Schedule" being part of "Project Time management" knowledge area and with well-defined control and measurement mechanism over previously established knowledge area outputs (such as "Define Activities", "Estimate Activity Durations" and "Develop schedule"). Expert judgement itself figures as one of the tools & techniques utilized in the very development of schedule; analogous and parametric estimations similar to budget controls are recommended [PMI, 2013 p. 143].

An important part of schedule controls is the formal mechanism of collection and evaluation of schedule data. They include "at least the schedule milestones, schedule activities, activity attributes, and documentation of all identified assumptions and constraints" [PMI, 2013 p. 184].

The formal objective of "Control Schedule" process is to provide "the means to recognize deviation from the plan and take corrective and preventive actions and thus minimize risk" [PMI, 2013 p. 185]; utilization of performance reviews, automated scheduling tools is recommended. Overall, controls over the establishment and measurement of time schedule are described very well in PMBOK.

Organizational structure

Management and control over organizational structure is comprehensively described in the knowledge area named "Project Human Resource Management", that comprises of following processes [PMI, 2013 pp. 255-285]:

- "Plan Human Resource Management"
    - The process of project role, responsibilities, skills, relationship identification is well established. This is the only process in this field that is recommended to be reviewed by expert judgement.
- "Acquire Project Team"
    - One thing is to establish a plan, the other one to acquire necessary people. This process helps project managers to understand and use techniques on people acquisition.
- "Develop Project Team"
    - The process oriented on continuous development of people; unrelated to assurance; related to overall quality.
- "Manage Project Team"
    - Tools and techniques how to track team performance, provide feedback and resolve issues. Related to change management and overall quality, slightly related to assurance.

By reading the list above, the reader should understand the overall – quite high – level of definition of controls over organizational structure.

Organizational readiness

The chapter named "Enterprise Environmental Factors" advises project manager to refer to conditions that are under control of target organization and adjust the project accordingly. These consist of, at least, following list [PMI, 2013 p. 29]:

- Organizational culture
- Geographic distribution of facilities
- Stakeholder risk tolerance
- Political climate
- Organization's established communications channels

The last item on the list brings us to the fact that the organizational readiness field is further described in the "Project communications management" knowledge area – mainly in the process

called “Plan Communications Management” that emphasizes on “developing an appropriate approach and plan for project communications based on stakeholder’s information needs and requirements” [PMI, 2013 p. 287] and appropriately revising it by using various tools & techniques in further processes such as “Control Communications”.

Policies

PMBOK states in its introductory part that “monitoring compliance with project management standards, policies, procedures and templates” is one of primary functions of Project Management Office and should be achieved “by means of project audits” [PMI, 2013 p. 11].

Following chapter that describes Organizational influences and project life cycle includes “Organizational Process Assets” chapter that describes policies and standards as inputs into planning activities, which are subject to quality audits, reviews and additions during the project life cycle. These include (but are not limited to) [PMI, 2013 p. 27]:

- Guidelines and criteria for internal processes
- Specific organizational standards and policies
- Quality policies and procedures
- Templates
- Monitoring and Controlling procedures and standards
- Project closure guidelines

According to PMBOK, the responsibility of compliance with policies lies on governing structures of the project [PMI, 2013 p. 41]. Almost every knowledge area includes a planning phase that consists of (but not only) policy establishment (such as “Plan Cost Management”) that “establishes the policies, procedures, and documentation for planning, managing, expending, and controlling project costs” [PMI, 2013 p. 193] and is later reviewed by expert judgement.

4.3.4 ASSURANCE OVER PRODUCT IN PMBOK

Since the PMBOK is a general project management standard that is not directly connected to information systems development, the author of this thesis has decided to follow general principles of product quality assurance instead of specific defined areas of software, data, implementation and post-implementation, that have helped to create the comparison with IS development methodologies in Chapter 3.

One of the first interesting mentions of “product” in PMBOK is the one in definition of project success: “Success is measured by product and project quality, timeliness, budget compliance, and degree of customer satisfaction.” [PMI, 2013 p. 8]

PMBOK confirms the approach mentioned previously numerous times in this thesis, that the longer the feedback cycle is, the higher is the cost implied. "The ability to influence the final characteristics of the project's product, without significantly impacting cost, is highest at the start of the project and decreases as the project progresses towards completion." [PMI, 2013 p. 40] PMBOK enables the reader to choose whichever value creation model he needs for the project – iterative, incremental, predictive or adaptive [PMI, 2013 pp. 44-46].

