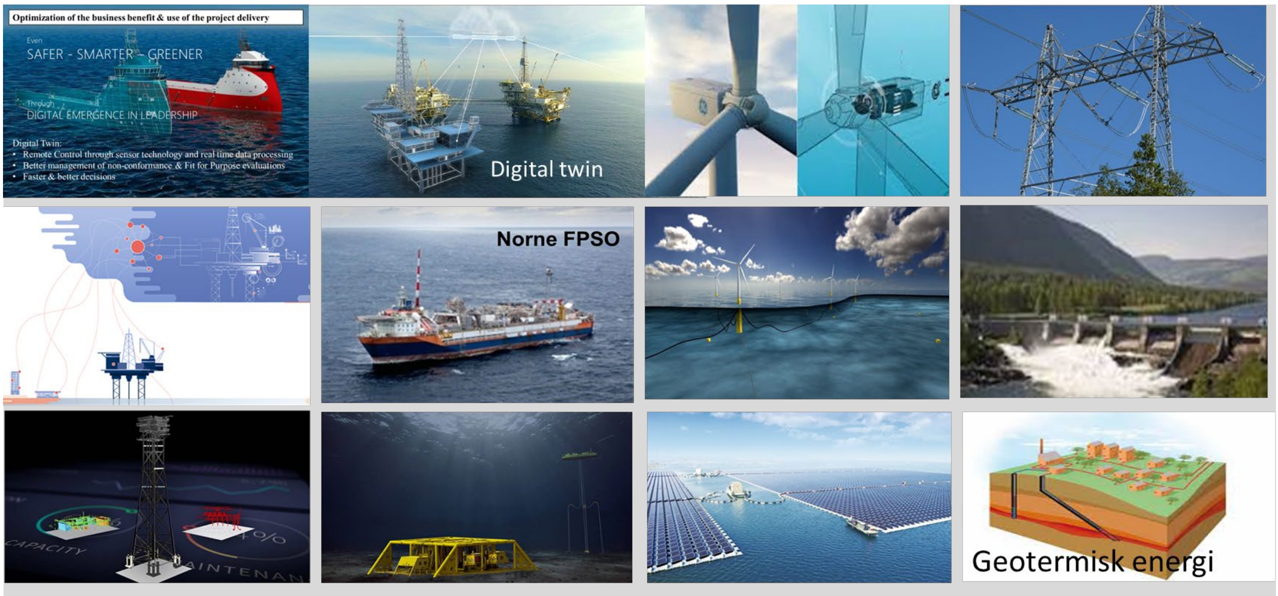
QRM in Projects

Quality and Risk Management in Projects

An Experienced Based Approach



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Preface

The book is generated as an experienced based reflection related to issues connected to quality and risk management in projects. Particular attention and focus are given to quality and risk challenges in projects compared to normal operations.

The overall purpose of the book is to ensure a harmonized and balanced totality driven perspective on quality and risk issues in projects. That means to cover the quality on actual product and service as well as on cost, schedule and business benefit in light of risk, both with respect to threats and opportunities. Management excellence in the control on cost and schedule is not enough if the focus on quality of the product is lacking, and the product/service fails to satisfy the specification requirements. This balance is reflected in the build up of the book, in which there are initially some general considerations on quality and risk thereafter focusing on the project specific processes on quality and risk. The structure and content is considered in full alignment with ISO 9001 Quality management built on the principles of a risk based approach.

Chapter 1 briefly summarizes the terms and definitions on quality and risk with particular focus on the project specific processes. Furthermore, the process definitions and design of processes are included as they are the basic builing blocks for quality management and risk management. The perception of quality and risk are also depending on the parties involved; thus, stakeholder management and expection management are included.

Chapter 2 covers key topics related to product quality in projects and the associated uncertainty and variability in the quality features of the delivered product or service. The importance of a well defined and specified scope of work is paid particular attention.

Chapter 3 addresses the issues related to deviation and non-conformance, changes, audits and technical evaluations and 3rd party verification in projects. Any project is faced by these challenges regardless of type of industry and type of project.

Chapter 4 is focusing on delivery quality and execution quality, system perspective and management systems in projects, from a client point of view as well as from a contractor point of view. These topics are discussed in light of risk and opportunity during the planning and execution phases in the projects. The quality and risk driven management system is a primary enabler for secuting full traceability, documentation and control of the product development and achieving the specified precision level on the delivery.

Chapter 5 is focusing on the contract management processes in projects, and how to manage and control quality and risk among the parties involved, with particular emphasis on the risk sharing between client and contractor and the consequence on how to manage the contract processes.

Chapter 6 includes topics related to the business driven issues related to quality and risk, including subjects such as business benefit and enhanced commercial mindset, a leadership understanding of risk and opportunities in light of risk strategies, decision making under uncertainty and non complete facts basis, project portfolio business management and managing uncertainty under dynamic and upredictable conditions.

Chapter 7 briefly describes organisational issues that affect quality and risk management performance. The Quality & Risk manager (QRM) role is discussed and the importance of understanding the organization culture is highlighted. Furthermoe, chapter 6 summarises the most relevant quality management models in which organizational dimensions are explicitly included.

Chapter 8 addresses some particular challenges related to quality and risk for a variety of project types likely to be present within different industries and within public service.

This book is to be considered as a supplementary textbook to the classic and fundamental text books in project management.

It is not a guide on how to use the respective ISO standards for quality and risk, it is not designed to be a guide on how to use PMBOK, and it is not a collection of check lists for quality control. Furthermore, this book does not replace any process description and/or procedures developed and implemented in the respective organisations and projects, but hopefully give an overall background and context on risk and quality issues in projects related achieve confident decision making and management execution of projects through in depth understanding of complexity in order to demonstrate & obtain excellent project performance.

The ambition and purpose with the book are to put emphasis on the manager and leader challenges related to quality and risk in projects, and how to efficiently contribute to achieve excellent project performance from a business, product and efficiency & effectiveness perspective.

Sincere thanks to colleages at Norwegian Business School BI, Norwegian University of Science and Technology, NTNU, as well as to colleages in the Partner association Project Norway (Norwegian Center of Project management). Discussions and experience exchange gave very valuable input and advises during the generation of this book.

Jon Lereim

Asker, Norway,

14th January 2024

Chapter 1 Quality and risk in the project context

1.1 Introduction and purpose

This text book is intended to be used as a supplementary text book to the classic well recognized books in project management, and not any replacement for any of those. However, it is a self standing book focusing on the challenging issues on quality and risk management in projects.

Most text books in project management are developed for the purpose of highlighting the management and control aspects of of projects, with particular emphasis on cost and schedule performance under a regime with manageable risk levels. In addition, the organizational, and leadership and team development topics and addressed.

In the present and future business and project world, the topics listed above are more crucial than ever, in the light of en ever tougher environment with respect to shorter lead and execution time, and tight approved budgets. In the context of enhanced business and commercial awareness, these dimensions must be paid particular attention. This is also frequently reflected in independent project reviews, in which there is a desire to confirm that there is established confident cost and schedule estimates prior to decision on sanctioning and approval of the project. These cybernetic dimensions form the basic elements to the project baseline, a necessary reference condition for achieving satisfactory management & control of cost and associated progress.

The corresponding organizational and leader aspects in management and project execution may be assessed by different health checks or project maturity models, in which the PMI based OPM3 is the most widely used model for analyzing issues related to culture, organization, roles, team development and leadership capabilities.

What is missing in order to move towards project performance excellence?

Classic project control and management focuses on the project dimensions i) cost, ii) schedule and iii) product quality. For a number of projects, particular management attention is given to cost and schedule control, whereas less focus has been on the actual delivery, the output product or service. The out-put product quality is defined in the specification requirements and included in the project scope of work. Key issues are product quality and scope of work, which should have same level of attention as cost development and progress/schedule.

Project success is considered to rely on a well balanced approach to the combination of the desired benefit/effect of the project results, the product quality itself, the cost expenditure and the time spent on completing the project under a controllable and manageable risk profile.

This book focuses on the quality and risk issues in the context of the project specific constraints and conditions, as these aspects are experienced to be as important as cost and schedule management and control. The goal is to achieve a harmony between the quality of the delivered product/service and the effort in finishing the product/service in terms of firm cost and schedule control for generation of satisfactory risk, efficiency and effectiveness in the project in question.

The fundamental background is the list of basic elements as listed in table 1 – 1, in which the classic high performing project management is to handle and master the product quality, the cost expenditure and the progress/schedule.

Budgetted cost and schedule are frequently estimated to a satisfactory accuracy and detailing level for making good cost control and progress during project execution.

Experience from a number of industries and projects has raised the question whether the actual product delivery and its product quality is specified, planned, monitored and controlled to the same level of systematics and preciseness as on cost and schedule..

Task/Scope	Product quality & Functionality	Project cost estimates	Project schedule & timeline	Business benefit
	The classic project control parameters			
Requirement to a neutral and objective description of the scope of work	Firm and realistic decription of product quality and specification requirements	Develop a realistic estimate of total cost and associated contingency and cost	Derivation of a realistic time estimates, critical path and float.	Identification of potential business benefit by use of the project delivery

Table 1-1 Primary classic control and performance parameters in projects

Quality and risk management in projects are key enablers for improving project performance and contribute to confident and efficient satisfaction of specified product quality requirements under a regime of optimized risk & opportunity control leading to mazimum benefit of the application of the project delivery for the user or client. It is of limited value to perform to the excellence in management and control of accumulated cost and the corresponding progress, if the project product delivery is not according to the specified requirements from the client and do not comply with the scope of work.

As a consequence, quality and risk management in projects should include the management of the development of the actual product delivery/product quality as well as management of the expected business benefit of the use of the delivery. The execution performance must be manageable and cater for the dynamic and changing uncertainty range associated with all the primary projet control variables. Following these considerations mean that quality management in projects is to manage quality and risk on any variable associated with the planning and execution of the project in question.

Initially it should be predicted the desired figure on the potential business benefit or effect goal for use of the project product delivery, at least establish a notion of what it is likely to be. The specified effect goal could as well be an enhanced reliability level, enhanced service level and operability, increased production capacity, extended operating life, an improved high-performance organisation resulting in higher efficiency with improved effectiveness etc. The business benefit could simply be reflected in the initial prediction of Net Present Value, NPV, Internal rate of return, IRR, or Return of Investment, ROI, or even pay back time. The question is simply as follows:

- Why do we launch the idea or project initiative?
- What are the objectives for the project or idea?

The predictions are summarized in the business case. The estimated business potential or business benefit puts ambition and direction on the desired delivery that is to be thoroughly described in the scope of work. The preciseness level in the scope of work is expected to be significantly enhanced if the business potential or expected business benefit is well formulated. Of particular remark is the clear dependency between the variables listed in table 1 – 1.

A thoroughly formulated scope of work is a condition for derivation of a firm specification requirement for the product or service to be delivered from the project, which again gives the basis for the estimation of budgeted cost and schedule, as well as preliminary estimates for the potential business benefit. There has been a clear tendency during the last two decades that the specification requirements are designed more as functional requirements rather that detailed specified requirements. The rationale behind that trend is the short "life time" of detailed specified requirements, whereas functional requirements are longer lasting. It gives you a more predictable condition for the suppliers of requested products and services. However, the derivation of functional requirements is considered to become particularly demanding as the desired characteristics are to combine objectivity and sufficient clarity & commitment in the functional requirement. That requests the most experienced resources for the derivation and design of the functional requirements.

Quality and risk are issues in any type of projects. The basic principles are the same, but the necessary detailing level in planning and control will vary depending on the type of project in question. Managing quality and risk in a reorganization project will typically be significantly different from a traditional construction project on land or offshore.

The primary objectives of quality and risk management are to continuously improve the project performance in order to satisfy the specified as well as expected features in an efficient way and resulting in an optimized effectiveness of the use of the project delivery. In that context high efficient and high effective project environments may likely utilize the basic principles from lean and agile methodologies in project development. In short, a planned mindset under dynamic conditions may most likely result in significant benefits compared to the classic ways of project execution in which rework may frequently appear due to unsatisfactory planning. The latter approach is more a kind of "fire fighter" than professional high performing project management. These aspects are briefly illustrated in figure 1 – 1.

The left column in figure 1 – 1 reflects the old fasion way that may give rise to significant amount of rework, due to lack of proper planning and control. By intensifying the planning activities you are convinced that planning pays off, in particular with respect to the expoected reduced amount of rework to be done. In addition, if the planning is done to the excellence, the amount of control activities may be reduced accordingly, and the benefits increased by the same amount. That condition is schematically illustrated in the right coumn in figure 1 – 1 and may be associated with the Six Sigma methodology striving for highest performance and reliability in the production. The accumulated quality costs are expected to be reduced significantly and the output delivery is expected to satisfy enhanced efficiency and effectiveness. You may consider the quality cost savings as benefits. Textbooks in quality management are covering these aspects in detail, as eg Aune and Oakland, for regular production operations in manufacturing companies.

Figure 1 – 1 reflects the basic principles that better and more thorough planning improves quality and accordingly reduces the amount of rework to be done to satisfy specified requirements. It does not necessary mean to perform more extended planning activities, but relevant and spot-on planning activities. In other words, it is not just doing things right, is is of utmost importance to***"do the right things right first time and in the right order or sequence"***.

These perspectives give directions on how to plan and execute the various tasks, which is quite different in a project compared to normal line operations. Projects are to some extent extreme in the sense that they are by definition a one time event and unique, in contrast to repetitive production operation. In projects, you have to do the work properly first time, and if not, rework is necessary and the risk of cost overruns and of delay is increasing.

In regular production operations, process management and control are key issues in order to achieve the specified product quality and desired efficiency. In process management and control, any deviation in product quality and efficiency may be readily adjusted back on track by utilizing the appropriate process control parameters for the production line in question.

The quality improvement loop was initially derived by Juran and Deming, and is the basis for the principles of continuous improvement and lean manufacturing. It consists of the following four steps, in teh so called PDCA wheel:

- Plan
- Do
- Check
- Act(and improve)

The PDCA loop is well suited for regular production operations; however, is it as appropriate for projects and their project specific constraints?

The nature and characteristics of any project are to deliver a unique ***"one-off"*** product or service. The ultimate is when handover to operations or users of the project delivery is done. Monitoring and control of the final product delivery will confirm the actual product quality, not more not less. It has value for the handover process and use of the delivery. However, it has marginal value for the project completed during its planning and execution phases. During project execution appropriate measures and control of the quality development should be a part of progress and status reporting. If any deviation is identified at point in time of monitoring and reporting, corrective actions may be done and the forecasted expected final quality should comply with the specified product quality requirements. The corrective actions might follow the principles outlined for the PDCA- improvement cycle. That is as important for any project as for regular production operations.

The textbook is covering a range of key issues connected to quality and risk management in projects. The outline is to a large extent based on a process approach, as process mapping and management may give the opportunity for monitoring and improving the performance continuously. Furthermore, the ISO standards for quality management, risk management and quality management in projects are all based on the process approach. The corresponding quality models are derived and founded on a core of processes.

The textbook is not guidance on the respective ISO standards; neither is it a catalogue of tools and methods for monitoring and control, and not a collection of check lists on various quality and risk issues in quality work in projects.

The intention of the textbook is to provide you with a comprehensive and concrete recommendation on how to do quality and risk management in projects to the level that provides you with project performance excellence by efficient use of appropriate quality and risk models in the ISO standards.

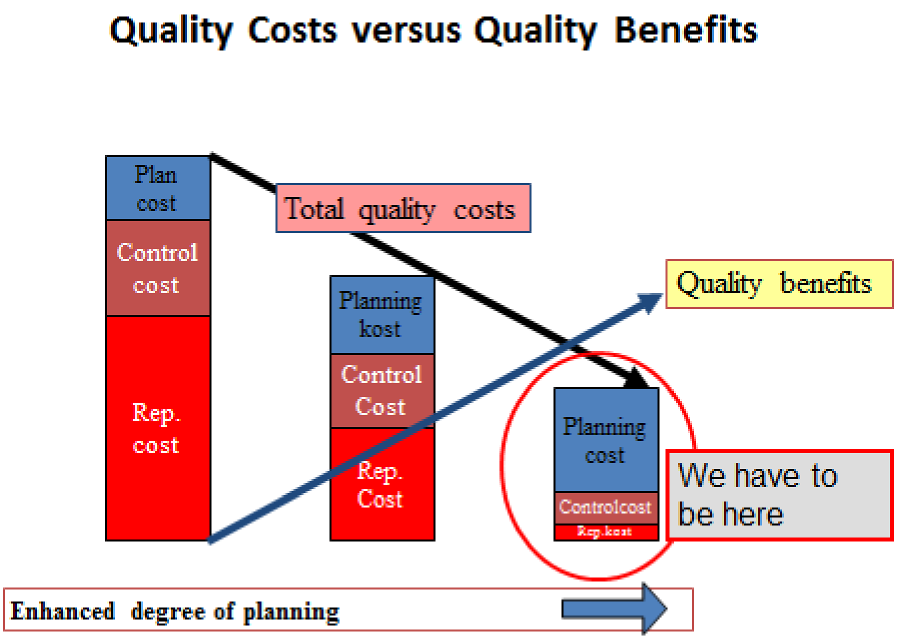

Figure 1-1 Quality costs and associated benefits; accumulated quality costs consists of planning costs, control & monitoring costs, and cost of rework or repair costs

1.2 Quality – The perception and understanding historic development

Quality – what does it mean? The perception and understanding of the term quality is partly influenced by the culture and the context where quality matters.

Some expressions related to the definition of quality are as follows:

- Something durable that does not break apart
- robust
- High reliability level
- Flexible
- attractive features
- luxury
- exclusive
- socially accepted.

ISO 9001 gives the following definition of quality: « to satisfy specified and perceived requirements to quality».

In more detail ISO 9000-series expresses the following:

Capability and ability characterising a product, system, or process to fully satisfy the requirements from customers and other stakeholders in which the requirements are needs and/or expectations that are:

- specified
- covered
- compulsory

Quality is dealing with satisfying our customer's specified requirements, needs and expectations. Perceived quality is thus to satisfy the customers expectations and requirements.

This approach and thinking may be reflected in the following simple equation:

(1-1)

$Q = R/E$

In which

Q: Quality

R: Result as the customer experiences it

E: expectations to the product/service, specified and underlying expectations. The latter might be culturally influenced.

Is there a due date on perceived quality? That might absolutely be the case. What was regarded as high performance quality a few years back may not be classified as superior quality today.

The fast technology development is a primary contributor to the changes. A typical example of this is the mobile cell phone. A 5 year old phone is considered not to have the desired features and functionalities of today. The perceived quality must be put in the context of the present society and market. A 10-year-old office building of superior product quality as such and almost infinite durability may still not be up to the expected standards and functionalities of a new-built office building. The perception may be old fashion and outdated although everything is in perfect order and functions as specified.

The perceived quality of a 20-year-old car is not at the level you expect and request for a new car. The functionality and features are much simpler than what is standard equipment in todays' cars.

Quality definitions considered specifically relevant for projects may be differntiated as follows:

- The product quality
- The delivery quality
- The execution quality
- The process quality
- The quality of desired effects

The product quality is defined and firmly described in the product specification requirements, in terms of a detailed specification requirements or a more functional description. What should be the preferred option may vary depending on the situation. Functional specifications seem to be the rule as the standards may not be revised sufficiently frequently in order to cope with the the rapid technology development.

Delivery quality in a projet shall cover, in addition to the product quality, the features related to the preciseness level for the delivery with the respect to the following criteria: rhet prosjekt inkluderer, i tillegg til produktkvalitet, også egenskaper knyttet til presisjon av leveransen ut fra følgende kriterier:

- The product or service is delivered according to the specified time of the delivery.
- The product or service is delivered at the right place.
- The as received product is in compliance with specified volume and capacity.

The project specific execution quality is connected to the confidence, predictability and reliability as well as efficiency in the project processes and knowledge areas. The execution quality in projects thereby includes quality and reliability issues related to cost and schedule management & control in addition to the product quality and delivery quality.

Process quality is an integral part of the execution quality and shall cover all the processes associated with the nine knowledge areas defined in the Project management Institute Body of Knowledge, PMBOK.

Execution quality excellence in projets is characterised by high precision level, high performance through confident efficiency in all processes and the capability to master continual improvements during project execution.

The process description related to the respective knowledge areas are well described in PMBOK, in ISO Guidance 10006 and ISO 21500 as well as in the process element in the *Project Excellence*-model from International Project Management Association, IPMA. That will be explained in further detail in section 7.4.

Effect Quality is related to the degree that the business benefit or desired effects by using the project delivery. It could be the degree of achieving the estimated project economics such as estimated NPV and IRR, but could also cover parameters such as regularity and reliability in operation of the project product delivery.

During the project lifetime, the execution quality in the respective project processess may be reflected in a set of success factors. On the other hand, the effect quality is linked with the corresponding success criteria, ie. It means whether the desired and specified effect/ business benefit are acheieved by use and operation of the product deliveries.

The respective quality terms are visualised in table 1 – 2 in order to link the broader project quality perspectives to the traditional project control and management parameters time, cost and specifications (quality)

A sincere quality organisation is characterised by a well established and firm organisation culture in which there is a quality perception and understanding related to any activity and detail in the organisation. Everyone in the organisastion is aware of the requirements to quality and strives for continual improvement. The culture dimensions must enclose the project business and execution environment in order to develop and improve the quality performance excellence. These perspectives are add-ons to the basic project quality terms outlined in table 1 – 2.

<table>
<tr><th>Project Quality Terms</th><th>Vusual illustration</th></tr>
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Product Quality

This covers the product technical specification requirements and specified desired features and functionalities & the ability to realise the product

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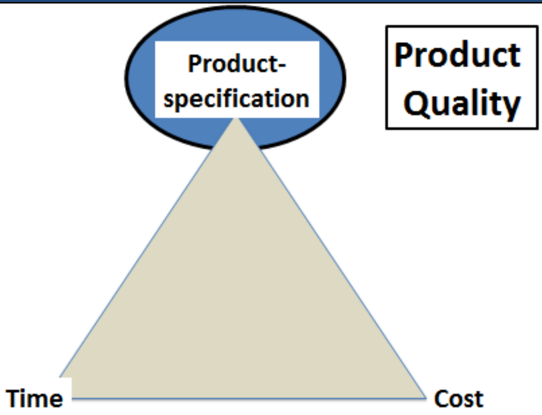

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Delivery Quality

The Delivery Quality includes , in addition to the product quality, the preciseness of delivery with respect to time, location and control of received quantities

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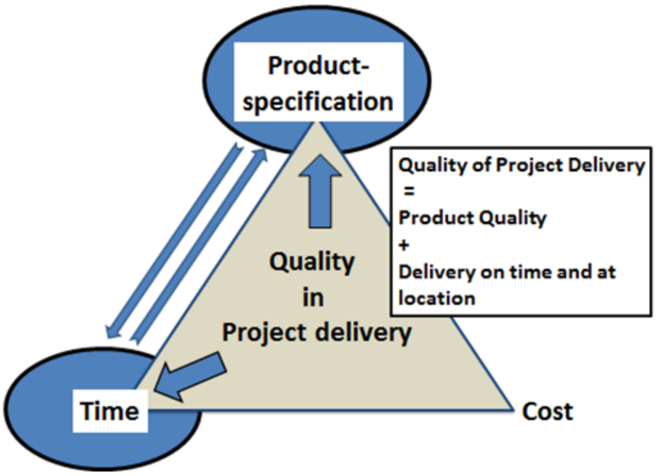

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Exeecution Quality

(Project Quality)

Execution Quality (Project Quality) is reflecting the total performance and efficiency in all project processes and knowledge areas in in addition to what is covered by the delivery quality. This should be reflected in the project success factors

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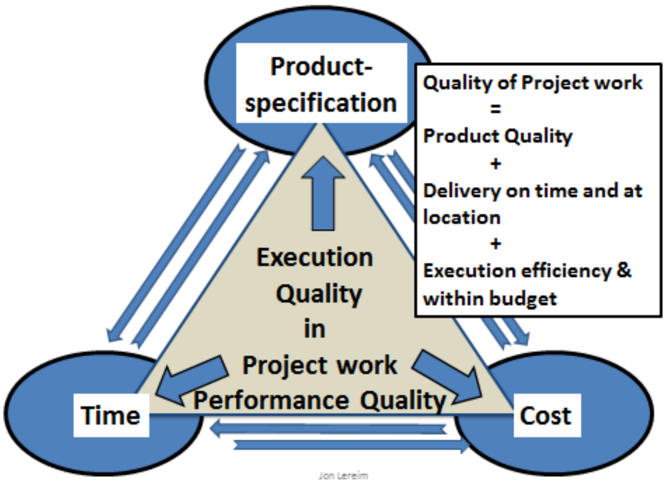

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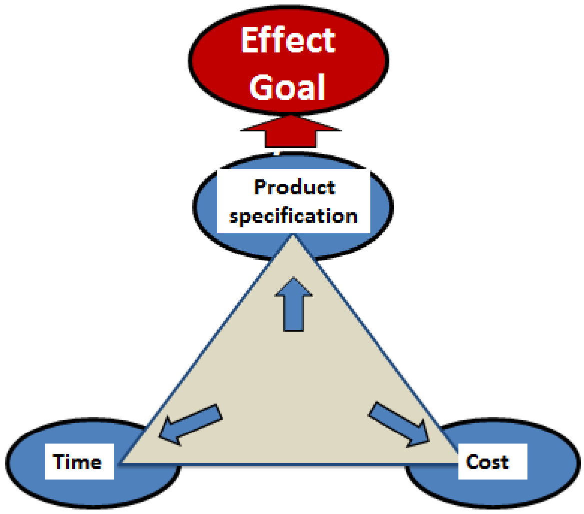
Effect Quality	
Effect Quality is linked to the benefit of using the product delivey from the project. It covers typically business benefit such as NPV, IRR or Pay Back, but could also be parameters such as regularity and reliability level. Success criteria include these.	

Tabell 1-2 Illustrastion of a range of quality dimensions in light of classic project management & control

Figure 1-2 Illustration of various quality terms in project work

Quality has allways been in focus. It provides you with a perception of something positive, for your self and for those receiving the product or service. A more systematic approach to quality has emerged gradually during the last 50 to 100 years.

After the 2nd World War, recovery and rebuilding the countries had to take place. The demand for industry build-up was enormous, in which systematic quality work and associated issues were addressed and highlighted. Japan and Germany were in the lead of these processes as these countries were to a large extent bombed, and production equipment had to be reestablished. Quality focus was an absolute necessity in that context.

During the decades of 1950'ies and 1960 'ies quality control and monitoring were key elements.

Statistical process control was an integral part of these initiatives. That effort was a vital first step in documenting as-produced quality.

Next step was focusing on planning for quality. Core management members were convinced that enhanced quality could be achieved through better planning and avoid waist or need for rework. These activities were additional efforts to the quality control activities and processes. Quality planning was a key issue in the 60'ies, and more detailed methods and models were developed in that peiod.

Systematic Quality Assurance methodology was derived by use of the quality planning activities and processes together with the quaality control activities. If a deviation from specified quality was identified a structured improvement process was established. In that context, The PDCA loop was introduced. (The Deming Wheel) It means planning (Plan) before execution (Do), check (Check) prior to performing corrective actions (Act).

The next level in quality thinking is by introducing Quality Management. It started during the 70'ies and more advanced models wre launched in the 80ies.The primary objectives were to do the right things, not just doing things right. Prioritization is a key issue, and the manager role as the accountable for the quality work became more pronounced than ever.

The awareness of the importance of the manager and the organisation led to the development of the methodology and approach frequently defined as Total Quality Management (TQM). Total Quality Management (TQM) and Business Process Management (BPM) were key methodologies and tools in that development. The importance of the organization on quality was highlighted by introduction of the term Quality Management, in which a multidimensional perspective on the quality was introduced by assessing the impact of organization, people in the organization, overall management structure and how the enterprize was run from a strategic tactic and operational level. ISO, International Standards Organisation, was under rapid development and expansion during this period. The ISO efforts were launched in order to contribute to and stimulate Eurpoean industry to become competitive relative to US and Japanese enterprizes. The process perspective was a vital element in that «development journey». Most industries have gone this route, and public services have adopted a major protion of that in their operations.

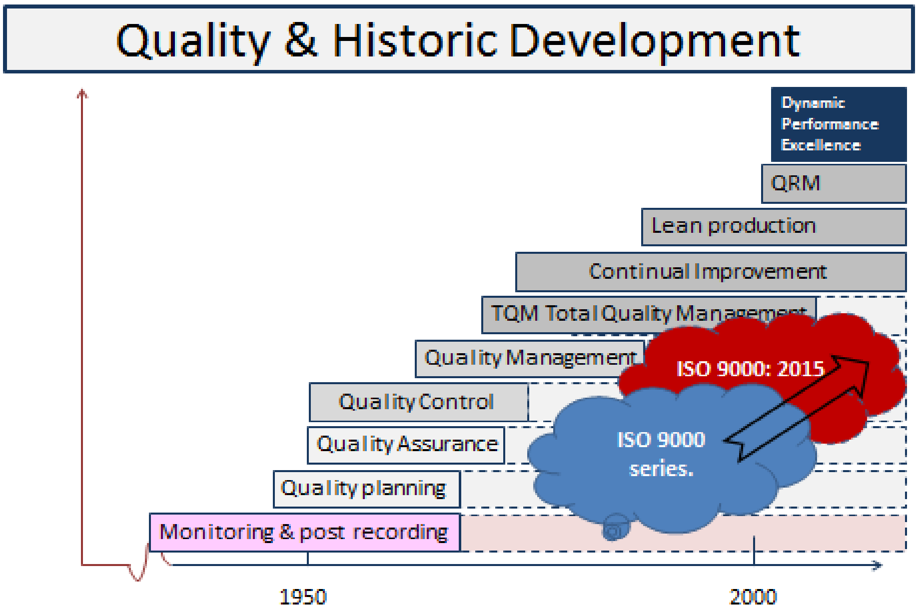
During the first decade of the 2100 Century new perspectives are added to the quality understanding. Lean manufacturing was introduced, which focuses on doing the right things and avoid waist and extensive rework. Waist is in that context not just physical products/material, but as much waist of time, or man hours spent with no out put results as well as efficiency due to improved management and leadership skills. A high degree of component standardization is a part of the model and methodology, as well as resource optimization, good organising and defined clear & firm roles.

Current and future requirements to quality management must cater for mastering a fully dynamic environment with rapid and sudden changes. Agility, speed and resilience are elements that may be the appropriate tools for achieving quality and business excellence under dynamic and changing conditions, in markets, products, organisations and projects. The overall objectives are to master the dynamics such that you are leading the project organization under execution in order to deliver specified and expected quality and performance in projects characterized by moving targets and ever-changing conditions. The agile approaches are described in more detail in section 6.6.

A business-driven management & leadership excellence is to demonstrate your ability and capability of handling dynamics, agility and resilience combined with satisfaction of the specified product & project quality requirements.

The quality steps build on each other. Quality Management cannot be achieved unless Quality Assurance and associated continual improvement loops are in place and functioning. Accordingly, Total Quality Management, TQM, is conditioned upon an organization perspective and leadership perspective that focuses on quality in alle activities and processes.

The formalised quality development has primarily happened in industrial production operations with manufacturing lines for repetitive deliveries with a high delivery frequency.



Figur 1-3 Historic development related to quality and quality management in an enterprise. Similar experience in projects

How does it fit into the world of the project?

Quality Management and Quality Assurance in projects are critical activities for achieving the specified product quality according to the requirements specifications. The characteristics of a project are that it is a one-off event. Thus, particular attention must be paid to the effort of doing things right first time and avoid repair and rework. Repair and rework are ferequently rather expensive and may lead to significant delays which again may have heavy impact on final delivery. The principle of doing the right things right first time may be better achieved through proper planning of all the projevct activities. That approach strengthens the attention and consciousness of what should be done. “Plan the activities and work the plan” is a well known expression among project people, and it becomes even more critical in projects with reduced execution time, in socalled “Fast Track Projects”. These approaches are vital building blocks in establishing a project quality culture based on planningsystematic follow-up assurance including principles for continual improvement.

The effect quality in project is considered to be an expanded perspective of the quality related to a project. The prime objective is to satisfy the customers desired effects by use of the out put from the respective project, specified, expected and perceived effect quality. This is particularly challenging in projects with moving targets and changing boundary cnditions which request a dynamic leadership driven approach with focus on perceived effects and mastering rapid changes.

1.3 Risk & Risk Management – basic elements according to ISO 31000

Introduction

Risk & Risk Management are topics addressed among mnay different professions in an organization as it relates to any activity in the oerations or in the projects.

The terms are used among corporate finance as well as among the technical environments. In the later years, risk management is also linked with HSE and used in the event focused HSE Risk analyses. However, event risk and event risk management should include and fully cover the cultural and organizational issues, including stakeholders. These sources of risk may have higher impact than technical or financial risks, and must be covered in the risk management analyses and processes.

Due to the wide spread of application, the actual terms and definitions may vary significantly across the organization. There are historic reasons for the different understanding and perception of the word risk and associated risk management.

The definition of risk is discussed in the next sub section and given some explanation and interpretation.

The chapter covers primarily the qualitative event risk issues, whereas quantitative risk estimations are catered for under the respective key performance parameter such as time, Capex, Opex and NPV/IRR.

In the context of the organizational performance, a company's risk strategy is elaborated and how to reflect it in the risk management approach at various organizational levels, corporate level, portfolio- / asset level and project level.

This chapter also discusses the impact of risk on the desired quality requirements and features, and how to integrate quality and risk management for dynamic conditions.

Numerous textbooks exist on risk management and uncertainy management. This section refers to some of the key textbooks and guidelines.

ISO 31000 Risk Management – Principles and guidelines is used as a primary reference document, supplemented by PMBOK and PMI publication by Ireland, "Quality Management for Projects and Programs". Other publications are also referred to.

Definitions of Risk and Risk Management

Risk is one of the most widely used expressions or term related to any activity in regular operations as in projects. Anybody speaks about risk, but what is the definition of it. There exist different interepretations and perceptions of it that is addressed in this section.

Most situations in life include uncertainty, and this characterizes the project world. In the project environment uncertainty is present though the life cycle, from idea through to implementation and handover to operations/users of the product, whether it is an external or internal client. The extent of uncertainty as well as the corresponding effect on the objectives will vary with the project phases and the type of project in question.

Risk is a common expression for these realities, covering the range of uncertainty and its effect or impact/consequence on the objectives for the respective projects.

These perspectives are covered by ISO 31000, and an excerpt of the definitions is given in the following sections.

The ISO 31000 is widely implemented in internal procedures and work instructions for general operations as for project development work.

With reference to ISO 31000 :2018 "Risk management – Principles and guidelines", Chr. 2.1, the following terms and definitions apply:

Risk*; effect of uncertainty on objectives*

There are 5 notes linked with the definition in ISO 31000 as summarized in the table below:

NOTE #	Description
NOTE 1	An effect is a deviation from the expected – positive and/or negative
NOTE 2	Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization- wide, project, product and process)
NOTE 3	Risk is often characterized by reference to potential **events** and **consequences** or a combination of these
NOTE 4	Risk is often expressed in terms of a combination of the **consequence** of an event (including changes in circumstances) and the associated **likelihood** of occurrence
NOTE 5	Uncerrtainty is the state, even partial, or deficiency of information related to understanding or knowledge of an event, its consequence or likelihood.

Table 1 – 3 Notes in ISO 31000

Note 4 is the interpretation of the term risk that is closest to the most widely used approach. It is covered in the plain definition, ***effect of uncertainty on objectives;*** however, it is not straithforward to understand the effect as a combination of consequence and likelihood.

In many professional environments, uncertainty is understood to be the deviation from expected value, expressed in terms of the standard deviation. It does not explicitly tell anything about the consequence of the deviation, just that there is a deviation with one or more standard deviations with associated probability level.

In this textbook the definition of event risks will essentially follow the explanations given for Note 3 & 4 from ISO 31000 and is thus expressed as:

(1 – 2)

Risk = **Probability of occurrence** combined with the **consequence if it happens**

In this context it covers the full range of uncertainty, both negative and positive deviation, frequently expressed as threat and opportunity combined with the associated effect in terms of consequence if it happens.

Experience and tradition in organisations and projects have focused to a large extent on the downside, the potential threats. It is of utmost importance to start thinking on the opportunities from day one of the project development route; if not, doors may be locked for several unique opportunities later during the project execution.

Risk is defined differently in different sources. Some of these are shown in the table below:

Source	Definition
Oil Company Governing Documents	Risk is a deviation from a specified reference value and the associated uncertainty. • Positive deviation: Upside risk • Negative deviation: Downside risk Reference value is expectation, most likely, forecast, a percentile or a target.
ISO 31000: 2018	***Risk***; *effect of uncertainty on objectives*
PMI PMBOK	An uncertain event or condition that if it occurs, has a positive or negative effect on a projects objectives.

Table 1 – 4 some examples of definition of risk in different standards and guidelines

The PMI PMBOK definition is close to the interpretation according to Note 4 in ISO 31000. It communicates well and may be easily understood.

The definition given by the oil company, describes the range from negative to positive outcome of a potential event, but does not explicitely cover the effect dimension, the consequence dimension.

Risk Management is another primary definition that is of particular importance.

Risk management: coordinated activities to direct and control an organization with regard to risk.

According to ISO 31000, the management of risk enables an organization to, for example:

– Increase the likelihood of achieving objectives.
– Encourage proactive management.
– Be aware of the need to identify and treat risk throughout the organization.
– Improve the identification of opportunities and threats.
– Comply with relevant legal and regulatory requirements aand international norms.
– Improve mandatory and voluntary reporting.

- Improve stakeholder confidence and trust.
- Establish a reliable basis for decision making and planning.
- Improve controls.
- Effectively allocate and use resources for risk treatment.
- Improve operational effectiveness and efficiency.
- Enhance health and safety performance, sa well as environmental protection.
- Improve loss prevention and incident management.
- Minimize losses.
- Improve organizational learning and improve organizational resilience.

In summary, management of risk covering the list above, but not limted to that, will enhance the confidence to achieve the specified and perceived quality of the project outcomes.

A critical perspective is to establish a proactive attitude for managing risk. It is not a post evaluation but shall be utilized in the daily managerial duties and operations in the projects by using the risk assessments as integral parts of the decision making and value generation though the project execution. Of particular importance is to continuously make prioritized actions and mitigations in order to minimize the effect if a negative event happens and maximize the effect if a positive event happens. The applied RM Process should cater for that.

A standardized risk management process and approach shall be used at all levels in an organization, from work package level, through project level, project portfolio level/asset level to corporate level. By using the same methodology and principles a common practice of risk management is developed and it ensures consistency in performance risk management.

The uncertainties identified and related to a project may be classified in three different categories (Rolstadås & Johansen 2008):

1. Operational uncertainty (internal risk and opportunity)
2. Strategic uncertainty, related to the connection between the project and the corporation/organization.
3. Contextual uncertainty, related to the external environment that the project is a part of.

The classification above helps you focus on the key issues regarding uncertainty. These considerations are linked to the event type uncertainty.

Of relevance is however to link the event uncertainty categorization into the uncertainty estimations, in which one distuingwishes between unsystematic and systematic risk that are reflected in the uncertainty estimations. The systematic risk is associated with the contextual uncertainty and is normally reflected in the risk premium included in the discount rate used in NPV estimation. The systematic risk dimension includes elements such as market conditions, political risk etc that the single project has no impact on. The unsystematic risk in projects is reflected in the uncertainty figures for the respective variables in the cost and NPV estimates.

Risk Strategy

The tolerance and acceptance for risk vary from one organization to another, as well as between different projects.

For simplicity purposes on may focus on risk strategy in three different main categories such as:

- Risk willing
- Risk neutral
- Risk averse

In some organisations there may be a risk willing approach, in other a risk neutral or a risk adverse approach. Legal and regulatory requirements may put constraints on parts of the risk management such as health safety and environmental issues (HSE).

- Firstly, how consistent and conscious are the respective organisations regarding establishing a firm and clear risk strategy for the corporation?
- Second, how well is the risk strategy communicated throughout the organization?

A firm and clear risk strategy does not necessarily mean that the risk strategy shall be identical in all organizational units and activities, but a consistency in practice means there are thorough arguments why differentiate when appropriate.

Observations in a range of industries are that an explicit risk strategy is rather seldom exposed and communicated through the respective organisations. Implicit there are risk strategies in most organisations, but they are not stated clear and firm. Under such conditions there may be a chance that the actual risk strategy will vary, which affects primary business decisions as well as quality of performance. Accordingly, the public sector should under normal conditions be risk adverse in order to perform a fully predictable and consistent service towards the inhabitants.

Regardless of type of organisations or industry, there is a significant improvement potential by deriving, formalizing and communicating the respective risk strategy in the organization of concern.

Risk strategy in projects should reflect elements such as:

- The project portfolio optimization through
    - business driven selection of new projects and
    - commercial performance excellence in current portfolio
- Project Economics & business risk & potential
    - Innovation & exploration
    - Execution control
- Technology solutions compatibility, integrity and maturity
- Degree of component standardization, system flexibility and business system agility
- Human resource & strategic core competence
    - Inhouse resources
    - Extent of use of external resources
    - Project organization
- Contract strategy
- Procurement strategy
- SLA, service level agreement
- Project Product Quality; Preciseness level and how stringent should the specification requirements be like
    - geometric tolerances,
    - Accepted variation in specified capacity level etc.
- Project Delivery Quality; confidence level in approved schedule plan
- Project Execution Quality; how to achieve confident efficiency & learning.
    - Robustness & resilience
- Implementation and handover plan
    - How to secure a seamless handover to operations and users
- Learning and continual improvement

Relationships between the risk management principles, framework, and process

ISO 31000 decsibes a sound methodology that is sufficiently flexible to cope with any risk related issues. It is however on an overall level and reflects the main principles, and the user must put it into the context within own organisastion or project.

Figure 1 – 4 illustrates the relationship between the Risk Management Principles, the Framework in which it occurs and the corresponding process for managing risk.

The RM Principles firmly state the totality approach regarding risk and risk management; it is valid for any acticity and event in an origanisation or prosjekt. They fully demonstrate that the RM Principles shall reflect the total organizational condition and characteristics.

The RM Framework follows the basic quality improvement principles according to Deming and Juran. Of particular notice is the statement of commitment linked with the mandate. All managers must achieve a strong personal commitment for using risk management in their role as leader and demonstrate a firm will of use in any event or activity. The RM Framework and RM Process must be a prime tool in the manager's toolbox to be used continually with the aim of improving the project performance.

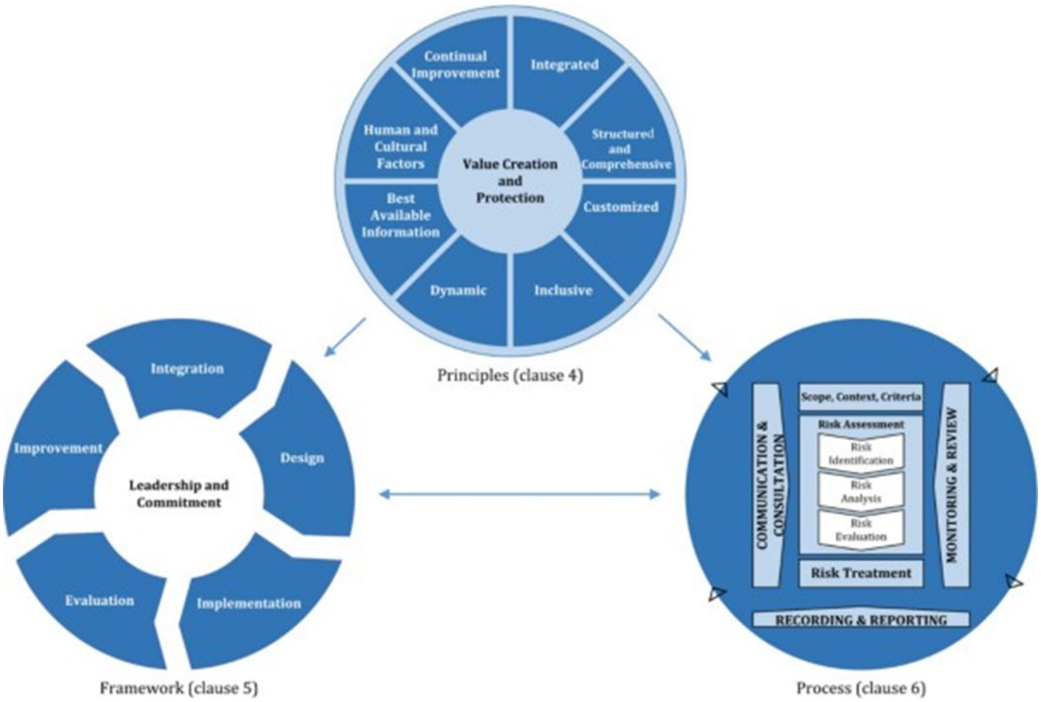


Figure 1 – 4 Relationships between the risk management principles, framework, and process

The implementation of the Risk Management approach is to activate the RM Process as shown in figure 1 – 4. It is of generic nature and consists of the following steps:

- Establishing the context
- Risk assessment
    1. Risk identification
    2. Risk analysis
    3. Risk evaluation
- Risk Treatment.

Surrounding the process is communication and consultation, monitoring, and review.

For making confident and sound assessments, it is crucial to know in which context we are. Within the project world, there are significant differences regarding the context when dealing with an innovation and product development project compared to reorganization projects and construction projects. The context must also cover issues like the political system, market conditions, etc. The purpose of establishing the context helps you when doing the assessments of risk and opportunities, as the assessments and evaluations may vary significantly in different contexts. The establishing the context should cover both the external context and the internal context, plus defining the risk criteria. The external context should cater for the social and cultural, political, legal, regulatory, financial, relationships with and values of external stakeholders etc outside the project in question, whereas internal context is project specific related to the planning and execution performance. See ISO 31000 2018.

Concerning the risk criteria, the project organization should define criteria to be used to evaluate the significance of risk. (ISO 31000 2018. The risk criteria should be derived in light of which risk strategy is established for the organization and the overall business values and policies of the organization. The risk criteria should also reflect the nature and type of risk in question and must comply with legal and regulatory requirements. Risk criteria for technical risks and opportunities are most likely different from risk criteria for organizational and human resource related risks.