PMBOK distinguishes project processes into two main categories [PMI, 2013 pp. 47-48]:

- Project management processes, that are described in the Knowledge areas.
- Product-oriented processes, that are basically out of scope of PMBOK Guide, even though product assurance activities are at least partially mentioned throughout the whole standard.

In the very creation of the already mentioned Project Charter, one of the key activities is "Product scope description" that describes and documents "the characteristics of the product, service, or results that the project will be undertaken to create" [PMI, 2013 p. 68]. We already know that the Project Charter is subject to audit-type procedures.

One of the key activities of "Direct and Manage Project Work" process is review of all Defect repairs that are "intentional activities to modify a nonconforming product or product component" [PMI, 2013 p. 81].

Assurance over the product and its implementation is not adequately mentioned in the process called "Close Project or Phase" that has a key output called "Final Product"; expert judgement is utilized only to oversee formal closure-related procedural activities, not the product itself [PMI, 2013 pp. 100-102].

Interesting way how to assure over the product is a "Requirements Traceability Matrix" introduced in the "Collect requirements" process that "links product requirements from their origin to the deliverables that satisfy them" and "helps ensure that each requirement adds business value by linking it to the business and project objectives" [PMI, 2013 pp. 118-119].

Additional assurance over product is gained by its description in Project Scope – its mandatory parts include following aspects [PMI, 2013 p. 123]:

- "Product scope description" that describes and elaborates characteristics of the product that has been defined in the Project Charter.
- "Acceptance criteria" that are a key stakeholder assurance element.
- "Deliverable" definition – either in summary or great detail.

Project Scope has its validation phase that has a key benefit of "bringing objectivity to the acceptance process and increases the chance of final product" [PMI, 2013 p. 133]; it is directly linked to Project Quality Management knowledge area that has been already described in the beginning of the PMBOK oriented part of this thesis. PMBOK approach to quality recognizes the importance of "Customer satisfaction", "Prevention over Inspection" or "Continuous Improvement" concepts [PMI, 2013 p. 229].

"Control Quality" process has already been mentioned in the organizational establishment of assurance in PMBOK; the main tool of this process is Inspection. It is described as "examination of a work product to determine if it conforms to documented standards" resulting in measurements; conducted at any project/product level. "Results of a single activity can be inspected, or the final product of the project can be inspected. Inspections may be called reviews, peer reviews, audits, or walkthroughs. In some application areas, these terms have narrow and specific meanings. Inspections also are used to validate defect repairs." [PMI, 2013 p. 252]

PMBOK recommends to create, maintain and store various documentation and datasets during the project execution, as mentioned previously (mainly in the Data Basis part of the evaluation). For example, the "Close Project or Phase" process urges the PM to update organizational process assets such as project files (data outputs from project management activities), project or phase closure documentation (project and stakeholder documentation) and historical information (knowledge base) [PMI, 2013 pp. 103-104]; note that "structured review of the project documentation" is part of "Identify Risks" process [PMI, 2013 p. 324]; update of both project and technical documentation based on review is subsequently described as a result of "Plan Risk Responses" process [PMI, 2013 p. 348].

4.4 COMPARISON AND CONCLUSION

LEGEND	WELL DEFINED	ADEQUATELY DEFINED	INSUFFICIENTLY DEFINED
ASSURANCE OVER BUSINESS	**PRINCE2**	**PMBOK**	**IPMA**
Addressing the needs			
Strategy compliance			
Data basis			
Process compliance			
Contracts			
ASSURANCE OVER PROJECT	**PRINCE2**	**PMBOK**	**IPMA**
Budget			
Time schedule			
Organizational structure			
Organizational readiness			
Policies			
ASSURANCE OVER PRODUCT	**PRINCE2**	**PMBOK**	**IPMA**
Product (Software)			
Documentation (Data outcome)			
Product rollout (Implementation)			
Post-rollout (Post-implementation)			

Table 11 - Comparison of assurance in PRINCE2, PMBOK and IPMA standards
Source: The author

Table 11 provides the reader with a summary of work performed in the three previous sub-chapters. It is clear that the level of coverage by assurance activities varies greatly in the three in-scope project management methodologies, with PRINCE2 having all of the parts well, or at least adequately defined. PRINCE2 is the only in-scope standard that directly and namely describes roles of both "Project Assurance" and "Quality Assurance".

The level of coverage in PMBOK and IPMA is very similar and additions to both of the methodologies will be created as a result of this comparison. For the additions, please refer to Chapter 5. Overall, the level of assurance establishment exceeded the expectation of the author; assurance over project is almost perfect in all of the standards; contrary on that, assurance over product is the area that is, in general, the least defined – possibly due to the general focus of all of the standards. Customization of these in order to meet specific needs of different industry fields is most likely a common practice. In the field of information systems implementation projects, they may be interconnected with software development methodologies described in the previous chapter in order to gain comprehensive assurance over business, project and product fields.

5. ADDITION TO PROJECT MANAGEMENT STANDARDS

The main objective for the work in this chapter is to cover assurance areas that are defined insufficiently by the three project management standards; if possible (due to topic overlap), improvement of adequately defined areas will be included. The author has decided not to create an addition to PRINCE2 due to the limited extent of this diploma thesis and mainly based on the fact that the level of definition of assurance in PRINCE2 greatly exceeds respective levels of definition in the other two project management standards, as reflected in Table 11.

5.1 ADDITION TO IPMA

Based on the comparison created in Chapter 4, the author of this thesis has decided that three individual competences need to be added to IPMA Individual Competence Baseline to make it nearly completely compliant with the theoretical role of assurance established in Chapter 2. The three added competences are as follows:

- Outside view ("Perspective" competence)
- Data ("Practice" competence)
- Product ("Practice" competence)

The main objective for this sub-chapter is to create the three abovementioned competences in such format that they are similar to the rest of IPMA Individual Competence Baseline and fit in it precisely. Every competence in IPMA ICB is described by following attributes:

- Definition
- Purpose
- Description
- Knowledge
- Skills and abilities
- Related competence elements
- Key competence indicators
    - Description of competence indicator
    - Measures of competence indicator

The addition created by the author respects this logical sequence and adjusts the wording so it is consistent with the rest of the standard. The work performed is documented in the following pages of this diploma thesis.

Outside view (Perspective competence)

Definition

The outside view competence describes how individuals working in project management use the view of independent experts to gain confidence and assurance over the work they have performed during the whole life cycle of the project. Assurance is the set of activities that monitor aspects of the project's performance and products independently on the project manager.

Purpose

The purpose of this competence element is to enable the individual to understand the need for independent assessment of the project and help to maintain relationships with outside teams performing the assessment by being able to present both results of the work of the individual and of the control mechanisms that accompany it.

Description

No matter how well the project is managed, different stakeholders always embrace the existence of an independent assessment tool that would give them certain amount of confidence over the performance of the project.

The individual will, during his time with the project, face different types of audits, reviews and assessments. He should, in his own interest, establish a working benchmarking and control environment over the project. This will allow him to increase his own confidence and ability to manage the project and project outcomes and also to raise the level of perceived confidence by the external assessing party.

Being able to understand and satisfy the needs of external audit-type parties is a crucial competence of any individual concerned for the outcome of the project, as opinion depicted in the independent report may help or thwart the project to a great extent. The very existence of abovementioned benchmarking and control environment will help the individual to fulfil such needs and cope with the outside view to the benefit of his own and the project.

All of the above will help the individual to convince stakeholders and sponsors of the project that performance indicators of Practice competences such as Time, Finance, Quality or Resources have been functioning to the benefit of the whole organization.