When the context is established, the actual risk assessment part of the process may be started. The first step is to identify potential risks aand potential opportunities. A variety of methods may be applied, from collecting previous experience on completed projects, through brainstorm tools and mind mapping. Risk and opportunity may be associated with any issue in the project, the organization or society at large, and a gross list of potential risks and opportunities can be derived by use of various relevant and appropriate methods for identification. A gross list risk and opportunity register may be derived. Some of the identified risks and opportunities may be outside your control and influence during project execution. Therefore, it could be sound to extract a net risk and opportunity register with risk and opportunity elements you may directly influence and manage. You should however never ignore the outside non-controllable elements but be prepared for them if hey happen.

Examples of risk & opportunity elements are shown in the table below, gross list and corresponding net list that is manageable in your role as leader.

Risks not controllable & manageable by you	Gross list of potential risks & opportunities	Net list (Extract from gross list) of potential risks and opportunities that can be influenced or managed in the role as project leader

• Geopolitical risks
• Mother Nature Issues
• Strikes
• New governmental regulations
  ○ Safety
  ○ HSE
  ○ Business
	• Technical risks
	• Technical break througs & opportunities
	• New features of product
	• Unpredictable political risk
	• Market risk
	• New market segments
	• Mother nature issues
	• Strikes
	• New governmental regulations
	  ○ Safety and environment HSE, and
	  ○ Business constraints
	• Sub contractor and supplier market
	• Human resources
	• Roles and responsibility issues
	• IS/IT support systems
		❑ Technical risks
		❑ Technical break througs & opportunities
		❑ New features of product
		❑ New market segments
		❑ Sub contractor and supplier market
		❑ Human resources
		❑ Roles and responsibility issues
		❑ IS/IT support systems

Table 1 – 5: illustration of a gross list of potential risk and opportunity elements and the corresponding extracted net list manageable by you. Risk management however must include proper actions even for the potential risks not controllable and manageable by you but initiate proper actions to minimize the consequences of these.

When identification is done, the risk assessment moves into the risk analysis stage.

The risk assessment process is identical whether it is positive or negative events/issues. The majority of organisations are familiar with use of the the risk assessment tool and process for downside risk, whereas less experience is gained for using the same methodology for the upside, or opportunities. The textbooks in project management also have focused on the downside risk, less frequently on the opportunities/ upside, except the books by Chapman & Ward on uncertainty management that cover both upside and downside equally important.

In the risk analysis, the risk analysis process is to comprehend the nature of risk and to determine the level of risk through risk estimation, expressed in terms of the combination of consequence and their likelihood. The risk analysis provides an input to the risk evaluation and to decisions whether risks needed to be treated, and on the most appropriate risk treatment strategies and methods. (ISO 31000: 2018)

Consequences and their likelihood can be determined by modelling the outcomes of an event or set of events, or by extrapolation from experimental studies or from available data. These can be illustrated in the matrices in figure 1 – 5 and 1 – 6 for threats and opportunities respectively.

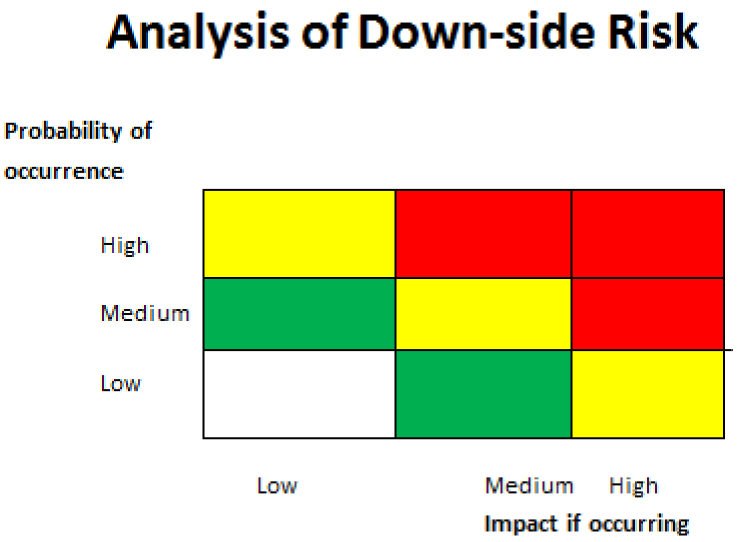


Figure 1 – 5 Introductory illustration of the combination of consequence and probability in its simplest form with a scale of low, medium hig on both consequence and probability for down side risk

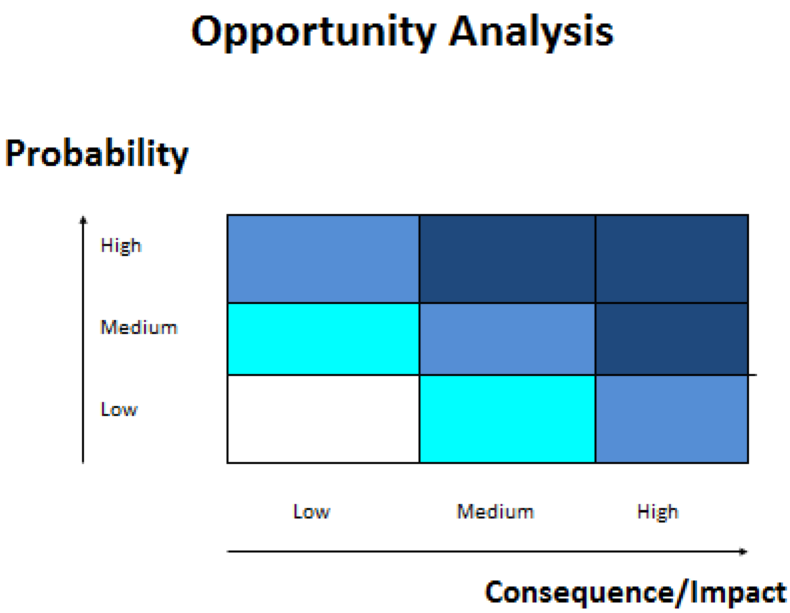
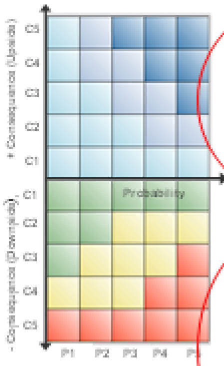


Figure 1 – 6 corresponding illustrations of the combination of consequence and probability in its simplest form with a scale of low, medium hig on both consequence and probability for upside opportunity

Next step is risk evaluation; see process in figure 1 – 4. The risk evaluation is to compare the level of risk derived in the risk analyses with the risk criteria for the context of concern. It provides a prime background for the decision whether to do proper risk treatment to satisfy the risk criteria. This is valid for the potential threats as well as for the potential opportunities. The decisions will differentiate between the kind of risk element that should be evaluated, as the risk criteria are different for economic & technical issues compared to organizational and human resource originated risk issues.

A combined risk and opportunity assessment is illustrated in figure 1 – 7 with a typical refined scale on the respective axes for impact and probability. The consequence dimension is split into the categories, HSE, reputation, quality, financial, svhedule with a consequence scale with the level, minor, moderate serious, severe, major. The coreeponding probability scale is made of 5 categories, very unlikely, unlikely, less unlikely, likely and very likely, with a specified probability level to each category.

Probability & consequence



Probability scale			Frequency in years	Planning period	
				3 years	6 years
P5	Very likely	50% to 100 %	More than 1 in 2	> 88%	> 97%
P4	Likely	25% to 50%	1 in 4 : 1 in 2	58% to 88%	76% to 97%
P3	Less likely	5% to 25%	1 in 20 : 1 in 4	14% to 58%	23% to 76%
P2	Unlikely	1% to 5%	1 in 100 : 1 in 20	3% to 14%	5% to 23%
P1	Very unlikely	0 to 1%	Less than 1 in 100	<3%	<5%

Consequence Scale		Category				
		HSE	Reputation	Quality	Financial	Schedule
+/- C1	Minor	Med. treatment No pollution	None	Minor effect capacity/reg.	< 0,5 % of estimate	< 0,5 % of schedule
+/- C2	Moderate	Brief absence Minor pollution	Local	Med. effect capacity/reg.	0,5 - 2 % of estimate	0,5 - 2 % of schedule
+/- C3	Serious	Long absence Pollution	Major local	Serious effect capacity/reg.	2 - 5 % of estimate	2 - 5 % of schedule
+/- C4	Severe	Long term impact	Negative media	Severe effect capacity/reg.	5 - 10 % of estimate	5 - 10 % of schedule
+/- C5	Major	Major incident	Int. negative media	Major effect capacity/reg.	> 10 % of estimate	> 10 % of schedule

Figure 1 – 7 Example of threat and opportunity assessment practice within Equinor/Statoil

The risk assessment process is followed by a risk treatment sub process. The risk treatment step has been the weakest spot in the entire RM process in many organisations. Efficient and concrete actions/mitigations may be difficult to identify and execute, thereby less priority has been given to this critical element. It does not help performing a proper risk assessment, if no concrte actions or mitigations are put in real.

The RM Process could likely be more refined than what is shown in figure 1 – 4. However, the basic and necessary steps are included and each organization should derive their own company or project specific RM process. It should comply with the RM Process in figure 1 – 4, but must be customized to the specific constraints and conditions within the organization or project.

Risk Treatment, or risk mitigation, is the key to manage risk and contribute to improved performance in the project. The risk treatment includes identification and creation of possible actions in order to master the risk issue in question, plus implementation of preferred and approved solution/action.

The risk treatment is applicable for both threats and opportunities. The process is identical whether it is positive or negative risks.

The main difference is that for threats, the risk treatment and actions are focusing on minimizing the effect of the potential risk element, whereas for opportunities, the risk treatment is to create and develop solutions that maximize the chance and value impact for the identified risk opportunity element.

The risk treatment might be an iterational or cyclical process of:

- Assessing the risk treatment
- Deciding whether residual risk levels are tolerable
- Assessing the effectiveness of that treatment/action.

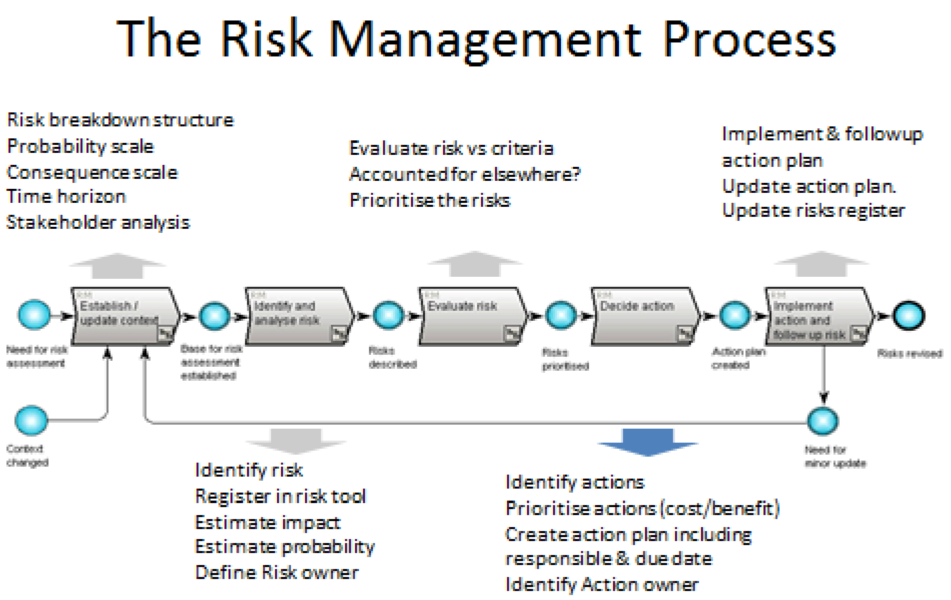


Figure 1 – 8 Sketch of an actual risk management process as used in a company.

Risk Escalation Structure

The qualitative and event focused Risk Management methodology has some unique characteristics. It generally communicates well and is easily understood at all levels in an organization or project. Thereby, consistency may be achieved regarding assessment and managing risk at all levels in the organization. Through that approach you derive a top 5 or top 10 risk element list, and corresponding opportunity list at the lowest organizational level such as the work package level.

The methodology provides you with the capability of derivation of Top 5 (10) risk and opportunities at any levl in the organization and a Risk Breakdown/Escalation Structure should be derived. An example of such is shown in figure 1 – 9 and figure 1 - 10. Enhanced confidence may be achieved by doing both top down and Bottom up bottom-up process wrt risk and opportunity.

The initial approach may be to take the top-down route. The principles appliy for a single project as illustrated in figure 1 – 9 but are applicable on project portfolio level and enterprise level. In the latter case the main level in figure 1 – 9 represents the enterprise level, the sub level the port folio or business unit level, and the package level represents thesingle project level.

A very interesting perspective is however the bottom-up process as a primary approach, the socalled Risk Escalaation Structure. With the bottom-up process, one has to assess the risk elements according to risk criteria for the next level up whether the potential risk element should be escalated. In that context the escalation process is of particular importance. Which risk elements are judged to move up the risk breakdown structure?

The bottom-up risk analyses must consider the two main variables i) the likelihood of occurrence and ii) the impact if it occurs. The primary variable is the impact or consequence if it occurs. One risk element may be analysed to have major impact on the package level, and may be on the Top 5 Risk Element list for the package level. However, when assessing the escalation to the level above, one has to consider the impact on a broader area/range than the package level; ie on sub project level. If it falls into the category of having major impact on the sub project level, the potential risk element should be escalated, conditioned upon hat the likelihood of occurrence is high. Similarly, a further escalation to the main project level should follow the same process as described for the sub project level.

The likelihood of occurrence may initially be interpreted to become stable regardless on level in the risk breakdown structure. That might be initially realistic when considered independent of other potential risk elements. That hypothesis should however be questioned and tested as the combination of different risks may lead to a change in likelihood of occurrence, either more detrimental or reduced.

The process of assessing the eventual escalation to next level up should be done in light of upfront derived risk criteria for the respective levels in the Risk Breakdown Structure. By doing both top down and bottom-up analyses you are in a position to compare the outcome of the top down and bottom up approach, and the two approaches will contribute with complementary facts in order to enhance confidence and consistency in the analyses.

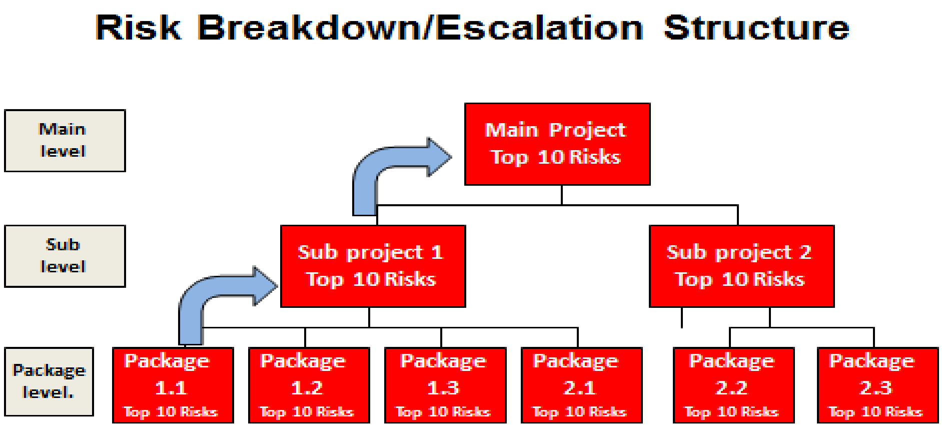


Figure 1 – 9 Risk Breakdown Structure/Risk Escalation Structure; illustration example for three levels of down side risks/threats

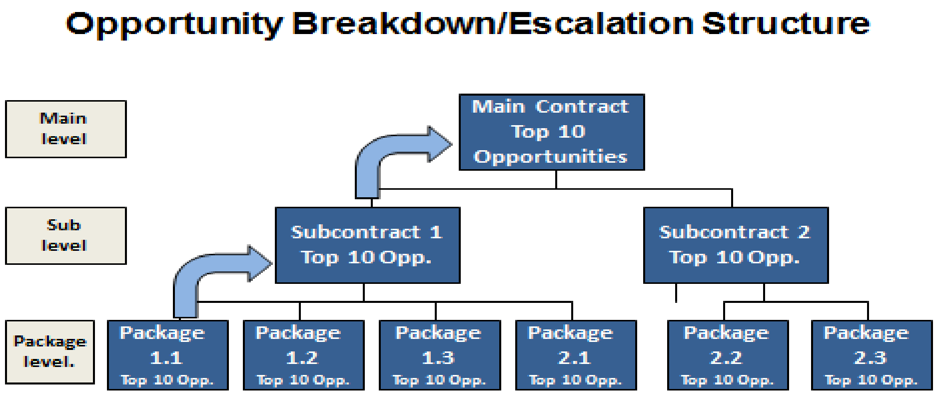


Figure 1 – 10 Opportunity Breakdown Structure/Opportunity Escalation Structure; illustration of example for three levels of opportunities

Impact of risk management on quality

Risk is associated with uncertainty combining likelihood of occurrence with the consequence if it occurs. These perspectives are valid for any issue related to the project of concern and its context. As a consequence of these facts, risk is directly connected to the quality issues of a project, which is also reflected in figure 1 – 8 in which quality is one of the dimensions covered by the risk analyses process within Statoil.

In this textbook quality in projects is differentiated into product quality, delivery quality, project performance quality and effect quality. Uncertainty is a variable and present for the various project quality terms & definitions.

Due to this reality, managing risk and uncertainty is considered to have direct impact on the specified and perceived project quality, and it should have first priority to master the risk and opportunities for achieving the desired project quality. That is in compliance with the definition of risk management by Chapman & Ward, stating “risk Management is to improve the project performance”.

The event focused risk & opportunity management approach may be perceived as a static approach and may not adapt to the reality of dynamics and ever changes during the project execution. The tools applied according to the highlights described in the preceeding sections are fully valid and appropriate. The managerial approach for mastering risk and opportunities is to perform risk analyses continually or at least periodically in order to cope with changes, progress, and altering boundary conditions through the project life cycle.

The risk management assessments should be done directly linked with the performance management & control during execution. The derived Top 5 (top 10) and risk and opportunity register should be updated, and a historic log should be established. Thus a one time risk analysis and assessment at start up of the project is not satisfying the requirements to professional risk management in projects.

Periodic updates of the risk analyses and assessments must be done combined with derivation of appropriate risk treatment. In that context it is of importance to derive the consequence of actions on the forecasts for completion of the project, in any dimension describing the project quality and performance, on product quality, cost, progress and efficiency as well as on the effectiveness of use of thr project deliverables.

The risk treatment needs particulat attention. Potential risks are to be treated such that they do not become real and the risks should generally be reduced or resolved during the project execution. What about the opportunity side? Opportunities may be identified during the project execution in parallel to the downside risks. Now the objectives are to maximize the probability and value of the potential opportunities. The accumulated value of the opportunities should increase over time during the project lifetime. Frequent practice in the past has shown that the opportunity side is often forgotten, at least in the initial phases of a project. Thus, several potential opportunities are not able to go live as many doors are closed during the project execution with new constraints as the project produst or service develops and matures. These perspectives are illustrated in figure 1 – 11.

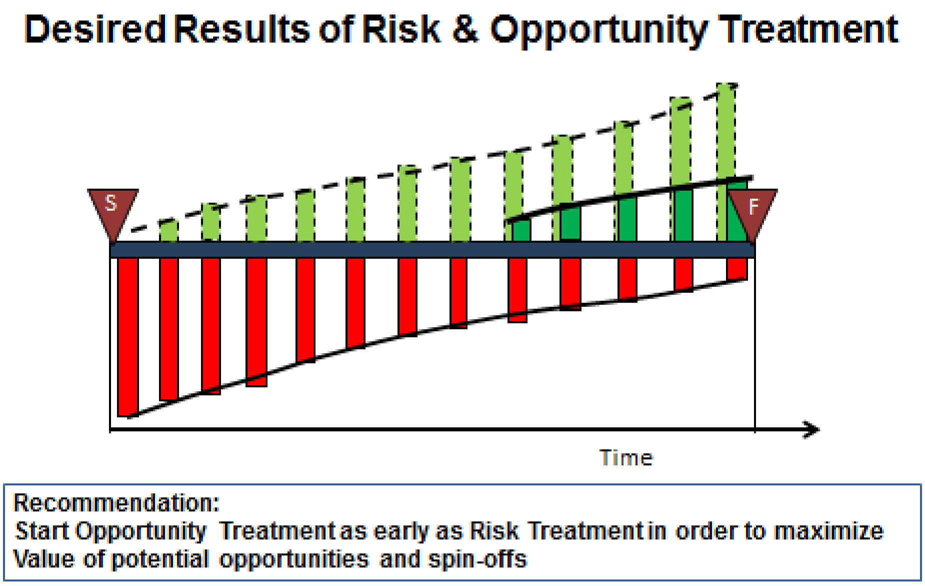


Figure 1 – 11 Schematic illustration of the desired results of Risk & Opportunity treatments

What kind of risks should be managed by the project? Rolstadås & Johansen (2008) defines three dimensions of project risk; operational risks, strategic risk, and contextual risk. Operational risk is traditionally the likely focus for the project however the strategic and contextual risk needs more attention. It does not help to manage and resove the operational risks if the strategic risks and contextual risks are not fully accounted for in the planning and execution of a project. The latter two addresses the importance of the role as project owner who could cater for the strategic and contextual issues related to the project in question, whereas the project manager should primarily handle the operational risk issues.

Why integrated QRM, Quality & Risk Management, in projects?

Most projects may be characterized by a dynamic system to a different degree. Project success depends on mastering the dynamics and change, and should obtain the specified project quality in any respect. It means that you have to be in the driver's seat for the changes and coping with the dynamics, not being dictated and foced by the imposed necessary changes. This is even more so in todays'and future project and business environment frequently characterized by steady increase in volatility, uncertainty, complexity and ambiguity, the so-called VUCA-world.

A proactive approach is a condition for mastering such an environment, and efficient use of risk management is a one of the most relevant approaches for making project success and deliver as specified and perceived.

The proactive approach is characterized by doing proper actions prior to the occurance of a potential risk and opportunity. Thus the risk management principles are linked with the role as manager and decision maker in the projects, not as a compliance and post control procedure. Thus, risk management provides a different function from the classic audits, as it is utilized in the operations and execution of the management of the project, not limited to a post evaluation of it.

The ultimate objective for a project is to deliver what is specified quality of the product or service, deliver at right location and within specified schedule combined with an execution performance that demonstrates the professionalism and efficiency of the project origanisation in question. Risk Management is in that context considered to be a primary leadership and decision support tool and is a key enabler for achieving the specified and perceived quality in a project world haracterised by dynamics and change.

1.4 Expectation management & stakeholder management in projects

Perceived quality is to a large extent related to how to perform expectation management towards the respective external and internal stakeholders. The expectations derived and specified must be realistic and readily achievable, easy to communication and sufficiently robust in order to avoid mis understanding, dissapointments and frustrations among the external stakeholders. The challenge is to establish a joint understanding and perception of the expectations for the actual project deliverables, the client and supplier must establish a common perspective and understanding of metrics, specified deliverables, in running operations as well as in projects.
Too high ambitions may be experienced as negative if they are not met, see formula (1 – 1). Lowering the expectations leading to exceed these at delivery is frequently a better approach. However, the practice must not lead to specifyning sub standard quality in order to exceed the expectations.

Many environments and functions are exposed and influenced by projects, during the initiation and planning phases as well as during the execution, and finally by the use of the project deliveries. In that context it has relevance to map the expectations by persons and groups affected by the projects in the respective project phases. Stakeholder analyses and stakeholder management are of particular value here.

The stakeholder analyses may by use of a stakeholder mapping derive who are affected by the project and the project results, who are supporting the project and who are sceptic and negative. Furthermore, the mapping should lead to a thorough understanding of the relative power and influence base internally and externally. These perspectives should be linked with the identification process of potential risk elements. It could likely be that some of the most important and powerfull stakeholders are identified as the higest ranked risk elements.

A stakeholder analysis in its simplest version may consist of the following steps:

1. Stakeholder mapping:
    a. internal stakeholders
    b. external stakeholders
2. Group the stakeholders in a range of categories

3. Analyse each identified stakeholder regarding how important he/she is, base don assessing the power base, relative importance, positive or negative to the project process and the outcomes.
4. Establish a top 5 list of the repective stakeholders.
5. Establish an action plan related to the top 5 stakeholders in the attempt to minimize the negative influence to those that are sceptic/negative, and maximize the influence by those who are in favour of the project
6. The action and implementation plan must include a firm description of the derived actions, who is in charge, and due date for the actual implementation.

It is of utmost importance to notice that stakeholder anslysis and stakeholder management should deal with both external and internal stakeholders.

The internal stakeholders may be rather obvious, but there are strong opinion makers and a grey eminence among the staff that may have significant impact on the project success in terms of degree of support to the idea and initiative as well as to the project execution. These informal leaders may not be present outside the classic organization charts but may have strong opinions and minds about the way of doing the operations and projects with heavy influence on the fresh graduates in the organization. The project managers challenge is to convince these opinion makers that they will benefit from supporting the project and act like ambassadors for the project iniative.

The external stakeholders represent a wide range of influensors on the project, who maay be affected during the project execution period, or by the use and operation of the project deliveries. Typical external stakeholders are contractors, sub-contractors, suppliers and vendors, clients, competitors, unions, central & local governmental bodies, public service offices and their officers, membership organisations, the local society, non-governmental bodies like Greenpeace etc. Through a thorough mapping of external stakeholders, you might be surprised who and how many that may be affected by and influenced by the project in question, both positive and negative influence and interaction. The range and kind of external stakeholders may vary significantly between different cultures. Nevertheless, managing stakeholders is considered among the most important activities for a project director/manager in large, complex and multi-national projects with many nationalities among the staff involved in the project execution phase.

The role of the project leader is to a large extent to manage the expectations and perceptions of the respective stakeholders. As a consequence, the project leader must be the ambassador, role model, and seller of the project idea and project. Stakeholder analyses and stakeholder management are key enablers in that context, firmly established and explained by Briner et al in the text book Project leadership, (Briner et al). In their project leadership model, stakeholder management and alignment are considered to reflect excellent project leadership in order to secure agreement with the the project stakeholders. The role of the project leader as integrator is illustrated in figure 1 – 12 below.

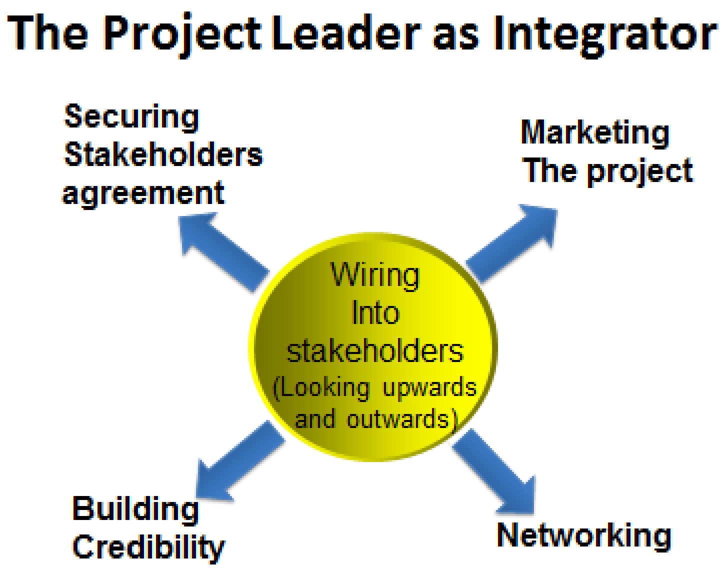


Figure 1 – 12. Project Leader as integrator to secure stakeholder agreement (Briner et al)

Excellent project leadership performance may be achieved by including appropriate stakeholder management as part of the leadership duties. This may be done to satisfaction if periodic stakeholder analyses are included as an integral part of the management of projects. Stakeholders change through the project lie cycle, from idea generation, innovation and development through execution, commissioning and handover to operations. Thus, stakeholder analyses should be done periodically in order to identify the changes in who are the stakeholders, but also the varying interest and influence among existing stakeholders when walking through the project.

The overall objectives of using stakeholder analyses and assessments in managing the projects are to contribute to secure a successful project. This is briefly expressed in a well known statement by Hartmann, such as: “A project is successful if all stakeholders are happy” (Hartmann, F.T., sec 1.6 p 11). The statement is an over-simplification but reflects the importance of managing the stakeholders. It does not mean to treat all stakeholders equally, but to secure that their expectations are met as much as possible. In that context, managing the expetations to the primary stakeholders becomes an important part of the stakeholder managenet.

In addition to mapping the potential stakeholders, the analyses include assessments of their relative importance as well as derivation of mitigations/actions for securing stakeholders agreement. A proper and committing implementation plan should be established.

The role as project leader is dealing with communication, and the ability to thoroughly expose and explain the project objectives, strategies and goals, and why they are so in the specific project of concern. Stakeholder management is in its broadest sense an understanding of the various needs for the respective stakeholders and should try to meet the expectations to each stakeholder. The type of communication should be differentiated including prioritization of the prime stakeholders.

A stakeholder analysis tool is a necessary part of the tool kit for the project manager in order to achieve satisfactory managerial performance. It will help you focusing on the prioritization of the most influencial stakeholders. The stakeholder analyses will also contribute to identification of the expectations to the respective prime stakeholders. Furthermore, it will help you prioritizing who should be shown particular attention and who could be downgraded in terms of the extent of follow up activities.

Excellent leadership skills are critical for obtaining good stakeholder management through a well balanced & wise approach towards the respective stakeholders. First of all, it means to show genuine respect for the stakeholders and their objectives & rationale, at the same time is firm and clear about your own role and objectives for the project. An upfront informal dialogue with the prime stakeholders may lead to clarification and resolution of an issue. Use of elements from the negotiation techniques may help, with particular focus on listening to the stakeholder’s arguments thoroughly. Frequently plain misunderstanding may become a part of the issue due to lack of complete information and facats sheets.

Situation dependent leadership & stakeholder management must be the basic approach during project execution, and cope with the different challenges during the project execution period. Thus stakeholder management must be proactive, and is not a passive one-off event prior to the project start up; a requirement equivalent as for risk management and quality management in projects. A dynamic and proactive approach must apply during project execution.

Stakeholder management should vary over the project life cycle, and could in many cases be split into thre main periods of the project life cycle such as:

- The innovation, idea and conceptual development period
- The project planning and execution including testing and implementation prior to handover to operations, either external or internal clients
- The post project period, the operation of or use of the project delivery.

The project manager must be a seller of his/her project, in order to obtain necessary attention with respect to get access to resources as well as priority of this project relative other projects in the portfolio. It is a fight internally as well as externally to get access to the right resources and the orject manager must be rather extrovert and convincing to make his/her project particularly attractive. Project managers having a good reputation, have a great advantage as many key resources will like to join a winning team. Thus the role of the project leader is to influence and convince resources and stakeholders about the preference of the project and its expected results.

In summary stakeholder management is a systematic and professional approach for the performance of lobbying in order to promote his/her own project, for achieving priority with resspect to resources as well as pprospect. Expectation management is an intergral part of the stakeholder and leadership issues and a necessary managment enabler for making project success.

1.5 A process-oriented perspective on quality and risk management

There is a general acceptance that value generation in enterprises and projects to a large extent happens through lateral work processes rather than in the classic hierarchic organization structure with a straight vertical line in command.

Many organisations have mapped their work processes in production operations, to a lesser degree mapped the other work processes connected to support processes and management processes.

The primary benefits by mapping the work processes are:

- Each step in the process is identified and the corresponding sequence of work progress steps in the as-is condition.
- The roles of those involved are identified.
- An assessment can be done of the as-is mapped process and corresponding roles.
- The mapping of the as-is condition gives you the chance to introduce changes and implement these; in particular reengineer the process such that unlogic loops and irational steps can be removed.
- The process approach becomes the preferred and obvious way of managing the value generation, whether it is a classic value chain or value networks-
- The process approach is ideal for digitalization and making the work processes seamless.

The perspectives above are clearly documented in the classic book "*The Toyota Way" by* Liker (Part Two, Session II). They pinpoint the need for continual process flow, standardization, removing unnessary steps in the work process and avoid waist in the work processes. These aspects are also addressed in the book "Business Process Improvement Toolbox". (Andersen, B.)

The foundation for the ISO-standards on quality is the process approach, in which the core of the quality issues is work processes, not organization structure as such.

The definition of a process accoring to NS-EN ISO 9000:2015, as follows:

- «A system of activities that utilize resources to transform input to output results of higher value than input. The processes in an organization are normally planned and implemented under conditions of being controllable in order to create value added»

A process may be explained as a set of activities that are executed in a logic sequence leading to achievement of specified objectives and goals by efficient use of the resources in the organization.

A process is briefly characterized through the following elements:

- Processes are a set of tasks/activities.
- The process has a start and end activity

- The process has a defined objective and output result.
- Processes are shaped through input/transformation/output relations.

Input consists of a set of input variables and resources. The respective process step transform and add value to the utilised input ressources, deriving enhanced value in the output results. This is chematically shown in the illustration in figure 1 – 13 below.

Transformation to being a fully process oriented company may be experienced as rather brutal if one is used to the traditional hierarchic organisation. The respective processes clearly expose where values are created, the output results are measurable and traceable, and including which roles should be involved in the processes. Unneccary roles will be exposed, and the performance is firmly documented by the output deliveries from the process.

The process-oriented company may be mentally challenging for some environments, in particular in technology expert groups, as the recognition from colleages is the ruling judgment of your work, not how you contribute to the value generation in the work processes. There is allways a supplier/customer chain in the processes, internally as well as externally. It is mentally hard for someone being requested to deliver value added services compared to providing you with expert advice.

A process-oriented company is fundamentally different from classic line organisation, when focusing on the control functions and value generation, as the value generation happens laterally in the work processes, not vertically in the hierarcy.

A fully process oriented company is achievable only if the organization is aligned with the processes, with clearly defined roles for process owners, process managers and task responsible. Every step may be controllable, and the output results can be compared with the desired ambition and approved requirements.

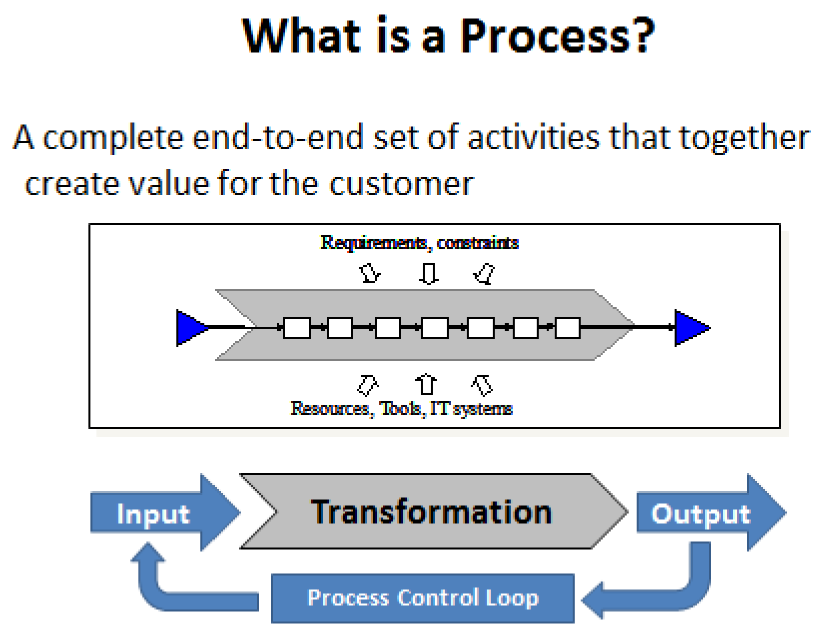


Figure 1-13 Schematic Process illustration

Business driven process management may be developed to different levels such as, see Lereim (2008a):

- Level 1 Process mapping
- Level 2: Identification of relevant out put result Indicators, KPI’s
- Level 3: Identification of the corresponding process control parameters, an absolute necessity for control and ability of continual improvement

Level 1: Process mapping

Launching process mapping in an organisation provides you with an intensified focus on how and where the value generation happens in an organization. Rather frequently, unlogic loops are identified in the work processes, resulting in double work or missing work activities due to lacking a firm process description. A corresponding issue is who should be involved in the processes, and that needs to be identified in the process mapping.

Process mapping should follow standardized ways and use of standardized symbols in the flow charts. A well-known standardized approach according to IDEF is shown in the figure below. The As-Is condition is mapped including the corresponding roles involved, and a variety of process mapping tools are available.

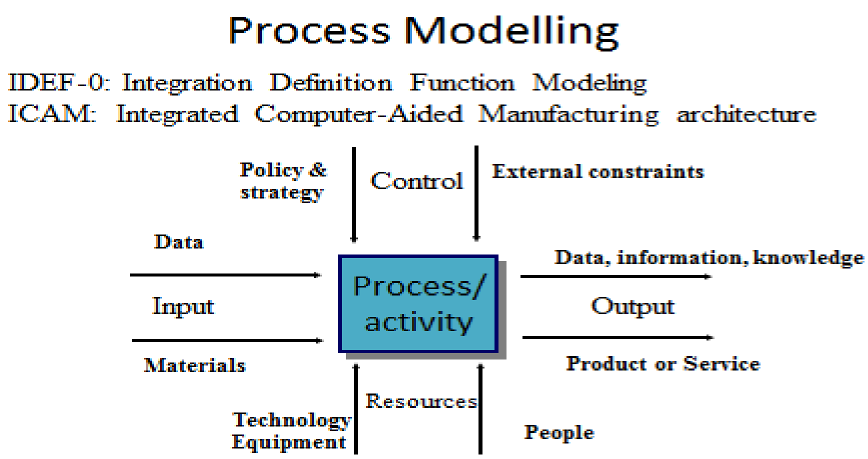


Figure 1 – 14 IDEF process identification and mapping

Level 2: Identification of relevant output performance parameters

Process design and process-oriented companies put firm requirements on documenting the output from the respective processes in terms of output Key Performance Indicators (KPI's). It provides you with the ability to monitor achieved results in the main processes as well as in the support processes.

The output results are intended documented in Key Performance Indicators. These should reflect the output results and should document what is achieved or produced of value. This is OK provided that the obtained results satisfy the requirement specifications for product quality, delivery and efficiency in a project. The status & progress reports will thereby become representative for the actual performance to date in the project.

A common misinterpretation in many organizations and projects are that the identified and specified KPI's are a measure of number of activities completed, not the desired output effects. The definition of a process requests a measure of the effect, ie the output results stated as a KPI. Many organisations monitor a wide range of activities, and less attention is paid on the desired effects.

The identification of relevant output effect parameters requests a thorough assessment of what are the values to be generated in the process, not just monitoring the activities done. If you primarily are monitoring the activities, the reporting just reflects the activity level or intensity, not whether the activities contribute to adding value and improve the performance in the process.

In the project world, what is the condition for monitoring value earned, efficiency and product quality development?

Which enablers are relevant for achieving and maintaining the specified performance indicators on product quality, delivery quality and project efficiency, and how to be able to achieve continual improvement? Such a condition is depending on having a set of relevant process control parameters that is standard practice in technical process such as chemical refineries or dynamic positioning of a vessel by running the thrusters in order to maintain specified location. Corresponding process control parameters should be established for the management processes and project generation processes in order to obtaain continual improvement for satisfying the specified goals and performance. These aspects are discussed in the next section.

Level 3: identification of Process Control Parameters – a necessity for management, control and continual improvement

The established work processes in an organization must be characterized by being manageable and controllable, through monitoring output results with appropriate effect based KPI's and with relevant Process Control Parameters (PCP's) used in the process control loop. The Process Control Parameters (PCP's) are critical and needed in utilizing the control loop for continual improvement if the monitoring of results deviates from specified performance.

How does the process definition fit the project world?

The project's Work Breakdown Structure, WBS, is designed similar to the Process Breakdown Structure, and the projects are among the first organisations utilizing control parameters.

The final project output is the product delivery at actual accumulated cost and at actual time (As delivered).

These perspectives are summarized schematically in the table below:

Output Key Performance Indicators	Process Control Parameters
• Output Result of a process/ part process • Effect of a process/ part process	• Enablers to be used in the process control loop; which buttom to push and which wheel to adjust • A nescessity for adjusting the output results • A condition for achieving continual improvement
Note: The output result should be monitoring the achieved effect, not activity level as such	Note: Provides you with the capability for addjustment and change of out put, a condition for management & control

Table 1 – 6: Output key performance indicators and corresponding process control parameters

The obvious process control parameters in project execution management and control are the classic project parameters Cost Performance Index, CPI and Schedule Performance Index, SPI. They reflect the performance with respect to cost control and schedule control respectively and are used in derivation ofprognoses/forecasts to complete. If there are deviations from planned and specified, actions are taken to regain the specified performance during execution.   The CPI and SPI are derived from recorded figures for actual cost versus planned to date, progress to date and the corresponding estimate of value earned to date. These figures are utilized in the prediction of the forecast to complete both with repect to total cost to complete and total time at complete. That approach is standard practice in todays' project management.

What about control of the product quality development? Is there a corresponding Index for product quality development in the projects?

The requested quality of the end delivery from the projects is described in the specification requirements to the product in question. That is the planned specified and required features and capabilities at complete.

How to monitor and control the product quality development during project execution?

The respective professional environment record and test the features within their own part of the delivery and normally have full grip on the development. It would be of great benefit however to communicate that development in a format that is compatible and aligned with the current project control practice on cost and schedule. Like the terms CPI ans SPI, a corresponding management formatted quality performance parameter is established.

It is as follows:

QPI: Quality Performance Index

It is a normalised figure, as CPI and SPI, in which it expresses the ratio of the actual figure divided by the planned or sspecified figure.

(1 – 3)

QPI = (Recorded Quality to Date)/ (Planned or specified product quality)

Why introducing the QPI parameter, since the professional & technical disciplines in the projects cater for the necessary development of the product quality in the projects?

The key is the accountability and management perspective in the projects. Project management excellence should cover management and control of any issue during the project execution, not just cost and schedule. From the project management point of view, there is a need to have a performance index on product quality development that has a format similar to and is similar in nature and interpretation as the CPI and SPI.

If the actual product quality is in excess of planned/specified, the QPI will have a figure higher than 1. If it is not, it falls below the 1.0 target line.

The desired level of the QPI is to be as close as possible to 1, but above 1. Then you deliver what is specified and meet the expectations of the client. See the illustration in figure 1 – 15 below. For achievement of a confident process control, the recordings must be done periodically in order to trace the development over time, and not the least identify the deviation from planned/specified and thoroughly assess the change from one period to the next. The latter is critical information for triggering actions in order to regain to what is specified performance.

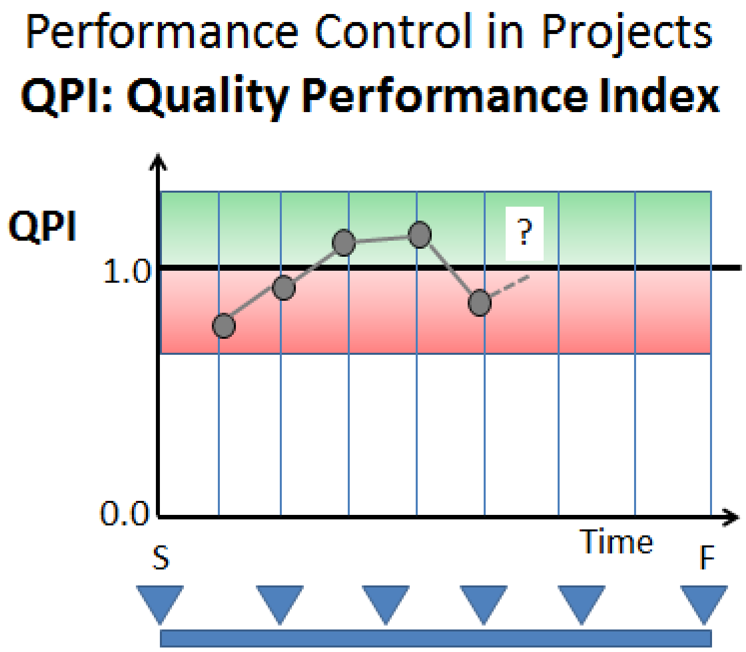


Figure 1 – 15 Schematic illustration of development of the QPI, Quality Performance Index over time during the project execution.

The QPI, the Quality Performance Index may be established for a part of the project and/or for the entire product delivery. It will represent very different features.

Examples of specified/planned quality requirements are as shown in the table below:

Construction Projects Buildings, vessels, oil rigs, highways	**IS/IT Projects** ERP systems, CRM systems
• Dimensional tolerances of structure • % acceptance of embedded defects in welds • Weld fracture toughness • Surface roughness & tolerances • Tolerances in concrete composition for strength grade	• System architecture • Specified reliability level of system (SLA, service level agreement) • Degree of compatibility with current IS/IT system in the organization. • User interface simplicity

Table 1 – 7: Typical Prodduct quality parameters for physical projects like/construction projects versus IS/IT projects.

During project execution, periodic recording of the actual quality gives you the opportunity to estimate the QPI, as it is the ratio of actual value divided by the specified quality requirement. The eventual variation from one period to the next provides you with confident process control on quality development.

A more holistic Process driven Management Control in projects is thus established by utilizing the three process control parameters QPI, CPI and SPI, not just CPI and SPI. It leads to an integrated management process control of the project development that is a necessity for achieving performance excellence in the projects. The project managers' Process Control Dashboard should then include QPI, CPI and SPI that are predicted periodically based on periodic recordings at established cut-off dates, weekly bi-weekly or monthly.

The most widely used project standard internationally is PMBOK – Project Management Body of Knowledge – issued by the American Project Management Institute. PMBOK is developed with a structure consisting of 9 knowledge areas and formatted by use of the basic process design prrinciples. Each process within the respective knowledge areas uses a standardized format with the elements Input, Tools and Output.

Correspondingly, 5 different work process groups are identified which are:

- The initiation processes.
- The planning processes.
- The execution processes.
- Monitoring and controlling processes.
- Termination processes.

The defined work process groups above are not separate project phases, but are present in any of the phases in a project.

The process groups are reflecting the basic principle in the Deming circle for continual improveement through planning execution, control and adjustment for improvement.