Knowledge

- Inspection methods and techniques
- Acceptance criteria
- Audit trail
- Internal controls
- Population
- Measurement procedures
- Performance indicators
- Reporting standards

Skills and abilities

- Utilization of external findings
- Negotiation
- Implementation of procedural controls
- Conducting quality assurance procedures
- Managing quality and compliance

Related competence elements

- All other perspective CEs
- People 4: Relationships and engagement
- People 9: Negotiation
- People 10: Results orientation
- Practice 2: Goals, objectives and benefits
- Practice 5: Organisation and information
- Practice 6: Quality
- Practice 10: Plan and control
- Practice 12: Stakeholders
- Practice added in this thesis: Data

Key competence indicators

1. Enable external assessment

Description

Successful execution of external assessment by an independent party is a key element of stakeholder satisfaction. The individual enhances the ability of all project functions to provide reportable results in form of performance indicators and control outcomes. Such data should be always provided in a timely manner to the assessment party on a need-to basis.

Measures

- Ensures that all elements of project management provide inspectable results
- Delivers traceable results and provides them to the assessor
- Identifies fields relevant for the assessment
- Cooperates with external parties

2. Implement, monitor and maintain results of the external assessment

Description

To be able to identify fields that require more effort to be made, the individual needs to understand results of an external assessment and be able to implement them into the project. Such implementation should be consistent with current control environment of the project, provided the findings are not of a design character. Priorities over implementation of mitigating procedures are determined by the project sponsor (owner), top managers or external customers.

Measures

- Knows how to perceive the nature and severity of audit-type findings
- Identifies the connection between findings and stakeholder requirements
- Supports and oversees the implementation of changes to the project
- Monitors the performance of implemented changes to the project

Data (Practice competence)

Definition

Every project is characterized by the dataset that serves as an input into it, dataset that is created during the execution of all project phases, and dataset that accompanies the project output – the product.

Purpose

The purpose of the data competence is to allow the individual to correctly track the data set, that accompanies both the project itself and the product the project is helping to create, and mitigate any deviations from expected data inputs and outputs.

Description

For excellent projects it is essential to correctly understand, review and utilize the data inputs, create as much reasonable documentation as possible, correctly systemize that documentation and allow the end user of the product to fully understand the principles it has been built on by formalizing the output dataset and assuring it is in compliance with previously collected data and also the needs of stakeholders.

This competence, in general, has two main elements: The ability of the individual to track the dataset that accompanies the project itself, and the ability of the individual to track the product dataset. To ensure the acceptance by (key) stakeholders, both abilities should be demonstrated by the individual.

Knowledge

- Data governance
- Business intelligence
- Data mining
- Integrated data management
- Data audits
- Cost of poor data quality
- Decision making
- Big data

Skills and abilities

- Data migration
- Data Quality Assurance
- Data visualization
- Data Quality Controlling
- Data Quality Organization
- Data Quality Processes and Methods
- Conformity checks
- Integrity checks

Related competence elements

- All other practice CEs (including “Product” created in this thesis)
- Perspective 2: Governance, structures and processes
- Perspective 3: Compliance, standards and regulations
- People 6: Teamwork
- People 8: Resourcefulness

Key competence indicators

1. Collect and analyze the initial dataset

Description

Projects are accompanied by enormous amount of data. The ability of the individual to collect, understand, review and evaluate the initial dataset obtained from various stakeholders of the project enables him to fully understand and fulfil the needs of such stakeholders and identify and control risks associated with the project. Furthermore the individual can help resolve how the initial dataset is going to be transformed into the output one throughout the project execution.

Measures

- Identifies data sources relevant for the projects
- Collects all necessary initial data from project stakeholders
- Creates a data-driven and data-dependent atmosphere
- Applies various data analytic techniques

2. Implement and maintain documentation standards

Description

When creating a project, it is absolutely necessary to create at least two types of the documentation. The objective of the first one is to provide confidence to (key) stakeholders over how the project is managed and the product built. The objective of the second one is to hand over the final product of the project effort accompanied by reasonable amount of structured documentation for various end-user groups.

Measures

- Differentiates among crucial, reasonable and obsolete documentation
- Encourages the project team to document its work
- Creates a data and documentation repository accessible to all key stakeholders
- Clearly reports and mitigates any data and documentation defects
- Hands over the final product accompanied by reasonable documentation

3. Assure that the output dataset is valid

Description

The ability of assure key stakeholders, that the output dataset accompanying the product is compliant with the initial one and all data created during the execution of the project, creates great amount of value to all parties involved. Such assurance activities may vary depending on the scope and specialization of the project; they usually consist of data migrations, data audits, data integrity checks and more. All of those help significantly reduce the risk implicated to the final customer.