PMBOK is designed such that the process is in focus. However, according to the definition of a process including process control parameters that are necessary for adjustments and continual improvements, such parameters are not explicitly visualised. However the tools identified and listed may be considered as an expression for process control parameters, in which also sub processes may be considered as an element in the list of enablers or tools.

This is an excellent reference standard but needs to be customized to each project. For more details see section 7.5. Standardization of the project processes is considered a significant benefit in most organization, provided that the organization is capable of using the PMBOK standard catering for the project specific characteristics in each project.

The ISO 21500 *Guidance on Project Management* standard is designed with a format and structure quite close to the PMBOK but has a somewhat more overall and generic structure including an intensified focus on the objectives and business case of a project. For more details, see section 7.4. The ISO 21500 standard lists knowledge areas and associated processes with input and output, without explicitly specifying tools or process control parameters to them.

1.6 From post recording of As delivered towards a holistic approach on quality and risk management.

There is a fundamentally different approach regarding quality issues when dealing with I) a post recording and monitoring of AS-delivered product or service relative II) a proactive management and control during the project execution. The mindset is totally opposite for the two approaches. The first approach is the classic one that confirms and documents what is delivered. The facts and figures are relevant as references regarding learning and post evaluation but have marginal value for the project management of the project in question.

The nature of a project is a one-off event which means that you must do the right things right first time and in the right sequence. It is an extreme condition, and you should be able to influence the product development through proper product quality control and adjustment during the life cycle of the project. A holistic oriented quality management approach is to act proactively, through proper planning and prevent potential risks and deviations to appear. It is a mental revolution and cultural paradigm shift in project organisations. Monitoring and recording oriented organisations focus on whether a deviation is happened or not, and not on making the right prioritized actions and decisions. Managers with low self confidence may tend to fall into the detailed monitoring and recording mode rather than stimulating the resource group to focus on the right activities and make efficient priorities and decisions.

Detail oriented organisations may have a tendency to monitor and report a wide range of activity performance parameters to en extent and detailing level beyond what may be considered appropriate for the purpose of efficient management. The facts and figures are not used for active management and control and the corresponding management resource utilization is waisted.

A quality measure or recording confirms the achieved quality, not more, not less. If the desired product quality is not as specified, the recorded figures tell you that. However, it is too late to discover that fact at time of delivery. As a consequence, quality must be built into the management culture through proper planning and continuous management & control through the project execution, where deviations are sorted out by use of a sound set of enablers for regaining to the specified quality level by using the principles of continual improvement in the execution processes.

Quality Assurance, QA, is a combination of making a good quality plan followed by reliable and predictable monitoring of actual achieved quality. If a deviation is identified, actions/mitigations are launched for adjustments. The Quality Assurance including a systematic continual improvement cycle provides you with the basis for sound Quality Management.

According to the PMI standard PMBOK, Quality Management includes the following product quality processes:

Quality Planning is to design the planning processes such that it focuses on doing the right things right first time and in the right sequence. The quality planning should identify which quality standards and product quality specifications that are relevant for the respective project and include activities how to achieve the specified quality requirements.

Quality Assurance comprises the systematic quality planning, monitoring and control activities in order to confirm achievement of the specified quality requirements.

Quality monitoring and recording is to measure and document actually achieved values on product quality in order to make comparison with specified quality requirement figures according to applicable and selected quality standards and product quality specifications. Additionally, there is a desire to identify means and methods for avoiding possible causes leading to nonsatisfactory quality performance and to avoid sub standard product quality.

The quality planning process according to PMBOK is schematically illustrated in figure 1- 16. It follows the basic rule for a process with input, transformation and output.

The transformation part is visualized through a set of tools and techniques available for control and possible adjustment for control and improvements. Among the tools and techniques are check lists, statistical analyses of recorded figures, comparison with other products and test results from pilots or mockups.These may be considered as enablers.

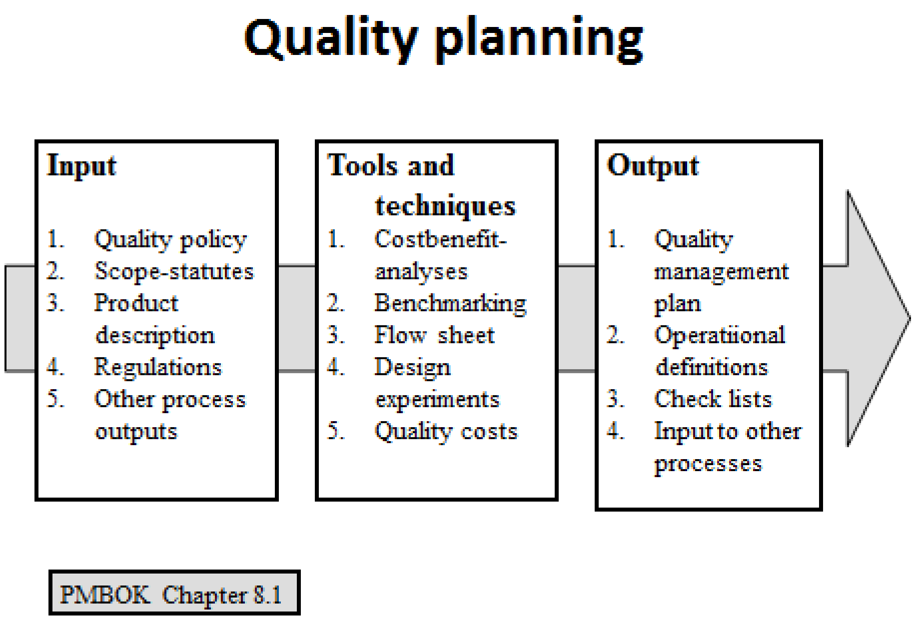


Figure 1-16 Process illustration of the quality planning according to PMBOK

Quality management is to cater for satisfatory quality assurance and control in a leadership perspective for the entire project organisation and its actiities, covering any process in the organisation.

Total Quality Management, TQM, covers the multidimensional and holistic perspective of managing the quality performance in an organisation covering all processes, main processes as well as support processes.

TQM is briefly defined as a multidmensional approach to managing organisations focusing on quality in all activities and issues occuring in the organization with the overall objectives to achieve business excellence and delight the customer.

The essence of TQM is summarized in focusing on the following desired outcomes:

- Achieve customer satisfaction.
- Secure employee satisfaction.
- Positive impact on society.
- Achieve satisfactory business results, financial and non-financial.

The focus areas above demonstrate that quality should be linked to far more that the satisfaction by the customer, including organizational and cultural apsects affecting quality and the quality attitude & culture in an organisation. An appropriate model covering these perspectives is the EFQM-model, which is described in detail in section 7.2, Quality models. (EFQM: European Foundation for Quality Management). It consists of 5 enabling elements and 4 result elements. The 5 enablers are leadership, strategy & policy, human resources, material resources and processes. The corresponding result elements are customers, people, impact on society, and business results. The EFQM-model includes a systematic experience feedback loop for eventually perform necessary adjustments/improvements by using the relevant enablers.

In the project world, a similar model is developed, and named the Project Excellence model. It is initially designed by the German Project Management association and later adopted and revised to an international model for the International Project Management Association, IPMA. The design and format initially followed the format and structure of the EFQM-model with enablers and result elements. It is refined and designed as an integrated project excellence model covering any aspect on quality in projects. The Project Excellence model is decsribed in further detail in section 7.4.

Of particular remark is that the work processes are one of the most important enablers according to the EFQM-model. That dimension is fully aligned with the basic philosphy for the ISO 9000 standards. Similarly, other quality models reflect the importance of the processes and the customer/supplier relationships, as clearly shown in the models by Oakland, see section 7 and (Oakland, J. S). Furthermore the importance of leadership and people is highlighted and accordingly the dimensions of commitment, culture and communication.

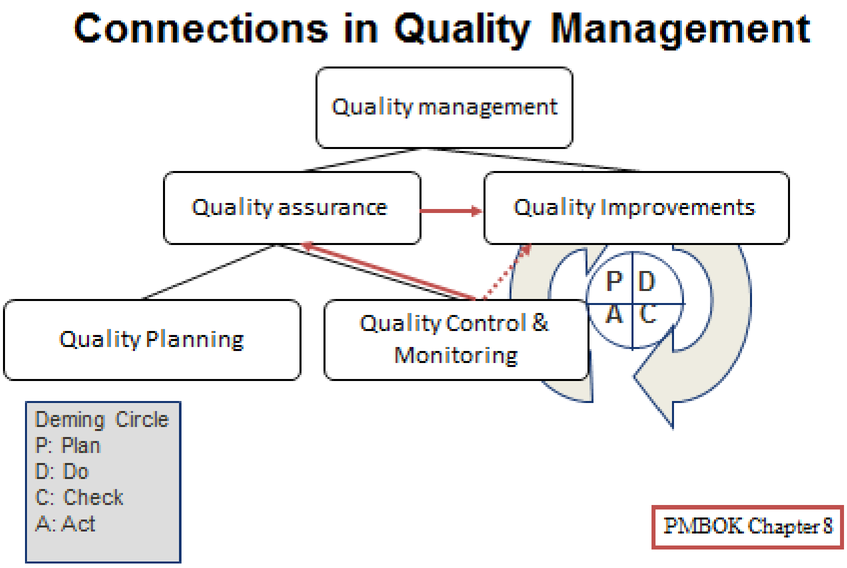


Figure 1-17 Interaction between Quality Assurance and Quality Management

1.7 What characterizes Quality in Projects?

The nature of projects relative regular production operation

A project is by its definition a one-off event, uniques with specified goals, limited resources and time, and performed by a temporary organisation.

The sum of these characteristics gives a particular work environment in projects and may be considered more extreme than in regular production operations. Regular production operations have a repetitiveness in their actvities as their role are to deliver products satisfying the specification requirements and at a production rate leading to an efficient and sound business. Prequalification and statistical process control should cater for the satisfaction of the quality requirements. Eventual deviations are adjusted through established continual improvement cycles and procedures.
In projects, the «one-off» characteristics provide you with particular challenges, as you do not deliver a series of products, but one single product. Then you are committed to do the right things right first time and in the right sequence. The chances of continual adjustment of the execution and product development are more limited compared to normal production

operations with a requested production rate of units. The project characteristics request further a detailed upfront planning, as you normally do not have the possibility for rework/adjustment of deviations without significant detrimental impact for the execution of the project. These considerations and challenges are further exposed in the illustration in figure 1 – 18. The sketch includes 3 different curves showing variation over time during project execution. One basic curve is the classic S- curve for planned accumulated cost versus time. The second curve indicates the relative uncertainty versus time. Most frequently, the uncertainty is at its largest during the initiation period of the project, and gradually decreases as the project progresses and activities are completed. The amount of information and facts increases and supports the profile of the declining uncertainty curve. Inexperienced project managers may be rather concerned about the level of uncertainty at start up and might in the extreme cases become almost paralyzed. Their reaction pattern may to the extreme be that they don't dare to initiate the project due to the high number of "loose ends" at the start-up phase. However, the situation is better than what the uncertainty curve reflects by itself. During which period can you influence the most? That is normally in the initial phases covering the definition and description of the scope of work and business benefits, and the the majority of work still remains. Thereby the third curve illustrating the relative rate of influence over time demonstrates the chance to influence in spite the fact that you are lacking information. As a consequence, the reative rate of impact compensates to some extent the associated expected high uncertainty level in the early phases of a project.

Frequently the projects are exposed to a delayed start-up/kick-off, still the specified delivery date/ completion date remains. There are obvious reasons for keeping the finishing date and for some projects there are no alternatives than deliver at the date as planned; that is true for international sport events such as the Olympics.

What do you do if you enter into a situation that the planned project execution time is sqeezed and reduced as the end date is remained but startup is delayed? Is the right "medicine" to skip the planning phase and jump straight into execution?

With very few excemptions the answer is No. When you are squeezed time wise, it is crucial to derive a confident plan comprising all necessary milestones and activities laid out in the right sequence. It is first of all a critical matter to establish the consciousness to cover all necessary activities and associated logic sequence, not necessarily spend very long time for planning.

Quality work in projects must be based on which goals are established and to be fullfilled, both with respect to the desired effect goal and the actual delivery, the result goal.

The client/customer, internal or external, must identify the requested and desired effect to be achieved by realization of the idea and accordingly use the actual project delivery in their operations.

When the client's effect goal is specified, the corresponding product delivery specification shoul be generated. The client produces a set of documents covering the actual delivery wirh the appropriate and necessary specification requirements and the description of the scope of work. At the realization of the idea/initiative, the result goal is common for the client and the contractor/supplier through delivery of the product in question at project completion date. The handover from contractor to client may for some projects be in terms of the total final product at project completion, for other projects at part-deliveries of sub-systems during the project execution period. These principles apply whether the client is internal or external. The supplier organization/project contractor should also establish their own effect goal, in terms of what is the objectives and purpose for them to deliver that product and execute the project. Their effect goals are not identical to the client's effect goals.

Figure 1-19 schematically illustrates the relation and connection between the effect goal and result goal. The result goal is the actual delivery of a product or service from the project, and is in common for the client and supplier, whereas the desired effect goals are different for clinet and contractor respectively. Of particular remark is that the achievement of the effect goals normally happens in the period after project termination and handover, ie during the operation and use of the product or service developed in the project of concern. Effect goal are both qualitative and quantitative. Relevant effect goals are enhanced reliability level of the operational regularity or increased capacity that indirectly increases the economics of the project, enhanced capacity or capability of a product or system. A desired effect could also be to increase the effectiveness and productivity of the use, be reduced demand for periodic maintenance of the system/product in operation, or contribute to increase the company's competitive position, as well as increased market share. The consequence of the desired achieved effects might lead to a firm business benefit, expressed in terms of the classic project economics parameters NPV, IRR or Pay Back Time, or break even price. One may distinguish between the effect goals and the corresponding possible business benefits as a result of achieved effects, (Christensen). Effects might be achieved but the corresponding business benefits are achieved after proper actions to let them come true.

Typical effect goals for a supplier are the profit margin in the project delivered, but as important may be to maintain or increase market share and increase their relative competitive strength. Also, strategic competence developmet and learning are considered being a desired effect of a project with delivery to a client.

The supplier's effect goals, and business benefits should be established prior to a request for tender from a client, as it will enhance the supplier's consciousness regarding priorities in a strategic perspective as much from a resource point of view and overall business point of view.

Competence development and learning are however potential effect goals that could be achieved during the project execution, for the client as well as for the contractor/supplier and other external stakeholders.

In summary, a recommended praxis is to develop and approve the effect goals and associated potential business benefit prior to derivation of the specified result goals. That sequence may enhance the preciseness level and confidence of what the delivery should actually be from the project, which again contributes to a more precise description of the scope of work. That approach complies fully with the principles in ISO 21500.

Past experience from a range of orgamisations and enterprises is that too little effort and time are spent on the generantion of the effect goals and the associated communication of these why this specific idea or initiative should be launched and go live. The ultimate consequence is lacking ownership to the idea and initiative, and incomplete understanding why the idea or project in question should be realized. Such a situation may complicate the conditions for making sound and firm resultgoals with a corresponding well written scope of work.

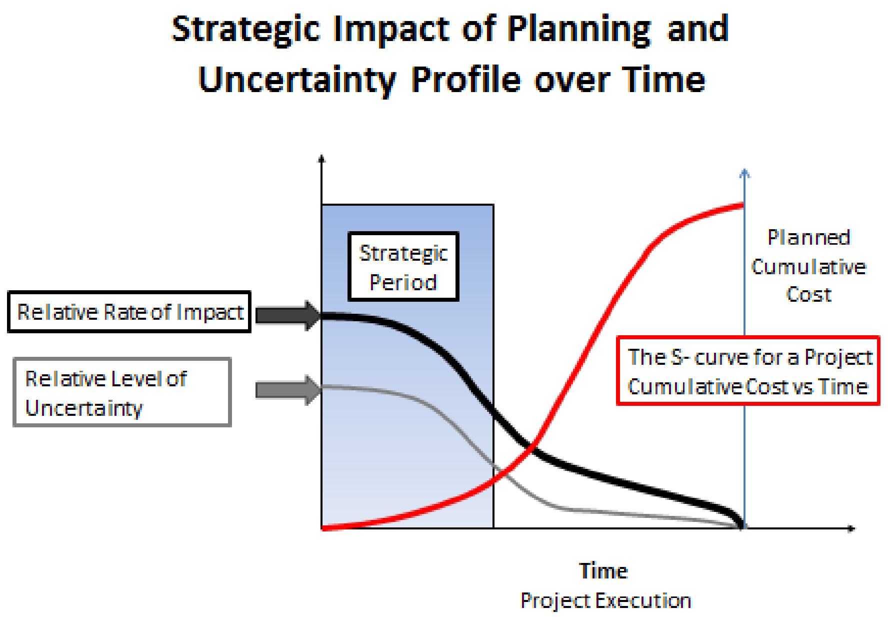
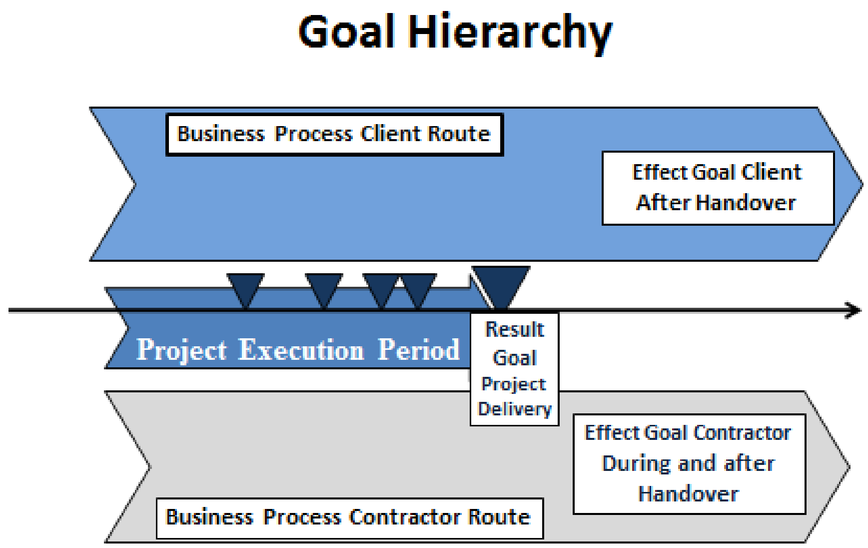


Figure 1-18 Relative Uncertainty level as function of time



Figur 1-19 Goal Hierarchy in a project (Samset)

What is Quality in Projects?

1. First, the product quality must at delivery and handover satify the specified quality measures and requirements to the product accoring to the specification requirement and scope of work. These features characterize the product quality resulting from the development work done in the respective professional environments involved in realization of the product or service. Of particular remark is that the quality specifications describe the requested level of quality, whereas the scope of work also includes the size/volume of the delivery. During project execution there might be situations in which the total scope of work must be reduced although the quality requirements remain at the specified level. A significant contributor to success is well established effect goals and corresponding result goals including a realistic description of the scope of work. In that context, it adds value to have a sound technical verification plan including peer reviews and eventually independent analyses in order to confirm compliance with specified values and characteristics. The quality control process of the product quality should be considered continually, including a systematic deviation control and procedures for continual improvement and regaining to desired specified figures.
2. The Delivery Quality in a project includes, in addition to the specified product quality requirements:
    a. Time of delivery
    b. Location of delivery
    c. Rceived amount according to requested volume
3. The execution quality in projects comprises, in addition to the specified product quality and delivery quality, the quality achieved in the other processes and activities in the project with focus on the quality planned and achieved on all processes connected to the project management execution and control. Actual efficiency and productivity are elements in this categpry of project execution quality. Satisfactory execution quality thus requests achieving satisfactory performance in all the processes defined according to the knowledge areas according to PMBOK.
4. The effect goal quality in a project is dealing with the precision and actually achieved effect goals such as project business benefit and effectiveness of use/operation.

The established project quality terms are explained in more detail in section 1.2 and illustrated in table 1 – 1.

Among the challenges related to the product quality in projects is the likely interdependency between product quality, cost and time, as illustrated in figure 1 – 20 containing interdependencies through the arrows in between the prime controlling variables. How realistic are the project baseline with respect to budget and schedule? If delays happen in one project phase, are there knock on effects both on cost and functionality? Is the specification requirement a customized specification or is it based on standard equipment? That is the kind of issues that must be addressed and managed during the project execution.

Relevant questions are:

- What is good enough, at what price and when can delivery happen?
- What is Quality Management excellence in projects?

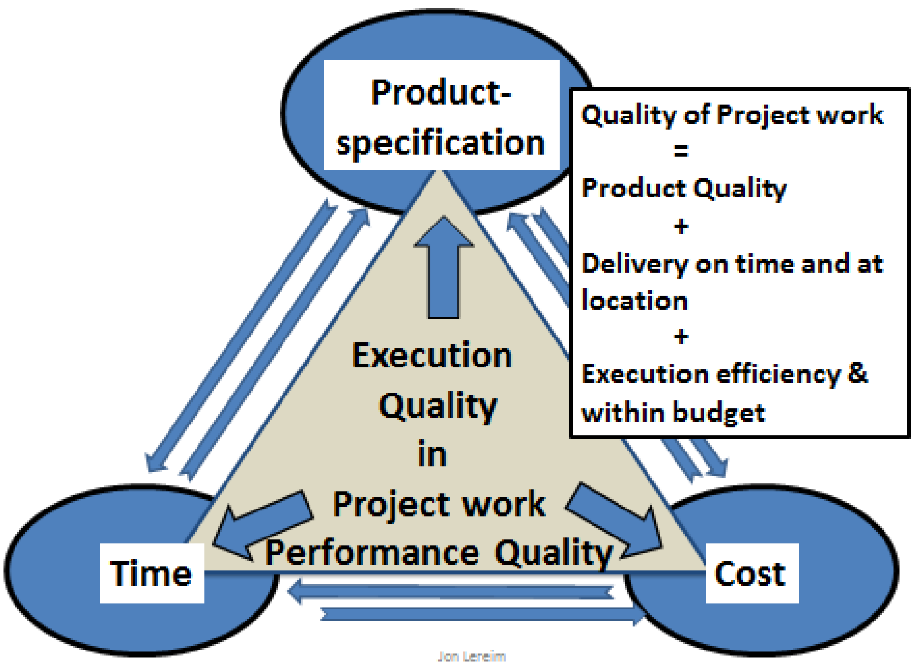


Figure 1-20 Interrelationships and dependencies between cost time and product quality

What is good enough, at what price and when can delivery happen?

There are cases of product development that have happened with little focus on development costs and schedule. Some professional innovation and technology environments may become so fascinated by the ideas that cost and time are not in their minds. Important factors in product development and project management are to master the respective interfaces, organisational interfaces, physical interfaces and/or contractual interfaces.

Excellent interface management is often experienced as a critical success factor during project execution and maturisation of the product delivery, and significant risks may appear directly linked to the interfaces.

Satisfacory business and project performance also request satisfactory quality on the project management and control processes during execution in order to achieve the desired efficiency and productivity during the entire life cycle of the project. That is furthermore a condition for maintaining competitive expecution performance.

An extreme scenario happens in a project if management focus is dealing solely achieving excellence on managment and control of cost development and the associated progress without paying attention to the actual product quality. If budget control has first priority, particular attention should be paid to product quality and schedule, as these parameters may suffer. If progress is the sole priority, both cost and product quality may be affected negatively.

Quality in the project management processes encompasses people, culture and organisation. Consequently, the perspective of delivery quality and project execution quality in projects are influenced by both the structure and culture dimensions during project execution.

Quality in projects deals with the combination of developing the product delivery according to the specification requirements and at the same time achieve an execution performance with satisfactory efficiency and productivity.

What is Quality Management Excellence in Projects?

Quality management excellence in projects is relying on the ability and capability of the management team to establish thorough understanding and knowledge of the uniqueness and project specific characteristics to the project in question.

The Management team must demonstrate a firm capability of identification of project specific characteristics and issues, in order to develop and design a quality plan and project baseline that cater for these. That is valid for the client/customer as well as for the contractor/supplier. Strategic tactical and operational considerations must be done in light of the project specific issues.

Identification of project specific issues must cover any topic or part of the project, deliverables, management and control.

The identification process should be able to expose and identify the following:

- What is project specific business benefits in addition to what is outlined in the business case? Project specific effect goals should be identified for both client and contractor.
- Are there specific issues and characteristics included in the scope of work that may affect the project planning and execution?
- Are there project specific functionalities associated with the requested product delivery?
- Are there project specific conditions for selection of execution methods?
- Are there project specific issues that affect the organizing, requested competence and culture in the project?
- Are there project specific demands regarding control, monitoring and follow up during project execution?
- Are there project specific contractual issues that affect the suppliers/contractors?

There is a general tendency in organisations to ensure learning from the past. That is a part of the initiatives for continual improvement. This is generally of great value in order to improve efficiency, standardization of work processes etc. However, there is a warning in this context, as experience in professional project organisations have sometimes demonstrated a “copy paste” approach, not only on methods and tools, but also on actual out comes of the respective analyses to be done. Thus the pressure on learning from the past must not lead to short circuit the good philosophy, as **the project specific dimensions** must be fully addressed and reflected in the respective project planning and execution processes on quality and project performance. The recommendations are to copy templates and methodologies from the previous projects but never completely pre-filled in with facts and figures from past projects.

Section 2 Product Quality in Projects

2.1 Quality of the Scope of Work and the Specification Requirement

Achievement of good product quality in the project is depending on the actual quality of the description given in the scope of work and the corresponding product requirement specifications both with respect to quality level and capability. A vague, incomplete and unclear description of scope of work is considered to be a major fault for not meeting the requirement specification for the product or service.

A firm and well written scope of work is considered to be a primary success factor for the project execution. There should be put priority in the client organisation for derivation of the scope of work to the detailing level and preciseness level that makes it possible for contractors/suppliers to delicer a project to the satisfaction of client and meet the efficiency ambitions and requirements in the supplier organization.

Key questions in that context are:

- What is the desired result goal, the actual product delivery at project completion?
- How precise should and could the result goal be specified prior to point of deccision for launcing the project with the corresponding sanction for execution?

The requirement specification of the end delivery/product is a critical element. It must cover any aspect of the features and functions of the product or service, including eventual constraints for the development and for use of the project. The latter may apply for issues connected to health, safety, and environment as well as for operability, inspectability and maintainability during operation/use of the product/service.

The scope of work description will vary significantly from one project type to another. Well known and mature concepts can be described to a high level of detailing, and are frequently categorized as closed projects, (Hetland). The delivery is known and most boundary conditions are known for the project execution, from kick-off to delivery and handover. The other extreme is socalled open projects, in which the conditions are vague, you may “walk in the fog”, and the the execution is a change journey with moving targets. That requests a description in the scope of work that has a format and structure that allows for management towards a moving and changing target for the result goal. The latter characteristics may represent IS/IT projects in which the final solution is not known fully at point of decision for launching the project. The same is valid for research projects. For such categories of projects the requirement specifications must be of a functional nature, and not include detailed specifications. The functional descriptions should be objective and solution neutral, not leaning towards one approach. Establishment of functional requirements for “open projects” are challenging as derivation of committing functional requirements is difficult. The functional requirements must combine the need for flexibility in solution and the demand for commitment in features and functionality. This is very demanding, and the most senior resources must be put on these tasks for generation of functional requirements. The individuals in charge of that development must posses sufficient experience and demonstrate a solution-oriented attitude. Fresh graduates do not have sufficient experience to fill that function and the most senior resources should be in charge of developing the functional requirement.

For the category of open projects, the result goal might be a moving target, whereas the desired effect goal is more stable. One should consider putting more emphasis on the effect goal rather than the result goal and let the potential suppliers to deliver a solution that fulfills the specified & desired effects and objectives for use of the product or system.

For construction projects, the scope of work and corresponding requirement specification could be more detailed and presice.

Which featurres should the requirement specifications cover? One part is about the As-built, As-delivered at time of handover. However, the requirement specifications should include the capacity and capability for the entire specified operation period or life cycle of the product delivered. The life cycle and durability should be addressed and included. The specified features should also cover parameters such as reliability level, operability efficiency, maintenance and inspectability as well as capability of upgrading during operations. These dimensions should be catered for in the scope of work and product description.

A well written scope of work should also cover the issues related to the users of the delivered product or service. It should address the operation and user requirements in terms of validty range and constraints. If not, misuse of the delivered product or service may lead to misinterpretations and in the worst case break down of the as delivered product. Such a situation must be avoided, and consequently explicit activities for systematic training of the operations and use of the product/service/system should be an integral and compulsory part of the scope of work. The associated training packages are actually a part of the product delivery at project handover.

Mainentance tasks and eventual features for upgrading capability could also be a part of the scope of work in order to obtain a life cycle perspective on the product delivery.

In summary, strong recommendations are given to spend sufficient resources and the most experienced resources in the derivation and design of the scope of work and associated requirement specifications. That will pay off.

The product quality is visualised and exposed in the classic project control as outlined in figure 2- 1.

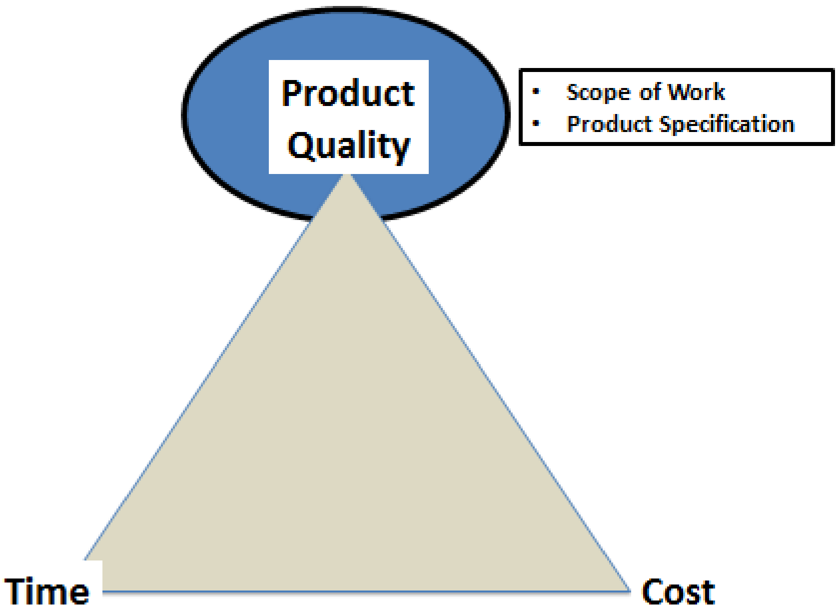


Figure 2-1 Illustration of product quality in the project described in the scope of work with its associated product specification.

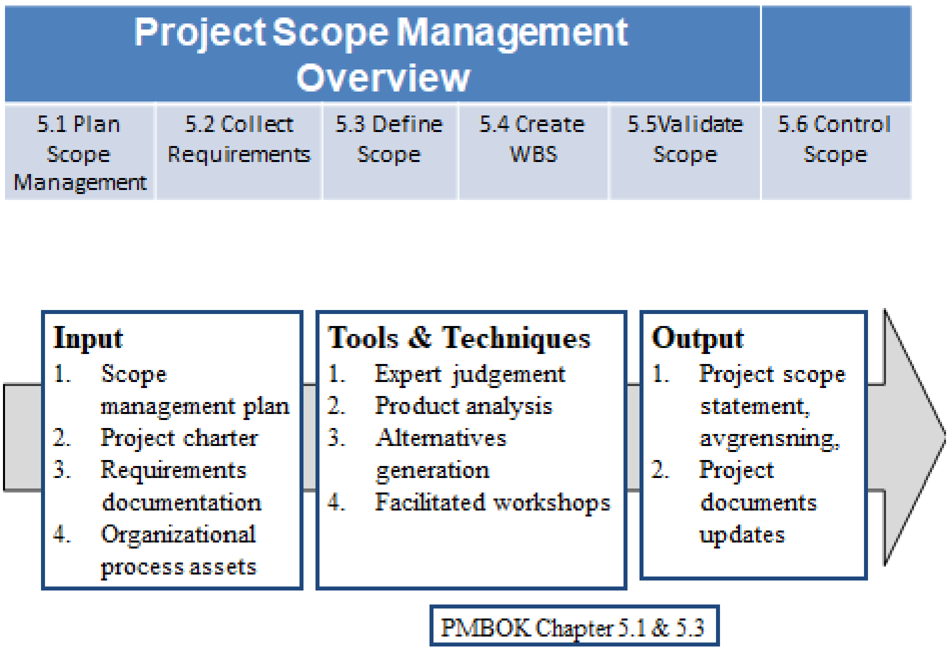
Scope management is one of the knowledge areas according to PMBOK, section 7.5. It includes the following part processes:

- Collect and formalise the quality requirements and functionality of the product
- Definition of the scope and task

- Derivation of the work breakdown structure
- Verification of the scope of work
- Management and control of the task during realisation and execution of the project.

The steps above add confidence to the process of making good quality. Furthermore the scope of work must respond to a specific need among the primaary stakeholders to the project. Those dimensions could be strengthened by use of experts and assessments on how to meet the organisation's needs.

Relevant tools in this context are market analysis tools and product analysis tools. Those should lead to a firmer identification of the real need and help deriving a realistic and robust development route. It may include structured methods for optimized design of the work breakdown structure to work package level, system analyses, systems engineering, value engineering and analyses.



Figur 2-2 Process – illustration of the scope definition according to PMBOK

2.2 Product Quality in a Project

Rollout per phase and final delivery

The Project approach is a well established and recommended way of planning and executing for delivery of a product or service according to established quality specification requirements within the actual constraints with respect to time and resources available for execution.

In this sub chapter some considerations are summarized regarding the actual product quality of the delivery. The final product delivery from a project undergoes a gradual maturation process. It initiates from an identified idea, through feasibility studies, conceptual development and towards a real detail design and development towards delivery. Through all phases a gradual maturation happens, frequently through an agile and iterational approach. This is schematically illustrated in figure 2 – 3.

In the idea phase, the description may be rather diffuse, but sufficient for further development. The key challenge is as follows: What is sufficiently precise for providing you with a satisfactory confidence for making the decision to continue? There must be sufficient evidence to identify the potential prospects and direction of the development.

During the next stage, the feasibility phase must create the product idea to a level at which it may be tested. Is the idea viable or is it not?

In the conceptual stage the basic idea shall be expanded and made more firm and solid in order to assess alternative solutions for realisation. The most important product functionalities and features must be documented to the level of detail that a decision can be made whether to proceed to project sanction and rollout. Final concept selection and conceptual freeze provides you with the formal basis for establishing the detail design & solution, contract and overall procurement strategy as well as the project execution strategy. The conceptual phase may futher be sub divided into prior and after concept selection.

The detail design & development phase shall lead to a product description to a detailing level making it possiblee to build or develop a final system solution delivery. That should include any element regarding featuress, capabilities and functionalities of the final product or service including specified tolerances.

The consequtive commissioning and handover to the client or operations should comprise the verification of the desired features, eventually perform final adjustments.

The commissioning and handover to the client should essentially be a verification and final adjustment of the delivery such that the FAT and SAT result in approval of the deliveries. (FAT: Factory Acceptance Test; SAT: Site Acceptance Test)

The process for product creation and development is initially ideally illustrated as a sequential process. However, in many cases, the development process is following a process route that is more characterized by partly parallel processes as in *concurrent engineering*, in which the consequtive part process starts prior to finalization of the previous part process/phase. There is a desire to utilize methodologies catering for iterational processes which uses the agile principles in order to mature a moving target. Scrum & agile project execution make it possible to initiate and manage a dynamic project development route coping for agility, resilience, and change. These princciples are brieefly described in chapter 6.6. It provides you with an execution approach where daily status meetings are held, what is achieved and what are the issues for the coming period. By that approach, the estimated cost of changes is kept to a minimum compared with more classic water fall models.

The product development process is expected to be run at a higher speed of realization when there is developed firm and clear desired effect goal prior to the derivation of scope of work and associated result goals. The development process thereby may follow the schematic maturation as shown in figure 2 – 3, from initially a rather diffuse picture towards a preciseness level satisfying the established quality specification requirements.

Another important dimension related to the product development is the derivation of firm milestones and the corresponding logic sequence of milestones. The well-known methodology Goal directed Project Management (Andersen et al) helps you in the solution generation process.

A milestone may be defined as «A new state is achieved», not a date as such. However, experienced planners may predict expected dates with reasonable confidence when making the overall project milestones plan. Examples of milestones are:

- System-engineering is complete and satisfies the specified detailing leevel & quality
- Detail design with associated work packages of construction drawings is complete
- Factory Acceptance Test (FAT) is complete and satisfies the requirements.

A milestones plan describes the logic sequence of states to be achieved in order to develop and realise the product/service.

The Scope of Work is the primary element towards realisation of the solution and delivery, as outlined in section 2.1. A precise description of the scope of work makes it possible to to deliver faster and to an enhanced preciseness level at handover to the operations. Furthermore, the derivation of the scope of work is considered far more successful and easier if the desired effect goals and result goals are established up front, fully documented and communicated to the entire project team at the project start-up.

A well written and documented Scope of Work is further the basis for establishing the Work Breakdown Structure. The Work Breakdown Structure (WBS) shall essentially be object oriented such that part objects may be developed and delivered according to specified quality requirements and features. Of particular importance is the issue of interfaces in the WBS. The design of the WBS should be as simple as possible with a desired minimum of interfaces, since the interfaces may readily be sources of risks in the project.

The sequence Effect goal => Result goal => Scope of Work => Work Breakdown Structure is considered to be a prime condition for achieving successfully a fast and efficient development of the product delivery from the project.

Phase	Preciseness Level
Idea Phase	– Overall functionality and features of the identified idea developed in light of the desired effect goal
Feasibility study	– Overall sketch of the idea/feasibility and corresponding list of conditions for realisation
Conceptual development	– A conceptual description that is sufficiently precise and concrete providing a satisfactory basis for the solution strategy and contract strategy
Detail design/ detail solution development	– Produce a complete and full description of the ptoduct to the level necessary for performing the actual construction/fabrication/ development for final solution, physically and contractually.
Construction/fabrication	– Fullfill construction according to as-designed documentation and produce within specified tolerance limits in the quality requirements.

Commissioning & hand over	– Verification of actually achieved preciseness level on product, eventually documentation of corrective actions after completion of a fit for purpose evaluation if quality deviations are registered during the commissioning.

Table 2-1: Skematic summary of the planned development of the maturation of the solution as a function project phase

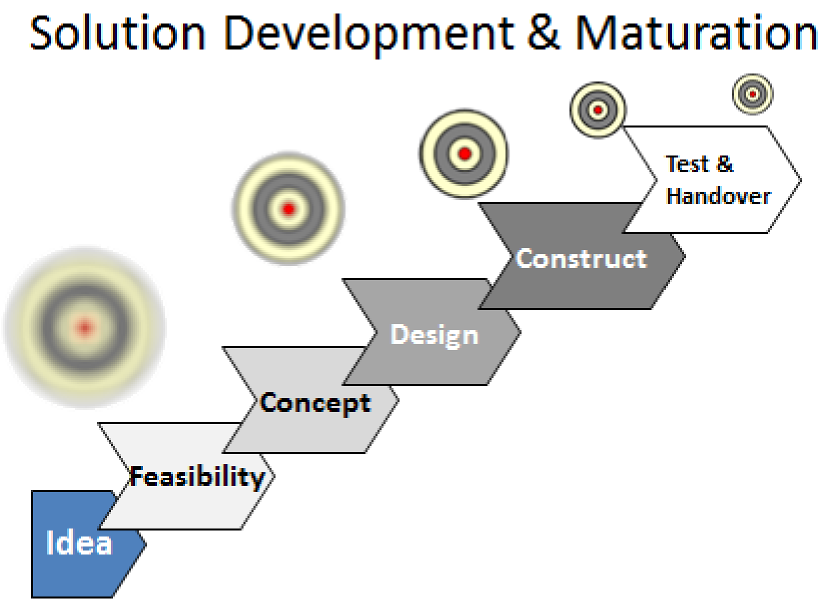


Figure 2-3 Sketch of illustration of likely solution development and maturation during project execution, from idea through to test and handover to user/operations

The actual product handed over to the client or operation must be so well documented that it provides you with a thorough facts basis that makes it possible to derive user manuals and facts for development of maintenance and periodic inspection planning procedures and manuals. These documents are considered to be part of the final project delivery. Attentions should be paid to the quality of the as-finished (as-built) documentation and the corresponding user manuals. These provide you with the necessary backup documentation for the training of the super users and operators of the project delivery and should be to a large extent self explanatory. Super user training is recommended included in the project scope.

Another key issue is the identification and perception of the internal supplier/customer chain in projects. Every preceeding phase is an internal supplier to the next project phase, which is the actual internal customer. These perspectives are skematically illustrated in figure 2 – 4. A critical success factor is to achieve enhanced preciseness level of the delivery from one phase to the next. This might be achieved if the internal customer has established a firm requirement specification to what shall be received from the preceeding phase. Furthermore, that requirement specification must be available at the start of the preeceeding phase, not suddenly at time of handover. With such a practice in place, the chance is significantly increased for delivering the specified quality at the phase interface. Manifestation of that practice may be achieved through formalizing the internal customer/internal supplier roles and associated "contractual obligations" from one phase to the next. The delivery from the preceeding phase is thereby on the conditions and specification made from the internal customer, and an expected enhanced quality and reliability should be the result. Typically such a situation might happen at the interface between engineering design and construction. When the construction group receives the as-designed shop drawings they might not fit the real condition at the fabrication yard and the physical constraints of the yard. Too often these constraints are not communicated properly to the engineering design team up-front prior to the start up of the engineering design. Consequently, the out put from the engineering design may not have incorporated the real constraints and assembly requirements for the product in question. If there was a firm requirement specification made by construction available at start up of the engineering work, there is likely that many misunderstandings could have been avoided. If not, rework of the engineering design may be required and there is a risk of delays regarding start up of construction, alternatively being forced to do "carry over work" on top of the planned construction work. The latter approach may lead to increased number of interfaces and increased complexity in the project with a risk of escalation in construction costs.

These perspectives are considered as a significant improvement area, as many industries admit that they are not sufficiently clever at pinpointing and specifying the need for firm requirements to deliveries from one project phase to the next.

The principles briefly outlined above are valid for any project phase, and every internal customer/internal supplier must secure that there exist a firm specification reuirement from the internal customer, i.e. next phase in the project execution model. This is skematically illustrated in figure 2 – 4.

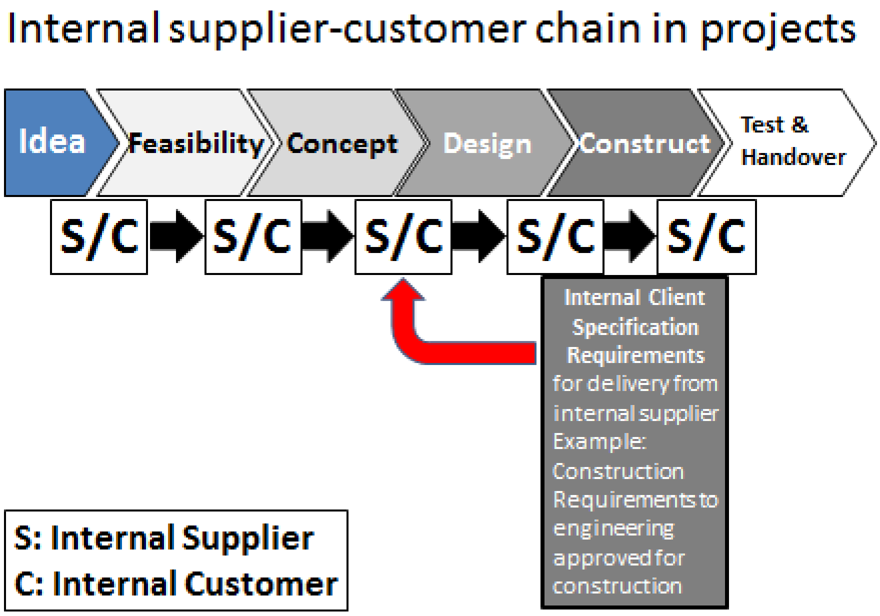


Figure 2-4: Sketch for illustration of the internal supplier/internal customer chain in projects.

The expected output results should reflect an enhanced quality precizeness level and enhanced project quuality in terms of improved efficiency in the project. The internal supplier/internal customer is more readily exposed and provides to you a better perception and understanding of the respective roles in the project chain.

2.3 Planning, control and monitoring of the product quality

Good product quality is fully depending on proper planning, control, assurance and monitoring of achieved results. These elements are catered for by the involved parties responsible for the delivery having appropriate quality management systems. 2nd party and 3rd party independent quality contols and audits supplement the internal quality control by the suppliers, and is briefly described in chapter 3.4.

Key activities within quality assurance and monitoring of as produced quality

The internal quality control is based on an established projet specific quality plan as part of the quality management system for the project in question.

An example of a possible template is shown in table 2 – 2.

Quality parameter & associated requirements	Type of Monitoring & Recording	Date/ period for recording	Measured /registered	Deviation (yes/no)	Action Due date Responsible

Table 2 - 2 Example of a template for measuring, monitoring, recording and control.

The quality control activities of the work may comprise the following:

1. Self control
2. Review by colleage
3. Scientific review among dedicated experts within the area
4. Cross functional control
5. Interface control
6. Actual recording of as produced to date.
7. Commissioning and testing in production facility (Factory Acceptance Tests)
8. Commissioning and testing at installed site/system (Site Acceptance Test).
9. Formalised hand-over post control of delivery.

The quality control methods are relevant for any type of project, however not all the various control steps are necessary, and depending on the type of delivery or product. The eastablished project specific quality management system shal have listed the types of monitoring and controls to be included for the project in question. Some controls & recordings are most appropriate for physical deliveries, others for «immaterial» projects.

The importance of periodic quality monitoring and measurements

First of all the performed quality monitoring activties confirm with a high degree of predictability of the actual quality of what has been achieved or produced to date.

The simplest and initial control activity is the self control. Fullfilling internal check list with prescribed questions is far better than not performing such a self check.

Thereafter, you let someone else review your work, preferably accoring to a preestablished check list with brief questions. You may formalize the effort by signature and date of control. This practice is common practice in many engineering consultancy firms.

Experience in the past has shown that non-conformance and product quality deviations appear even among very experienced professionals as frequent as among the younger in the organization. This sounds as a paradox however some of the most experienced resources may have a rather relaxed attitude concerning control, assurance, monitoring and measurements unnecessary. They have done the operations so many times that monitoring and measurements are waist of time. The result is the need for redoing the product or service, inefficiency appears, and time is lost.

Present and future work environment request transparency and traceability to an extent beyond previous practice. The same is valid for the compulsory requirement to work according to established procedures and designed work processes. Also in this respect some of the most experienced resources seem to skip following the prescribed procedures.

The lack of loyalty or discipline to the procedure and process in question may lead to the following situations:

- Double work may be done due to lack of clear roles; who does what
- Other parts of the task may be overlooked and not performed due to ignorance of the sequence of workflow specified in the work process.

Step 3 of among quality control actions may be applied when the quality issues should be highlighted in a broader perspective through access to expertise with relevant experience from similar issues and projects. The approach is a widely used alternative within IT and software development.

Step 4 is a critical step in quality control and assurance. Cross functional review may identify logic inconsistencies and interdependencies between various technical disciplines. Without a cross functional review the socalled “silo effect” may likely appear with the risk of suboptimization that may result in a detrimental impact on the delivery quality. Superior performance discipline-wise does not necessarily lead to the ultimate solution as the totality perspective may suffer. Cross functional review should be an integral part from day one in the established quality plan for the project in question, and is a condition for avoiding suboptimization, waist and inappropriate total delivery. That is a key project manager responsibility.

The requirements for a cross functional review is valid for any project that is multidiscipline by nature and/or the use of the project output is spread around many users.

In IT- development and implementation projects, the overall organizational demand must overrulee the IT solution as such, which is a typical characteristic for ERP and CRM type projects.(ERP: Enterprise Resource Planning; CRM: Customer Relationships Management) The cross functional issues should be continually addressed during planning and execution of such projects,

The organisation's multidimensional demands must govern the functionalities of the IT-solution, not vice versa. Consequently, the cross functional capabilities must be reflected in the specification requirements as well as in the desired proposed solutions, including features of compatibility with existing systems in the orgaanisation.

In building & construction projects the cross functional review and control should be catered for already in the idea and feasibility stages, conceptual design phase and during the overall engineering design phases. The architects must demonstrate a mind set that focus on practical issues and the buildability and operability of the delivered building of construction such as a bridges, marine vessels or offshore units. The technical functionality must be addressed from the initiation of a project, not after the conceptual design is finished. It does not help you to have a brilliant design if necessary technical systema and installations are not catered for through identification of location and space in the structure layout. It will not be technically feasible.

Execution capability is also a function of the economic constraints and realities. Technical solution may most likely be derived, but the economics may not allow for it. This is illustrated by for example location of shafts for piping and electrical cables must be identified already during the feasibility & conceptual design. Furtheremore the desire for a high degree of component standardization may help in the process of generating an economically sound technical solution based on high degree of component standardization that again makes room for a higher degree of system flexibility.

Therefore, cross functional review must cater for focusing on the total solution as well as the corresponding impact on the respective technical disciplines. During the last two decades, object oriented digital models are launched and utilized in the design work, such as the BIM models (Building Integration Model), a new generation model expanded from well known complex CAD-models. The BIM model is as much a communication and dialogue tool as it is the multidiciplinary physical clash & control check model, well suited as a primary decision support tool for the project management internally in the repective projects, towards the client and other prime stakeholders.

Step 5, interface check is an extension of the cross functional review. The intetface check should identify deviaations and non conformaties in the physical interfaces as well as what kind of information should be exchanged across the physical interfaces. Is the information system compatible and are the data transferable at the interface? Or do you need to develop middleware software between systems for making the information flow seamless?

Interface check should also cover organisational and contractual interfaces. These two categories might be the most challenging ones regarding progress and execution efficiency in the projects. Those issues are addressed in more detail in section 7

Step 6 deals with measuring and markups of as produced work. The extent may vary significantly from one type of product to another, and which parts should be assessed. These aspects are paid particular attention in section 2.4 including statistical treatment of monitored and collected data for derivation of expected values and confidence in the recorded facts data base.

Step 7 is related to the actual testing of the project delivery, frequently performed as an FAT, a factory acceptance test. The FAT testing is considered as the first in a series of completion testing performed under well defined and controlled conditions and environments. During the FAT process, even extreme conditions might be tested under well defined and controllable conditions and perform sensitivity testing for a range of scenarios. Is the product sufficiently robust, and are the as tested & recorded deviations within the tolerance limits in the established specification requirements?

For IS/IT-system the primary focus areas are on functionality, reliability, and robustness/resilience whereas for more physical delivery projects the dimensional tolerances and capacity are the prime issues of concern. Testing might be performed on component level, part system level and on total system level.

Step 8 is actual testing on the installation site, SAT; Site Acceptance Test. That is the proof of the pudding. You perform testing on the real conditions and applicability ranges. You may essentially follow the same procedures and principles as for the FAT processes and procedures. Pressure test to maximum design or proof pressure level is a typical SAT for a piping system and pressure vessel.

Step 9 is the final check of the product delivery. The whole system shall be proof tested according to the specification requirements for the respective systems and full documentation of the test results is mandatory. If a deviation or non-conformance appears, you may do a Fit for Purpose evaluation in order to assess whether the system or total product still fulfills the spectfication requirements to integrity, reliability and capability. Are the results of the Fit for Purpose evaluations negative, corrective actions must take place as soon as possible, and prior to handover to the client/customer. The as built and as installed/implemented documentation should be summarized in a separate as build summary document. It should contain the as designed highlights and conditions, from constuction/ development only deviations from tthe as designed conditions. The same principles apply for as installed/ as implemented in which only the deviations for the as designed conditions should be included. In total that final as build documentation summary provides you with key information and facts for derivation of inspection planning and maintenance planning.

2.4 Quality Monitoring and Control of As-Produced Work

A project is unique and a one-off event for delivering a product or service. The actual execution and realisation consist of several single & independent activities, but also include sevaral repetitive activities. The latter category is quite typical in construction projects.

The quality checks must cover both the one-off activities as well as the repetitive activities. The designed quality plans and corresponding control check lists should reflect those characteristics.

The milestone control & review is an overall quality check on the work performed. Is the specified product quality achieved? Is there dervied a set of firm paramenters for monitoring the actual product quality at the respective milestones?

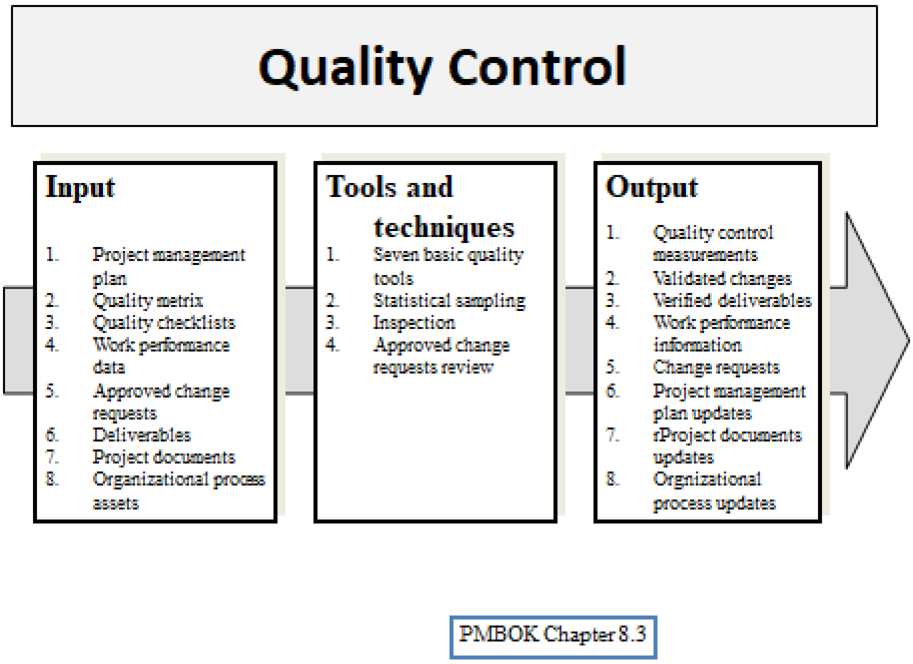
One definition of a milestone is that «a new state is achieved». It is not a date as such, rather achievement of part deliverables during the execution phases of a project. Examples of the term “New state is achieved” are:

- The business case is complete.
- The overall project plan is complete to the specified detailing level.
- The system design is complete to the level specified.

However, experienced project planners may identify likely dates for the various milestones identified and thereby included in a milestones plan and timeline.

On the activity level, as shown in the Gantt-diagrams, the quality monitoring could preferably be done on the overall main activity level or package level in the WBS, whether specified quality is achieved.

Quality control must be based on measuring and monitoring facts, analysed through appropriate tools and methods, followed by approval of achieved quality, alternatively flag non-conformance and quality deviations that need further assessments prior to a decision whether the quality may be accepted or requests adjustments or full rework. These perspectives are incorporated in the part process 8.3 in PMBOK and shown in figure 2 – 5.



Figur 2-5 Part Process for Quality Control and associated measurements

Project work is characterized by many repetitive activities, although the project itself is defined as uniques and the end product is a one-off category. For repetitive activities it is appropriate and most desirable to utilize statistical quality measuring and control in one way or another. The basic principles are to perform a statistical control of a fraction of the activities that are classified as repetitive, conditioned that they are representative for the quality check in question. The recorded data are collected and alanyzed, and from the total population of recorded figures one may derive the following key parameters:

- The most probable figure, m
- The expected Value, E
- The standard deviation, σ
- The 5th percentile often labelled the characteristic value.

This book does not include a firm description of specific techniques for statistical analyses, but standard tools and techniques are available in a range of textbook on quality management and control in general.

Corresponding quality requirements may demand a specified expected value as well as maximum standard deviation and a specified figure for the characteristic value.

The characteristic value is frequently defined as the 5th per ceentile at a given confidence level. It could be the upper or lower per centile depending on the kind of parameter to assess and measure. Figure 2 – 6 contains a schematic illustration of a distribution density curvre (the frequency curve) including the most probable figure, the expected value, the standard deviation and the characteristic value.

The statistical data should be analysed and assessed. What is the impact of the observed figures if the expected value is somewhat lower than specified sombined with a standard deviation significantly smaller than in an alternative set of data representing an alternative case?

One aspect is the derivation of the expected value and the corresponding variation. But what is the confidence level for the derived figures? The actual confidence level of the expected value and the corresponding standard deviation is significantly higher if the figures are derived from a statistical population of 50 recordings compared to a set of just 5 recordings.

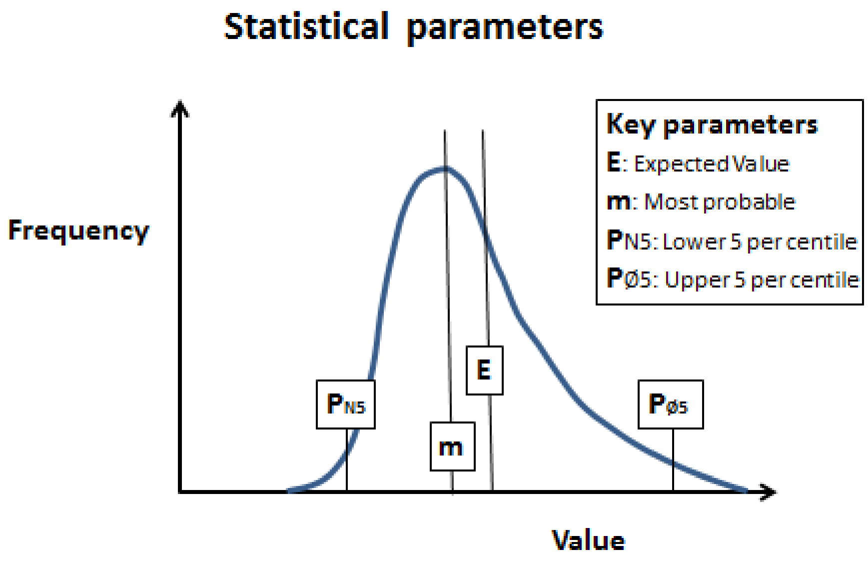


Figure 2-6 Illustration of the statistical terminology for assessment of recorded and monitored control parameters.

The lower 5th per centile is a design figure relevant for strength or capacity. Below are listed some examples on recorded test & control parameters in which the lower 5th per centile is of relevance:

- Surface cover layer of contrete on reinforced steel, measured in mm
- Materials characteristic strength as for example minimum yield strength and tensile strength in metallic maaterials
- Minimum compression strength of concrete and other materials exposed to compression.
- Minimum caapacity of a system solution with respect to number of users simultaneously logged on and active.

Quite often the frequency distribution curve is skew as indicated in figure 2 – 6. For such a case, the expected value, E, is higher than the most likely figure, m.

Similar examples for the upper characteristic value are:

- Maxsimum size of weld defects, both embedded defects and surface defects and the weld-toe (under cut)

- Maximum dimensional toleraances for a structure
- Maximum accepted value of imposed loads, such as load effects from natural forces, temperature and currents.

In the examples provided, the upper and lower limits are indicated to be specified by the upper and lower 5th per centile. However, the requirements may be even more stringent and specified that the variaation should be within 6 standard deviations (sigma). If the upper and lower acceptace limits are close in actual values and representing the limts of “6 sigma”, the requirements to be within 6 standard deviations are considered to become extremely demanding. This is essentially the basis for the 6 sigma principles applied for statistical process and quality control. Six Sigma was initially introduced in the IT-industry, among IBM and Motorola, but has obtained a widespread application in a range of industries as the primary model for statistical modelling and control of the production quality.

The relevance of Six Sigma in project work is related to repetitive activities in which there is a possibility to measure the statistical variation.

Such considerations may be relevant for assessment and control of:

- The reliability and regularity of IT coding and programming
- Production of technical drawings and recorded inconsistencies & mistakes on the drawings
- Recorded weld defects in specified inspection areas
- Recordings of dimensional figures and eventual deviations
- Recordings of functional capacity of a ventilation system.
- Recordings of functional capacity and variation of an IT-system
- Recording of robustness and compatibility capability with other systems
- Recorded shut down time for a system specified through agreed system reliability level and regularity SLA (Service Level Agreement)

2.5 Quality Performance Index, QPI, in Projects

In project management and execution, a classic approach is to derive and utilize the Cost Performance Index, CPI, and Schedule Performance Index, SPI, for assessing the actual performance and state of condition during the project execution. The corresponding achieved product quality to date is not monitored and formatted as done for the cost performance and schedule performance.

In this section the Quality Performance Index, QPI, is introduced to represent the actual product quality in a parameter similar to CPI and SPI. Then the project management and control may have a performance dashboard covering all the basic variables connected to the project performance.

The QPI is designed with a format equivalent to the CPI and SPI. The features are such that the estimated figure for the QPI at the respective cut off reporting dates follows the principles for CPI, and SPI. It means:

- QPI = 1; Measured product quality to date is equal the specified figure
- QPI> 1; Measured product quality to date is exceeding the specified figure
- QPI< 1; Measured product quality to date is below the specified figure, and corrective actions must be initiated

A periodic monitoring will thus lead to a graph such as the illustration in figure 2- 7 below.

A key question is:

- What is the specified product quality for the respective activities and work packages? That is a necessity for derivation of a QPI at the planned cut off and reporting dates.

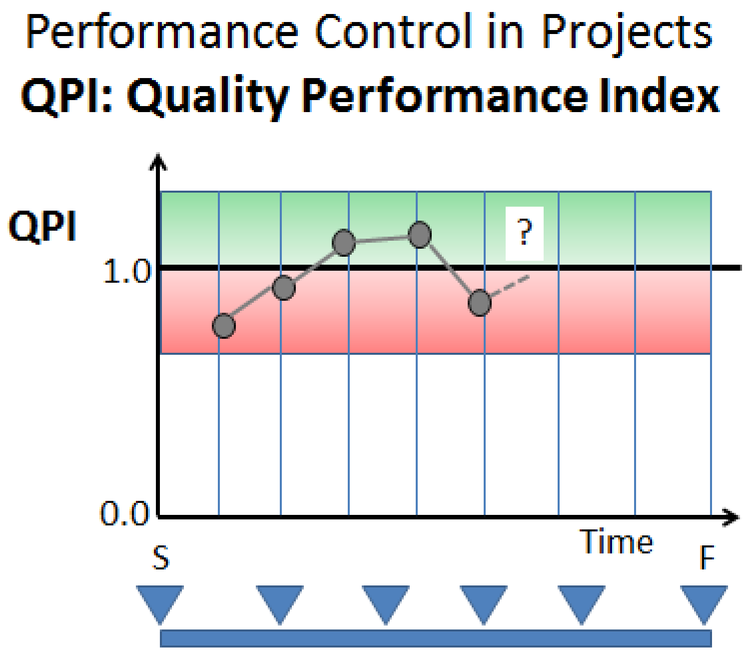


Figure 2 – 7 Schematic illustration on the development of the QPI over time in a project; when QPI is above 1 the condition is good whereas when it is below 1, the project management must assess why, what are the causes, and identify corrective action to regain to satisfactory figures in the next period.

The reference figure for the specified product quality must be representative for the part in question. One may differentiate between to two basic categories:

1. Specified product quality for repetitive activities and measures.
2. One off activity in which the product quality gradually matures.

The category 1 product quality is typically measuring and monitoring the performance of producing repetitive activities and the performance during execution follows the principles outlined in figure 2 - 7. Typical examples are:

- Welding of steel buildings, bridges, vessels and offshore platforms, in which there is monitoring whether the welds contain embedded defects below or above the specified values/limits.
- Variation in dimensional figures for standard components used in the assembly of a system solution.

Through statistical control and monitoring, the expected value, standard deviation and characteristic values may be derived and compared with the specified acceptace requirements.

For category 2, it needs further elaboration. You must predefine the progress in maturing and precision level of the product quality over time. The development processes result in a gradual improvement in the features and capabilities of the desired product.

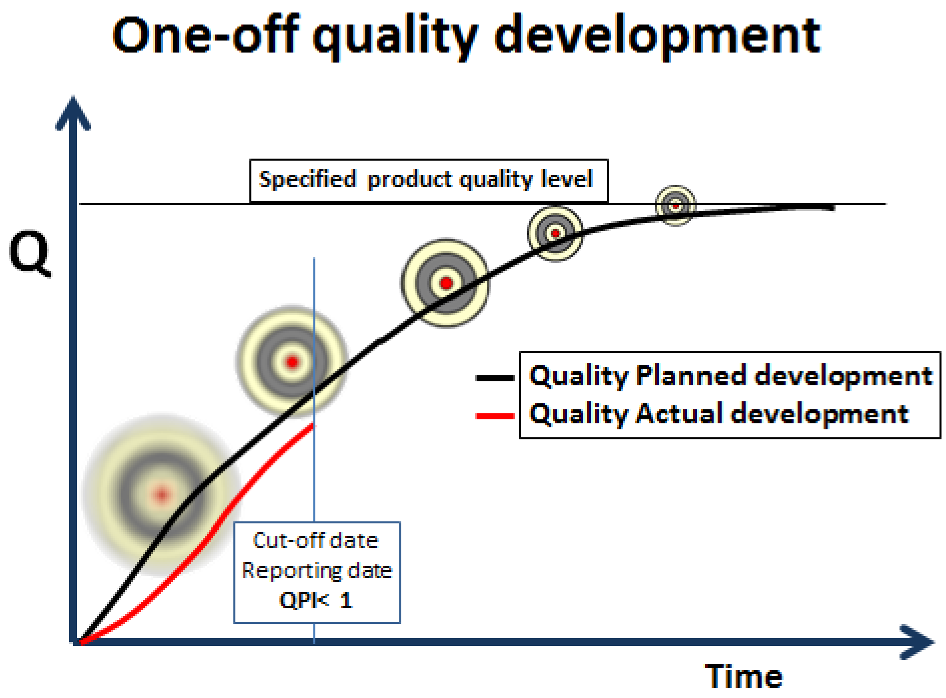


Figure 2 – 8 "One-off" development in product quality over the project life for the product in question. The illustration shows the planned development of the desired product quality, in terms of the black curve, the actual progress in product quality is illustrated by the red curve.

The Quality Performance Index QPI will for the category 2 type product quality development be as the ratio of the actual quality measured over the planned quality level to date, i.e.:

QPI = **Q**(actual)/**Q**(planned)

At the respective status reporting dates as illustrated in figure 2 - 8, the actual quality achieved to date is below the specified final product quality; it is also below the planned planned product quality to date. This is illustrated in figure 2 – 8 by the planned and the actual product quality development at the reported cutoff date.

The situation is different for the category 1 type product quality for repetitive activities. In that case the planned quality is identical to the specified product quality. The actual product quality is then derived from the recorded and reported values for the measurements and plotted versus the specified value as illustrated in figure 2 – 9.

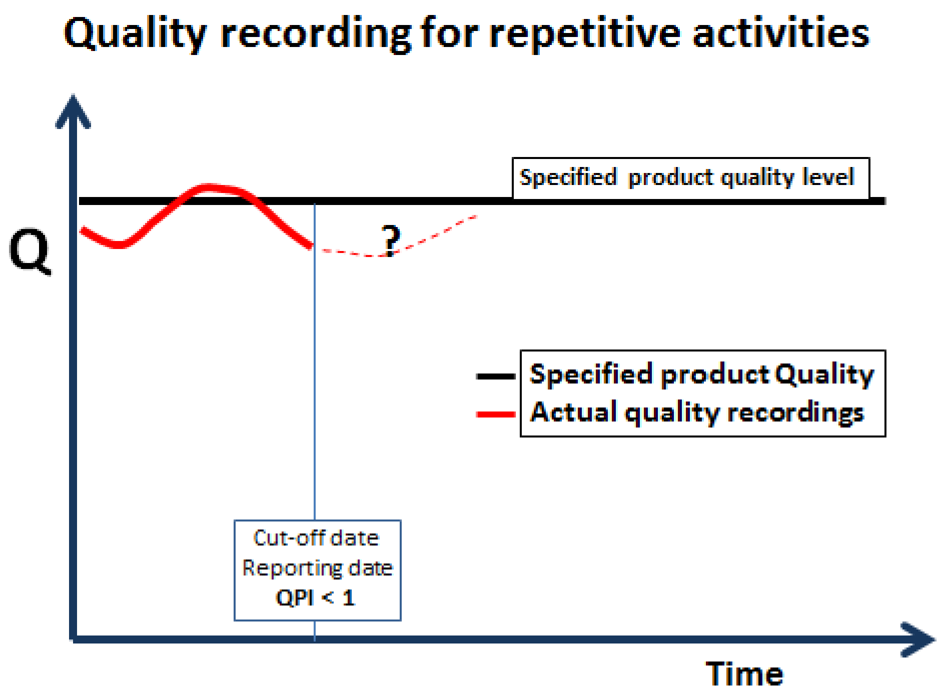


Figure 2 – 9 actual recorded product quality versus specified for repetitive activities and work processes.

The introduction of the Quality Performance Index, QPI, opens up for establishing a project performance dashboard containing the three basic control variables, cost, time and quality in a consistent and comparable manner. This is considered to become a necessity for the project manager in the role of mastering the actual total performance and making confident forecasts with consistency focus on the three basic project control variables cost, time and quality.

The performance dashboard may be designed as shown in the table 2 – 3.

Period	1	2	3	4	5	6	8	9	10
QPI									
CPI									
SPI									

Table 2 – 3; Project Performance Dashboard with performance indexes for the core project control variables cost, quality and schedule.

The traffic light symbols may be applied on the project performance dashboard as illustrated in table 2 – 3. The following rules may apply:

- If the performance index is above 1 it is green light.
- If the performance index is less than 1 but above 0.9 it is yellow
- If the performance index is below 0.9, it is red

That approach could be applied as a simple performance control during project execution. The example shown in table 2 – 3 is an illustration of a project with the latest reporting from period 3.

Why introduce a quality performance index, QPI, instead of using just the actual recorded quality?

The rationale is based on the following:

- QPI has the same format as the well-established CPI and SPI
- The specific quality measures are best understood by the professionals within the respective parts of a project.
- The project manager may not be a specialist within any of the various areas and does not achieve a full perception by reviewing the basic quality measures and recordings only.

Introduction of QPI makes it possible to establish a Project Performance Dashboard that contains the three basic project control variables quality, cost, and time in a common reporting format through the QPI, CPI and SPI respectively.

2.6 Quality perspectives of engineering design work

Engineering and design

Engineering and design are key elements in the development of a project, in which the deliverables are the result goal of the project. Examples are IT system solution, a marine vessel ready for operation, or an offshore oil platform ready for start up of production, buildings and bridges etc. The engineering & design form the basis for realization of an idea or approved concept and provides you with the primary specifications and descriptions for the realization of the idea in question.

Engineering quality and quality of the developed design solutions request the combination of creativity, innovation and solutions that satisfy established specification requirements including standards for safety and reliability. At first instance, it sounds as an impossible combination but nevertheless reflects the challenges of engineering.

Emgineering & design work are performed by experts and specialists within their professional area of knowledge. The professional performance is managed on basis of established theories, models and performance & quality standards standards as well as their own field experience. The cutting-edge solutions may frequently appear when theory and practice are combined. A well-known myth is the expression “Nothing is as realistic and applicable as a good theory”.

Relevant experience is a key within engineering & design, regardless which industry & product that is in focus. The professionals demonstrate most frequently a high degree of self confidence and scientific pride which is a mental strong value driver for delivering the ultimate product or service. It is considered almost as a shame to deliver a product or service with sub standard quality & performance, leading to a respectless reputation scientifically among colleages. The professional & scientific reputation and recognition are important elements for achieving quality excellence, and the projects should in general contribute to stimulate to a continual improvement scientifically. These considerations are normally catered for in the respective professions or disciplines. These qualifications and capabilities may provide you with the conditions necessary for achieving the desired quality requirements for dedicated projects within one profession with satisfactory effiency and effectiveness.

Challenges may however appear when dealing with conceptual development and design that request a multi professional and cross functional team for realising the ideas and desired products/services. Every professional area delivers as specified and to full achievement of the requested quality and performance level within their own area of concern, but what about the total solution and cross functional issues?

«No total system solution is better than the weakest link» is a frequent expression. All scientific areas involved must deliver according to the specified quality within their respective area; a condition for delivering a product satisfying the specification quality requirements. However, that is not enough, as it may not result in a total solution with features and capabilities according to the specifications. The missing link is the cross functional control and attitude, which must be catered for though all phases of a project, from the idea and innovation stages through the conceptual and detail design stages to execution and handover to the user/client of the project deliverables. Cross functional management and interface control are key success factors during project planning and execution.

The desire for interface control is two-fold. First of all any project should establish a formalised interface control with appropriate interface control processes and associated interface registers, and the professional environments contribute and apply the principles and templates for periodic interface control. However, the mental mind set regarding the need for interface control may vary significantly. A successful solution may hardly be achieved unless the professional & scientific resources involved cater for a holistic perspective and attitude to the development process. The holistic approach is to identify and be concious about the totality through the details, in which superior detail solutions create excellent system solutions. Those principles are considered very demanding but a necessity for achieving successful solutions fully satisfying the quality specification requirements and performed efficiently & effectively.

One example on a demanding system design solution is the engineering of a complex building with numerous stringent technical specification requirements. The characteristic of the task is multi- and cross functional including the technical disciplines, HVAC, electrical, mechanical and structural in addition to the architectural issues. Such a development process must make sure that the cross functional issues and the corresponding intefcaes are managed and controlled properly through all the project phases, from the first sketches and ideas through to the finalization and erection of the building. The architect may have the overall responsibility to ensure that any technical issue is catered for in the system solution and total design through the life cycle of the project. It is likely that there may be a very difficult situation, if the system approach and the cross functional dimensions are not incorporated in the early phases of a project. In an extreme case, that may ruin the project and the project must be stopped, if technical solutions do not exist or are not economically affordable.

Design thinking, development and solutison must ensure that a life cycle perspective is present regarding one or more of the following features:

- Capability, durability, and reliability
- Flexibility and demand for standardization
- Market demand and commercial life cycle
- Constructability
- Operability & use

- Inspectability and maintenance
- Energy efficiency
- Health, Environment & Safety (HES)
- Corporate Social Responsibility (CSR)

It is by nature during the design phase that the “right” and brilliant solutions may be etsblished providing improvements and enhanced quality. Post recording and measurements just confirm what is achieved, not leading to “break through” new solutions resulting in improvements with respect to any of the features listed above.

As a consequence, the designers and solution providers must have a mind set that is cross functional and multiprofessional. Excellent HSE figures may be achieved if the designers develop solutions that hinder emissions, avoid situations leading to hazardous work conditions during construction, assembly and operations, i.e. good design leads to improved HSE recorded figures on incidents, emissions etc, and good HSE performance is achieved though good design solutions.

Accordingly, superior energy efficiency is largely depending on developing the right design solution, not solely the operational practice.

Conclusively, the role of the designer might be underestimated in some business environments and the “design thinking” approach should be better exposed and reflected in the project execution and management. The recognition of excellent system design solutions based on principles of a life cycle approach must be communicated and highlighted in the respective organisations; and the designers themselves must improve their consciousness and responsibility for thinking totality solutions in a life cycle perspective, not just their own professional area.

Standardisation in design solutions

There is an almost infinite demand for achieving any combinations and configurations in design solutions. In a range of conditions, reengineering and customizations are requested, whereas in other situations there is a demand for achieving a high degree of standardization and reuse of technology and components.

A challenge is to achieve both flexibility and efficiency simultaneously. Is the solution to intensify the desire for standardization? Second, what do we mean by standardization?

Standardization may be categorized into two levels such as:

- Degree of component standardization
- Degree of system standardization

The two levels of standardisation may be combined, as listed in the table 2 – 4

Degree of system standardization	**High**	• High system standardization • Low efficiency	• High system standardization • High efficiency
	Low	• Low efficiency • Low system standardization • High system flexibility?	• High efficiency • Low system standardization • High system flexibility?
		Low	**High**
		Degree of component standardization	

Table 2 – 4 Catergorization of standardization in design solutions

A low degree of component standardization is considered under normal conditions to lead to low efficiency, due to the fact that numerous alternatives on component level must be designed, produced, installed and maintained during operations.

A high degree of component standardization is considered likely to result in a drastically reduced number of alternatives on component level, the reliability and quality of the design is expected be enhanced, production in larger batches with fewer variables, reduced number of variables of components in stock as spare parts, repetitive installation methods and simplified maintenance and inspection. Furthermore rework and replacement of broken or malfunctioning components may be drastically simplified. Also the actual flexibility is enhanced when maximizing the degree of component standardization. The net effect of high degree of component standardization is thus an improved product quality and associated enhanced operational quality. Conclusively, it is highly desireable to achieve a high degree of component standardization in the design solutions developed in the respective projects.

The other variable covered by the term standardization is the system solution.

Is it desirable to achieve a high degree of system standardization? Does that constrain the degree of system flexibility?

Accordingly, may a low degree of system standardization in effect lead to a high degree of system flexibility?

It is not straight forward what is the optimal combination when concerning the degree of system standardization.

Focus in future design work is on the combination of maximum flexibility and high efficiency.

Is high efficiency a result of high degree of component standardization only or does high degree of system standardization adds value to the efficiency? Will the high degree of system standardization limit the ability to achieve maximum flexibility in the final system design solution?

The recommendations on the system level are situation dependent. A high degree of system standardization may add value to enhanced efficiency, but does it put some restrictions on the flexibility in the total solutionand on the desired effectiveness? Development of some families of system standardisations may be beneficial, and should be carefully investigated

Based on the considereations above the following design recommendations are derived:

1. Establish a component design philosophy with the goal of maximum degree of component standardization.
2. Implement the principle of maximum degree of component standardization in the design work.
3. Establish a system design philosophy that contributes to maximum flexibility in total solutions.
4. Utilize the principle of system design standardization if the total design flexibility is maintained or improved.

The request for enhanced degree of standardisation in design solutions may be perceived as a provocative statement for some designers. Instead, some designers would like to make their footprint on even every nitty gritty compenent and system configuration. The effect is likely increased unit cost as every detail and component is tailor made, is it at all possible to produce, and how to ensure the requested quality level according to overall specificaction requirements. The actual product quality might be reduced as it is hard to obtain the quality standards on one-off products since not sufficient time and effort are spent on quality testing of the respective products as well as real life operation experience. Furthermore, if the project and product in question is mechanical, the number of units of respective components might be too small leading to minibatches of deliverables from a manufacturer. The manufacturers may not prioritize the mini batches if it is customized a "one off" to the project in question. Project delays may result, and the interface issues may escalate as there might be necessary to accelerate the remaining activities if the final delivery and handover date is firm and fixed.

In conclusion, a higher degree of component standardization may lead to higher flexibility and opportunities on system level. Such an eye-opener is necessary for some of the responsible innovators aand conceptual development resources in order to achieve a total solution that satisfies the specified product quality according to the established specification requirements. Additional efficiency improvements may be obtained if the recommended degree of system standardization may guarantee or expand the system flexibility, a critical parameter necessary to make success from a market point of view as well as from an efficiency and effectiveness point of view, provided that the product quality requirements are met.

The personal ambitions to experts and professionals

In some high-tech expert environments, a personal authority is developed and established by demonstrating that *"you are the best man among equals*". It may lead to that the actual solution is superior to and in excess of what is purchased and specified. If the reaction from the professional is of the kind: «I know much better than what is requested», be awaare of the danger that you deliver a product or service beyond what is purchased.

The individuals' pride is a key factor in that context. Although you know better than what is specified by the client, deliver what is requested, not less, not more but just acording to the specification requirements. The exception is if the request demonstrates full lack of understanding what the content in the purchase should be. For such situations there is a scientific integrity obligation that may lead to guidance of the client or purchaser. The individual's self confidence and professional pride should be utilized in such a way that you question what is best for the project in question, not what the expert consideres most interesting and fascinating for the moment. This might be considered as a significant mental barrier with respect to the scientific qualifications. There is a tendency that the real excellent designers have the self confidence to deliver what is sspecified and good enough, whereas the less experienced and not so brilliant take the opportunities to demonstrate their capabilities. The latter may easily be counter productive.

Many innovative designers tend to «forget» time and situation due to shear enthusiasm and eagerness to deliver an over ambitious solution, They become so fascinated by the challenge and jump straight into creative problemsolving resulting in solutions far in excess of what is needed. Milestones, time limits and resource expenditure are not in focus. Consequently, there is a risk of project delays as well as the delivered quality is not according to specified values.

Excellent delivery quality is to deliver a product or service that fully meets the product specification requirements, in which the solutions are delivered at the time specified with a minimum risk of delay and a minimum of over-expenditure of resources. Accordingly, the design development team must make sure that the the development process cater for the interdependencies between the product development, the progress and the resources spent. It means that the designers must understand the importance of the project totality, not the solution isolated from and independent of the resources utilized and time frame available. That should result in a business-driven design development approach as indicated in the sketch in figure 2 – 10.

What is the case if a client/customer is not qualified to derive a firm specification requirement? In such situations the supplier or contractor has, in the light of scientific and professional integrity, an obligation to respond towards the client explaining that the proposed scope is not possible to realise or will not meet safety standards, and should kindly request an improved specification requirement and improved scope of work is established. The client may engage independent specialist consultancy companies to produce scope of work aand product specifications, if the client is not able to produce the scope of work and associated specification requirement.

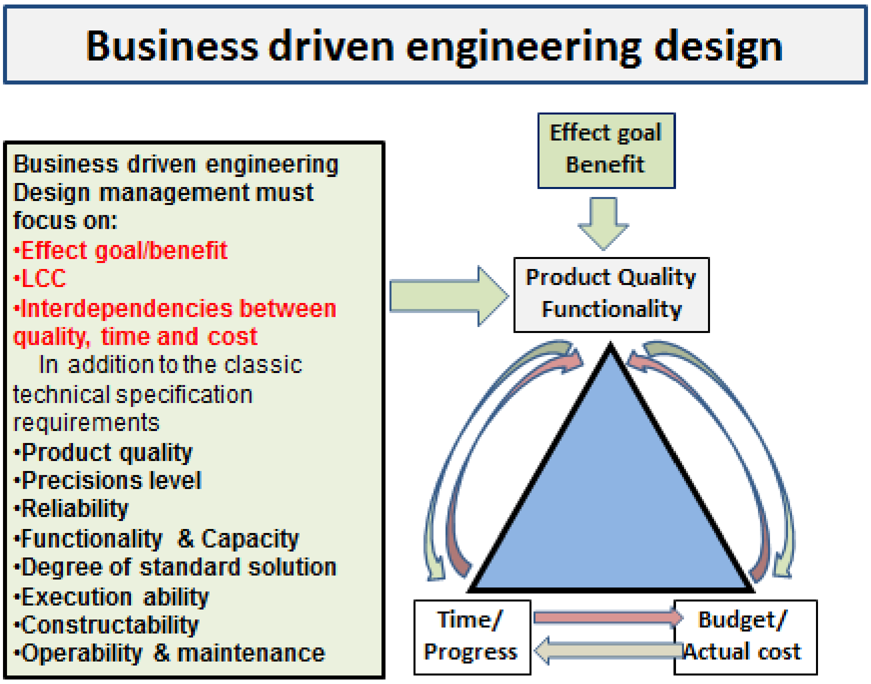


Figure 2-10 Illustration of desired features, interaction and interdependencies in business-driven engineering design catering for the links between, effect goal, LCC, product quality, cost and progress.

Design & solution performance monitoring during execution – "design thinking"

The completed design & solution is the firm basis for the actual execution, testing and implementation, whether it is an IT system solution or a physical delivery from the project.

Land based building & construction projects normally have an overall sequence of the main activities and phases as shown in figure 2 – 11. A firm understanding of the split of roles is crucial, how the roles are filled and performed influencing the gradual development of the project output results. Figure 2 – 11 shows an illustration in a classic sequential manner, with interfaces between the respective phases. In order to make the value generation efficiently, it normally follows a linear and sequential pattern during execution with a complete set of "internal" deliverables between the respective phases. The reality is however somewhat more unpredictable and a likelihood of delays may appear. Practice is a more gradual transition from one phase to the next. It may result in enhanced flexibility, and further iterations and improvements of the solution may provide you with an improved performance. You tend to work more like in concurrent engineering which is highlighted later in the textbook.

Of particular remark is the importance of the respective roles involved in the project execution. For building and construction projects the main contributors are the architect, the engineering designers and the manufacturing and construction bodies. There is a desire to focus on the life cycle of the project delivery, from a cost point of view as well from a reliability and endurance point of view. Frequently, the selected contract forms and formats do not stimulate to cater for an optimum solution in light of the life cycle, but leading to focus on your own part of responsibility. The result may be suboptimization which does not necessary lead to the optimum solution in a life cycle perspective.

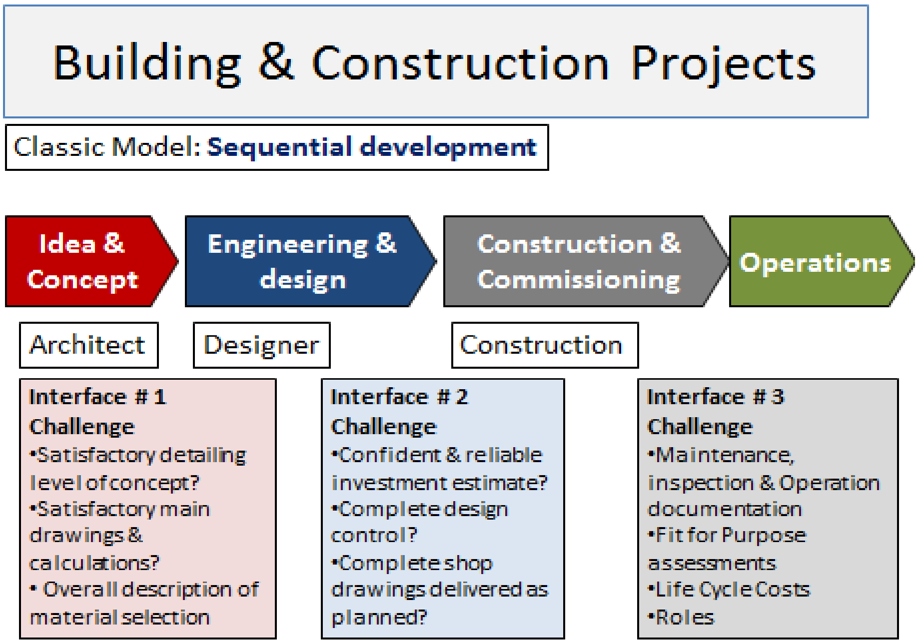
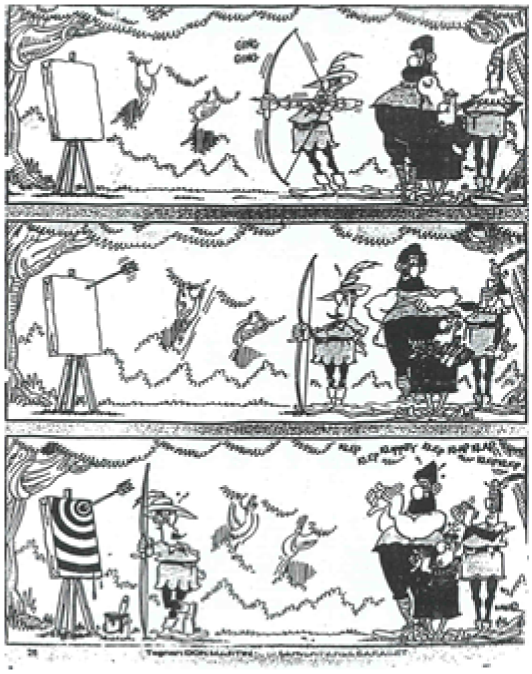


Figure 2-11 Sequence of phases in building & construction projects highlighting the interface challenges in between the main phases and parties involved

A technical peer review and technical verification is recommended during the execution and construction phases of a project in order to assure that that actual product delivery quality satisfies the specification requirements. Identified deviations and non-conformance must be handled professionally through the use of a systematic deviation control and process. The cartoon in figure 2 – 12 is not a desirable attitude.

If a non conformance or deviation relative to specified is observed, the response and judgement should raise the question whether you still could live with the “as- produced” quality or not. Such considerations should be differentiated depending on the consequences of the actual deviation. Is the system functionality and capacity maintained? These aspects are further elaborated in section 3.2 Fit for Purpose assessments and considerations.

A morning in the Sherwood Forest



Figur 2-12; a rather special judgement of quality of achieved result in the Sherwood Wilderness Park

Chapter 3

Deviations, Changes, Technical Evaluation and Verifications

3.1. Managing deviations and non conformance

This chapter deals with the process of managing deviations and non conformance that may happen during the development of the product delivery from the project.

There is a desire to establish systematic routines and processes for handling deviations and non-conformance in order to resolve them in a consistent manner in the projects under execution in an organization.

The process should include the following steps:

1. Establish the evaluation criteria to be applied in the project. On what ground do you judge the deviation and non-conformance? The established specification requirements are providing the key features and performance to be reached for the final project deliverable and are the reference parameters for the assessments. In that context there hould be derived a specific template for the devation handling including a differentiation on the type of deviation of concern. These evaluation criteria should be established prior to the actual execution of the project. The rationale for that is that you may be more objective and logic prior to the start-up whereas you may be affected by an actual deviation when that appears.
2. Formal registration of a deviation. Make sure that an identified deviation is registered and logged with unduly delay. That document is an essential tool for keeping track on the identified deviations, who is in charge of actions and due date when actions/mitigations shall be in place.
3. Firm documentation of the deviation. You should make a facts based documentation of the deviation, including recordings, measurements and even pictures when relevant. The description should explicitly specify what kind of deviation it is, the extent and initially indicate the potential consequences of it on the product quality and project performance.
4. Classify the deviation, what kind of technical deviation it is related to the features and quality of the output from the projects and rank the relative potential detrimental impact

5. Identify who is affected by the deviation, what is affected, and which part of the project delivery is influenced.
6. Assess and evaluate the identified deviation versus the evaluation criterias & specification requirements.
7. Classify the type of deviation and rank the relative impact on the product development and output product quality.
8. Assess whether the deviation and non conformance must be corrected immediately, or if it can be resolved and adjusted within a specified period ahead of normal production.
9. Identify actions if necessary.
10. Derive firm and realistic actions to the necessary detailing level.
11. Make an implementation plan for the identified and approved actions with firm due dates and responsible person for implementation.
12. Implement as planned and perform a post control to confirm that the implementation has happened.

Figure 3-1 shows schematically how a deviation may be managed professionally internally and, in the dialogue, and collaboration between client & contractor. The example represents a typical construction project, but the main principles are valid regardless of type of industry and project.

The formalised process for deviation handling may be perceived as an unnecessary administrative burden. However, a well functioning deviation process is by itself considered as preventive and contributes to the commitment of delivering the product quality as specified without deviations and non conformance. It also provides you with a systematic and consistent way of collecting, assessing and executing deviations with full traceability of facts and corresponding actions implemented.

A golden rule is that deviations and non conformance should normally be resolved by those closest to the issue of concern and best qualified to derive proper actions fast and with the desired predictability and reliability. These perspectives fit into the desire for making a resilient project organization, as the one who has the shoe on knows best where it hurts and should be best qualified for derivation of the optimum solution to regain the specified product quality.

For identified major quality deviations and non conformances it might be recommended to engage 3rd party either as an independent individual or typically certification or verification bodies like DNV GL or Lloyds register. In a smaller scale you may also just formalize an independent advisory board or group outside and independent of the the project having access to expert knowledge relevant for judgement & verification of the output delivery for the project in question.

If the project execution has reached a state that you are beyond the point of no return, one may initiate a Fit for Purpose evaluation as described in more detail in section 3.2. The intention of a Fit for Purpose evaluation is to check whether you still could demonstrate satisfactory integrity, safety and capability although a deviation and non conformance were identified and recorded.