Measures

- Constantly checks the accuracy and integrity of data used
- Identifies key datasets that bring value to stakeholders
- Chooses appropriate data assurance techniques
- Determines appropriate mitigating mechanisms over data defects
- Monitors all implemented adjustments to used datasets

Product (Practice competence)

Definition

The individual should be able to spot the final product of the project effort even in the very beginning and motivate the team to understand the effort and help create a quality product. To maintain confidence, the individual establishes a comprehensive assurance initiative over the product and implements it into the project design.

Purpose

The purpose of this competence is to enable the individual to help create a stable working environment that bears in mind the final product throughout the whole effort and assures that it's created in compliance with best practices and requirements of the stakeholder, delivered as demanded and maintained as needed.

Description

The ultimate effort of most projects, even though it may not be easily spotted in the beginning of long-term initiatives, is the final product delivered to the stakeholder. The ability of the individual to assure, that the product is created according to best practices of both project management and the field to which the product belongs to, represents added value to all affected parties as well as to product itself.

The very existence of comprehensive control environment over the product represents a strong motivating element in the project effort; it's one of the reasons the individual should create one; the other one being his own self-confidence and confidence of the stakeholder.

Working teams that are able to oversee their own work breakdown and spot the final product – such as the janitor that is "building the cathedral" – are necessary for every project that shows excellence.

Excellent project efforts do not end at the delivery. The individual should always be able to provide reasonable level of service to the stakeholder after the product is handed over, so that all involved parties are satisfied with the collaboration and demonstrate the willingness to collaborate once again.

Knowledge

- Milestones
- Design for testing
- Customer requirements
- Critical activities
- Fit for purpose
- Business development

Skills and abilities

- Systems thinking
- Result orientation
- Stakeholder relationships
- Synthesis and prioritization
- Analysis and synthesis
- Presentation skills
- Business orientation
- Product orientation
- Field of work expertise

Related competence elements

- All other CEs (including “Data” created in this thesis)
- Perspective 1: Strategy
- Perspective 4: Power and interest
- Perspective 5: Culture and values
- People 4: Relationships and engagement
- People 5: Leadership
- People 6: Teamwork
- People 9: Negotiation
- People 10: Results orientation

Key competence indicators

1. Test the product

Description

We have already learned that the very existence of control environment enhances the quality. The individual should conduct maximum reasonable amount of test procedures during the whole lifetime of the product to ensure maximum possible quality and reliability and low risk associated with the deliverable. Such activity will help the team to understand the whole effort and oversee the horizon of their own work.

Measures

- Conducts testing procedures
- Documents and evaluates results of conducted testing procedures
- Urges others to perform as much reasonable tests as possible
- Creates a pleasing environment for testing
- Encourages others to participate in product assurance
- Ensures the product meets the expectation of the key stakeholder

2. Help to implement the product

Description

The implementation phase is the perfect time to sell the product once again to the stakeholder. As most products are handed over so-so, the ability of the individual to introduce the value gained to the stakeholder differentiates the individual from others and represents a key element of excellence.

Measures

- Helps the stakeholder to understand the value created by the project
- Puts all the possible effort into stakeholder perception
- Provides opportunities for stakeholder feedback
- Addresses all relevant findings during the stakeholder acceptance phase

3. Improve the product over time

Description

The ability to provide the stakeholder with services that take place beyond the hand over phase represents a way how excellent relationships may be maintained between the individual and (key) stakeholders and also how excellent products can be built. As formal or informal feedback should be performed and evaluated in both directions, both stakeholder and the individual should benefit from such effort and create excellent, working products.

Measures

- Provides the stakeholder with post-implementation assistance
- Defines a systematic approach to post-implementation phase of the project
- Implements all relevant feedback into his future projects
- Implements all relevant feedback into his future products
- Addresses all deficiencies found by the stakeholder

5.2 ADDITION TO PMBOK

By reading the comparison in sub-chapter 4.2 and examining the summarizing table in sub-chapter 4.4, the reader should understand that even though product itself is out of scope of PMBOK standard, it is nevertheless mentioned – even in connection with assurance – in various ways throughout the standard. The delivery of the product and assurance of such delivery and post-delivery is nevertheless described insufficiently, and the aim of the following addition is to make PMBOK standard compliant with the theoretically established role of assurance from Chapter 2.

One complete PMBOK process is added into the knowledge area called "Project Integration Management". Namely it is "Deliver Project or Phase". Even though it is focused on the implementation and post-implementation phase of the product, the phase is named as it is for two reasons: To be compliant with another process in the knowledge area named "Close Project or Phase", and due to fact that Product is the essential goal of the Project. Therefore the delivery of Project Phase – for the purpose of simplification in this diploma thesis – may be interchanged with the delivery of Product Phase. The author would like to recommend to place the following addition between chapters 4.5 and 4.6.

Deliver Project or Phase

Deliver Project or Phase is the process of formally delivering the result created as a result of all activities of the project. The key benefit of this process is that it provides the project management and stakeholders with formal control over the created product and the way it was delivered, in order to find and resolve deficiencies and identify ways of future improvement of the product creation process. The inputs, tools and techniques, and outputs of this process are depicted in Figure 32. Figure 33 depicts the data flow diagram of the process.

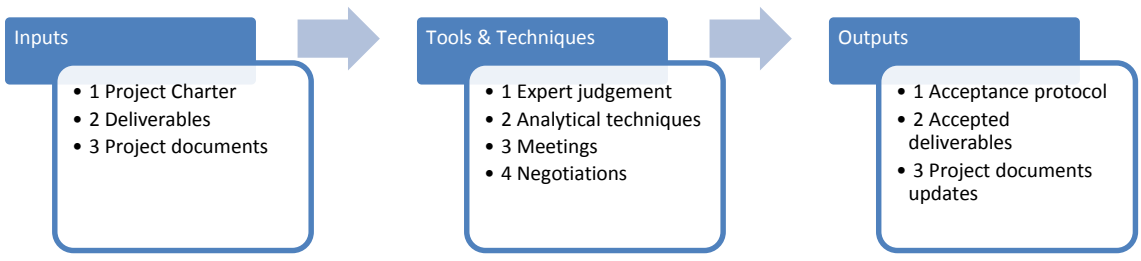


Figure 32 - Deliver Project or Phase: Inputs, Tools and Techniques, and Outputs
Source: The author