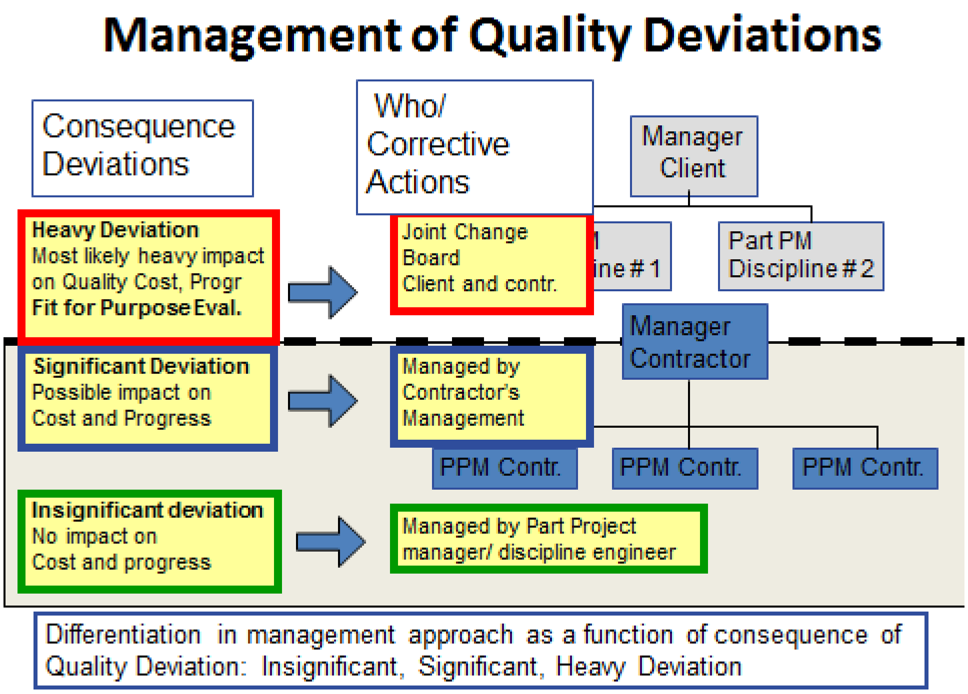


Figure 3-1 Differentiating on deviations and non conformance and involvement of the respective parties for a typical construction project.

3.2 Fit for Purpose assessments of deviations.

During project execution, situations and conditions may lead to deviations in the desired output product quality relative the specification requirements. Functional and technical specification requirements are most frequently provided in international and national standards protocols and governmental regulations. In some cases the clients may derive mandatory company specific requirements in addition to the well established international and national standards. Typically, the national armed forces may request more stringent specification requirement with respect to preciseness level and reliability level of equipment and product for for in their service on land on sea and in the air.

What do you do if a deviation and nonconformance are identified?

The response is situation dependent and key issues are:

- At what point in time during the project execution is the deviation identified?
- How significant is the deviation relative the specification requirements and design conditions?
- Is it possible to resolve and regain the performance to satisfy the as specified features and capacities?
- What are the consequences on cost and schedule of the actions necessary to regain to as specified product quality?
- Should a Fit for Purpose evaluation be done for the deviation issue of concern?

If a deviation or a non conformance is identified sufficiently early, one might have the chance to execute appropriate actions or make a restart of the project.

The conditions are totally different if the deviation and non conformance are discovered late during the execution phase. Many activities are finished, and there are constraints regarding type of actions that is possible to realise in a partly completed project. Under such environments the socalled Fit for Purpose evaluations are highly relevant with primary focus on the product quality, but even including the impact on accumulated costs and schedule.

A Fit for Purpose assessment is essentially focusing on whether you still may utilize the total output delivery (system level) from the project to the satisfaction of integrity, safety, operability and reliability of the system output, although single components or parts may show deviations or non conformance from specified values.

The Fit for Purpose assessments should address and cover the following possible states:

- Is the final product delivery «Fit for its Purpose» on system level although there is recorded deviation or nonconformance on component level?
- Is the final product delivery «Fit for its Purpose» after making necessary corrective actions to the area/part having non conformance?
- Is the final product delivery «Fit for its Purpose» after making restrictions to the operations and use of the product or unit?

A range of technical standards and guidelines accept Fit for Purpose assessments prior to a major decision for the project considering drastic actions to resolve the issues appeared. The ultimate decision is to scrap what is produced so far or request a restart of the project process.

Most technical standards are based on classic design methodologies with respect to technical functionality, safety and reliability. They are devloped on basis of component reliability, component safety and component functionality, and most frequently some degree of conservatism and extra buffer is embedded in the design requirements more than the required safety and reliability level.

The use of the "Fit for its Purpose" approach accepts advanced methods of estimating the reliability and safety. It opens for utilizing non-linear methodologies that are simulaating the capacity to a higher preciseness level and accuracy than classic linear approaches. That approach is particularly relevant for structural and mechanical engineering design of buidlings, bridges, vessels, and offshore platforms & rigs. Alternatively, a system approach may demonstrate satisfacory integrity, safety, and reliability of the entire system although some single components are recorded as sub standard. Consistent system reliability analyses may document a satisfactory level of safety and reliability even with some part or components with as-produced substandard characteristics. This reflects the redundancy in the system and indirectly supports the desire for resilience in the solution of the final delivery from the project. These "Fit for Purpose" considerations may be done by use of the well-known reliability theory on system level and component level respectively.

During the project execution phase there are supplementary issues that may influnce the decisions to be made, primarily the potential cost as well as the schedule impact. These issues are typical during construction, commissioning and assembly on larger structures like buidlings, marine vessels, oil platforms and oil & gas drilling rigs.

From a project management point of view it is considered equally important whether the time for performing the “Fit for Purpose“- evaluation is longer than acceptable for the entire project. The cost consequence of a potential schedule slip may lead to that the alternative is immediate replacement of the non-conformance parts rather than wait until the Fit for Purose cconsideration may say yes or not. Replacement or immediate repair might be the right decision instead of waiting for the results of the Fit for Purpose evaluations.

A classic and well-known example is during construction of a welded steel structure. If the weld inspection and monitoring during fabrication discover and identify weld defects more than the acceptable sizes, the question is:

- Can you live with those embedded defects in the welds or is repair necessary?

If the assessments take for example more than 3 days, the likely decision is to do repair welding immediately instead, as the issue may hinder progress on other parts of the structure.

Remark: The designers should never speculate in achieving approval of the design solutions through utilizing the advanced Firt for Purpose analyses that may be introduced to document satisfactory safety and reliability level by use of non-linear methodology and/or systems thinking. Robustness in design should be rule No. 1 in order to meet unpredictable challenges that may appear during the execution stages of a project.

The system analyses consideration may result in satisfactory safety and reliability level of the product on system level. Still it might lead to the derivation of some restrictions in use in terms of the request for intensified periodic monitoring and inspection.

Fit for Purpose assessments should preferably be done by 3rd party organisations in order to strive for maximum degree of objectivity and not being one of the parties involved.

During operations of a vessel or platform, damage and incidents may happen that affect the continued use of the unit. In extreme cases it may lead to close down of the operations, more likely it may lead to some restrictions on the operations. This might be typical for an offshore oil installation with physical damages on a vital part of the structure. Can you live with it until repair or do you put restrictions on use? It may readily result in request for close down of the operations when the expected wave size exceeds some limit as the platform is exposed to the environmental forces from the waves, the larger the waves, the larger are the wave force load effect on the platform. A typical example could be to state that with a weather forecast with waves above 10 meters, the damage on the platform is considered so significant that close down is the appropriate action under such wheather conditions. The intial design is made for withstanding the 100 year wave, figures typically 25 meters or above.in the North Sea. The derived restrictions are made to maintain the requested safety level, but nevertheless has negative impact on the operational performance and production rates are reduced accordingly, hurting the project economics.

3.3 Managing Change in projects

Most projects experience changes of different type and nature. This section focuses on key issues related to managing changes from a client point of view as well as from a contractor point of view.

The desire for change may result from one or more of the following topics:

- Change in scope and output delivery, initiated by the client/customer.
- New governmental rules and regulations affecting the project execution.
- Changes in regulatory requirements on HSE, Health Safety and Environment
- Politcal decisions affecting the schedule and progress or eveen stop approved project initiatives.
- Change in Scope of Work; volume, quality & timeline.
- Change in functional specifications
- Identified tasks that were not initially included in the original scope of work; the contractor should notify the client on identified tasks necessary for completion of the project.
- Delay on company supplied items, and assessment of the impact on the execution strategy.
- Changes in project financing format and model. The BOOT – model may be an alternative to traditional financing of public infrastucture projects (BOOT; Build Own Operate Transfer)
- New technology request changes
- Changes in work flow and methodology by the contractors and suppliers
- Changed contract standard and compensation format.

The above list of changes may impact the timeline and the total resource demand, ie change in schedule and budget may result.

Managing change from a client perspective

If a need for change is identified by the client, the client normally has the right to instruct the contractor/supplier according to a majority of contract standards within different industries. The request for change should be formalized and registered. The client may then make a Variation Order that is formally sent to the contractor who must respond and act according to the contract standard used on the project, see section 5. The client, who makes the Variation Order, should preferably perfom their own independent consequence assessment of the requested Variation Order prior to receiving a reply from the contractor.

The contractor's response to a requested change must be analysed thoroughly in a consistent manner. The eventual changes should be differentiated according to the relative impact in terms of consequence and extent on the project quality and execution performance. Key questions in that context are:

- Could the proposal for change have any detrimental effect on other parts of the project delivery, and is there a risk for sub optimization?
- Could the change proposal have impact on the total progress in the project?
- Could the proposal have impact on the accumulated resource demand?

The three questions above should be raised prior to any decision regarding change proposals.

A separate organisational unit or advisory board could be established for evaluations of change proposals more objectively as a 3rd party, or on a joint arena between client and contractor wirth representatives from both parties in the advisory group.

There are different practices across industries. For IS/IT systems and ERP like business performance system projects the change processes are the core of the actual project execution. (ERP: Enterprise Resource Planning) Under such conditions, the project management is essentially an ongoing change board and the agile project management methodologies are more appropriate approaches for managing and executing the projects than classic project control, see section xxx.

In major construction projects, on land or offshore oil & gas, the change processes are frequeently formalised as a separate organisational unit on the respective organisation charts for the projects. The change processes may readily follow a sketch as shown in the illustration below. Initially one should establish on what ground should the change proposal be judged; ie establish the evaluation criteria which should be generated and mutually agreed upon prior to any assessment of flagged change proposals.

Why should the derivation of evaluation criteria be the first activity connected to the development and implementattion of the change process?

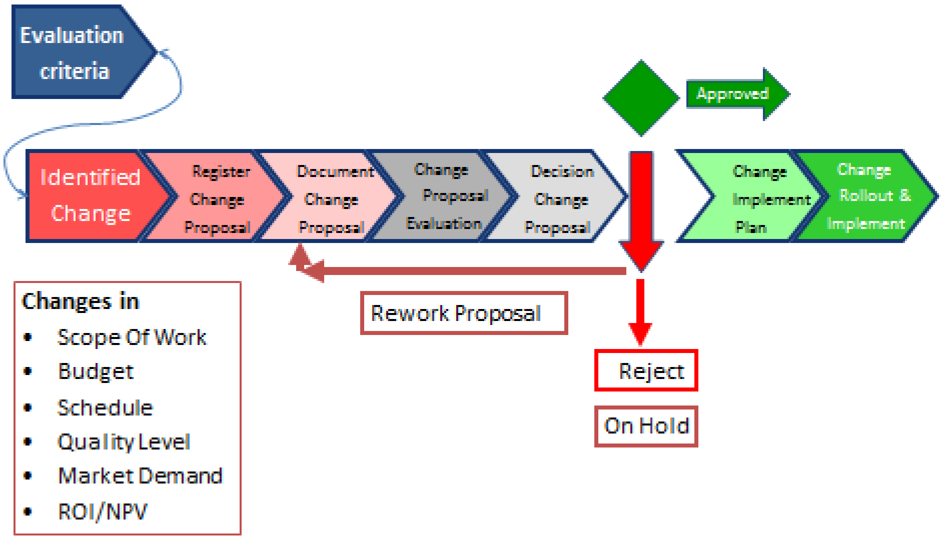
If the evaluation criteria are generated up front without leaning towards one specific solution, the actual criteria may have a chance to become objective and no specific idea may be pre prioritized. The sketched change process is linear with sequential activities in which the change proposal is registered, formal documentation is provided, followed by an assessment i light of the evaluation criterias established for the project. Then there is a formal judgement and decision whether the change proposal shall be approved and and implemented or not.

If the change proposal is approved, the developed implementation plan is put into action and the change become real.   Contrary, if the change is not approved for implementation, different outcomes may result. One may request that the proposal is stopped, alternatively revised & improved, or put on hold.

Change proposals having impact on delivery time and total cost of execution are among the different types as listed below:

- Volume changes
- Lacking key descriptions and facts in the specification requirements
- Improved proposals
- Unrealistic plans of execution
- Lacking supplies for subcontractors
- Delays internally or at sub contractors
- Other non planned issues

The overall evaluations must cover the quality and reliability of the solutions/delivery as well as considerations on the impact on cost and scehedule whether it influences the right for compensation to the contractors.



Figur 3-2 Sketch of a change process in projects with a formilised change request regime.

The proposed change process is generic and applicable for any idea or proposal for change. However, a differentiated approach should be taken on the consideration of the relative impact and correspondingly who should be involved.

One may differentiate change proposals according to the following categories and involvement by client:

- Type 1: Insignificant impact on product quality & solution, cost and schedule; the client responsible person for the area influenced should be noticed by contractor/supplier
- Type 2: Moderate impact on product quality & solution, cost and schedule; client project management should receive formalized actions and plans for resolution from the contractor and registered in the change log
- Type 3: Significant impact on product quality & solution, cost and schedule; preferrably be handled by an established change board with representatives from both client and contractor.

Due to the potential consequences of a change proposal any identified and flagged change should be treated and administered rather formally and a change log should be established as an integral part of the change management. The change log should then provide you with

latest updates and status on any change idea proposed and registered. Change proposals not registered in the change log should not be paid attention and not spend resources on them.
A proposed change log may include the following elements as shown in the table below:

Log #	Brief Description	Source	Date Regist.	Impact	Approved by	Approved **Yes/No**	Date approved	Comments
1								
2								
…								
n								

If a change is minor in nature, as type 1 change defined, and can be approved by the project manager, this may be noted directly in the change log. (Buttrick, Part 4) If approval is required by higher authority, it is recommended that a change request form is used, as for type 2 and 3.
A change request form is used for:

- Document requested changes
- Summarize the impact of change
- Formally record the decisions regaring the change.

An example of a change request form is shown in the table below.

Change Request Form
Project Number:
Project Title:
Change Number:
Part I Proposed change
Brief description of change requested: Reason: Approval required by:
Part II Decision
A. Change is accepted B. Change is accepted subject to the comments noted C. The change proposal is rejected
Action required/Comments:

Change management in projects in a contractor/supplier perspective

Most projects experience changes of different character during the project planning and exeution. The basic reference is the established Scope of Work (SOW) at time of decision for launching the project, see section 2.1. The Scope of Work may be designed differently with alternative approaches such as:

A. A detailed and complete Scope of Work is derived prior to the point of decision and approval of the project including thorough detailed specification requirements.
B. An overall functional description characterizing the most important functional features to be fullfilled and which corresponding business benefit should result when utilizing the product/service provided by the project.

The client normally develops the Scope of Work, and is responsible for the content and approach in the Scope of Work, whereas the contractor must respond to the approach applied. The way of managing and executing the project will thus vary significantly between the two alternative approaches, for the client as well as for the contractor. Important in that context is to have steady focus on the respective roles and mutual understanding and perception of the importance of achieving a professional and solution oriented collaboration between the parties.

The two alternative approaches have major impact on managing changes in the projects, and how the contractor/supplier shall perform the work.

Category A is the more classic approach and most frequent for large and complex construction projects in land-based building & construction industry as well as within maritime industry and onshore/offshore oil & gas.

With a detailed scope of work any possible change should be assessed and evaluated in light of the impact on the product quality for the total project, not limited to the local area of change, but may have negative imact on other areas of the project. A detailed scope of work requests a firm regime for change control, in which any change proposal must be assessed thoroughly.

Both the client and the contractor may flag a change request. In contractual terms, the client may ship a Variation Order (VO) to the contractor, who is contractually obliged to perform the Variation Order within the framework of the current contract. If the contractor flags a change request, the contractor must according to the contract standards on classic contracts formally send a Variation Order Request (VOR) to the client. The client must evaluate the VOR and give a formal response in due time for effective performance execution. If an approval of the VOR is achieved, the client sends an official VO on the initially requested change from the contractor.

Action must be taken by the contractor when a Variation Order is received from the client, although the consequences are not yet assessed fully. The contractor must respond whether it has schedule consequences or not, and within undue delay provide to the client an estimate of the cost consequences.

A critical issue for the contractor is to derive a sound and confident estimate of the accumulated effect of the change proposal. For significant changes, the question must be raised whether there is a need for a shift in the methodology for executing the project, and does it request an alternative sequence of activities during execution? If that is the case, the contractor should predict the accumulative impact of the change proposal on the total project, not only derive an estimate of additional manhours requested for the enhanced scope of work.

Category B is predominantly connected to IS/IT system projects as well as business development projects. A critical characteristic of such projects are continual changes during the life cycle of the project; change is steady state. Under such conditions the primary objectives are to describe the desired effect and impact of the use of the project delivery rather than specifying in detail the potential solution. How to achieve those features are not the primary focus for the client, whereas the contractor/supplier must utilize their competence and expertise for providing an optimal solution satisfying the overall functional specification requirements. That approach will encourage a development route characterized by dynamics and continual changes during the project execution. These perspectives are essential and critical for projects in which the technology development is impacting the solution rapidly during the project life cycle and you have no chance for derivation of a detailed technical specification requirement with validity and due date beyond the project period.

Managing changes under the regime with a functional requirement and moving targets is fundamentally different. Initially the Scope of Work and associated description of the objectives and goal may beome rather diffuse and will evolve during the execution. High quality functional descriptions & specifications are hard to derive to the desired peeciseness level that is truly functional and at the same time committing for the potential contractors. The clients' technical champions should take charge of such a development as it requests long-term high-level expert knowledge put into a totality for the project.

For such a dynamic state, the contractors & suppliers will experience the project execution as a change journey characterized by frequent changes and adjustments of the solution. It results in a series of iterations and the actual project execution approach may be done accordng to the well-established spiral model for software development and by use of scrum methodologies in an agile environment with high performance & efficiency. A critical success factor for utilizing the agile and scrum approaches is that the corresponding contract compensation formats firmly create incentives driven win-win condition for both parties. See section 6.6. Focus wil then be on the output features, objectives and the desired effects for using the project deliverables, not on tedious control of schedule and resource expenditure.

If the scrum approach is not utilised, the supplier will generate a continuous flow of variation order requests on the concept, the solution and progress, what is frequently experienced to be bureaucratic hurdles.

A key to success for such projects are to secure a common perception and understanding of the project objectives and the desired effect goals between client and contractor/supplier, which is depending on a fully integrated process between the parties involved.

In fact, at time of decision for launch of the project the actual system & technical solutions may not be known, however, the desired effects and business benefit should be satisfactory described, and the corresponding overall functional specification documented and established to the detail providing committing conditions, direction and purpose for the suppliers.

Through the functional approach there is an acceptance for utilisation of the supplier industry experience & competences to a larger extent than following the classic way of contracting by use of detail specifications. Furthermore, the functional approach is founded on the basic principles that the suppliers normally know best how to achieve the specified quality with confident predictability and efficiency. Consequently, the contractors/suppliers may then plan and execute the project tasks on their own conditions and preferred ways of working, including their own management systems and governing documentation.

The clients should rely on the suppliers and the clients should show respect to the suppliers'competencies, ways of developing and manufacture the products and services. That approach may be confirmed by checking the performance through 2nd party audits during the project planning and execution.

There is a general trend that the functional approach becomes more attractive even on traditional construction projects as the clients do not have the detailed knowledge for specification of the project delivery in question. The clients should focus on the desired project objectives and effect goals and let the expert suppliers and contractors develop the solutions that will meet the specified objectives and effects/benefits in use of the project deliverables.

3.4 Technical evaluation and verification in projects

Technical evaluation and verification are key elements in the external quaity assurance in projects, either as the clients' 2nd party assessment or as 3rd party independent evaluation.

The overall purpose of external quality assurance is to contribute to project success, not solely as an investigation to detect non conformance and identify whom to blame. The quality assurance should be considered as a support to the project during the project execution, and not used as a post control of the final delivery.

The single projects must have their own quality and management system in place in order to achieve high performance and high quality, the system must be project specific and at the same time comply with the overall company management and quality systems.

Although there is established a project specific management system, there is a need for an independent evaluation of the tasks in the project in question. The internal management and quality system with the associated quality & performance controls are focusing on the execution processes and how to achieve the specified product quality, whereas the external quality assurance & reviews shall focus on raising the right questions regarding confirmation of the product quality from the user point of view.

An external independent assessment during the course of the project execution may have varying approach, format and detailing level. An experienced assessor may readily discover whether the project results comply with the specified quality requirements or not when performing a classic review of project produced documents to date. However, a crucial point is that the experienced assessor or auditer is able to identify issues not covered by the reviewed document.

The issues not covered by the reviewed project documents may sometimes become the most important issues, and particular attention should be paid to what is not covered and not documented. The identification of non-documented issues requests relevant competence and long-term experience among the auditors. It is highly recommended that the auditors have a holistic totality view and attitude, not mentally limited to the technical discipline she or he is an expert. They should be able to make priorities and identify the relative importance of the different findings during that process.

Projects are particularly demanding compared to regular production, as the output is by definition unique and a one-off delivery from the single project.

A technical post evaluation at handover to operations or users may confirm the condition and product quality as delivered. That is a part of the final delivery package from the project and has value for the customer; however, it has limited value for the performing project organisation during the actual planning, execution and commissioning phases of the project.

The results of the post evaluation are providing you with the lessons learned from the project in question, which has significant value for the organization as such in its effort to obtain continual improvement and establishing a learning organization.

If the final evaluation identifies significant non-conformancies, which should not happen, immediate actions are requested prior to hand over to client/customer. Normally commissioning, a factory acceptance test, FAT, or a site acceptance test, SAT, should cater for avoiding such a situation. If it is still the case, the impact is most likely further delays and escalating the total cost of the project. In some projects, it may be very difficult to resolve when the as completed product is assembled and handed over to the user/customer. Thus there is a need for performing independent project evaluations during the planning and execution phases in order to benefit and recover from the identified non- conformancies; it could be done as reviews or independent analyses of managerial as well as technical tasks.which is illustrated in figure 3.3. With that approach, the project may benefit from the independent evaluations on three important perspectives:

- Scientific and technical quality of what is produced to date in the project, including lessons learned on the product development and solution(peer reviews or independent analyses)
- Efficiency in the project processes and organisation
- Provide an independent evaluation document as input to the decision support package at the respective decision gates in a stage gate-based project execution model, see section 6.3.

With these dimensions and elements on operation during the life cycle of the project, the out put results of the evaluations will contribute towards achieving a real learning organisation; the project may utilise the evaluation results in the respective project phases and achieve the specified product quality more efficiently in an agile and solution-oriented manner.

In summary, independent evaluations and verifications should preferably be done during all phases of a project, and key elements are summarized in the table below.

Project Phase	Independent reviews	Independent analyses
Idea & Feasibility phase	• What are the prioritised focus areas • Market assessment of the product idea • Strategic consideration in context with other tasks in the organisation	• Introductory technical screening and feasibility analyses • Derive the impact of the technical solution on the project economic potential
Conceptual phase	• Is the concept technically realistic? • Are the Life Cycles perspectives accounted for? • Does the product fit into the portfolio? • Has the executing party delivery capability and capacity?	• Independent project & technical verifications by screening and scantling models catering for the functional specifications. • Risk and Opportunity analyses
Design phase	• Design-strategies and project strategies on technology & uncertainty • Degree of component standardization • Contract strategy • Interface check and cross functional evaluation	• Detailed technical verification analyses on design basis characteristics. • Risk & opportunity analyses • Technical consequence assessments • Technical integrity verification
Construction phase	• Assessment of interface register & control • Evaluate the production and rollout plan. • Evaluate the HSE plan and control. • Assessment of document quality • Assessment of cross functional control during execution	• Technical analysis of the total delivery, weight analysis etc. • Fit for purpose analyses when non-conformance on product quality- • Indepen.ent analyses of productivity • Risk & opportunity analyses
Commissioning	• Experience feed back to the respective disciplines involved	• Technical analysis of As Built • Risk - & opportunity analysis
Guarantee period	• Review of whether the delivered product or service is functioning as intended & satisfy the functional specification requirements?	• Technical analyss of eventual changes of the delivered product/service; Example: Weight increase on the deck of an oil platform when additional equipment is to be installed

Table 3-1 is showing examples of relevant tasks for evaluation on an overall level. A more detailed level is discussed for a range of projects and industries in section 9.

The extent of the reviews and analyses must be customized to the appropriate level on the respective project. Small mono scientific projects request a very limited extent of verification activities compared to larger cross functional investment projects for new ERP systems or construction projects for infrastructure or oil & gas industry.

A 2nd party evaluation may be performed by the client on the project under execution by a contractor/supplier.

However, it might be preferable to engage independent professional organisations for doing a 3rd party evaluation, reviews as well as independent analyses. Such services should be made by professional independent organisations with tailor made independent services of different kind. Some perform independent project analyses of cost & schedule estimation of a project. Some provides you with independent risk analyses and project economic analyses. On technical services, the internationally recognized classification societies like for example DNV GL, Det Norske Veritas Germanische Lloyd, ABS, American Bureau of Shipping, Buerau Veritas etc. These may provide you with Certificate of Fitness and Classification Certificates for different categories. They may also perform the so called Fit for Purpose evaluations of identified non conformance of the product under development.

Figure 3-3.shows a schematic illustration of doing independent evaluation in parallel with the actual primary project execution processes. With that approach you may utilize the findings alongside the project and continual improvement may be achieved during execution of the project. In principle this is valid for any type of project regardless of industry or within the public service sector.

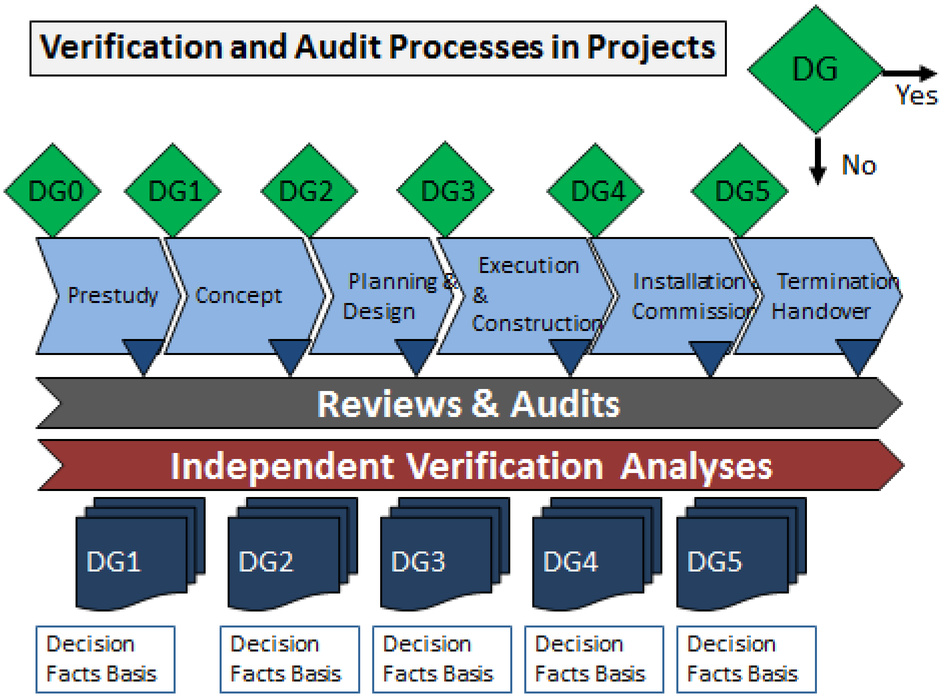


Figure 3-3 Illustration of evaluation thorugh independent review and or independent analyses during the project execution, including quality performance facts provided to the decision support packages at the respective decision gates

Chapter 4

Delivery Quality, Execution Quality and System Perspectives

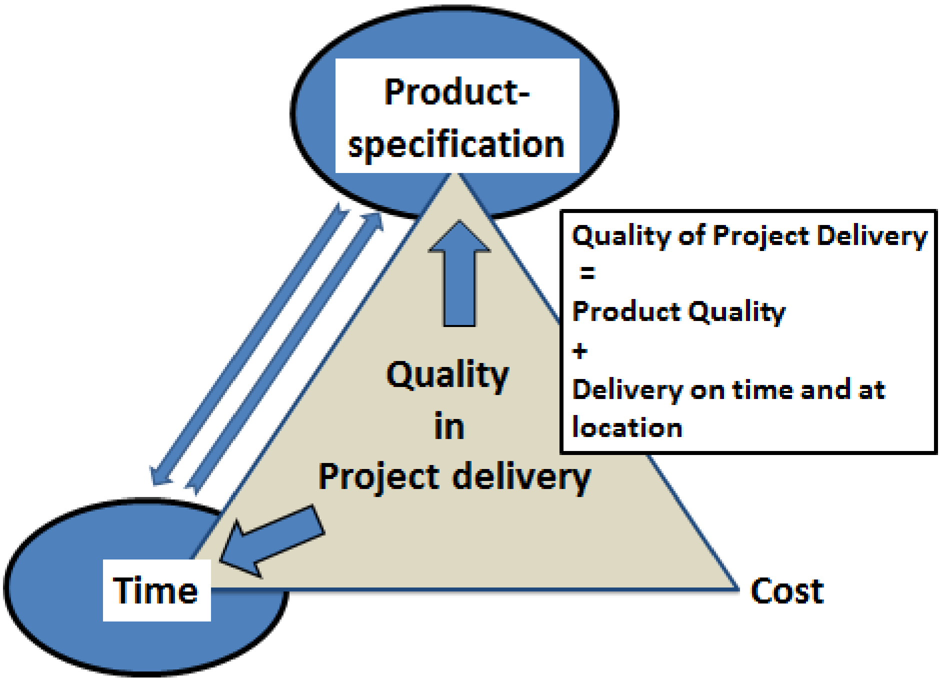
4.1 Delivery quality in projects

The delivery quality should cover the ability to deliver on time, at right location and ready for use in addition to the quality of the product/service according to the specification requirements. These perspectives are schematically illustrated in figure 4 – 1. It does not help to produce the right product quality if the delivery is severely delayed and delivered at a wrong location.

The desired delivery quality is depending on achieving a product quality as specified and described in the specification requirements and scope of work; however, timing and location may also impact the product quality. Political constraints at various locations may affect the achievement of the specified product quality. A similar detrimental effect might be present due to the varying access to qualified resources at the different sites relevant for project execution. Furthermore, significant delays may influence also the product quality as key resources initially made available for the project are booked for a specified time slot. Delays may result in lacking qualified resources.

In addition changes and non conformance may influence the final product quality. A rather moderate change may have significant impact on the conditions for delivery of the project. A change in functionality may request a supply of a critical component from other sources than initially planned for the original specification of the product. Such situations may also be present for potential deviations in quality, non-conformance according to the product quality specifications. Under a regime of change or non-conformance, that condition should be explicitly evaluated in a fit for purpose assessment. Key questions are whether it may impact time of delivery and installation, as well as assesssing the eventual need for change in methodology for execution, if it has impact on the sequence of activities during execution.

Figure 4 – 1 provides you with a visual illustration of the interaction and focus on the product quality and delivery conditions.



Figur 4-1 A sketch of what delivery quality encompass; Product quality plus the desired precision level connected to delivery on time, at right location and coordinated with other tasks

4.2 Execution Quality in projects and impact of lean thinking

Project quality is characterised by and defined by achieving the specified quality level and reliability level on any of the activities and processes during the project life cycle- from innovation and idea generation through to completion and handover to the user/customer.

The established project organization must demonstrate performance excellence and satisfactory quality in any activity and process in the project; in the primary product processes as well as in the project management proceses and the support processes.

In projects where a supplier organisation is involved as performers in the project execution, the selected contractor/supplier must document that the work to be done will satisfy the requirements to performance and product quality.

There is a steady pressure to improve the project efficiency and productivity combined with the request for ever shorter project execution time.

The project governance principles have resulted in an intensified focus on enhanced efficiency and productivity in order to optimize the return on investment for the project in question.

The consequences are ever more requirements to delivery precision and efficiency in the entire project work; In essence it becomes more important than ever to do the right activities right first time and in the right sequence, not just doing it right. That approach fully complies with the latest development in lean manufacturing through minimizing the degree of waist of any kind, whether it is time consumption, resource utilization, energy efficiency, supply chain logistics etc.

Lean manufacturing is a formalised methodology and principles that manifest the importance of these topics on doing the right things not just doing it right. The Lean principles are founded on the philosophy to avoid waist of any kind as noted above, also covering access to key expert resources. The latter may in many cases be the most critical factor in prioritized projects. Lean thinking is as important on organisational issues and on competence development of key resources as it is on product development. Strategic competence development and resource portfolio management are key elements under a desired condition of continual development. This is valid for critical technology resources procurement and supply chain management. Lean supply chain management covers the effort of achieving supply chain optimization; considering “Just in Time” performance, balanced risk, control and management.

A key to success according to Lean principles is to minimize the risk of rework in the project work. Many project organisations have bitterly experienced that they do not have time for proper planning but are forced to do extensive rework to achieve the specified product quality. With the right approach on planning, one may minimize the risk of doing rework. In that context, one may consider launching and execute a pre project or doing a so-called FEED-study prior to launching and sanctioning the project. (FEED: Front End Engineering & Design). The confidence of the concept and the solution will increase significantly when there is an expectation that the demand for rework is reduced accordingly during execution of the main project.

Who are qualified to perform and lead a FEED-study? The FEED-study shall typically cover the total conceptual idea, which frequently is multi-discipline. A systems approach is requested in which the totality should overrule on alternatives. It means that key reseources on

FEED studies must demonstrate the capability of thinking systems and total solutions, not prioritizing their own area of interest.

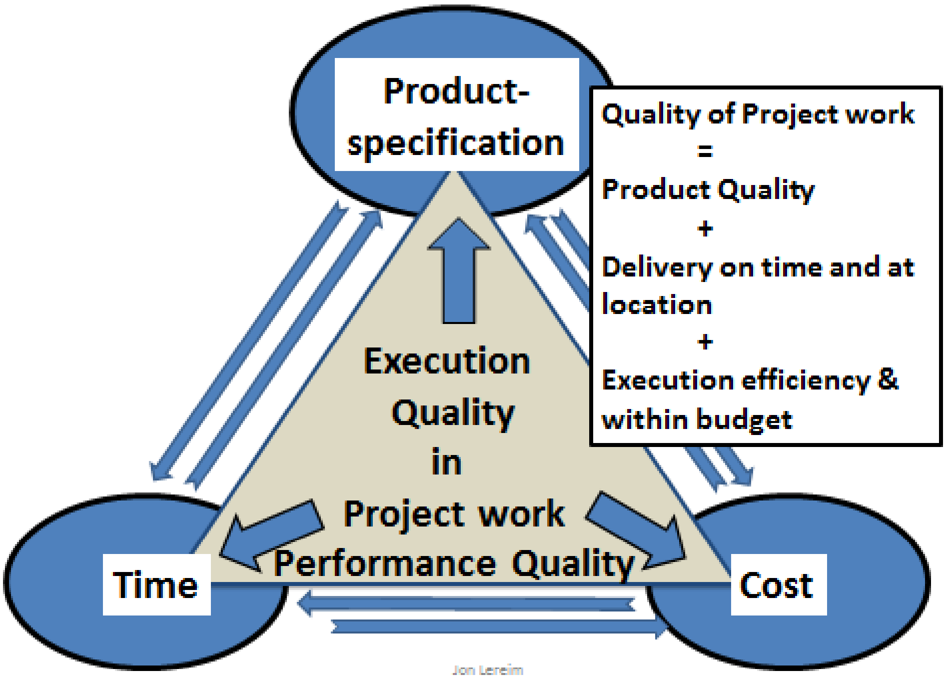


Figure 4-2 Sketch of execution quality in projecs (Project quality)

PMBOK, (Project management Body of Knowledge) covers the perspectives on execution quality in project work with a primary focus on the project internal processes.

The PMBOK standard includes nine knowledge areas that are consistently formatted and documented as processes. The nine knowledge areas are:

- Project Integration Management
- Project Scope Management
- Project Time Management
- Project Cost Management
- Project Quality Management
- Project Human Resource Management
- Project Communication Management
- Project Risk Management
- Project Procurement Management

PMBOK has a standardised way of mapping the project processes within all knowledge areas, which contributes to a more consistent methodology of approaching the project execution. The standard process format for the project processes are shown in figure 4.3. The process design and format according to PMBOK contains the following three parts:

- **Input:** Input shall cover all necessary information and facts for the process in question including baseline plans as well as recorded performance figures
- **Transformation:** The transformation of the input facts is dealing with assessment and evaluations of the actual conditions versus the planned, including consequences of the facts on the efficiency and performance as well as prognoses for the final delivery. The tools and techniques included may be considered as enablers for the process improvements and as process control parameters.
- **Output:** Output are recorded facts, derived performance figures, prognoses to the total budget to complete, as well as revised plan for execution.

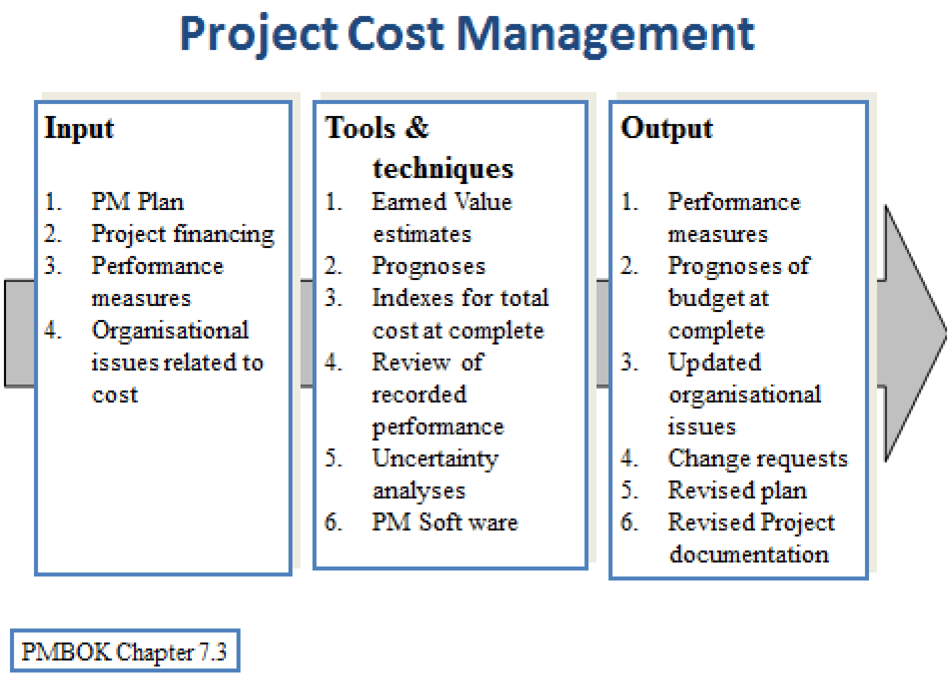


Figure 4-3 Illustration of standardised format according to PMBOK with an example for project cost management

Similar to PMBOK, the execution quality in any activity of project management and execution are well covered in the guidance ISO 21500. ISO 21500 has the same 9 knowledge areas however they are named topic areas.

Furthermore ISO 21500 is explicitly addressing the stakeholders as a separate topic area. That approach is considered very sound as stakeholder management excellence is a critical success factor for high performing project management and execution.

ISO 21500 has grouped the main processes in the following three categories:

- Project management processes
- Product processes
- Support Processes

High quality performance in the three process categories should provide you with an increased confidence of achieving a product quality as specified and with an efficiency level demonstrating project execution excellence. There is a general recognition that the product processes are the core elements of the work execution. Simultaneously project success is highly depending on satisfactory performance of the management processes as well as having well functioning support processes in order to achieve the desired efficiency and flexibility during pallning and execution of a project.

The three categories of project processes are to be executed within the framework of the project organization. Project exeution excellence is depending on establishing a well functioning project organisation with clear roles and stimulating team culture.

ISO 21500 also demonstrates the link and connection between the single project and the enterprise as the organizational issues are encapsulating the project processes and organization. In that context a business case is to be developed for identified organizational needs. Figure 4 -4 shows the ISO 21500 model framework, including the project processes as well as the operating organization, whether the operating organization is internal or external to the project organization.

The project Product process should secure the achievement of the specified product quality, whereas the management processes and the support processes should lead to a satisfactory efficiency, ie satisfactory execution quality in the project work, the project quality.

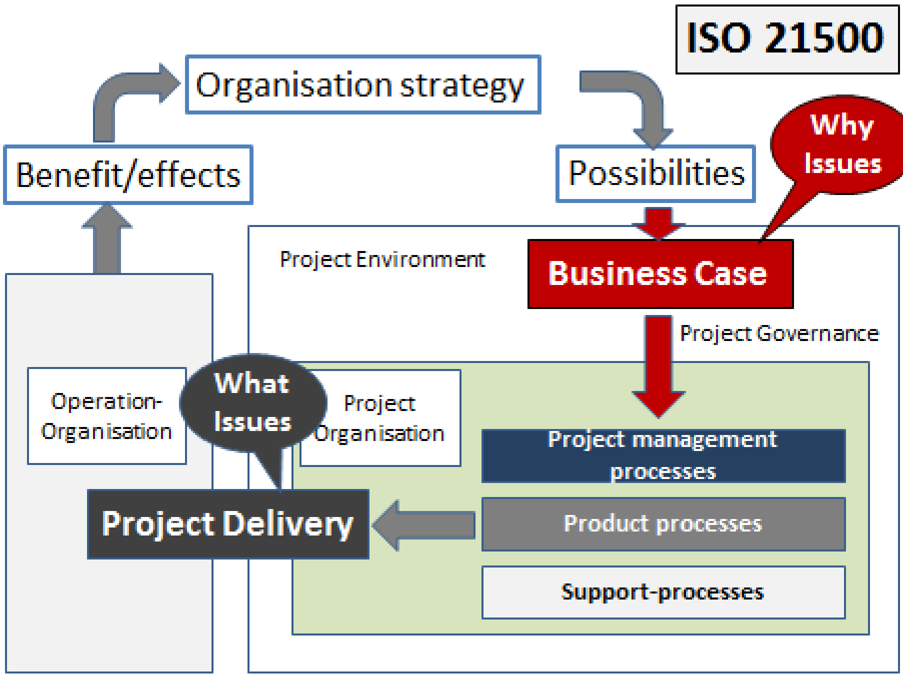


Figure 4 -4 the main model in the ISO 21500

Satisfactory project execution quality has different meaning in various projects and organisations. For some projects it means solely the delivery of the requested product/service in compliance with the specification and as planned timewise. Thus, the execution quality coincides with the delivery quality as outlined in section 4.1. The simplest prediction of progress could be by estimating the % progress to date. It is better than no information on progress, but it may easily become subjective with questions on the confidence level. Is there a tendency to be overoptimistic at reporting?

In other organizations, the perception of satisfactory execution quality also includes achieving the part deliverables at predefined milestones. Firm milestones control could serve the needs for such projects, and a likely methodology would be to apply the goal directed project management approach (Andersen et al). This may be satisfactory for client organisations in which the primary objectives are to get the developed product into service and operation. The same principles may be most appropriate for internal evaluations and internal product development & services. To some extent this might also be the recommended approach for managing and control of procurement activities in projects.

The meaning of execution quality is more extensive if it also should cover the dimensions of efficiency resource controls and budget/cost control. Then there is an issue of identifying the progress of work, and at the same time identify and monitor the accumulated resources spent to date.That gives you the chance to derive the performance on cost and schedule to cut-off date/reporting date, which are figures to be used for predictions and prognoses of total cost at complete and total time at complete according to classic project management & control fully described in many text books on project management, among these Rolstadås (SeeRolstadås) It gives you the possibility to assess the efficiency at any period during the project execution. If the efficiency is estimated below the requested level, proper actions must be initiated by the project management in order to regain to as planned figures. The Eraned Value principles are the basic background here through derivation of the Cost Performance Index and Schedule Performance Index respectively. That methodology is first relevant for any project organisation requesting management & control on efficiency, which is an absolute mandatory issue among contractors/supplier project organisations.

There is a particular issue for that approach on how to achieve confident prediction of the actual work produced to date, the earned value, to derive a confident figure for the Cost Performance Index, CPI. In physical projects as building and construction projects you may measure progress as amount of work done, like measures and recording of number of tons concrete casted last period, number of kilometers of cables installed etc. In non-physical projects the predictions of progress might be harder. A possible approach is to predict the progress as an approximate figure of the progress in terms of a percentage of total work. That figure could then be plotted into the normalized accumulated cost-time curve as shown in figure 4 – 5. The illustration in figure 4 – 5 shows that the actual work performed/produced to date is behind the actual schedule at the cutoff reporting date.

A frequent way of reporting progress on non-physical projects is to predefine % completion at respective milestones. Examples from engineering work are as follows on typical control objects:

Milestone	Brief description	Progress
A1	• Identified/started	15 %
A2	• First Draft	30 %
B1	• Preliminary design/self checked	50 %
B2	• Approved for design/clash checked	70 %
C1	• Frozen for area design/ Issue for shop drawings	90 %
C2	• Issue for Complete Engineering/ IFC	100 %

Table 4.1 Definitions of milestones in engineering design work at an engineering contractor

Similar definitions of milestones may be utilized considering progress on procurement and supplies of equipment.

The actual progress in the work performed may be associated with a budgeted cost of the work performed to date, that is the socalled Budgeted Cost of Work Performed BCWP represented by the corresponding cost figure at the classic accumulated cost-time curve in figure 4 – 5 at the predicted % progress. When the actual costs to date are recorded at the cutoff date, the cost performance index is the ratio of of BCWP over the actual cost to date, ACWP. The derived CPI tells about the actual cost efficiency. If the CPI is below 1.0, the cost performance is below the desired efficiency and proper actions should be taken. It is of primary concern for contractor/supplier project organisations if the number of resources spent exceeds the planned figure and the corresponding efficiency is below the conditions for the signed contract.

An alternative simplistic approach may be applied in the prediction of actual progress of work performed and estimate of the corresponding eraned value. Consider the the project plan is consisting of a series of activities of limited duration and with estimated volume in manhours or direct costs. That is the foundation for the accumulated cost-time curve. For such a case one may utilize the so called binary principle. It means that there are two states for each activity; start and finish. The questions are:

- Has the activity started? Yes/No
- Is the activity finished? Yes/No

The actual budgeted cost of work performed si then just the sum of budgeted figures for the activities completed to date, representing Earned Value to date of reporting. That figure may be compared with the actual cost of work to date, ACWP and the cost performance index, CPI may be derived.

A satisfactory confidence level by the binary method is depending on establishing the activities with rather short durations to monitor progress through just recording the number of activities completed and summarizing the budgeted cost figures. Recommended duration of each activity is maximum 2 weeks or 10 working days. 2 weeks stretch may be perceived as firm and concrete whereas activities of 4 weeks duration or more might be somewhat diffuse.

Is the cost efficiency of concern for the client organisastion as well? Absolutely, in particular if the contractor works on a reimbursable contract and the client carries the whole execution risk; then it is of utmost importance that the client has a firm grip and control of the contractors' efficiency during project execution. Is that statement also valid when contractora work on a lump sum contract? Even under a lump sum regime the clients should carefully watch the efficiency in the supplier organization, as it reflects the capability and capacity of performing the assigned contract. The actual product quality may readily suffer if the contractor is under-performing with respect to efficiency on a lump sum contract.

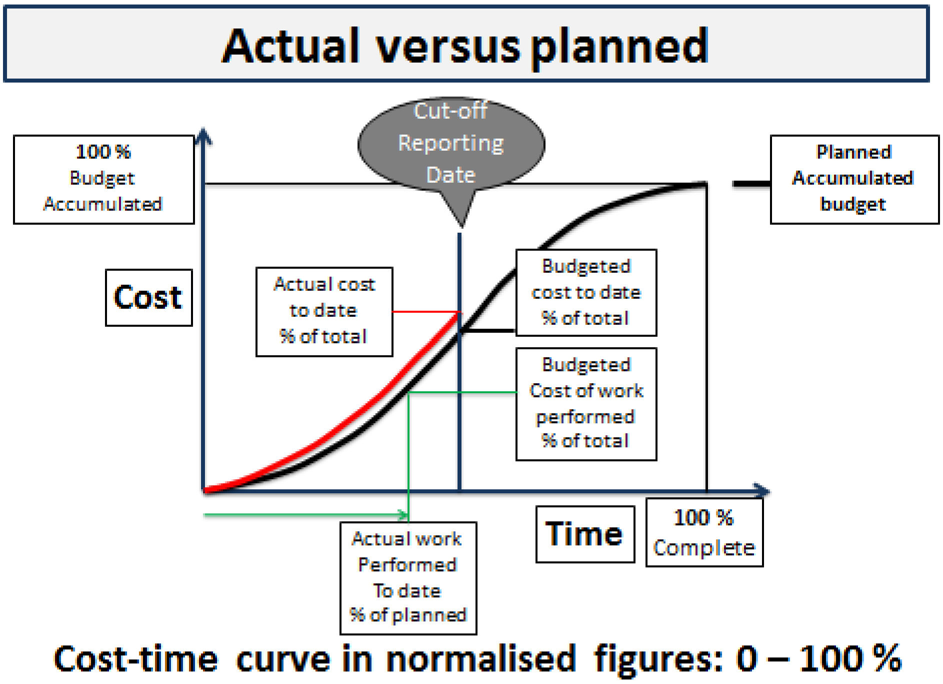


Figure 4 – 5 Sketch of the classic accumulative cost-time curve in project work in a normalized figures format

Satisfactory execution performance may be achieved differently on projects characterized by dynamic conditions and continually changing directions. For such cases, one should rather focus and manage on the desired effects from use of the project through continually assessing the evolvement of features during the execution phase. Normal Earned Value methodology may not be the most appropriate approach; the recommendation is that there should be generated an arena on which the parties involved may obtain real synergies and incentives. That will stimulate to a culture of working towards common goals and you may create real win-win conditions for the parties involved. The assigned contracts must have compensation formats that create the incentives driven win-win conditions. Agile Project Management methodology may be combined with incentives-based contract standards.

In summary, achievement of satisfactory execution performance and quality will vary depending on the type of project of concern. That is briefly summarized in table 4.2 for a range of approaches, different organisations and various project types.

Approach	Organisation /role	Type of Project	Methodology applied
% Progress	Any organisation	Small internal studies	Best estimate & judgement of progress
Milestones Control	Client organisations Engineering Contractor organisations	- Internal evaluations - Internal product development - Procurement project - Engineering design projects with predefined milestones.	Goal directed Project Management, (Andersen et al)
Earned Value	Client organization Contractor organisation	Delivery projects with reimbursable compensation format Delivery projects with lump sum or other compensation formats	Earned Value Principles according to project management & control (Rolstadås, Meredith & Mantel etc.)
Effect Goal & Benefit driven	Client & contractor organisations	Dynamic Product development projects with moving targets Software development ERP-type projects Incentives format for client & contractor	Agile Project Management & Scrum methodology Performance Management control on predicted features, effects and benefits

Table 4.2 Categories of execution approaches for different projects. Recommended execution approaches are shown in chapter 8 for a range of projects.

4.3 Uncertainty estimates on cost and schedule.

At time of approval for launch of a new project, the key estimates of costs and time may likely contain significant uncertainty. The same is valid for estimating the business benefit of the use of the project delivery. Uncertainty is real and must be included in the decision facts basis. Coping with uncertainty is challenging as the perception and understanding of uncertainty may be difficult for many. In particular, the uncertainty estimates should be done consistently from one project to another to make appropriate comparison between various concepts/solutions. Decision makers, individuals, and organisations, frequently tend to demonstrate an over optimisstic approach regarding estimates for project costs and timeline. The consequences are likely cost overruns and significant delays. Of importance is that the timeline is realistic and possible to keep deadlines. Experience from most projects is to include buffers for unexpected evennts and lacking precision level in the Scope of Work documentation.

When the Gantt diagram is established from the sum of activities in the project, a corresponding network analysis is recommended. The network analysis provides you with the exposure and documentation where is the critical path in the project. That is important information for the project management since the activities on critical path should have prioritized attention by the management. Any delay on an activity in the critical path may lead to a knock-on effect or domino effect. Resolving such a delay may be obtained by accelertion of the remaining activities on critical path.

Network analyses and time estimation are thoroughly and well known documented in most classic textbooks in project management & control. This section just pinpoints the importance of bringing in realism in the estimates in order to deliver according to specified product quality and achieve delivery certainty. Uncertainty estimates may be established for the single activities, followed by estimation of the total estimation in time, in which the expected value may be derived for the total duration on critical path.

Similar issues are present for derivation of the estimates on costs which forms the basis for the budget approved.

Uncertainty is present to a varying degree in the cost estimates at time of decision. The actual uncertainty and associated budget constraints may influence the work product processes and the desire to achieve the specified product quality. On that ground, the following should be checked up-front:

1. What degree of realism is there in the cost estimates?
2. On what ground are the cost estimations derived?

Lacking realism in the cost estimations may hinder the opportunity of satisfying the required specified quality. The derivation of a realistic and manageable cost budget should find the fine balance between being ambitious on improved efficiency in the work processes and keeping the budget frame realistic to achieve.

A range of estimation techniques exists. Among these you find:

- Relation estimation
- Factor estimation
- Use of productivity norms according to the company's project cost data base

A brief summary description is outlined and the three categories are derived from as delivered completed projects and processes.

Relation estimation is base don the principles that estimates of previous work exist for comparable type of work, and adjustments are done to calibrate between projects in the past and the current work. The relation estimation approach is founded on common characteristic parameters for the reference project and in the new project. Calibration and adjustment may be performed due to capacity, time and location/facilities. The latter may reflect local geographic variations as well as different size (Rolstadås, chapter 7.5, page 215).

Factor estimation is established on conditions regarding relative cost proportion remain unchanged. If the costs are known for one or more cost categories between two different projects, total estimates may be derived by using the the relational estimation approach (Rolstadås, Chapter. 7.5, page 217).

Estimation by using productivity norms is an alternative methodology based on historic figures from as finished projects. The cost estimate for the respective work packages may be derived by use of the following equation that is more detailed than the first two approaches:

(4 – 1) Cost = Rate * (Productivity norm) * Volume

The latter approach is one of the most used approaches for cost estimation in larger & complex projects. Rate could be the man hour rate or day rate, the productivity norm is number of man hours per produced unit, and the volume is the number of units or directly volume. The equation in (4 – 1) gives the possibility to scale up by volume, by rate or by actual productivity.

Of remark is that cost estimations based on any of the three approaches briefly described are relevant and valid only if the estimation object is within the experience range for the facts and figures in the data base. Extrapolation beyond the range of validity in the experience data is highly questionable and not generally recommended unless a thorough technical review of the product specification and Scope of Work demonstrate relevance of the figures in the data base. An assessment must be done considering the specification requirement, size and complexity. Experience numbers may normally not be utilized if the complexity deviates significantly from the facts of the past projects contributing with the experience facts in the data base. If the complexity exceeds what was the case for the previous projects, there is a likelihood that underestimation of the costs happens. The consequence of underestimation may likely lead to too low budget figures which make serious constraints for developing the desirect product quality. The opposite may also happen if the complexity is lower on the project in question compared to the projects providing the historic facts into the data base. The consequence could be that unique new and simpler solutions become too costly due to use of inappropriate reference productivity norms.

The lessons learned is that the cost estimators should have the necessary competence and perception of the key features and associated complexity prior to the cost estimation.Engineers and cost estimators must work as an integrated team in order to derive the best likely estimation prior to point of decision.

In spite the facts that the product developers, designers and cost estimators work as an integrated team, still there is likely that the Scope of Work and the associated specification requirements do not cover the nitty gritty details which are crucial for the execution processes in the project. These aspects should be catered for by introducing specific buffers in the cost estimates:

- Uspecified tasks
- Unexpected tasks

The unspecified tasks are connected to costs associated with tasks that by previous experience and track record may appear during the project execution, and that are hard to identify during the derivation of the scope of work.

The unspecified element is connected to the uncertainty in the cost estimate and is expected to be consumed during the project life. Thus the unspecified element is expected to appeaar during the execution as there are difficulties of identifying these at point in time for the initial cost estimation, due to partly a non-complete scope of work description.

The corresponding unexpected element is intended to cover significant changes to the initial conditions and premises for the project and shall not be consumed if the boundary conditions remain as specified.

Both cost buffers contribute to build in realism in the cost estimates and create a more confident and sounder economic framework for the project in question. The consequencees are higher economic manouverability which in term provides you with better chances of delivering the specified product quality.

Introduction of the two contingency elements in the cost esstimation, the build up of the total cost may follow the sequence as below: (Rolstadås)

	Base estimate
+	Unspecified/ contingency allowance
=	**Reference estimate**
+	Unexpected/ contingency reserve
=	**Total cost estimate**

The base estimate represents the most likely cost figure; the unspecified contingency allowance is the figure to add to reach the 50/50 estimate. During the course of project execution, the uncertainty in the base estimate is normally reduced, ie the standard deviation is reduced, and the corresponding unexpected contingency allowance becomes smaller. That is schematically illustrated in figure 4 – 6.

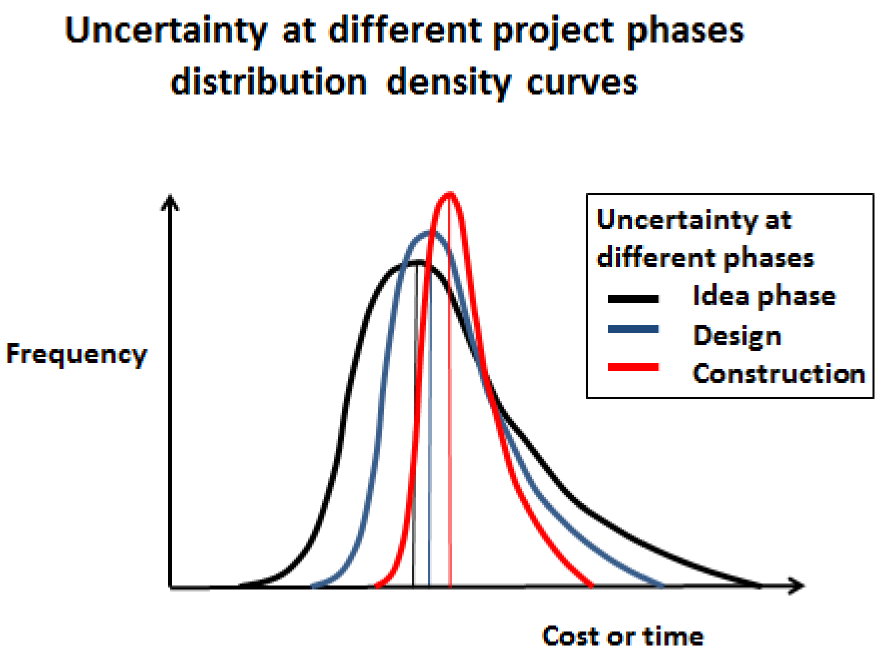


Figure 4-6 Sketch of the gradual reduction in uncertainty of cost estimates at different project phases plus illustration of likely increase in most probable estimate.

The estimation uncertainty will normally become smaller during the project execution. Activities completed have no longer an associated uncertainty, the accumulated information base is increased, and the confidence level is increased. The completed activities are converted into fixed figures and do not contribute anymore on the uncertainty. The expected value may also change, and frequently the expected value may increase as indicated in figure 4 – 6.

The gradual development of the product delivery may also be reflected in class estimates and the corresponding level of uncertainty. Likely figures are shown in table 4.3. Typically in the conceptual phase the cost estimates with 80 % confidnce may be in the range – 30 % to + 40 %, whereas during the execution phase the corresponding uncertainty range is within - 15 % to + 20 %.

The figures in table 4.3 are established for oil & gas construction projects in the Norwegian Continental Shelf. The table is calibrated and reflects typical North Sea installations, but firmly illustrates the principles of including uncertainty ranges in the estimations.

Class	Decision Gate	Cost estimate with uncertainty at 80 % confidence level	Accuracy in technical information at 80 % confidence level	Normal level on recommended contingency allowance
A	Idea generation and Feasibility			
B	Conceptual development	–30 % / +40 %	+/–25 %	25 %
C	Design & Execution phases	–20 % / +30 %	+/–15 %	15 %
D	Sanctioned budget figure	–15 % / +20 %	+/–10 %	10 %

Table 4- 3 Illustration on class estimates at different stages in the project development.

The actual quality in the cost estimation is fully depending on what premises are put forward.

On well known products and services there is a higher confidence and certainty of the cost estimates, whereas unkown and immature products will result in larger uncertainty in the cost estimates.

4.4 Independent assessmets of cost and schedule

An estimate is a prediction of what the likely total costs and duration for a project idea. At time of decision for realisation of a projeect, the estimates are indications with a varying degree of uncertainy and confidence.

Any estimation is derived and modelled through simplification of the scope and tasks in consideration, and uncertainty in the estimates is present at time of the estimation. As a consequence, there might be recommended to perform 3rd party independent estimation analyses of cost and schedule, at least for larger & complex investment projects. The independent cost and schedule estimation analyses may add confidence to the decision facts basis in the sanctioning process for the projects in question. If the independent analysis results coincide with the project internal figures, a rather firm condition is established, and the derivation of the sanctioned project budget should reflect a high confidence level. If there is a significant discrepancy between the 3rd party estimates and the corresponding internal project figures, an assessment of the reasons why differences appeared should be done.

Experience from large public investment projects the latter two decades shows major cost over runs and heavy delays relative to planned and sanctioned budget figures. That pattern is experienced in a number of countries.

As a consequence of that reality the Norwegian Government, by Ministry of Finance, developed and implemented a compulsory independent quality assurance of major public investment projects; currently any project with predicted budget above 750 Million NOK. That initiative resulted in improved confidence in the sanctioned figures and the as build/ as completed figures showed dramatically reduced overruns compared to experience in the past.

The quality assurance principles and guidance are focusing on the confidence and reliability in the estimation figures as well as a thorough review of the conditions for the realisation of the projects. The guidance is split into two steps, the socalled QA1 (KS1) andQA2 (KS2)-analyses of the project idea and investment demand. The QA1 assessments are explicitly focusing on the socio economic rationale for the idea or proposal. The QA1 shall be performed at end of a pre-study and shall include an independent assessment of the following 4 documents:

- An overall demand analysis
- An overall strategy document
- An overall functional specification requirement document
- An alternative scenario analysis

The overall purpose of the QA1 independent analysis is to support the client in making a sound framework for concept selection in a socio-economic perspective in the process of securing political & public governance of the idea under consideration. That is of particular importance when dealing with the approval of major public infrastructure projects, like construction of new roads and railways.

The results from the QA1 assessments are included in the total decision facts basis for the evaluation whether to move into the next project phases, the feasibility & conceptual design phases of a project.

When the conceptual design is complete a QA2- independent assessment is requested. That assessment will cover independent analyses of cost estimations and schedule estimations including uncertainty analyses as well as considerations of LCC Life Cycle Cost. In addition, the event based qualitative risk & opportunity analyses are a part of the QA2-tasks.

The overall purpose of the QA2/KS2 efforts is to provide to the client and sponsor an independent analysis of the project prior to sending a White Paper to the Parliament for formal approval. The analyses should contribute to the accumulated facts basis for the final investment decision.

The following elements/tasks are included in any independent QA2/KS2 analysis:

- The basic project conditions and constraints
- Contract stratgy
- Key Success factors & particular attention areas
- Uncertainty analysis
  - General
  - Estimation uncertainty
  - Event uncertainty
  - Identified risk reductions and mitigations
  - Simplifications & limitations
  - Conclusion, including recommended ecomomic frame/budget; economic frame including contingency allowance and reserves, and recommendation for the total budget.
- Recommendations regarding project organisation and project management approach

A key issue of the QA2/KS2 assessment is to check that the project is well defined and the scope is firmly described & limited, and confirms that the conditions identified during the QA1/KS1 assessment are still valid.

The QA1/KS1 and the QA2/KS2 independent analyses do not explicitly cover the technical product quality of the project delivery, but are conditioned upon that the different product processes cater for the technical quality of the product delivery.

The value of performing independent quality assurance estimations is depending on using appropriate and well accepted tools for analyses of cost and schedule. The applied tools should have the capability of deriving the the probability density curves with associated cumulative probability, provide you with the most likely estimate, the expected value, the standard deviation plus the P85 & P15 values as schematically illustrated in figure 4 – 7.

If a large uncertainty appears on the total project estimate, the P85 & P15 will show up with fogures significantly away from the expected value, EV, as well as from the most likely figure. Such a condition requests particular follow-up activities during the detail engineering & design and not the least during the construction phase.

The four key figures are the following:

- The most probable estimate
- The expected value EV and the P50 estimate.
- Lower P15-percentile
- Upper P85-percentile

The QA2/KS2-evaluations are included in the total decision facts basis together with the White Paper for approval by the Parlament in Norway. Currently any public investment project above 750 Million NOK must be approved by the Parlament.

The lessons learned after introduction and launch of the QA1 & QA2 independent assessments are that a significant improvement is gained in the realism and derivation of budget figures with enhanced confidence for investment projet on the nation level. The success on the state level has led to introduction of similar practice on county and municipality level, at least in the main cities of Norway.

The QA1 & QA2 assessment should be done by a 3rd party organization relative to the project in question. Ideally it should be external expert environments with project experts on cost control and project planning. However another organizational unit within the corporation could also perform the independent analyses provided they do not participate in the actual execution of the project of concern, unless the Government requests external bodies doing the analyses. A separate PMO or PMSO, Project Management Support Office, could eventually serve the function of performing independent analyses.

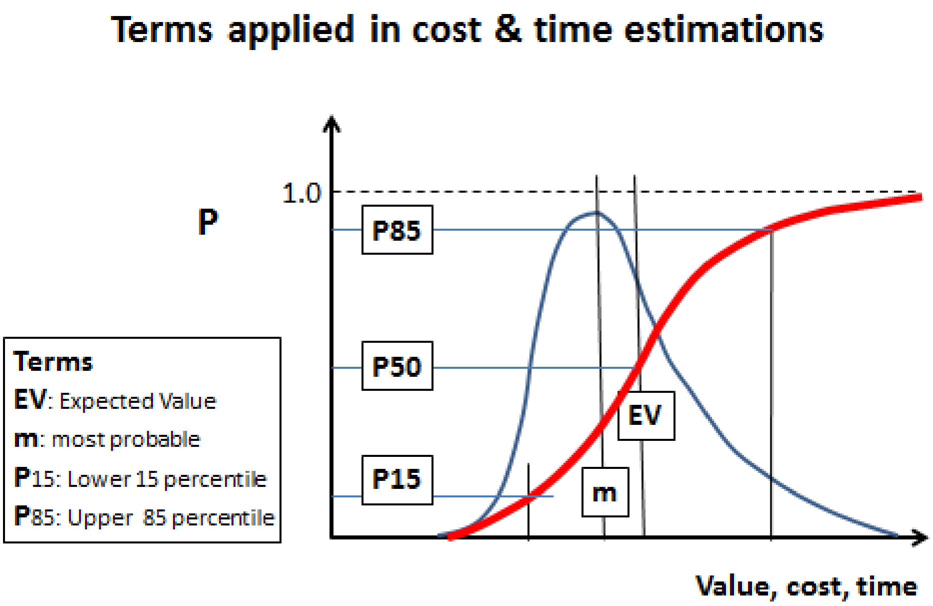


Figure 4-7 Illustration of an uncertainty curve with associated key terms included

The desire for a 3rd party organization doing the independent evaluations is frequently handled by the base organisation of the operator/field developer in oil & gas when assessing a separate field development project. Frequently the partner committee on an oil field licence may agree on who should perform independent analyses, whether to use the base organization of the operator, or a legally fully separate 3rd party.

Key questions are:

- When should independent evaluations and analyses be performed on the key project cost and schedule parameters?
- How to utlilize the results from the evaluations done during the project execution?

A key point is to do the independent analyses prior to major decisions and prior to decision gates commencing the next projet phases. That will provide you with facts whether the current cost estimate and master control estimate are still valid; the same is relevant for assessing the current schedule/timeline. If significant deviations are identified, it should be considered whether a revision is necessary on cost and schedule, and what kind of actions/mitigations are possible to eventually regain to original budgeted figures.

4.5 Management & quality sytems in projects

Any professional organisation has a management and quality system for the entire organization, for the business development, for the operations, sales and for the projects.

The overall purposes are to secure that the output results satisfy the quality specification requirements provided by the customer or internal requirements by working efficiently and with firm standards on value, management, HSE issues and security. It means to have a management & quality system that makes you capable of planning and managing any activity in compliance with statutory regulations, national & international laws and standards in order ot secure achievement of the the specified quality requirements within a culture of continual improvement and lean principles.
The management & quality system shall formalise and explain the totality and interactions in the organisation. That should cover any aspect related to vision, corporate values & strategy, goal achievement, organization, operations etc.
The overall objectives of the management & quality system are to ensure that:

- The corporate visjon, values, corporate strategies and policies are reflected in and are an integral part of any activity in the organisation.
- All activities in the organisation are performed according to specified quality requirements, standards, and regulations.
- Consistent high quality is achieved in all output deliveries from the organization, and superior quality is a characteric of the organisation.
- The organisation has established confident systems for quality assurance that contractors, sub-contractors and vendors have implemented satisfactory quality systems in full compliance with the client specifications.
- The organisation is focusing on continual improvement, organisational development and learning in full compliance with the latest quality and lean principles and approaches.
- The company is prioritizing competitive advantage and has ambitions to achieve the condition of being a selected and preferred supplier among prime customers.
- The company is prequalified for tendering within their business area and segment.
- The organisation shal have implemented specific processes for continual improvement and development as an integral part of the ISO 9001:2015 certification.

A management and quality system should thus include the following elements:

1. The organisations' vision, values, mission, strategy and overall goals
2. The company's organisation, design, and roles
3. The main work processes in the company
4. A system description for the development & generation quality requirements through processes, flow charts and corresponding procedures
5. Quality plan for the company/organisation
6. Quality control, measures, recordings and monitoring
7. Identification and managing non-conformmance and deviations.
8. An established system for continual improvement.

The documentation requirements according to ISO 9001: 2015 are also covering the following elements:

- Quality policy and quality goals
- Quality manual/handbook
- Procedures/guidelines covering:
  - Handling of non-conformance and deviations
  - Corrective actions/mitigation & other preventive measures
  - Document control
  - Inspection, measuring, recording and registration
  - Internal audit practice on system audits as well as peer reviews
- Documentation describing the way of making an efficient operation and control of the work processes.
  - Mapping of the work processes, flow charts, key performance indicators, process control parameters, procedures, work instructions, manuals, drawings, etc
- Recordings and formal registration according to the respective quality standards

The management and quality system is general by nature and covers all aspects of an organisation with reference to the above list of elements.

However, the actual use and implementation of the management and quality system may vary from one activity area to another. The management & quality system must be customised on the items 3 – 8 within the respective organizational units. For the elements 3 – 8 production specific versions must be developed and implemented, that explicitly reflect the general and special quality requirements and conditions. That approach is of particular importance as the management and quality system must be calibrated to the respective organization unit and demonstrating real commitment. Figure 4-8 shows an example of a classic structure of a management and quality system.

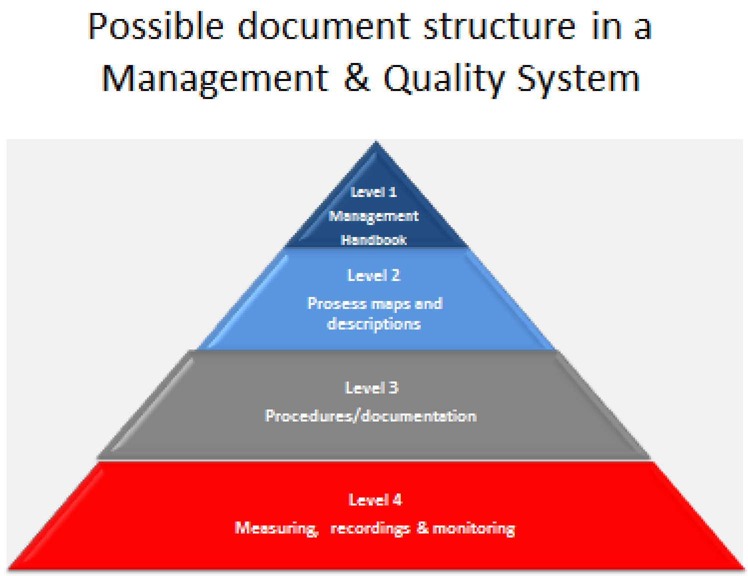


Figure 4-8 A classic structure of documentation for a management & quality system

Level 1 shall cover the overal principles in the organisation regarding managing and operating for achievement of a superior quality organization. It should include the company’s vision, mission, values, strategies, and overall goals, how the company is organised, guidance on management practice and the way of working, description of code of conduct, interface and relations towards the society at large. The level 1 documentation should also describe the company’s quality policy and desired quality goals as well as how to master uncertainty issues on risk and opportunities in the activities, including the capability of managing a dynamic business environment. Furthermore the level 1 management & quality documentation should specify firmly who is accountable for the quality work, and who is in charge of designing and updating the management & quality system according to the latest revisions and editions of relevant laws and and regulations. An overall strategy and operation plan for the enterprise should be included in which the overall management &

quality plan is integrated. It shall reflect the corresponding quality activities, the overall periodic plans for system audits as well as the management review in context with the annual operating plan.

Level 2 shall comprise the main processes in terms of the management processes, work processes and support processes. The process approach and mapping are very efficient ways of documenting what to be performed, which sequence of the process steps and who should be involved in the process work. Any step in the process flow should add value to the output, if not, the step should be omitted. Output results from a process may be monitored and recorded, and the process approach is among the cornerstones in modern quality work and ways of designing the management & quality systems. Well founded work processes contribute to ensure that the desired process quality is under control and a condition for achieving satisfactory product quality.

Level 3 may consist of procedures and instructions on how to plan and do the work processes for the different activities. Procedures are normally requested in order to establish a consistent practice. Professional procedures frequently refer to national and international standards within the respective disciplines. A particular challenge is to develop technical procedures based on functional requirements. There is a need for making procedures consisting of functional specification requirements rather than detailed technical solutions. The product and technology development happen at such a high rate of change that the detailed technical specifications become out dated in short time, whereas the functional specification requirements have longer duration of relevance. The functional requirements are thereby more stable and will not be revised as frequently as one must do when using detailed technical specifications.

Making good and sound functional specification requirements are challenging, as they must combine the:

- Objectivity demand in the desired features, and independent of one specific solution, and
- The request for firm commitment and being sufficienty concrete.

Such a rare combination is very hard to achieve and the organisations in question should use their best senior scientific experts, the champions, in making such function-oriented specification requirements. Far too often a major part of functional specification requirements is not sufficiently committing, are vague and unclear in goals and solutions, which may creat uncertainty in the roles betwwen the client and the contractor.

Level 4 covers the documentation and activities for measuring and recording of the actual results including inspection and control measures. The obtained results are compared with the specification requirements. If a non-conformance is identified, the organization must initiate proper actions to regain to specified values in the out put key performance results.

In order to establish a regime and culture characterized by continual improvement, the corresponding process control parameters must be derived. These may be considered as enablers for doing the proper adjustments or improvements in order to regain to the desired output quality level which is thoroughly described in chapter 1.4.

The measures and the recordings must be properly documented, be tracable and correct. Recommendations on corrective actions should be managed formally according to the procedures for adjustments and improvements such that the management may readily perform the approval of the proposal. An explicit procedure for approval of corrective actions should be differentiated according to the relative importance and consequence if the actions are not going live. The differentiation should also be reflected in a RACI diagram/matrix that explains who is accountable for the different kinds of deviations with the corresponding assessment of the recommended corrective actions.

From a business and quality point of view, it is of importance to identify and monitor the key performance parameters on capability and efficiency. Those parameters are crucial in the effort of striving towards ever better competitiveness and achieving sustained competitive advantage. Typical performance parameters are productivity norms in a range of activities, documenting how many man hours are spent on a specific service or product generation. These performance parameters may be utilized in bench marking with the competitors, alternatively for comparison purposes between different production sites within the same company. Best practice may be distributed to the other sites and there is in reality a continual improvement culture in the organization. If your own orgaanisation consumes more man-hours than your competitors on similar tasks, there is a strong message that the work processes may not be suitable for efficient manufacturing. The current work processes may be unlogic and there might be unnecessary loops inside the process leading to delays in the production. A relevant question is then: Must everybody be involved as it is in the current format of the process, or is it possible to simplify and reduce the number of resources involved in the workflow through the process?

Over the last decade, the format and content in procedures have changed significantly. In the past, the procedures were frequently very extensive, and detail oriented in order to cover any eventual scenarios and conditions. The due date for a detailed technical specification becomes shorter and shorter. The trend is to move towards more functional descriptions and specifications which are considered as a sound approach and development.

The design and format of functional descriptions and specifications may be streamlined to an enhanced efficiency and become more comprehensive through application of process mapping of the work processes including the associated roles involved. The volume of text may be drastically reduced, and the flow process charts are self explanatory in terms of wihich the sequence is present for the respective activities and with firm illustration of the associated roles to be involved for each process step. The visual format has demonstrated to be an excellent communication format, as one illustration/flow-diagram of the work process tells more than pages of written text. Thus, the process format and mapping provide you with procedures of high functional precision with just a fraction of number of words compared to the classic approach in design and development of procedures.

When focusing on the projects, what are the appropriate management and quality systems in projects?

The single projects are unique and the associated conditions & premises are project specific. These characteristics must be reflected in the management & quality systems in projects and at the same time fully comply with the overall company management & quality systems. The derived project specific management & quality system must be founded on the general management & quality system in the organization.

The challenge is to customize the management & quality system such that any relevant project specific issues are included and integrated in the established project management & quality system.

Some recommendations are summarized for the respective levels in the management & quality system for the projects:

Level 1 project specific management & quality

For the overall level, the main principles from the general management & quality system are to be applied, in which the project specific issues on the overall level are covered by the following:

- Organisation: The established organisation chart for the project is included. The corresponding key roles on the organization chart are included such as the roles of the project owner, the project manager, part project manager, as well as the support roles of the controller, risk & opportunity coordinator, the quality coordinator and the HSE-coordinator. If the support roles are not included in the project organization as such, the chart should firmly show how to utilize resources in the organization for the support functions needed. They could be organized in a Project Management Support Office, PMSO, serving a portfolio of projects. Such a situation is relevant for small projects that cannot afford to be self supported on the staff functions & services.
- If there are project specific quality measures aand specification requirements, these must be added to the general quality requirements for the organisation and output deliverables. There may in that context be client specific add-on requirement that is influencing the ways of achieving the specified project quality requirements. On site conditions should also be catered for in that context.
- A project specific management & quality plan must be developed and integrated in the management & quality system. The management & quality plan for the project shall include activities on planning, execution and termination on the three categories of project processes according to ISO 21500, which should cover management and performance issues on the desired benefits of use, the cost, the schedule and the product quality. The specific management & quality efforts are covering the project quality perspectives as a whole, including activities on measuring & recording, inspection, identification and handling of opportunities & risk, deviation & non-conformance handling, management & system audits, technical verification and peer reviews, efficiency and effectiveness performance assessments, management & quality reviews in advance of the decision gates in a stage gate-based project execution model. The associated inspections, measures and recordings are key elements in the quality review and control plan for the project. The actual project delivery is unique and the approach for monitoring, recording and assessment of the development of the product quality should vary accordingly. Furthermore, the

client/user of the project delivery may have needs for control and monitoring of the product quality during the development. The type of review and extent by the client should also be a function of the type of contract standard and compensation format on the respective project in question.

- The overall level in the management and quality system should include firm project specific change processes and processes for managing deviations and non-conformance.

Level 2 work processes – project specific. The basic reference is the general work processes developed and applied in the organisation. The desire for standardization applies on work processes however the project specific issues should be adjusted within the framework of standardized processes and procedures. The need for adjustment is for example a production process at a shipyard in Norway compared to China and Korea. In the Norwegian yard a high degree of automization is a condition for maintaining competitiveness, wheas several Far East yards are established by more extensive use of a large working staff with very low salaries compared to western companies. The restriction on number of men working gives no meaning on a yard where the salaries to the workers are not the primary cost driver.

The mapping and design of work processes is recommended done such that the core workflow description is in common, supplemented by a project specific and site specific adjustment. The project specific adjustment should be in place prior to project startup on the actual work. The design and layout of the project specific processes could be made such that the generic in common processes are copied from the core process data. On top of that, empty boxes/activities should be added with the term “project specific” in which the actual project specific issues must be filled in. approval for start up of the work is conditioned upon that the empty boxes are filled in. That approach enforces the professional environments/staff to identify what is project specific this time, what is different and that must be included in the project specific processes prior to approval. “Copy paste» from the previous projects is no longer valid and is hindered by this approach. Continual improvement in efficiency and quality request reuse and refinement of current practice, however a blind copy paste approach is not stimulating to establishing a true learning organization, it will rather prolong the presence of a non-optimal practice. The necessary project specific adjustment could also be acheived by making project specific amendments to the core generic processes and procedures.

Level 3 procedures – project specific. As for the process level, the procedures should account for the project specific issues. The procedures should support the work processes and give a brief description on how to generate and develop project results fully satisfying the specification requirements established and prescribed in standards and regulations.

During the project planning and development of the project plan, the following activities should be included:

- A list of all general procedures relevant for the project
- Sort and verify which procedures may remain unchanged and without amendment for the project in question.
- On procedures in which project specific changes are requested, the modifications should be performed by leading experts within the organisation and approved by the respective discipline leads. The procedures shall not be formally implemented and put into practice until they are approved and loaded nto the project plan document.
- The formal discipline approval shall be visibel on the first page of the procedure in question.

Level 4 measuring, recordings and control – project specific

The need for measuring, recording and control will vary from project to project. The project specific issues should be reflected in the established monitoring and control activities. According to ISO 9001:2015, the project organization must plan, implement and perform the monitoring, measurement, analyses and improvement processes needed.

a) To demonstrate conformity to product requirements in the project
b) To ensure conformity to the project quality management system, and
c) To continually improve the effectiveness of the application of the principles in the general management system adapted to the project specific arena.

Of particular importance are the project interfaces from a management, quality and risk point of view. Experience from a number of projects is that the interfaces are frequently a primary source for risk and opportunity which must have particular project mangement attention.

Recordings and measuring of interface facts cover dimensions such as physical measures as well as organisational and contractual issues.

The measures and recordings apply on the product delivery from the project and for key control parameters related to quality & value generation, cost performance and progress. Those periodically recorded facts are the background for deriving the Cost Performance Index, CPI, the Schedule Performance Index, SPI, and the Quality Performance Index, QPI.

These indexes should apply for the derivation of the forecasts and prognoses on the project completion and quality on the final product delivery.

For measuring and control an associated detailed checklist and control plan should be included. Example on such a record sheet is shown in table 4.4 below.

Parameter Quality specified requirement	Control activity	Measured / registered	Deviation/ non-conformance (yes/no)	Actions/mitigation Accountable & due date

Table 4.4 Example of list for measuring & recording of facts compared with specified value

The project specific perspective is illustrated in figure 4 – 9 having the similar format as for any general management & quality system and inclusion of the project specific issues.

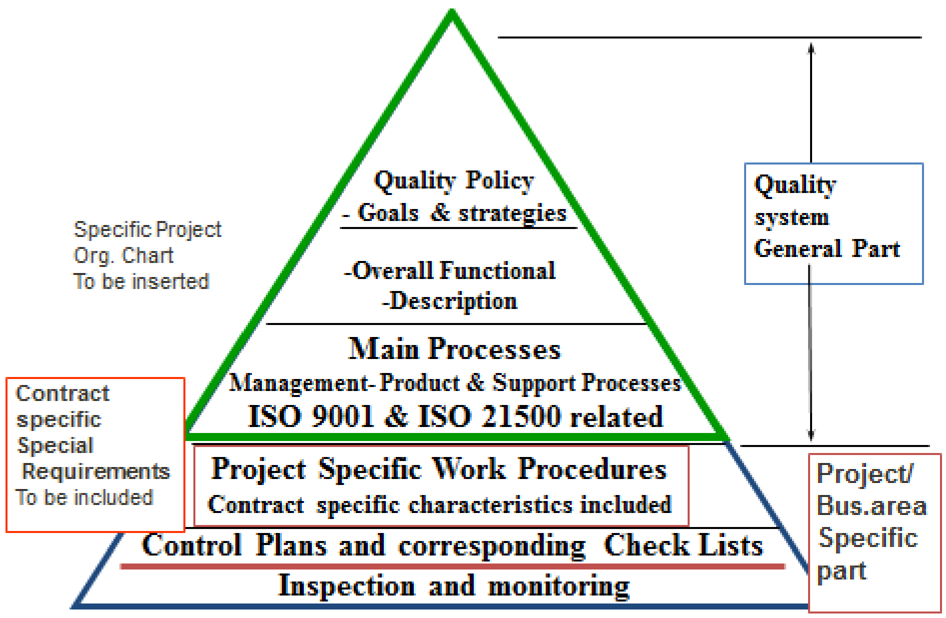
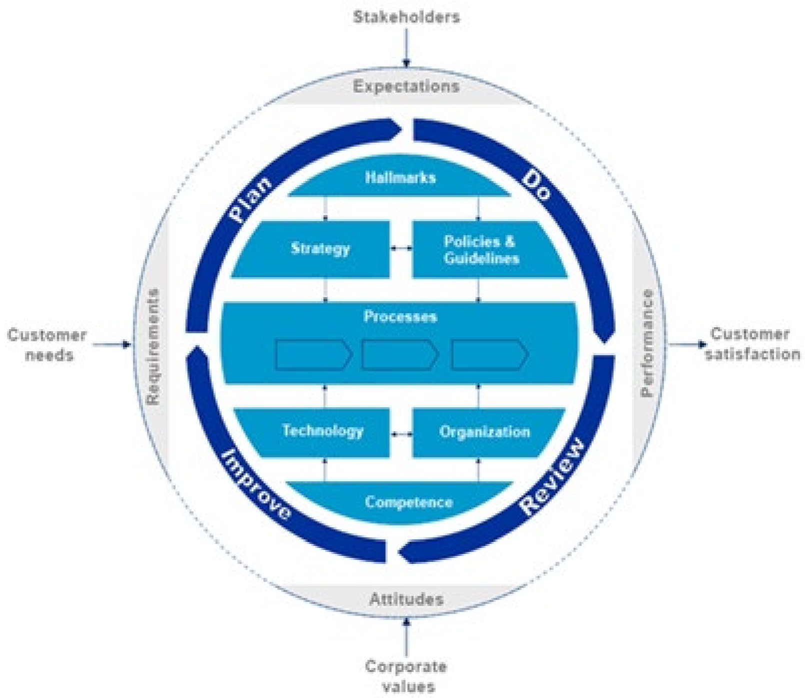


Figure 4-7 Project specific adjustment of the management & quality system applied in projects

Good practice Example on a management & quality system: Wilhelmsen Maritime Services
Wilhelmsen Maritime Services (WMS) has established a process based management & quality system named GIMS: Global Integrated Management System. GIMS was established as a governing system for Wilhelmsen Maritime Services, WMS. The objectives and rationale for the design of GIMS was first of all to establish a corporate and management system based on the organisations' needs for a consistednt and fully aligned process-oriented governance and management of the business. The established principles are in compliaance with the basic rules in the ISO standards, and the process design structure is made such that it stimulates to achieve good corporate governance. State of art process mapping tools are utilised and all processes in the organisation are modelled. GIMS provides a consisstet visualisation and expossure where values are generated, why and how. The corresponding roles involved are further readily explained and linked to the respective steps in the process flow, made self explanatory in simple flow charts showing the involvement of the respective roles at the various steps. GIMS is conssidered to represent state of art in process design and approach on being a processes-oriented company, and the Wilhelmsen Group has refined, improved and expanded the tools and system over the last years. A realistic practice on continual improvement. GIMS combines the process perspective in work process and the continual improvement approach within a holistic organisational framework for the organisation. The transformation to a prosess based organisation within WMS resulted in the following: • Significant efficiency improvements • A consistent process flow • Waist is minimized in line with best Practice according to the Lean principles. • Clarification on where values aree created. • The right quality is achieved on the respective deliverables at time specified. • The roles in the orgaanisation become clearer. • A larger organisational flexibility is achieved. • A larger degree of standardisation of solutions and methodologies applied.

- Simplified client/supplier interfaces



Sketch of the Global Inteegrated Management System GIMS i Wilhelmsen Maritime Services, WMS, a part of the Wilhelmsen Group

The GIMS-model and the associated project Execution Model

WMS has established a specific project execution model, for single projects and for a portfolio model of projects. They are fully integrated in GIMS and project governance is achieved aligned with the corporate governance in the company.

The developed project execution model is based on the stage gate principles as described in detail in chapter 6.3. The overall generic model is illustrated in the figure below.
The project execution model is designed such that there are common overall approaches, on level 1, whereas the project execution model is customized for a range of projects on the detail level, level 2. Thereby the established methodology fit any relevant project type within WMS and the Wilhelmsen Group.

A Generic project execution model, a part of GIMS

The differentiation in level 2 project execution models reflects the variability in nature and business environments for different projects.
Business development and IS/IT development projects have a different character compared to new building of vessels/ships and HVAC for ships and offshore rigs aand platforms.

The actual differentiation has led to the following split of project categories in the project execution model:

- External delivery projects like for example a complete HVAC system & hardware
- Business development & IS/IT product development projects
- Small internal improvement projects

The differentiations are reflected on check lists at decision gates as well as on templates for the various projects, the extent and how to apply these. Small internal projects may be successfully executed by using a very limited number of tools and methods with simplifications, whereas the larger & complex projects request more detailed follow up & control.

Chapter 5 Quality and Risk in Project Contract Work

5.1 Quality & risk in contracts – general considerations

Delivery & execution projecs will to a varying degree be requesting external supplies and procurements and several project specific contracts.

Typical procurements in projects may include:

- Purchase of equipment, on components as well as on systems
- Awarded project contracts on part of the work or as a total contract.

In simplifiied terms, a plain purhase is characaterized by the fact that the buyer has no impact on the delivery and the development of that product after signing the deal.

A project contract is on the other hand an agreement in which both parties may influence the product delivery during the development and during the entire execution time, not only during commissioning and testing at handover.

Quality is requested in any part of the commercial elements in project work, whether it is a regular buy or a project contract.

Procurement of any kind is based on the request for tender and the corresponding decsription of scope of work including the product specification requirements. A firm and precise scope of work description is a critical success facator for achieving the specified and desired product quality. The description in the scope of work should be a combination of being realistic and ambitious, and should be possible to achieve. A preferred differentiation is to split between strategic purchase and standard equipment.

Another issue of concern is to decide whether functional specifications should apply rather than detailed technical specifications.

What is the rationale for such a statement?

The functional specifications shall reflect the the intention and the benefit of using the product delivery from the project. The functionally specified features should be measurable and concrete. The expected time of validity for the functional specifications is expected far longer than the detailed specification requirements, due to the fact that technology development is performed at a speed that international standards and guidelines cannot implement sufficiently fast, in particular within information technology and other high tech industries. Under such environments and conditions, functional specificaations are recommended.

The derivation of functional specification requirements are considered as a challenging task since they should set the conditions for the business relations between the customer and supplier, which must provide you with concrete facts, not just thaughts. Such characteristics may best be developed by the most experienced expert resources in the organisation, who knows what the prime features should be and how to describe the scope and associated specifications.

On standard components the market conditions and completion should be utilized to the extent possible, whereas on strategic critical components and project contracts there is a need for close interaction between the parties during the development and production.

In that context the project specific characteristics and issues must be addressed. Within many industry segments there is a business dynamics leading to continuous efforts for improved efficiency and cost reductions though rmergers and acquisitions, resulting in super major global manufacturing corporations. The consequences are the demand for large production batches far in excess of what are the requests from a single project.