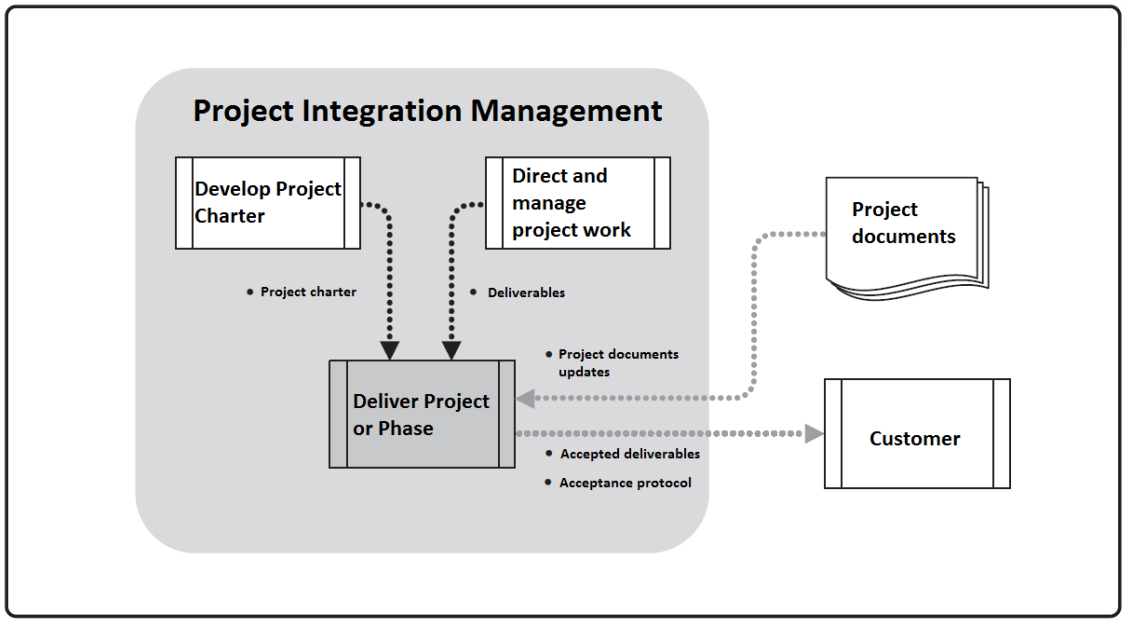


Figure 33 - Deliver Project or Phase: Data Flow Diagram
Source: The author

When delivering the project or phase, the project manager reviews all previously created parts of the product among with all key stakeholders and overviews the delivery of such parts of the product to ensure it has been implemented into the target organization in compliance with stakeholder requirements.

The Deliver Project or Phase process also establishes the procedures to document, evaluate and investigate all defects created or discovered during the delivery phase. In order to successfully achieve this, the project manager needs to engage all the proper stakeholders in the process.

This includes at least following:

- Actions and activities necessary to satisfy acceptance criteria for the product;
- Actions and activities necessary to satisfy delivery requirements of the product;
- Actions and activities necessary to adjust the target environment to the needs of the product or vice versa;
- Actions and activities needed to collect delivery records and implement them to the project documentation;
- Actions and activities needed to review the delivery using audit-type procedures and the work of experts.

Deliver Project or Phase: Inputs

1 Project Charter

Described in Section 4.1.3.1. The project charter defines the product approval requirements, stakeholder list, project purpose and justification, measurable project objectives and other requirements that will influence the management of the delivery.

2 Deliverables

Described in Section 4.3.3.1. A deliverable is any unique and verifiable product that results in a validated deliverable required by the project. Deliverable may also consist of implementing a previously created deliverable into the stakeholder environment.

3 Project documents

Described in Section 4.2.3.1 and Section 2.1.4. Formal documentation of project delivery guidelines and requirements (e.g. project evaluations, product evaluations, quality reviews, test procedures, and acceptance criteria) affects the management of the delivery and need to be updated afterwards.

Deliver Project or Phase: Tools and Techniques

1 Expert judgement

Expert judgment, guided by historical information, provides valuable insight into the delivery of similar products into similar organizations. Expertise should be considered from groups or individuals with specialized training or knowledge of the subject area.

Expert judgment can also suggest whether and how to combine analytical techniques described in the following section.

Expert judgment may need to be applied to technical and/or management details of the implementation and may be provided by any group or individual with specialized knowledge or training, such as:

- Consultants
- Subject matter experts
- Professional and technical associations

2 Analytical techniques

Analytical techniques are applied in project or phase delivery to ensure that outcomes of the project do not show significant deviations from requirements and that they can be implemented into the stakeholder environment successfully. These include (but are not limited to):

- Product Quality testing
- Product Integration testing
- Documentation review
- Integration review
- Post-integration review

3 Meetings

Described in Section 4.3.2.3. Meetings may be face-to-face, virtual, formal, or (unusually) informal. They should include project team members and other stakeholders, involved in or affected by the project output. Acceptance meetings should be prepared with a well-defined agenda and acceptance evaluation criteria and result in a formal documentation.

4 Negotiations

Negotiations take place if the parties disagree on the defects, their classification, work acceptance or the measures how to resolve identified defects. If possible, the objective is to reach a beneficial outcome of the negotiating procedures for all parties involved.

Deliver Project or Phase: Outputs

1 Acceptance protocol

The key formal output of this process is a customer's legal act by which he certifies the completion of the product or phase and its accuracy and quality. The customer should, as part of product or phase acceptance, agree with the project management over methods that will help resolve identified deficiencies of the product and its delivery based on their severity.

2 Accepted deliverables

The product or phase produced by a project and validated by the project customer or sponsors as meeting their specified acceptance criteria. Partial or interim deliverables may also be included.

For excellent projects, all involved parties should agree on measures how to continuously implement the quality of delivered product and assure stakeholders over the operations and maintenance and also propose ways how to adjust the target environment in a way it is fully procedurally compliant with the implemented product.