As a consequence, a purchase from a single project may be considered too small in volume and may not achieve the requested priority in the order pipeline. Those concerns are more exaggerated in situations when specific customized specifications are required. In some cases it may be almost impossible to set a special order. These aspects are becoming more predominant in the supplier industry for process plants and oil & gas industry.

Likely consequences may be:

- Limited access to component supplies of the requested and specified quality
- An unacceptable large variation in component product quality
- Challenges with achieving priority in the order pipeline among global suppliers of critical components when requesting customized specifications on the products and components in question.

How can we meet these challenges?

A general recommended design philosophy is to apply standard components as much as possible in the design solution. The recommended approach may be a mental barrier and challenge for the designers as they may prefer to develop and deliver a one off solution every time, in every project. For such considerations, one must distinguish between standardization on component level and system level respectively. Frequently, there is a tendency to prioitize the development of fascinating and unique one-of-a-kind solutions rtaher than searching the most appropriate solutions with a high degree of commponent standardization.

The ruling design philosphy should stimulate to maximum use of compnents standardisation. Through that approach, well proven high quality is built into the components in the solution delivered, and the procurement department may purchase larger batches for supply of components to more that the single project.

The expected results of a high degree of component standization are twwo fold: the number of component versions are drastically reduced and at the same time increase the flexibility with respect to system solutions. These trends are experienced with great success in a range of industries, in particular within IT, both software and hardware, and not the least in the automotive industry. The success in those industries is being transferred towards other industries such as oil & gas with particular emphasis on subsea instalations regarding component standardization as well as reuse of established technical solutions.

When the product design solution contains a high degree of component standardisation, the purchase of components may be done in larger batches, serving the supply demand in a protfolio of projects; and expected higher priority in the order line among the prime suppliers on critical components. With an off- the shelf standard component philosophy, there is a larger guarantee of for provision of those components as the components may be on stock. In the project context, the likely effects are reduced risk of delays, and an enhanced confidence level of achieving components of specified product quality.

If there are no or very little compentions on supply of equipment, components and services, the customers may start a prequalification programme for introduction of new potential suppliers on critical components. The overall objectives are to have access to a larger production capacity spread on a range of suppliers on specific components, and not relying on sole source. By that way, the risk of lacking supply capability on critical items may be drastically reduced, and the pricing of components may be rduced. However, one should be aware of the specifiied product quality requirements for supply of critical components. The client, who potentially wishes to introduce new component suppliers in a market, must establish a prequalification system that confirms the desired product quality in all steps in the production chain with a reliable and stable production methodology supplemented by fully traceable documentation from the entire product development and manufacturing chain. Furthermore, the prequalification programme must have such a volume that the production is experienced as stable and satisfy all specification requirements for the products in question. Those requirements must be reflected in the final delivery as well as in the preceeding work production processes in order to demonstrate a reliable and highly confindent production with a minimum of product variability well within specified tolerance limits.

Quality in the contraact processes

A project contract is applied on tasks in which one may engage a supplier/contractor on a speccifired scope of work that is influenced by both parties during the project execution. The project contract process may in simplified terms be divided into two maun stages such as:

- The Pre-contract Stage/ Tender Stage
- The Contract Administraation and Execution Stage

The split is valid for the client as well as for the contractor/supplier organization as illustrated in figure 5 – 1.

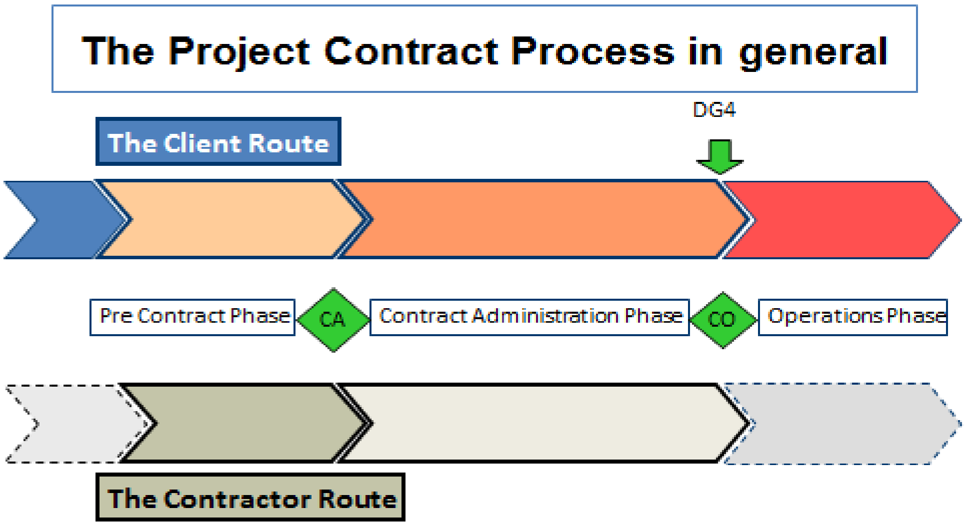


Figure 5- 1 The contract process in projects – a general illustration.n

Figure 5-1 illustrates that there should be parallel processes through the contract lifetime with client and contractor respectively, according to the principal-agent theory, (Kolltveit et al, chapter 4).

Form the left in figure 5 – 1 there is identified a process step prior to the precontract stage and a similar process step with the contractor/supplier, however marked with a dotted boundary. During that identification and market investigation stage, the client should communicate to the contractor/supplier market when a request for tender is expected launched, what kind of contract is of relevance etc. That communication and information is essential for professional contractors/suppliers in order to plan for tendering on a potentially new project contract, which resources should be applied, addressing the issues of total resource planning as well as strategic and tactical use of facilities as well as human resources if awarded the contract in question.

Simulateneously, the contractors/suppliers should provide to their poteential customers what they can provide in terms of services & products and about both capacity and capability of delivering services and products. The suppliers' Key Account Managers have a critical role in that context, caring for a constructive dialogue with current clients as well as potentially new customers. The duties of the Key Account Managers include activities covering novel product development and innovations in their organisations plus perform an ongoing and thorough market search for possible new requests for tendering.

A positive dialogue in the up-front stages is of mutual benefit for the parties and adds value to the contract process and is expected to contribute to create new opportunities & secure an improved product deliverey in the end. Many clients may not be aware of the latest innovation and products among contractors/suppliers that may hinder the application and implementation of those in the upcoming projects. New opportunities may appear for the client organization when knowing latest news on innovations and products among suppliers.

The day when the client sends out a request for tender among potential and/or prequalified suppliers/contractors, the rules of collaboration change. During the tender stage, the dialogue and communication must follow strict rules securing absolute objectivity and no discrimination of any prequalified supplier/contractor. The code of conduct is firm and demanding and full traceability of the evaluation processes must be guaranteed. The actual client role execution must be correct according to the commercial and contractual regulations for the contract in question. These aspects are dealt with in the following sub chapters 5.2 & 5.3.

The formal restrictions on communication between the parties are of particular importance during the tender process stage. Depending on the contract type, the dialogue during negotiations and clarification meetings should be to the best of the final product. On complex deliveries there is a strong need for close dialogue during the negotiations for firm clarification on scope of work and the associated speficication requirements.
When a contract is awarded, client and contractor start on a contract execution stage highly depending on the mutual respect and dialogue in the daily work in the project.The roles must be clearly defined and mutually understood, as well as establishing a common perception of what the desired delivery is at the handover date.

5.2 Quality & risk in the contract process – the client route

The tender period for the client - the pre contract phase

The client duties are to manage the pre contract process and the overall objectives are to obtain a professional tender phase and receive tenders that satisfy the specification requirements.see figure 5 – 2.

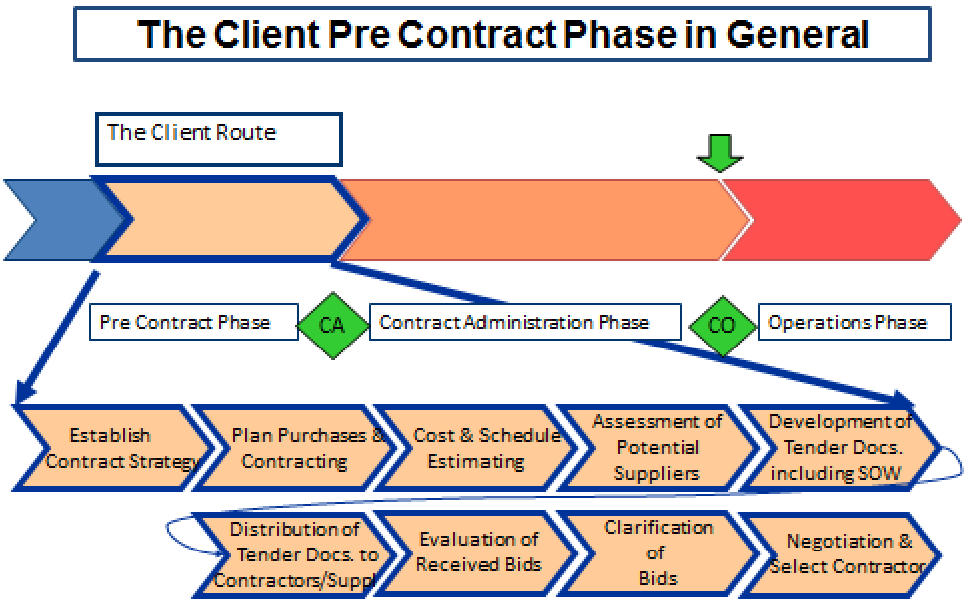


Figure 5-2 Sketch of the pre contract phase in the client route including sub prosesses.

The pre contract stage for the client/customer should include the following steps:

1. Establish a contract strategy including risk strategy.
2. Planning of procurement and project contracts.
3. Own cost and schedule estimates including contingency considerations and budget.
4. Assessment and pre-qualification of various suppliers and vendors.
5. Develop the for tender documents including the scope of work and specification requirements for the delivery.
6. Submit the invitation for tender documents to potential and/or prequalified tenderers as well as derivation of the evaluation criterias.
7. Evaluation of received tenders.
8. Clarifications towaards the respective tenderers.
9. Negoatiantions, screening and selection of supplier/contractor in the projects.
10. Decision and approval of the selected contractor plus signing the contract.

Each step is briefly commented in the following sub sections and paragraphs.

Establish the Contract strategy

The Contract strategy directly influences the product – and delivery quality, as well as the efficiency in the project during execution. Why and how may that happen?
The overall objectives of making a firm and clear contract strategy are to secure a contract & project execution that is well planned, structured and organised. A key issue is that the respective tasks in the project should be performed by the party best qualified to do so, on organisational level and on individual level. In some projects it is most appropriate to establish a contract strategy using total contracts like an EPC & EPCI contracts for the whole or parts of the contract work. (EPC: Engineering Procurement Construction; EPCI: installation added to the EPC). On other projects a split of the total work may be the right solution, due to a range of various aspects. One element is access to the best qualified resources, an other element is the degree of competition. On large complex projects one may experience too little competition if selecting a total contract strategy by using for example an EPCI- contract. Not many companies are capable to deliver on the total package. If it is split into an EPcontract and a CI contract, the number of potential bidders may increase to acceptable level. Alternatively EPCI contracts may be awarded on different area in a project.

The quality dimensions are critical in the derivation of the recommended contract strategy as the selected contract strategy should promote and stimulate to the best quality according to the specifications made.

The contract strategy should be established with the aim of generating a unified and firm description of the product quality in the project.

The product quality is influenced by how the total scope of work is structured and divided into sub tasks and work packages. Sufficient focus should be on derivation of the Work Breakdown Structure, WBS, with particular emphasis on the importance of developing the right interfaces.

The interface recomended practice should cater for achieving the following features:

- Keep the number of interfaces as low as possible
- Make the interface designs as simple as possible
- Derive clear and firm deefinitions of interfaces covering physical dimensions, information flow, organizational and contractual interfaces
- Keep the number of roles to a minimum regarding interface management and administration,

The delivery quality is the integral of the achieved product quality and the delivery capability resulting in delivery in due time within the prescribed time limits/dates for the delivery including the corresponding documentation necessary as facts for derivation of proper plans for inspection and maintenance during operation of use of the project deliveries. The selected contract strategy may influence the delivery quality.

The clients may hit a dilemma when searching for potential suppliers/contractors. Should the invitation for tender be sent to the well established suppliers only, or should you allow new players being prequalified and invited to tender? The selection criterias for awarding a contract should be a part of the overall contract strategy, and those criteria should reflect whether the lowest bidder will be the winner, alternatively, the one with the best solution and best crew on the execution. Should the recorded performance on completed projects/contracts be a part of the selection criterias? The clients should prior to invitation for tender establish the selection criteria including the relative weight on each of them. Is price the most important or is it the qualification of the personell offered together with the proposed solution? The criteria should reflect the importance of demonstrating a management and quality performance in the past that fully satisfy the requirements on quality & risk. If the price is chosen as the dominating criterion, on may squeese the offered prices to a level that has no room for unexpected events and robustness in the execution is lacking. The results may likely be detrimental delays of completion ruining the delivery quality.

These aspects should be key elements in the derivation of the contract strategy and corresponding criterias for selection of contrator as potential delays may be very negative with respect to the detrimantal impact on the project economic estimates on NPV and internal rate of return. (NPV: Net Present value; IRR: Internal rate of Return)

The derived contract strategy should also to some degree reflect the importance of the life cycle costs for the system or product. You may consider a determination of a specific expected life time on key components or systems,and systematically plan for upgrading, improvement or even replacement after som years. That situation is typical for examplen on a cruise ship or an oil installation in which the unit is intact and certified to acceptance for the next operating period on mechanical and structuraal parts, but the integrated management operation and IS/IT security systems must be replaced or being upgraded during the design operating life time.

Planning for procurement and contracts

Good planning is a key success factor for achieving the specified product quality and the associated delivery quality. It is considered valid for procurement in general, and on project contracts explicitely.

Procurement planning for regular supplies should utilise the market to the extent possible and ensure that the the specified component product quality can be achieved in the repective purchases. A frequently successful approach is to differentiate between strategically critical supplies and regular simple supplies. For regular & simple supplies the process should cater for digital & automatic purchases from approved purchase webs, whereas strategic purchase should request thorough assessments of the statisics for performance of the single potential suppliers. The product quality and delivery quality should be checked periodically through system audits and or on technical peer reviews, and the suppliers must demonstrate full traceability and show processes for eventual actions and mitigations if sub standard quality is identified in the product batch.

Quality control of as-received product should be done on the batches delivered at site, and possible deviations must be corrected prior to implementation and use in the total product quality from the project. Key quesstions are:

- Is the actual product quality on as received units as specified?
- Is it the correct number of units of the recived batch of components and delivered at the correct location/site?
- Are the supplies received on the specified date of delivery?

Project Contract planning is facing similar challenges. Is there sufficient time for doing your own estimations on cost and schedule prior to evaluating the received tenders? A firm notion on what are expected level on the estimation figures is essential in order to assess the confidence in the received bids, and the likelyhood of impacting both product quaality and delivery quality.

An other important issue is how to plan the work such that the right resources are involved and dedicated to the respective tasks in the contractor organisation? Past exxperience has shown that project execution success is depending on that the right resources are mobilised and that they are committed to perform the tasks. Those elements are considered among the most important factors to achieve the specified product quality. The contract planning activities for the client should include clauses in the contract with the contractor awarded the contract, such that the key resources offered in the tender show up during the execution as promised and planned. The contractor should not have the option to transfer the promised key resources to another project, unless they may be replaced by professionals with competence equal or exceeding the level on the initially offered resources.

The client’s contract planning should result in determination of the type of contract standard that is most appropriate, and which compensation format that is applied, including the assesment of the risk sharing among the parties. These issues are considered as important elements in achieving the specific product quality in efficient and agile manners as well as minimizing the risk of not meeting the total delivery quality.

An integral part of the client contract planning is development of a proper communication plan in order to obtain a mutual perception and thorough understanding of the specified product quality and delivery quality among the parties involved during the project execution.

That issue is frequently underestimated on large global and multi national projects facing language barriers as well as cultural barriers.

A good communication plan may cater for the language barriers through professional translation and training. However, the cultural barriers are harder to overcome and master and should be paid particular attention. The perception of technical information and messages may be significantly different in the Far East cultures compared to Scandinavian cultures. Building cultural bridges is crucial, and a necessity for achievement of the secified product quality and delivery quality with a range of contributors from different cultures and countries. These reflections are linked with the risk of interpretation and understanding the Scope of Work differently in different cultures. No Scope of Work description is “100 % complete” and without holes and there is a need to overcome these hurdles.

Own estimates on cost and schedule

The client should establish a firm understanding and opinion regarding expected levels of project costs and the corresponding timeline. That could best be achieved if the client performs its own estimates of costs and schedule. The cost figures are normally focusing on the project costs, but life cycle costs LCC are frequently also included. It is of utmost importance that the client organisation has created their own expected figuress on cost and chedule respectively prior to evaluating received bids from potential contractors. On these activities the client should utilize their most experienced professions from the different disciplines in order to derive realistic figures in their own estimates as well as ensuring the necessary competence when evaluating the received tenders from the contractors. Knowledge and long term experience in the various areas add confidence to the process on evaluation and negotiation with the bidders, a condition for selecting the most and best qualified relevant supplier/contractor. The planners and commercial analysts in the client organization nust know the product/services requested and have an overall understanding of the characteristics of the business area of concern.

The presence of first-rate relevant experience in the client organization is “a must” for being able to develop a high quality description of the Scope of Work of high precision with its associated product/service specification requirements, which in tern is a condition for developing realistic estimations of cost and schedule.

The complexity and maturity of the scope are challenges when doing the estimations to a satisfactory confidence level and reliability level. Sound and thorough interpretation of the scope are critical elements in derivation of the estimates, and the client team representatives should posess the necessary experience in order to fully understand the impact of complexity on the estimations. Fresh graduates will normally do not have that kind of experience and knowledge; as a consequence the senior key resources should be appointed to these activities and tasks.

A performance oriented commercial project culture is characterized by firm ambitions on ever increasing efficiency and speed in the projects, typically reflected in increased target figures on cost performance efficiency and progress. Setting new targets is a very fine balance, compromising between high ambitions and realism in the desired efficiency improvements. These considerations are vital elements when doing evaluations of the estimations on cost and schedule from the various tenderers. If a bidder has introduced a performance productivity norm far above experience, the experienced assessor in the client team should easily identify the lack of realism in the tenrderers estimations in their bids. Furthermore, if the tenderer has used a set of productivity norms beyond its experience data base, outside its validity range, one should flag that immediately during the dialogue and negotiations with the potential contractor.

The client evaluation of the scope of work and reviewing of the estimations made by the potential suppliers should be performed with a totality approach including the benefit potential assessment rather than just focusing on cost and schedule isolated and independently. The competence among the client representative must be able to detect any disharmony or inconsistencies in the estimations provided.

The result oriented commercial approach in many industries has a tendency to put extra effort on minimizing costs and reducing lead time. Cost consciousness is important, but a boomerang effect may appear if there is only focus on minimizing the investment/development costs for the project, and not include considerations on the predicted business benefits/effects of use of the product or service deliveries. Solely focusing on minimizing the development costs may lead to suboptimizations and hit back on higher operation costs and lower capacity in use resulting in reduced return on investsment.

Unrealistic estimations on cost and schedule may increase the risk for not achieving the specified product quality and lead to delays relative the overambitious timeline. In many projects there are interdependencies between cost and schedule which must be assessed thoroughly as it may likely impactt the product and delivery quality.

Achievement of the specified delivery quality may better be reached by doing planning in close interaction with the commercial and contractual work in the project. The plan should be used dynamically and having featurs of continually simulate effects of various changes in scope and project execution. For the project manager, the derivation of the critical path provides information for use in prioritization of the management and leadership efforts during execution. Knowing at any time where the critical path is, helps the project manager to focus on the activities and tasks resulting in a domino effect or knock on effect when delays appear in any of the activities on critical path.

A good project plan, with firm milestones and activities, will contribute to achieve the specified product quality, a necessity for achieving good delivery quality by handover to the operation/user as planned.

Assessment and prequalification of contractors & suppliers

In many projects the value generation and work are performed by contractors and sub contractors, in particular in larger development and investment projects like implementing new Enterprise Resource Planning solutions or larger multi discipline construction projects of any kind. The process for selection of the right contractors and suppliers is more important than ever in order to secure a delivery and value generation of high confidence and high-quality standards. The potential suppliers and contractors must be able to provide a proven track record from previous projects demonstrating performance excellence, but also guarantee that they are qualified and capable of doing the work on the new project, competence wise and capacity wise.

Qualification and prequalification schemes should be paid particular attention.

A specific prequalification process should be considered in any case on a new project, and for potentially new entrants a prequalification programme should be mandatory in order to fully demonstrate and document that they have

- The capability of delivering what is requested according to the contract scope of work and associated specification requirements
- The capability of meeting other specified delivery requirements

- A well established and documented management & quality system with firm quality assurance and quality control of the output product quality, according to ISO and or supplementary client specific system requirements
- Documentation of an organisation sufficiently robust to master possible enhanced and intensified requirements from the client with respect to the product quality as well as accelerated delivery requirements
- A well documented track record of achieved high performance on the project deliveries and to the satisfaction of the specified quality requirements from the clients.

For new potential candidates a more thorough prequalification process should be executed. On component supplies, the prequalification should check and evaluate the production capability and system including check and control of their sub suppliers and documentation of component documentation including certificate of compliance etc. In construction contracts the pre-qualification could include socalled “Mock Ups”. A mockup is a scaled model of parts of the delivery that is expected to be representative for extra high complexity areas/topics and is considered to be particularly demanding to produce. The mock ups are test objects of particular relevance to be completed to satisfaction, prior to awarding the real project delivery. For IT projects a pilot may serve a similar purpose; to add confidence to the actual development and execution processes.

Within mechanical industry and construction yards for marine vessels and offshore platforms, a mock-up will typically represent a structural part or section that is particularly demanding to produce, and the mockup is testing the most challenging design and fabrication elements in the actual delivery.

A prequalification should be performed over a longer period in order to check whether the specified production quality is predictable demonstrating that a minimum of variability can be achieved at the contractor in question.

The client organisation may limit the effort of qualifications of a supplier or contractor if it is already prequalified within the area of interest. For such cases, periodic system audits of the organization may be sufficient. The system audit should cover a review and assessment of the management and quality system, how it is implemented in the respective production lines and in the single projects. The organisations’ ability to handle deviations and non-conformances is an important element in a system audit, as well as how the requirement on a process for continual improvement is implemented and executed in the production line and in the projects.

The process and evaluation of potential suppliers should also include inspection and check of certificates of various kind, applicability ranges, due dates and validity.

Any client is searching for the best suppliers who demonstrate a performance with high delivery precision and that are competitive on price.

The recommended approach during a system audit by the client for the purpose of qualification of suppliers is to focus on the most important issues and not handle all findings with equal criticality and importance. The objective of the system audit is to contribute to improvements not to be the "procedure police". The client should in that context approach the issues through dialogue and not through suspicion. The project deliveries on project contracts are fully depending on creating a trustfull and constructive dialogue & relation between the client and contractor as both parties have strong influence on the project delivery, the product quality as well as on the meeting the delivery conditions and achieving an efficient production and execution in the project.

The evaluation and qualification should also include an assessment of the suppliers' ability and capability to carry and manage the execution risk on the contract of concern with respect to risk connected to financial, technical, organisational and human resource issues.

Among the potential sources of risk listed above is the risk of lacking well qualified and competent human reopurces among the risk that should have particular attention. That issue is of concern in almost any industry or public sector however is considered as extra demanding on technology founded projects, typically within IT, infrastructure projects and larger investment/construction projects in oil & gas, and shipping.

A system audit of qualified suppliers and contractors should include a check and inspection how the tcehnical experts are to be involved in the project product processes. That may be of particular concern on suppliers with extra high organic growth as there might be too few resources with the necessary competence and experience for the tasks in the portfolios of contracts awarded. The consequences may be that inexperienced human resources are used resulting in a negative impact on the actual product quality. In general, an organic growth above 10 % annually should be a warning signal to the clients, and that information should be delt with in the system audit. One of the effects of a high organic growth is that the most experienced human resources must spend extra time on training of the new employees which is often a condition for making the new employees capable of utilize the processes and established procedures in the organization. As a consequence, the most experienced resources have less time available for the work performance, which in short terms lead to a reduced production capacity with a risk of poorer quality in the deliveries fom the projects and the organization. These aspects should be identified and elaborated during the evaluations and qualifications of contractors and suppliers, both the established and new entrants.

Development of the invitation to tender documents including the scope of work and specified product quality requirements

The invitation to tender documents must cover any aspect that affects the achievement of the the specified product delivery to the requested quality level. In that context the scope of work is a key and is addressed as a separate knowledge in the PMBOK, Project Scope management.

The development of the Project Scope of Work is considered to be one of the tasks of the largest challenges in project management and quality management in projects. The project scope of work is the basis for all proceeding activities during the project execution, and project success is fully depending on a firm and well written description of the scope. It does not help to be a champion in project control if the scope is improper and diffuse which may be the primary cause to increasing the execution risk. The ambition and requirements to the Scope of Work are to develop a description that is concrete and committing, but at the same time solution and brand neutral. The potential tenderers should immediately recognize what the scope of work is about. The corresponding product specification requirements should be supplier neutral and not tailor made towards one supplier exclusively. Such quality features may best be established through extensive use of functional requirements than through application of detailed technical specifications. That approach makes it easier to become solution neutral which is a condition that the invitation to tender is relevant for a range of potential contractors and suppliers, not exclusively to the one with a specific solution. Over the last decade there has been a trend that functional specifications are the dominating approach rather than detailed technical requirements as the functional approach provides you with an expected extended validity period before the need for revision and upgrades compared to the classic detailed approach. This is particularly the case for the software industry in which the product and technology development happen at a rate that the international protocols and standards cannot meet if the detailed approach should still be the preferred approach. Thus, functionally based specification requirements may cope with those facts and requirements.

A key challenge is however the following:

- How to make firm and committing functional descriptions and associated functional specification requirements that are mutually understood and can be tested and measured in use?

That work requests involvement by the most experienced human resources in the organization that should have the capability of combining the demand for senior expert competence and the totality view. Those issues are important for derivation of the functional properties and specifications that are project specific with respect to operation and use as well as performance and efficiency of the product/service delivery.

In the process of development of the scope of work the degree of uniqueness is a variable to account for, or could standard solutions and standard components provide you with a product quality as specified?

The actual total product delivery must meet the project specific quality and performance requirements. Which design and product development philosophy should apply? There is a general demand in most industries to maximize the use of component standardization combined with reuse of technology and system solutions. Such an approach should normally be the preferred and recommended, as it will provide you with a reduced technical risk and at the same time may readily lead to cost reductions. A positive effect is expected on the total product quality with the priority of using component standardisation and reuse of technology, as thoroughly tested standard components and solutions most frequently have gained a reliability and product quality level that is not expected achievable on a first time of a one-off component or product.

Distribution of invitation to tender documentation to potential contractors and suppliers

The clinets are obliged to create consistent and identical conditions for the companies invited to deliver a tender on the respective project contracts. It means that the invitation for tender documents must be shipped to all potential and pre-qualified contractors and suppliers simultaneously.

All formal rules must be strictly followed, and the client representatives must show an extreme caution in their behavior and communication with potential contractors and suppliers during the tender process. Confidentiality must be absolute during the entire pre contract stage.

An important element in the pre contract stage/tender stage is to establish a set of evaluation criterias for evaluation of the received bids. The evaluation criteria should be developed prior to any review of the respective bids. Normally the evaluation criteria should appear at the time of shipping the invitation for tender to potential contractors and suppliers and the evaluation criterias could be included as part of the invitation for tender documentation. Frequently the client derives a relative weighing of the various evaluation criteria. For standard purchase of standard components, it is likely that price is the most important criterion conditioned upon that the specified product quality is met. On research contracts the situation is the opposite. For such contracts the ability to deliver the desired quality in the research work is mainly depending on the competence and qualifications to the scientists, and the cost is of less importance in the selection process for the provider of a research project contract.

The evaluation criteria should cover a range of appropriate perspectives. Among these are:

- Perception and understanding of the scope of work by the potential contractor
- Technology and proposed technical solution
- Capability of achieving compatibility and compliance with the clients systems and solutions
- Innovation capability
- Documented delivery precision
- Organisational capacity to carry the contract through to delivery.
- Documented customer satisfaction
- Price
- Degree of service and follow o.n
- The way of organizing the task
- Key human resources and competencies
- Communication plan and proposed dialogue practice with the client
- Reputation & Corporate Social Responsibility, CSR

- Health Safety and Environment, HSE, and recommendations on Security issues, when relevant.

Relative weighing of the evaluation criteria are logic in most cases. A plain delivery project should not have the same relative weighing of criterias as for a research and innovation product development project. For the latter category of projects emphasis should be paid on expert competencies and the ability to establish and run an innovation process, in which costs are less important.

A mutual understanding must be established in the client organization regarding the type of criterias to be used and the relative weighing between them. A joint understanding among the client team representative must be established prior to the evaluation of the received bids.

Evaluation of received bids.

All bids received shall be treated identically and consistent according to the rules and established evaluation criterias. The evaluation team makes a plan for the evaluation and how the evaluation criteria should be applied. In some organisations, the evaluations may be split into a technical and a commercial evaluation, which is quite typical regarding larger contracts. However, it is of utmost importance that the established evaluation criteria are used correctly and consistently, and all evaluations shall be traceable. A final evaluation should be performed combining the technical and commercial considerations including assessments of eventual clarifications with the respective bidders.

Clarifications

Quite often there is a need for clarification questions between the client and the bidder.

Clarification questions from the tenderers shall be responded by the client and the communication should be distributed to all tenderers on the task.

Correspondingly, the client may contact the respective bidders for checking whether there are some direct misunderstandings in the received bid.

Negotiations, ranking and selection of contractor/supplier

The nature of many projects is considered as complex which makes it particularly challenging to plan and execute the tasks. It will in many projects become almost impossible to derive a bullet proof scope of work, and consequently there may be significant uncertainties associated with the understanding and perception of the scope and possible constraints during the project period. Thereby, the assessment and interpretation of the scope and tasks with the complexities present should be evaluated in a common dialogue and process between client and contractor. That approach should be flagged in the invitation for tender documentations and addressed during the negotiations.

Professional negotiation skills are advantageous when doing negotiations with a series of bidders. During the negotiations it is important to establish a mutual understanding and peception of the characteristics of the scope and the complexity of the tasks, a critical issue for successful planning and execution of the project contracts.

When the client has received bids form several tenderers, a recommended practice is to start a screening process and initiate negotiations with a limited number of tenderers. The bidders are given a chance to present their proposal prior to the actual negotiations. After an introductory negotiation the list of bidders may be shortlisted, and the second step of negotiation may be done with just two or three candidates. The final negoatiations may thereafter be performed with the preferred tenderer.

The conclusions and proposals are put forward to the appropriate management level for approval.

When a decision is made, the winner is first notified followed by information to the other bidders. Evaluation feedback should be provided to each of the tenderers.

Signing the contract

The decision and approval of the selection of contractor is formalised by signing the project contract for the project or area in question. Then the client and the selected contractor should plan for a kickoff meeting and a launch of the execution stage in the project contract.

Contract Administration and Execution in a Client Perspective

At the start of the execution stage a formal kick-off meeting is recommended and frequently mandatory in which the main issues in the scope and the contract are presented to the entire project team. The client is focusing the requested quality all over through systematic planning, execution and control. The corresponding support processes for the client role are illustrated in the client administration stage. See figure 5 – 3.

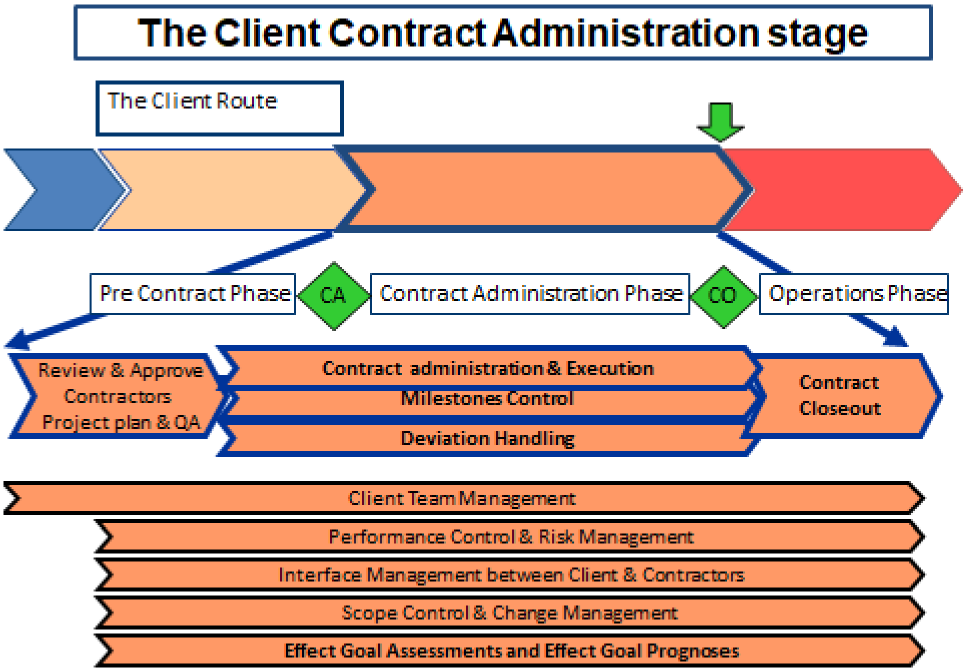


Figure 5-3: The client process for contract administration and execution

The contract management during the execution stages would normally include the following steps that are frequently partly running in parallel:

- Review and approval of the contractors' project management and quality plan
- The contract execution and administration of it
- Milestones control
- Deviation and non-conformance handling
- Contract close-out

Review the contractors project management and quality plan.

The initial process step shall secure that the client and the contractor have a mutual understanding on how the management and quality plan should be utilized and followed.

The client shall approve the management and quality plan provided by the contractor. In the evaluation of the received plan, attention should be paid to the understanding of roles, what does the plan mean and what should be measured and checked?

Contract management and execution

The client contract management and execution approach is depending on the type of product or service, the degree of ucertainty and maturity of the tasks, the type of contract standard and the corresponding compensation format established in light of the predicted execution risk and who is best qualified to carry the execution risk.

From a product quality point of view, the client should preferably focus on milestones control and not on detail check on the single activities in the contractors' activity plan/production plan.

The client should also show respect for the contractors' approach and strategies on how to manage and perform the tasks. In that context, the client should not request new functionality added to the original scope without careful consideration of the actual impact on the execution of the contract scope. The total product quality may suffer from ideas introduced along the execution and may lead to sub optimization and delays of the total delivery. The contractor may be confused, it may disturb the planned work execution methodology derived and the change proposal may request an alternative execution methodology by the contractor.

The client has contractually the right to instruct the contractor to do the change and the requested change proposal is communicated to the contractor through a formal Variation Order, VO. Key questions connected to the introduction of a requested change are:

- What is the impact on the schedule, and
- What is the impact on the total costs for the entire project, not the change proposal isolated?

Change management is the tool in that context as outlined in chapter 4.3. The total impact on costs may be far more than the requested added manhours for the tasks in the change request itself, as it may in some cases lead to the need for alteration of sequence and approach in executing the project scope in total. The so-called accumulated effects must be evaluated in that context.

Good role descriptions are important during the contract execution. The client team shall manage and govern the main contract execution process and the associated sub processes as decribed in the contract. Of particular remark is to ensure that the client team does not take over the design responsibility from the contractor and is interfering with the contractor through the execution and production stages with frequent interruptions and alternative proposals to the solution. This is a balancing act. If the client team is more experienced than the contractor team, there is a risk that the representatives in the client team would like to take over the development process. That may create a mess through mixing roles and who is in charge of the design and development process. Such a takeover by the client team is ruining the collaboration and breaking the rules for who is accountable for what according to the established contract. The client team may move into a weak position if the client interference has resulted in deviations and guarantee claims.

Cntract close-out

High performance contract management is achieved only if the contract closeout is done according to the established processes, procedures and standards in order to generate and deliver the specified product quality and to the satisfaction of the requested execution quality through efficiency and dynamic flexibility. Included in those activities are commissioning and testing for confirmation of satisfaction of the specified quality of the product or service.
As importance is that the receiving user organization is prepared and trained to receive the product or service; it is valid whether the receiving organization is an external client operation organization or an internal operation production organization. It does not help that the contractor/supplier is capable of delivering the right product or service, if the client organization is lacking basic competencies for implementation and use of the product/service. Such a situation may happen during implemention of a new software solution and system if it is done without sufficient training of super users prior to the implementation.
The client contract management during execution is depending on firm and confident follow up on the corresponding parallel sub processes.
The identified sub processes during contract administration and execution include the following:

- The Client contrat team
- Performance measures and control
- Risk & opportunity management
- Milestones control
- Interface management and control on the scope and in the interaction between client and contractors
- Project Scope management
- Change management in the project contract during execution.
- Management control on effect goal prognoses

Each of these sub processes are briefly described in the following sections.

The client contract team

Good contract management is reflected in achievement of high quality deliveries from the contractors according to the scope and constraints established for the respective contract. Relevant experience in contract work is considered as a necessity among the client team members. They should be capable of managing the execution processes and create a stimulating dialogue with the contractors. Both the client and the contractor have major impact on the product development, efficiency and progress in the project contract and the actual contract itself regulates the relations between the parties. Of importance are relational competences and the ability of being solution oriented.

The client's contract management team should consist of members with different background that creates a team with cross functional and multi discipline competences, a necessity for performing the contract management with a holistic approach under a regime of firm direction, determination, and flexibility.

The recommended management approach is to become solution oriented rather than dispute oriented, as experience in general has shown a higher efficiency performance when solution being oriented. That attitude should be present amomg the client team members as well as among the representatives for the contractor and performed in the light of the commitment to deliver as specified, and according to the constraints present in the contract.

Milestones control

A realistic and ambitious milestone plan is an important element for project success. Each milestone must be clear and firm, measurable and easy to control, and the sequence of established milestones must be logic and obvious.

The overall milestones plan, established by the client, should schematically characterize the logic sequence of actual value generation in the project contract. That milestones plan must be included in the invitation to tender documentation distibuted to the potential contractors & suppliers and used for management control of performance and control during the execution.

Milestones control has particular management focus during execution. The sequence of milestones in the milestones plan will normally be stable, whereas the coreesponding activity plan may vary since all details may not be known or fully documented at time of decision for launching the project.

What are the desired characteristics of a milestone that makes it manageable and controllable?

According to Andersen et al. & Jessen, the milestones must be SMART:

- **Specific**
- **Measurble**
- **Ambitious**
- **Realistic**
- **Time determined**

The term *Specific* addresses the need for a description of the state at the milestone that is mutually understood by the parties involved. *Measurable* pinpoints the desire for measuring and checking the state. *Ambitious* should reflect the attitutde of stretched targets on part deliveries or schedulewise, whereas *realistic* is included for balancing the ambitious attitude with what is possible to achieve. The term *Time determined* focuses on the expectation of reaching the new state at a certain time.

A specific definition of a milestone is "A new state is achieved", not a time limit as such. That might be considered as a paradox to the requirements above asking for the characteristics *Time determined*. An example on this type of definition is as follows:

- «System engineering is complete to the specified detailing level and maturity».

The milestone is not achieved at a certain date if the state is not reached according to the specification. If that is the case, there might be better to continue until the milestone state is achieved instead of moving to the next stage or phase at that predescribed estimated date for completion of the milestone. However, good planners with appropritе experience are able to predict expected dates of achievement of the various milestones, and the milestones may be set in a timeline with reasonable confidence.

A negative situation may likely appear if the work moves on into the next stages of work without fulfilling the milestones requirements. The results are a condition in which non-completed work must be taken in parallel on top of the planned activities for the next period. That may add complexity, the efficiency is expected reduced, and in extreme situations the the planned work in the period must be delayed until the specified milestone state is achieved. The non-completed work is in some projects defined as «carry-over work» and often documented in «punch lists». There are numerous examples of bad project managemment in that respect.

Performance management and control

The task connected to each contract shall be firmly and clearly defined in a scope of work as a part of the contract. The scope of work should be so precise and easily understood that it is likely to derive a firm work breakdown structure, WBS.

The scope of work should contain functional characteristics and features that are possible to measure and check during the project execution. The Work Breakdown Structure should preferably be object orieneted and designed such that the breakdown hierarchy firmly describes the part objects of the entire task in a consistent manner. The number of interfaces should be at a minimum and logically describing the split between the various parts in the WBS, reflecting the physical, organisational and contractual interface issues.

The scope of work and the tasks should be thoroughly understood by all members in the client contract team and demonstrate commitment and discipline with respect to the limitations in the scope, a necessity for success. The conditions and premises may however change during the execution and a review of the scope and task are requested. A revised scope of work may result and the corresponding consequences must be addressed fully. A projectbaseline revision is a natural consequence.

The scope and task control by the client will vary, depending on the type of contract and associated compensation format. Client contract management shall be fundamentally different under a lump sum regime compared to a plain reimbursible contract. With a lump sum compensation format the client contract management should essentially follow the principle of milestones control on the main milestones, supplemented by reviewing the received periodic status reports from the contractors. Success on a lump sum contract is also depending on establishing a common perception and understanding of the scope between the client and contractor at start-up of the executtion, whereas practice a minimum involvement in the work during execution, except control of milestones achievement.

A lump sum compensation format should first of all be used on tasks and projects in which the solution is well known and conceptually mature. Then the scope of work can be documented with a high degree of precision and the number of uncertainties is expected to be very limited. Under such conditions the contractor/supplier should be capable to carry the execution risk on their part of the project and hand over a product to the client organization with the specified quality and in due time. A challenge for the client may be to stick to the original scope of work in the contract and not introduce new ideas and added scope every second week during the execution.

The situation is totally different when a reimbursable compensation format is applied. The reimbursible compensation format should be used primarily on tasks that are immature and not easily defined, characterised by significant uncertainty and unkown variables. The results goal, the product delivery may be experienced as a moving target and difficult to manage with a lump sum regime. If a lump sum format should be applied on a diffuse scope, the risk premium would be very high if the market is in balance. That means the potential contractors are not willing to do a job which is vaguely defined without protecting themselves towards unexpected and unidentified cost triggers. A typical situation of that category is modification and upgrades of an old system, rebuilding of an old house and modification and upgrade of a vessel, process plant or offshore platform. The As-Is condition is often not well documented and there may be a lottery to start doing the modification work. It is considered not fair and not appropriate if the contractor shal take the burden of the unkowns on such tasks. Thus, the execution risk should be carried by the client under a reimbursable regime as the client should be governing the entire exceution process. It requests however that the client team has the necessary capability of managing and controlling the execution work. The reimbursable contract compensation request a sufficiently strong client team, capacity wise and competence wise that they can demonstrate a firm and consistent management approach. As a consequence the client contract team on a reimbursable contract must be larger than on a corresponding lunp sum contract on a mature and well defined scope. Lacking qualified resources in the client contract team may be risky as the contractor may speculate and misuse the trust established as a premise for the execution.

Change management

Change management during projecte xecuttion is a critical part of the project management and control. The client must demonstrate that the cient role is mastered and managed in a professional and systematic manner such that any change proposals and requests are undergone evaluations and considerations according to established processes and procedures.

The change process is briefly described in chapter 3.3, Change management in projects and schematically illustrated in figure 3 - 1. A key question is on what ground the change proposal should be evaluated and assessed, which evaluation criteria are valid.

In general, the evaluation criteria for changes should be derived during the planning of the project, prior to any formally requests for change. The chance of objectivity is increased as there are no personal favourites of changes present at time of derivation of the evaluation criterias. The impact of the emotional and subjective perspectives is thereby reduced.

Interface management and control

Project interfaces are of particular concern and should have prioritised management attention. During the design of the WBS, the Work Breakdown Structure, focus should be on the interfaces as they are primary sources of risk and affects the product quality as well as the project efficiency. The interfaces cover physical interfaces as well as contractual and organizational interfaces. On physical interfaces typically key issues are dimensional tolerances in the end product, achievable by through well defined physical interfaces followed by firm & precise measurements and distributation of the dimensional tolerances on different parts.

Cross functional and interdisciplinary understanding is also key topics when elaborating the interfaces. On buildings, the cross functional and muti discipline approach must be in the mind of the architect from day one of the idea- and feasibility study and onwards. A robust design is desirable, and location for cable shafts etc should be determined already during the feasibility study. Fortunately, modern digital tools may provide you with clash checks in a 3D model of the building with all disciplines involved, structural, electrical, mechanical, HVAC etc. The object-oriented BIM models are appropriate for that purposes (BIM: Building Integration Model) ensuring confident clash checks and a multidisciplinary approach.

BIM is considered as a powerful dialogue tool between the parties involved, between architect and engineering, between client and contractor, and should be fully utilized in the decision-making processes in the design development, construction and assembly. Extensive digitalization and real time big data processing increases the confidence and preciseness level of the BIM models and contributes to enhanced confidence, quality and predictability in the decision making during the project phases.

Contractual and organizational interfaces should be controlled with respect to the respective roles involved, how the various parties are performing during the contract execution and project execution. The contractual interfaces are to be checked according to interface descriptions on the running contracts, whereas the management of the organizational interfaces request particular attention on organization design & structure, as well as the roles and responsibility for the respective roles and parties involved.

Uncertainty management during execution

Uncertainty management, both risk and opportunity management is becoming more and more a primary decision support tool for managing the projects and contracts. It should be used as a proactive tool, not an alternative tool for post evaluation and post auditing and post control as briefly outlined in chapter 2.6.

The client organization should establish their own risk and opportunity matrices with the corresponding action/mitigation efforts for resolving the most critical elements, top 3 or top 5.

The confidence and quality on the uncertainty management is relying on how the processes are developed and followed. In particular, the following three elements request particular attention:

- Identification of the risk and opportunity elements and the corresponding process
- Development of firm documentation for the decision of recategorization of the top 3/5 risk and opportunity
- A committing plan containing who should be involved in the mitigation, who is in charge, and due date for implementation.

The brainstorming sessions for identification of potential risks and opportunities should involve senior resources with relevant experience and including representatives out side the client team.