3 Project documents updates

Project documents that may be updated include (but are not limited to):

- Requirements documentation
- Requirements traceability matrix
- Contractual agreements
- Scope for the next phase of the project

6. CONCLUSION

This diploma thesis named "The role of assurance within project management standards" has been created as a closing work of the Information management study program, and as such, it makes a considerable effort to utilize significant portion of previously gained knowledge.

The objective of the theoretical part of the work (represented by Chapter 2) was to establish the role of assurance within information systems implementation projects. Various scientific literature and journals, both domestic and international, have been used to do so. Based on the research performed, there are three significant areas that require notable involvement of an external assurance team: Assurance over business, assurance over project and assurance over product.

The first one aims mainly on the stakeholder satisfaction, compliance with internal processes, strategy of the organization and contractual agreements. On the boundary between business and product lies the budget and time schedule, as they affect both of these areas. To ensure correct execution of the project, the assurance team usually reviews also controls over organizational structure, organizational readiness and policies that accompany the project. Confidence in the product is – at least for information systems implementation projects that have been in scope of this diploma thesis – gained mainly by conducting various quality assurance procedures over the software itself, as well as over data migration, implementation and post-implementation phase.

The work performed in the theoretical part of the thesis has been summarized in a three-page comprehensive table that establishes the role of assurance within information systems implementation projects, and also in enhanced V-model, both closing Chapter 2 of this thesis. By reading all of the abovementioned, the reader should be able to recognize the objective set for the theoretical part of the work as fulfilled.

Chapter 3 followed and provided the reader with comparison of the established role of assurance over product with three distinctive information systems development methodologies: Agile Unified Process, Scrum and Feature Driven Development. Activities that help development teams as well as stakeholders to gain assurance over software quality, data, implementation and post-implementation phase have been looked up inside the methodologies with various amount of success.

The summarizing comparison of all three methodologies concludes the chapter and brings up a finding worth future investigation: It is highly possible that there's a correlation between the level of assurance definition and agility of the methodologies represented by the length of their feedback cycle.

The main objective set up for the practical part of the work has been fulfilled in Chapter 4 and subsequent Chapter 5. The fourth chapter intended to perform very similar work to the third one, but with the three most widespread project management standards: IPMA, PRINCE2 and PMBOK.

The comparison between the theoretical role of assurance and the practical one provides basis for the summarization that concludes the fourth chapter as well as for the addition to project management standards that are not adequately compliant – IPMA and PMBOK. No addition has been created for PRINCE2, since the level of coverage by assurance activities greatly exceeds the ones in IPMA and PMBOK and PRINCE2 is the only project management standard that namely describes roles and responsibilities of both project assurance and quality assurance.

Three individual competences have been added to IPMA Individual Competence Baseline v5 to make it almost completely compliant with the theoretical role of assurance: Perspective competence "Outside view", practice competence "Data" and another practice competence named "Product".

The whole process named "Deliver Project or Phase" has been added into the "Project Integration Management" knowledge area of a Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fifth Edition, making the PMBOK standard compliant with the theoretical role of assurance in fields of assurance over product and its delivery.

Both of the additions respected the type, format and wording of respective project management standards they've been added to. This – and also the fact that additions have been created in the original language of both of the standards – allows the thesis to fully support the claim for merits that have been set during the introductory part.

Knowing any of the standards and reading the fifth chapter, project management professionals should gain better understanding of the need for assurance over their project and product respectively. They should identify and implement measures that help assessment teams, satisfy their needs, and subsequently satisfy the needs of project stakeholders and the steering committee. It is important to emphasize that even the very existence of external assessment mechanism improves the quality of the work performed.

Several possibilities of future research arise from this thesis and will be described in following paragraphs.

The first one has already been mentioned: Is there a mathematically-provable correlation between the length of feedback cycle and amount of assurance activities defined by the development methodology? That might be an interesting topic for a bachelor thesis in the IT field.

The second one is a topic of a diploma thesis extent: Explore the role of assurance in PMBOK and/or PRINCE2 to a greater degree, since this thesis has oriented on three different project management standards (IPMA being the primary focus) and the amount of detail put into the work could not be the maximum possible one.

The third one may be an option for a dissertation thesis that would find a way how to connect a particular project development methodology and project management standard in order to create a functioning, usable framework for conducting IT-specific as well as general assurance procedures at the same time, throughout the whole lifecycle of the ERP implementation project.

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