The top 3/5 risk and opportunity elements need attention and reaction. For the risk element a recategorization is likely necessary from unacceptable levels to acceptable levels. For the identified and ranked opportunity elements, there is a need to predict the potential of realising the opportunities. The recategorization shall be based on facts and firm predictions, not on general consideration and "gut feeling". In particular, the justification of down grading the top 3/5 risk elements must be based on analyses and facts. Also the upgrading of the opportunity elements must be rooted in proper analyses on facts in order to not being too optimistic. The recategorisation on top 3/5 risk and opportunity elements should require management approval, to avoid a potentially subjective reassessment of the uncertainty variables by those affected and involved.

The third step in the qualitative event oriented risk and opportunity analyses is to develop and design the actual actions/mitigations for making the recategorisations come through. A firm and committing implementation plan must be developed, including who shall be involved, who is in charge of the implementation, due dates for implementation and final approval of the implementation.

Effect goal management

The clients' overall objectives for launcing a project is normally the effect of the use of the product delivery from the project. For users of a received product, system or service, the desired effect is the impact of using it. For a ship owner, the overall objectives are to get the vessel into service as fast as possible with the desired capacity, features and functions as specified. The business benefit for such an investment is reflected in for example the prediction of the net present value, NPV of the investment. Of non-monetary variabales is the demand for maintaining or increasing market share when introducing the new vessel to the market. It will add confidence to the client contract team if they have a firm grip on the predicted effect or benefits of the use already during the execution stage. You may have a situation in which the cost expenditure is close to planned figures however the progress is significantly behind as planned. The importance of time is of importance regarding the predicted effects and business benefits, as delays are detrimental on the predicted NPV due to the delayed start up period for the use of the product/operation ras well as one may loose market share if the product is not delivered according to the planned schedule.

The desired effect goals and business benefit estimations may remain stable through the project execution phases, although the actual product delivery/solution may change significantly during the execution. Such a condition may typically appear in IS/IT development projects in which the requested effects may be specified, although the solution may not be fully developed at the start of the execution stages, and the development of the solution is experienced as a moving target. In that context, the client should monitor and review the predictions of expected outcome on the desired effects, not just the classic project management control parameters on the product quality, cost and schedule. If the forcasted effectgoal/business benefit predictions are below the planned level the figure is below the target line as shown in figure 5 – 4. Necessary management actions should be triggered if the performance on the predicted effects and benefits are as shown in figure 5 – 4. For fully dynamic project management control of performance should preferably be on the predicted effects and benefits rather than the product delivery which is developed through iterational processes and are characterized as moving targets.

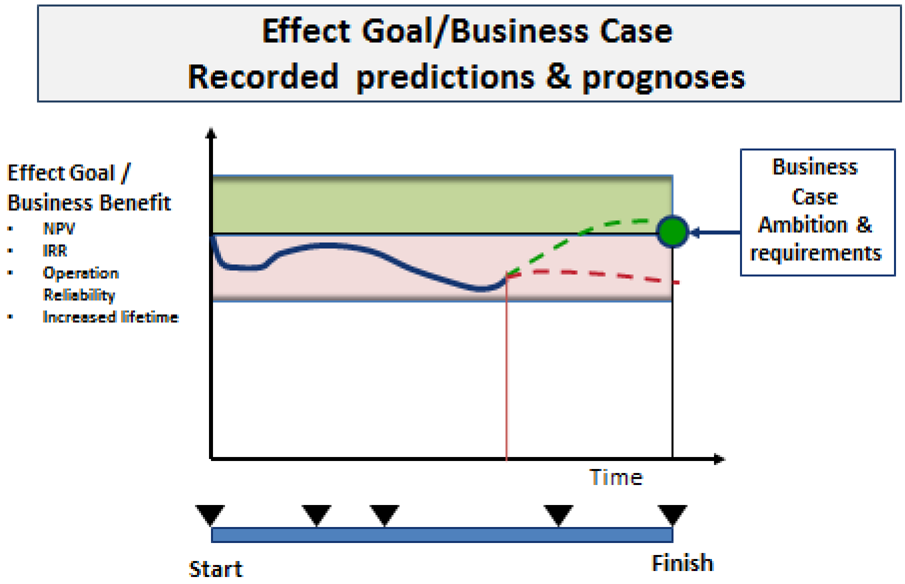


Figure 5-4 Sketch of review and monitoring of predicted business benefit/effect goald during the execution of the project

There might be situations that questions are raised in the client organization whether the predicted effects or business benefit may be improved compared to the initially approved business case target. Such considerations could be catered for by using option design principles in the conceptual design & solution. If planned for options, a marginal added investment may pay off far in excess of the extra investment, which is schematically illustrated in figure 5 – 5.

What kind of options do we talk about? Within oil & gas industry, the following examples are illustrating the phenomenon:

- A key feature of a floating production unit is the deck area. When using a socalled FPSO, Floating Production Storage & Offloading unit, an extra storage tank represents minor added investments compared to the total investment in such a vessel. The majority of the costs are connected to the topside process facilities. In addition to the added storage capacity the extended vessel will then have an extra deck area which is available for later expansion and add-ons of future tie-ins from neighbouring satelites.

- Over-sized oil & gas pipelines. The largest investment when introducing new offshore oil & gas pipelines are connected to the laying operation and the laying contract with the service contractor on the laying barge. An expanded pipe diameter adds only margical investment costs though the extra steel in the pipe it self, whereas the laying costs remain essentially the same. A 10 % increase in pipe diameter, increases the capacity by more than 20 %, an important figure when considering new field developments and increased reservoir volumes.

The desire for added capacity may readily show up on larger oli & gas field developments, if the reservoir contains larger reserves than initially estimated and/or there is a demand of bringing in new marginal field to the existing transport system.

In summary, the operators must consider options and the corresponding added investment in a commercial risk perspective. Are the operator and the partners on the license willing to invest in an extra cost in order to make options real in practice? It is essentially a business risk considereation, but there is also a socio economic and political dimension as there is a governmental requirement to steadily increase the oil recovery. The case is schematically illustrated in figure in figur 5-5.

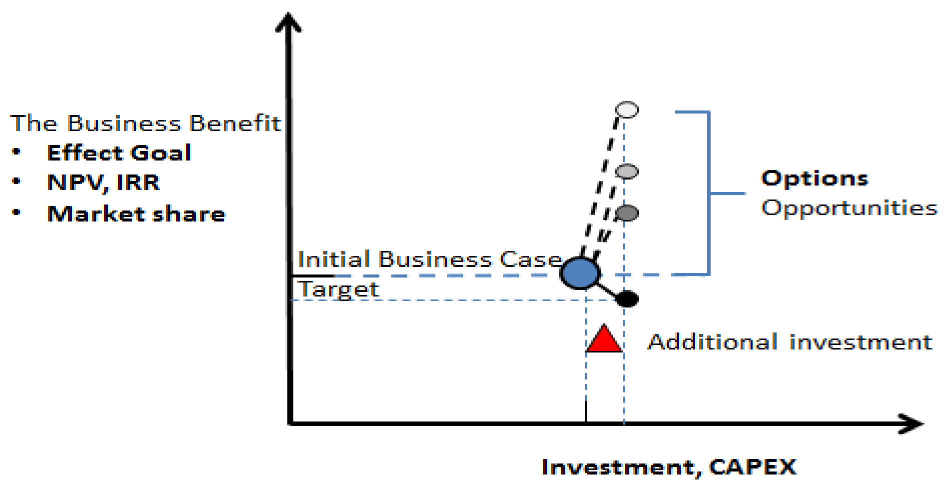


Figure 5-5 Simplistic illustration of likely options through added capacity in the solution/product delivery

In figure 5 – 5 the triangle symbol represents the eventual added investment and covers the downside risk in terms of marginally reduced predicted NPV, if the options are not becoming real during operation. If the options become real, there are predicted significant improved business benefits in terms of an increased NPV.

The business risk strategy to an enterprise influence whether it is willing to invest extra in order to be prepared for future opportunities. The use of decision tree analyses one may make facts-based scenarios with predictions of the added business benefit.

The considerations outlined are valid for any types of projects. It is as relevant for IT product development projects like implementaion of a new CRM or ERP system in which built in extra functionality up front may easily pay off during rollout, implementation, and operation.

Performance measurements and control

Satisfactory performance management and control of the project contract with a contractor or supplier is depending on the capability of making confident measurements and control on the respective contracts in order to make sure that the progress is as planned and the dvelopment of the product follows the planned route. That approach is applicable on all project control variables plus eventually the corresponding effect goal and business benefit parameters. The client management control on cost and schedule is making comparison with the project baseline in the periodic reporting.

The review on monitoring of the product quality and features should have priority. Frequently, the product quality is of overall importance relative cost and schedule. The client may perform technical verification or peer reviews, either in a 2nd party role by doing it themselves, or through engagement of a 3rd party. Likely methodologies are described in chapter 3.4. However depending on the case, an independent review may satisfy the need for establishing the state of the product. In other cases independent analyses should be performed.

In market critical product development projects, priority is on launch date combined with the achievement of the desired functionality to the product delivery in question. Provided the planned launch date is fixed, the performing product development team in the project should concentrate of the most critical functionalities of the new product and the gradual evolvement of these. In project performance control, a likely format is to establish a so called "Bull's Eye diagram" for the actual product quality development. That is schematically illustrated in figure 5.6. The two most important features & functionalities of a product under development might be capacity and energy efficiency. Periodic monitoring and measuring can then be plotted in the diagram as shown in figure 5 - 6.

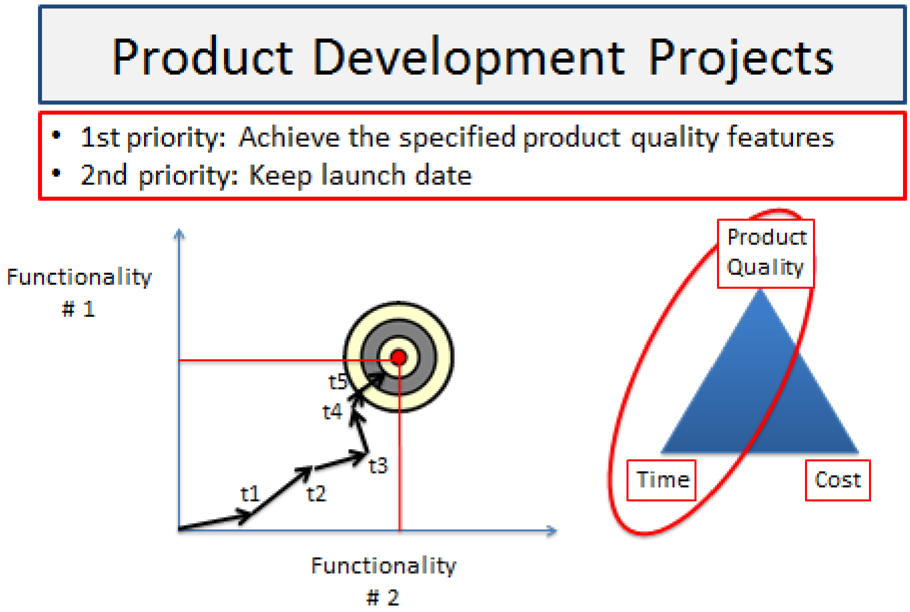


Figure 5-6 Performance monitoring and control of the product/system quality on the two most important functionalities to the desired system

Figure 5 - 6 pinpoimts the gradual development as the recorded figures in combination improves from one cut-off reporting period to the next and hopefully in due time, the desired capacity and features are met well in advance to the planned launch date. That approach is considered to the desire for simplicity in periodic recording and reporting and at the same time focus on the most critical parameters.

The preferred project execution strategy is also reflected in figure 5 - 6, as it firmly illustrates the priority on time and functionalities over development cost. That profile is typical for market sensitive product launches of software and hardware. The rationale is that there is less harm on the total NPV if the development costs increase, but launch date is maintained and the features meet the expectations in the market. The predicted market share may then be achieved or exceeded.

5.3 Quality & risk in the contract process for the contractor

The pre-contract stage for the supplier/ the tender phase

The likelyhood of achieving the specified product quality is highest if the task is awarded to the one who is best qualified and capable of undertaking the job specified in the contract and associated scope of work.

The potential tenderers must firmly demonstrate their capability of performing the scope and tasks specified in the request for tender documents, with respect to the competence as well as capacity combined with the attitude of delivering the as specified quality on the product/service in an agile and efficient manner.

The tender period should follow a process with the steps as included in figure 5 – 7. Some steps are strategic/tactic issues, the following are about the development of the tender and the associated negotiations. The main steps in the tender process are discussed in further detail in the following sections.

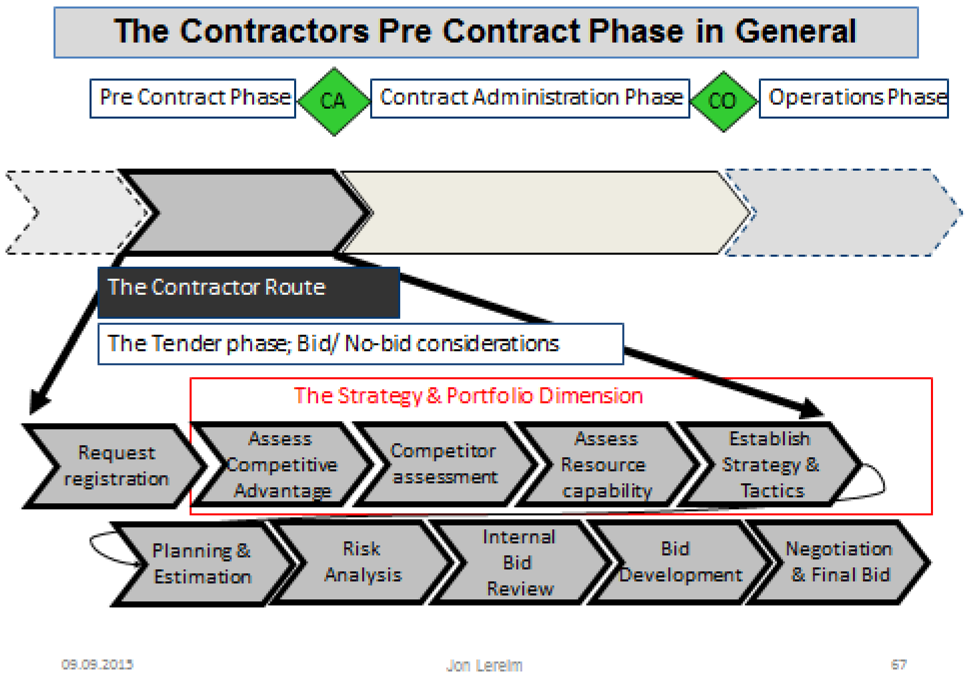


Figure 5-7 Pre-Contract period for a contractor/supplier

The first step in the process should be a formal registration of the request for tender followed by a categorisation of the type of request. Is the request from a new client or is it an urgent request from one of the primary customers. An initial prioritization should be performed including differentiation between existing clients and potential new clients. The relative prioritization should however reflect the market conditions for the contractor/supplier and the relative strategic importance.

The following steps in the tender process for the contractor are of strategic/tactic nature and should include topics and issues such as:

1. An initial assessment of the request for tender in light of your own competitive advantage and own uniqueness on the actual request for tender.
2. Assessment of your competitors on the scope and tasks in question on the actual request plus review of the competitor's workload situation. Are they "sold out", or still have spare capacity may significantly influence the pricing.
3. Assessment of own capacity.
4. Assess the priority of the request relative the current portfolio on ongoing and awaraded contracts.
5. Assessment of strategy and tactics on how to deliver in light of your own capability in terms of human resources and own equipment.

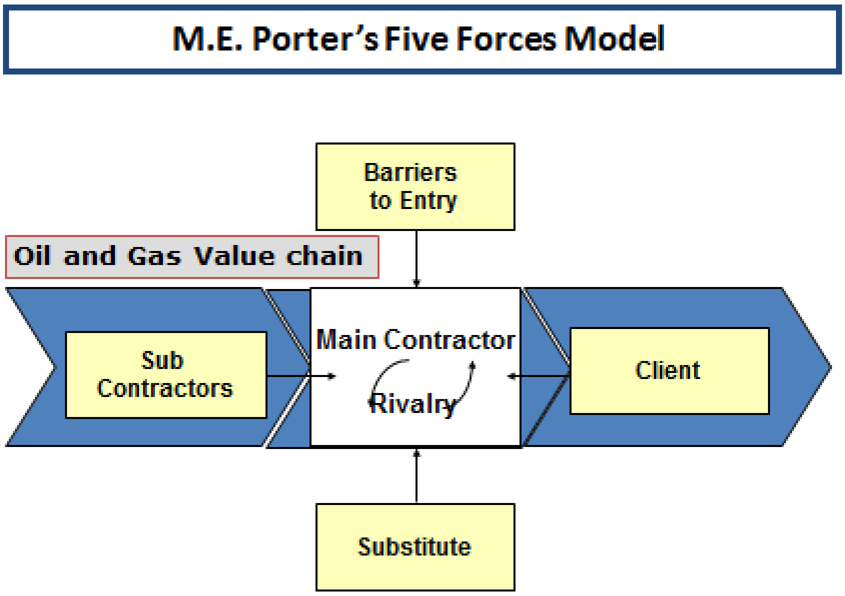
Assessment of own competitive advantage related to the actual request for tender.

The service contractor industry is designed and equipped for winning large project contracts. There is a continual hunt for maintaining the activity level through being awarded new contracts. The approach is fully dependent on the market conditions from time to time. During some periods you may be willing to reduce the margins in order to win the contract, in other cases you may even be willing to subsidise the request in order to maintain the activity level and the market share.

The contractor/suppliers should become rather self critical regarding the competitive advantages and associated uniqueness.

The first screening should examine whether the actual request for tender is an area in which you as a supplier has particular advantages. The basic rule during the first screening is to prioritize requests in which you as a supplier has particular competitive advantage through your uniqueness regarding human resources, methodologies and solutions. Such an approach is considered to contribute to satisfying the specified product quality.

The self assessment of yor own competitive position may preferably be performed by use of M.E.Porter's 5 forces industry analysis model, eventually supplemented by a classixc SWOT-analysis. The use of the 5 Forces model provides you with a format that is a systematic way of approaching the competitive position in the light of and in the interfaces between parties involved and present on an arena. The 5 Forces model exposes the relative bargaining power towards the clients as well as towards your subcontractors. The recommended practice is to apply the 5 forces model in the initial screening of your relative competitive position. The model is schematically illustrated in figure 5.8. The brief assessment of the relative competitive position may result in a first indicator whether you as a potential contractor/supplier should prioritize the actual request for tender.



Figur 5-8 M.E. Porter's «Five Forces»-industry analysis model

The «Five Forces»-model will also generate an assessment on the competition and the corresponding forces present on the area in question. The 5 forces exposed in the model are:

- BPB: The Bargaining Power to the buyer
- BPS: The bargaining power to the supplier/contractor
- RIV: The rivalry on the area to consider; the competition on the request for tender
- SUB: Substitute; are there alternative solutions for the buyer/client?
- ENB: Entry barrier; how unique are you and how can you achieve sustained advantage through bulding barriers?

The entry barrier should reflect how you protect yourself towards the competitors, Is it easy to copy you regarding the product, production methodology or the solution? The issue is to steadily build new barriers in order to obtain sustained uniqueness and competitive advantage. That approach and attitude are valid regarding product quality as well as delivery precision. As a consequence, the product- and delivery quality become critital success factors for achieving sustained competitive advantage.

The arena reflects how fierce the rivalry or competition is. If you are the only tenderer a monopoly situation is present and no threat from potential competitors. However, such a situation is normally rather temporary, as the experience is that competitors enter the arena if there is a chance to expand and do more business. If a sole source condition is the result, the client may cancel the request and replan the project in terms of change in contract strategy in order to achieve real competition between qualified suppliers. A total EPC type contract on large construction projects may typically have insufficient number of potential contractors bidding on the contract. The client may cancel the request and split the EPC contract into several smaller contracts divided by area or phase.

Furthermore the client may introduce new players into the market of concern by training and prequalifying new actrors in order to create real competition on the arena. For the current contractors that may not be problematic on short term. That is due to the fact that clients may underestimate the efforts needed and time needed to prequalify new actors that demonstrate a reliable and confident quality and performance level. If there is limited or no competition on the requested tender, the main contractor has a relative strong bargaining power towards the client, unless there are real substitutes to the product or service requested. A substitute dimension may also be if the client cancels the request for tender.

The relative bargaining power to the client, BPB, is influenced by several variables. If there is no competition, the rivalry is essentially zero, and the main contractor may be positioned with a rather high bargaining power towards the client whereas the client's relative power is reduced.

The bargening power to the supplier/contractor is also dependent on how important the product delivery is for the client. Is the client totally dependent on the delivery by the contractor, the contractor is in a powerful position. Although the position might be considered positive at first, there is a danger of being blind and the self confidence turns into arrogance. The potential ultimate detrimental consequence of such a situation might be less focus on delivery excellence and the corresponding product quality may suffer.

The principle of relative bargaining power is as valid towards potential sub-contractors. Is the main contractor solely relying on its sub-contractor, the sub-contractor is in a favourable position towards the main contractor. The logic question for the main contractor is then: Can more than the one identified sub-contractor deliver what is requested? Introduction of alternative sub-contractors is a classic way of reducing the relative bargaining power to the sub-contractor. Another method of reducing the relative bargaining power to the sub-contractor is to intensify the desire for maximum degree of standard equipment and standardized solutions. Therebyby, the main contractor becomes less dependent on the explicit solution and equipment from one specific sub-contractor with its protected and patented solution.

The last element in the 5 forces model by Porter is the dimension named Substitute. A substitute is the alternative to the product specified in the request for tender, and the client may satisfy their need by alternative products or solutions. An equivavelent situation may be true for the main contractor towards the sub-contractor market. A main contractor might utilize different solutions from a sub-contractor on the parts of the total delivery that is possible as well as recommended to sub-contract. The clients may benefit from making systematic surveys of the competition on the respective markets.

A semi quantitative integral is developed for expression of the relative competitive position and advantage and estimation figures may be derived in the Competitive strength model by Lereim (Lereim, 2008, 3)

The assessment of the relative competitive position is the first step in the strategic tactic considerations whether it is sound to start the process of developing a tender on the request. A critical consideration and assessment should be done by the main contractor if the introductory analyses of the relative competitive strengths show no particular advantages relative the competitors. If that is the case the question should be raised whether it is sound to spend human and material resources on derivation of a tender on the received request.

If the answer is yes, then there is recommended to move to the next step in the tender process.

Evaluation of the competitors

A first rate contractor or supplier is continuously assessing the competitors, their strengths and weaknesses as well as their introduction of new products and services but not the least whether they are sold out. For such considerations the 5 forces model is highly relevant.

It is important to notice that the assessment of the competitors should focus on the specific tender, not an anlysis for the whole enterprise. It is highly recommened to perform such considereations of the competitors and their advantages & strengths.

Critical supplementary information is a survey and summary of the work load and the contract awarded to the respective competitors relative their capacity and capabilities, volume wise and competence wise.

If the competitors have spare capacity, there is likely to result in pressure on the prices in the market. On the other hand if they are sold out, there is a chance for increasing the tender price. The competitor surveys and corresponding analyses should be a compulsary part of the tender process.

Such surveys should cover topics such as technology, product portfolio, and production methods in addition to the basic capacity assessments. That should identify the competitors' productivity level as well as whether they have invested in new facilities for the manufacturing that may result in enhanced product quality as well as increased reliability level and reduced variability.

Self assessment of own capacity and capability

The next step in the contractors tender process should cover a realistic self assessment of ones own capacity and utilization of it at the time of execution of the requested task/project. Many contractors oversell in the way of onloading more contracts than the actual capacity of the production facilities.The reality is brutal if you cannot deliver as specified and committed in the respective contracts in the portfolio. There is an appealing approach to start the tender process for derivation of a full tender, in particular if the request is within your core area and you consider the situation that you have particular advantages of the specific request. That approach may be strengthened in cases in which your competitors do not demonstrate particular advantages and strengths, or are "sold out".

The brutal reality is that it does not help to document competitive advantages on the specific request for tender if all your production caopacity is overbooked.

In many industry segments there are traditions for responding positively on requests for tender anyhow and in particular if the request is from one of your prime clients. The approach is in many places that "you never say NO to your client". Add-on to the overbooked order list may hurt you in the long run if the next deliveries show sub standard quality, and substantial delays appear. The ultimate consequence is bad reputation and the ability to deliver as requested and specified is significantly reduced.

High performing professional suppliers should have full control of the human resource capacity relative the awarded contract portfolio, on the total human resource demand and within the respective disciplines. Such an approach should provide you with a firm control and understanding of the work load relative the capacity. A critical issue is how you utilize key professionals and experts within the organization. In many organizations, non-planned and ad-hoc tasks are utilizing key resources allocated to planned activities in the daily operations as well as on planned development projects. If possible, you should record the amount of time spent on ad-hoc/non planned tasks in order to plan next year resource demand including the the unplanned tasks but expected from the monitoring of the total activity level in the organisaation. In particular, there may be a danger for overloading the key experts, and the actual product quality may be reduced if those strategically important human resources enter into a "burn-out" situation. The solution may be to build in robustness and redundancy in the organisation through systematic qualification and training of talents and fast trackers in the organisation. Thereby, the organisation will not be so vulnerable and dependent on the single champions in the organisation.

The delivery quality is depending on the core competence resources and an organisational robustness should be achieved through development of expert groups not dependent on **"the one and only".** More than one person should be able to manage the respective tasts within the various professional areas. Thus the delivery and production is performed with qualified resources and the requested and specified product quality will be satisfied.

Assessment of priority in existing contract portfolio

You as a potential bidder should assess the request for tender in light of your total commitments in the current contract portfolio, although the preceeding steps may recommend you to develop a tender on the request.

The first check point is whether the request for tender fit into the current portfolio. Is it in line with the established corporate strategy and business direction to hunt for winning the request in question? How to prioritize relative other requests and differentiated with respect to the range of current and potential customers?

Prioritization includes the option of not tendering, although it mught feel uncomfortable towards a core customer. However, in the longterm perspective it is essential that the organization is capable of making priorities from a scientific as from a business point of view. The result is likely to enhance the quality level and contribute to improve the competitive strength and position. .

Strategic and tactical consideraations on the request for tender

If the request is still considered of interest, in light of a project portfolio, the supplier/main contractor should assess the scope and task specified in the tender documents, from a strategic and tactical angle. The primary objectives are to establish efficient and sound execution metodologies and strategies, with the capacity, resources and facilities available that can meet the specified product quality features according to the specification requirements.

Any enterprise has its own characteristics with respect to inventory, facilities, equipment, human resources and organisational design of projects and process lines. These company specific characteristics must be reflected in the tender submitted to the customer in question. In house own working methodologies, modelling and materials provide predictability in the planning and execution of the project delivery. Predictable delivery quality according to specifications and on time is highly regarded among professional clients. The predictable approach and attitude steadily build trust in the relation to the clients, a necessity for being a preferred product and service provider.

If approval is made in the management group for starting the tender work, the tender process is initiated. Detailed activities and sub processes are briefly described in the next sections.

Among the key activties and sub processes are the following:

- Review and assessment of the specified scope of work
- Planning and estimation of cost and duration
- Risk and opportunity analøyses
- Making the tender documents
- Internal management review of the developed tender
- Management evaluation of price offer
- Final tender, handover and negotiation when part of the tender mechanics

Review and assessment of the specified scope of work

When the bid team is established, first priority is to read thoroughly and review the specified scope of work. Everybody in the team should read in detail the request for tender documents with particular focus on their own area of responsibility. Frequently, there is a tendency to flip through the request for tender documents and start working on the bid without careful evaluation on which strategy and tactics might be most appropriate in light of own capability and capacity.

Planning and estimation of cost and duration

The bid shall include a milestones plan and assoctiated activity plan that represent the amount of work to be done as well as duration. Firm estimations of cost and schedule are crucial input to the tender development process.

The suppliers' milestones and activity plan must comply with the client overall milestones plan from the request for tender documents. The contractor/supplier should expand the plan to further detailing both on milestones and on activities identified to do the job. When the milestones plan is established, the corresponding activity schedule plan is to be derived to the detailing level appropriate for establishing a confident understanding of the scope of work and how to deliver to the client according to the specification requirements and on time.

In that context the contractor/supplier should put efforts in making a firm and efficient work breakdown structure, WBS. The WBS should preferably be object oriented in order to cater for eventual cross functional and interdisciplinary issues. Of particular importance is to make the interfaces as simple and well defined as possible based on clear definitions in order to minimize risks appearing at the respective interface?

The derivation of the cost estimations should be based on industry specific standards plus inhouse cost estimation figues on norms and productivity for the different tasks. The inhouse figures should be sorted and grouped systematically for maximum reuse on later tender processes. A key question is however: are the current figures in the inhouse database still valid, or are they not appropriate for the requested scope?

The estimating practice for prediction of volume and duration should be ambitious but still realistic. Unrealisctic estimates in terms of too optimistic figures on cost and schedule may readily lead to overruns during the execution and rework may result. Rework and additions may hinder effective execution of the planned work for the tasks ahead during execution. Uncertainty in the estimates at time of estimating is most frequently catered for by establishing buffers as add-ons to the base estimates, catergorized as contingency and allowance. In oil & gas there is a tradition to establish class estimates that reflect the relative maturity level in the different project execution phases. In the feasibility and conceptual stages the idea is not that mature and it is likely to add a significant fraction as contingency/allowance, typicall + 40 % of the base estimate. During the detail design and construction, the add-on is gradually reduced.

The build-up of the estimation figures may be performed according to successive estimation providing estimates for the elements included with a following sum-up of the total estimate. Alternatively, full stochastic modelling may be applied by use of Monte Carlo simulation tools. The out put is a cumulative probability curve for the different variables such as NPV, investment cost or duration.

Risk and opportunity analyses

During the development of the tender an introductory risk and opportunity analysis should be included. Identification and ranking of the potential Top5 (3) risk and opportunity elements should be included in the produced documentation for the tender. If some of the risk elements are critical, proposed actions should be included. Furthermore the tenderer must demonstrate to have in-place and in operation a well functioning system for managing the facts and figures for the analyses.

A risk escalation structure is recommended in order to demonstrate consistency in managing risk at various levels in the organisation. Accordingly, a corresponding opportunity escalation structure should be established.

Of particular remark is that there should exist established criteria for escalating risks and opportunity elements from work package level to paart project level and furthero n to the total project.

The work process for development of the tender documents

The proceeding activities are to develop the actual tender documents containing the facts and figures and considereations regarding strategic and tactical aspects on how to resolve the task and scope that should clearly demonstrate confidence that the specified product quality can be achieved and delivered on time and budget.

The process should comprise the collection and integration of the cost and schedule estimates as well as flagging the initial risk and opportunity elements identified.

Furthermore, the tender must show a firm project organization with clear roles to the key resources that must be dedicated and committed to contribute.

The identified and listed key human resources in the bid are committed to execute the work. Eventual deviation from delivered tender must be discussed with the client in order to check whether alternative resources are accepted. For the contractor/supplier, some flexibility may be achieved if there is stated firmly what kind of resources are offered with respect to actual competence level and experience log. Then the dependency on individual may be reduced and the supplier shows some kind of organisational redundancy and robustness.

Internal bid review

It is highly recommended to perform an internal bid review by management when a final draft proposal is ready for review. Likely adjustments are done based on comments from the management team. The final adjustments and pricing must be done in light of the total project portfolio and relative priorities within the desired focus areas.

Also, there is recommended to do an uncertainty analysis of the costs and schedule estimates. That makes it possible to derive the percentiles of interest of the total uncertainty profile. That approach makes it possible to derive figures for the P_{15}, P_{50}, and the P_{85} percentiles plus derivation of the socalled tornado diagrams showing the relative importance and influence on the uncertainty in the estimates.

Final assessment of the price offer

The contractors' executive management team must determine the price to be offered on the request from the client.

Several variables influence the the considerations and derivation of the offered price level. Amongst the likely variables to conssider are:

- What is the market situation as per today?
- Are you as a supplier in a monopoly position, or is there fierce competition?
- Is the risk acceptable?
- May the current task open up for synergies and new potential contracts?
- How crucial is the job for your business?
- How important is the client providing you the request for tender?

The final pricing in the offer should reflect the state and condition of your compaany. Is the client totally dependent on your supplies? If yes, the price may be escalated, but be sound and reasonable if this is a client with long term relationship. Most corporations may not stay in a monopoly situation for long as new entrants appear if the market segment is attractive and appealing to others.

Negotiations and signing of contract

The final step in the tender process is to execute negotiations and clarifications related to your offer.

The actual negotiation should follow the common principles of negotiations in which you as one of the parties should strive to identifying the range of negotiation that is present on the hand to the negotiation team from the client. If their range partly overlap with your own, there is a chance to negotiate and converge towards an acceptable price and acceptable conditions.

When agreement is achieved, a summary statement is produced and a letter of contract award is created and signed by both parties.

Contract execution and administration in the supplier role

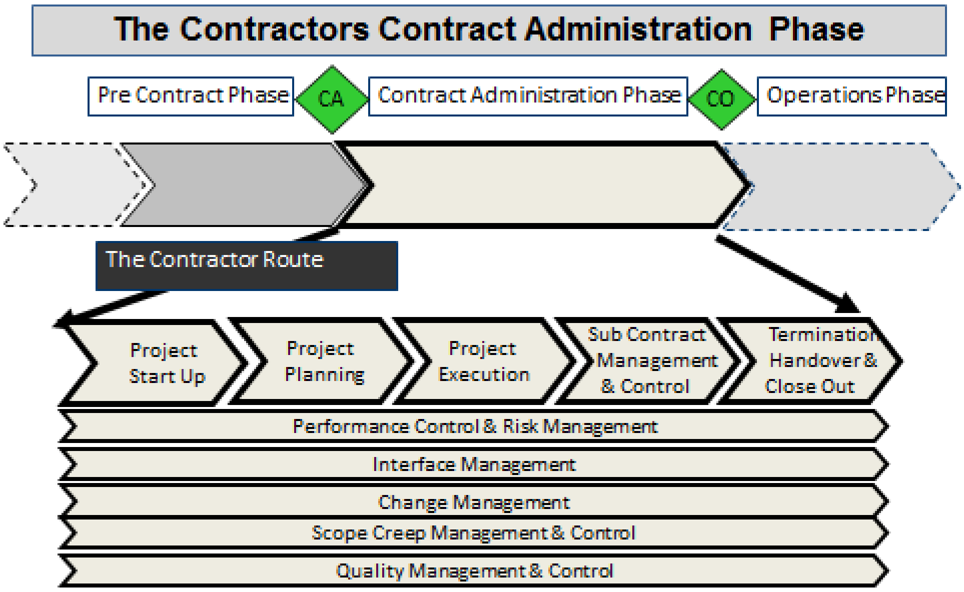


Figure 5-9 Contract administration and execution by the contractor/supplier

Each main step/stage in the project execution process is described and explained in the consequtive subsections.

Project Start-up & kick-off

An excellent start-up is the primary foundation for achieving acceptable execution petrformance. The specified product and delivery quality may be achieved most efficiently when well-established kick-off and start-up processes are used.

Any project member should know the project scope of work to the necessary detailing level and has the ability of fully understanding the impact on the actual execution performance. It requests a thorough review of the scope of work in detail, but not the least identifying what is project specific on the task and scope.

The objectives of "lessons learned" are to utilize the key learning points from previous projects, but never lean towards the practice to perform copy paste from the previous project. The danger by the approach of "Copy Paste» is that project specific issues re not identified.

Project specific issues on the task in question should be identified and discussed in the core project team. Facing the reality and challenges ahead the project specific issues and conditions should be thououghly discussed in the entire project team, and a mutual understanding and perception is critical at the start up phase. Those who have the shoes on must know in detail the consequences of the project specific characteriestics on execution performance.

These aspects and issues are obvious topics for workshop group discussions at kick off meetings and team building events related to product quality, delivery quality, as well as in the processes for identification of risk and opportunities. The corresponding project plans must reflect the challenges and consequences on execution performance.

Project planning

The detailed project plan must complement and expand the overall plan included in the tender.

The milestones plan in the tender should be reviewed with fresh eyes whether there is a need for adjustment or add ons with new milestones identified.

The critical point on derivation of the milestones plan is to achieve an optimal and sound sequence of milestones.When new milestones are identified spend sufficient time to discuss the sequence and timing on where to introduce it on the timeline. The milestones plan shall reflect the logic of sequence of states to be achieved and is a manifesto of the interpretation of the scope and tasks for the project.

With the milestones plan established and approved, the corresponding activity plan can be developed with satisfactory confidence and reliability. The actual detailing level should be considered in every case/project.

The corresponding project baseline is derived based on the facts from the milestones – and activity plans and the determined work breakdown structure, WBS.

The achievement of the specified product quality should be assessed with respect to which execution methods should be applied, including the robustness of the execution approach regarding the guarantee of satisfying the product quality specifications. If a deviation appears, it is also of importance to know the project's resilience capability both on regaining to planned progress and on the achievement of the specified product quality.

The desired ambitions must be to deliver as specified on time and within budget through making it right first time, with a minimum of rework necessary.

The specified product quality is possible to achieve through rework if not satisfactory quality is delivered first time; however, it hurts the productivity/efficiency as extra resources are necessary for performing the rework. The approach should be to do it right first time, within time and budget.

Project execution

The management of the project execution is based on the scope of work and associated specification requirements that are reflected in the project baseline documentation.

The project execution management is to cater for obtaining an actual development as planned according to the project baseline. Firm commitment and loyalty to the plans during execution are essential for making project success.

The project baseline plan is compulsory for the tasks to be done by the execution team and should be firmly followed.

Elements of particular importance for the evolvement of the product quality, include the following, but not limit to:

- Design and development of a solution that is realistic to achieve, robust and user friendly
- Interfaces of any kind between modules of the total solution of the product
- External interfaces with other systems or installations
- Compatibility between systems
- Extensive use of standard components in the system solution
- Reuse of existing technology when relevant and appropriate from a total solution point of view
- Quality assurance and control of work performed by sub contracators and suppliers
- Correct material handling, specified in MTO's, integrated with efficient logistics and optimal supply chain though receival of goods at constructiion site.

Management & control of sub contractors

In larger and complex projects the value creation happen to a large degree at sub contractors. Parts of full sections of the scope of work are awarded to sub-contractors, whereas main assembly, mechanical completion and commissioning happen at the site of the main contractor. In some cases approximately 75 % of the value generation happens at their sub contractors.

How to achieve the specified product quality for such cases?

First of all, the client specification requirements are the governing specifications also for the sub-contractors. Securing this level may be done by use of the socalled “back-to-back” principle. It means that the sub-contractor must fulfill the specification requirements provided by the client on his/her part of the scope of work. The back-to-back covers elements such as economic risk on their part of the scope, schedule, product quality, CSR, coporate social responsibility, and HSE. Furthermore, the subcontractor is committed to execute their work in such a way that it complies with the production methodology by the main contractor. That should cover production, assembly, standardisation of material selection, dimensional tolerances etc.

The main contractor should perform audits periodically, both system audits and technical peer reviews. An audit plan should cover the planning and execution phases plus as delivered audits.

A factory acceptance test, FAT, is a part of the auditing plans and controls. Number of issues not closed should be zero or very close to prior to handover to client, as open issues not resolved creates confusion, disorder and inefficiency during the final stages prior to formal handover to the client.

Project termination and handover to client

The final stages of the project execution are frequently experienced as rather hectic and intense with several product tests whether the actual delivery satisfies the functional specification requirements or not. Full traceability and correct documentation records are key perspectives in this context.

The as delivered product shall include certificate of fitness and protocols that state the performance of the product, the functional capabilities and fitness for use including manuals for use and modification/maintenance.

The testing should as a minimum cover a factory acceptance test, FAT, and a corresponding site acceptance test at receival of the product7system at the client site, but could be supplemented by a site integration test, SIT.

The product delivery is covering more that the physical product. It includes the following:

- The product/system it self
- Firm documentation from quality control of the as delivered product/system.
- Operations manuals/user manuals
- Training documentation
- Maintenance manuals
- Inspection plan documentation (when relevant)

Perceived product quality is influenced by the training of use of the system or product. That part of the project delivery is frequently underestimated and not given satisfactory attention. Thorough training of the super users is a critical success factor, and should be done in due time prior to installation and operation. These considerations are as valid for a new ERP system, reorganisation, a building, and on land process plant, a vessel, a mobile offshore unit or permanent offshore installation.

For physical units such as buildings, vessels and offshore installations, it is strongly recommended to derive an executive summary/resume of the as-designed features, the following summary of as-fabricated condition and at last a summary of the installation history. The fabrication/construction summaary should not include all as-built documentation, only the documentation on issues deviating from as-designed condition. The same practice is valid for the summary of the installation and commissioning phase. The documentation to collect from that phase is the documentation on issues deviating form the design basis documentation. Summarizing the documentation above should result in a firm documentation on the as-installed product with eventual restrictions in use after assessing its fit for purpose.

The summary document comprising, design basis, eventual any fabrication and installation deviations provide you with a primary facts database for derivation of inspection and periodic maintenance plans during operation and use of the product.

In the following, there are some considerations and elaborations on the corresponding sub processes that are present throughout the whole contract period.

Performance measures and risk management during project execution

Periodic inspection and measuring of as-produced quality may strongly indicate what the expected product quality of as-delivered product.

For software product development projects there might be sound to start pilot testing prior to full rollout of the system within a corporation. The pilot testing is a rather common practice for development and implementation of a new ERP or CRM system. The objectives of using pilot testing are to reduce the uncertainty regarding functionality, operability and reliability of the solution. Pilot testing according to established protocols is common practice. A critical success factor is to identify and select relevant pilots. The pilot tests should represent the more severe conditions of operations with complexity in excess of what is expected at normal sites/locations. The hypothesis for that approach is that if it functions at the most difficult spots, there is an expectation that it will function well under less abnormal conditions.

In mechanical industry such as fabrication yards for marine vessels and offshore units, the piloting consists of prequalification of the welders at the yard and what types of welds are they certified to do.

Furthermore, yards may make so-called mock-up tests for testing the capability of doing the fabrication of a complex unit. The mock-up is normally a scaled test unit with geometry that is reflecting the most severe geometry on the full-size unit. If it functions well on the mock-up it is expected that satisfactory product quality is achieved on full size production.

When doing physical projects, the logistics and supply chain of goods and materials must guarantee that correct quality of the input materials for use in the fabrication, as well as received correct volume/amount, on time, and at right location.

Typical control questions are: Are the materials received arequirements? A 2nd party or 3rd party quality check may confirm whether the right material quality is received or not. The actual material certificates should be provided on request.

For buildings and structures particular attention must be on the specified dimensional tolerances, and secure that the as built is within these limits. The erection and construction planning should cater for that the total dimensional tolerances of the finished building/structure are met. The accumulation of as-built dimensions on part products should guarantee that the total tolerance limits are not exceeded. Modern digital equipment with laser and GPS helps you in that context.

Dimensional measures and materials tests, destructive and non-destructive may clarify whether the specified quality is achieved or not. On metallic structures it is common practice to do materials tests with standardized test specimens for tensile strength, impact toughness tests, fracture toughness, and corrosion resistance.

On concrete structures, test specimens are made from the actual cast. You make test cubes that shall cure a certain number of days prior to compression tests for determination of the compression strength. Furthermore, control measures should be done for the reinforcement in terms of location in the concrete element, anchoring and pre tension. A supplementary quality check is to identify which production method is used for manufacturing of the reinforcement bars and mesh, as the production method may heavily influence the mechanical properties.

For welded steel structures, material's testing is recommended on components and on as-built structural sections. The material Certificates on base material and on the selected weld deposit material must satisfy the specifications. In addition to that, there should be periodic control of the as finished welded structural sections. The tests may include destructive and non-destructive testing.

Destructive testing may be performed by cutting off a small piece of the plate or weld for mechanical testing of different kind by making test specimens followed by measuring the actual mechanical and chemical properties of the as welded product. The tests may provide you with measured data for strength, toughness, and durability regarding long term impact of wear, corrosion and fatigue.

Nondestructive testing could be of the kind ultrasonics or X-ray to eventually detect defects in the weld and heat affected zones in the as welded structures. There is normally acceptance limits for embedded defects and surface defects. The recordings from the non-destructive testing can then be compared with the acceptance limits of the size of defects. If the recorded figures are below the acceptance limits, the defects may remain. If they exceed the acceptance limits, repair is required unless a fit for purpose assessment may confirm that they may remain unrepaired in the structure. Other non-destructive tests are hardness recordings as the hardness of the steel is directly correlated with its strength, ductility and fracture toughness.

Differentiation is requested regarding the extent of quality control of as produced product or service such that the relative criticality is reflected in the quality control and monitoring during execution. More extensive & detailed monitoring and measuring are to be requested on critical components in a system or structure relative less important elements. Consequently, the management of quality control provides you with the principle of focusing on the most important parts of the product or service.

An example of these principles is the development of programmes for monitoring and control of as produced quality of structures of any kind, buidlings, vessels, offshore platforms. The key is the engineering design that provides you with the facts & information about relative criticality of the respective parts and components. Those facts form the basis for the derivation of a criticality and risk based inspection monitoring and maintenance programme.

The risk analyses serve in that context as a management support tool for prioritisation.

The qualitative risk analysis is of particular importance for mastering the technical issues demanding particular attention and efforts, including interface issues between different parts of a system.

Indirectly the technical risks are influenced by the access to appropriate human resources regarding competence and capability utilised on the respective projects. Furthermore, technical issues may escalate if there is a demand for rework or acceleration of the remaining tasks in the project.

An optimal approach may appear if client and contractor use the similar tools for the qualitative risk analyses, see section 2.6.

The qualitative risk analyses should cover and include a range of technical issues and challenges, such as assessment of:

- Use of current technology beyond its validity range
- New application of current technology
- New technology applied on known issues
- New technology applied in new areas

The qualitative risk analyses performed by the contractors should cover and include the following:

- Run risk analyses periodically
- Assess and establish the Top 5 (10) risk elements at all levels in the project.
- Identify and derive possible actions for reduction of the risk level of the current Top 5 (10) risk elements.
- Implement the approved actions/mitigations through firm due dates and clear accountability and identify who is in charge of the implementation.

The issues listed should also cover which sequence is most appropriate for the series of actions covering total product quality & performance as well as safety, environment and human resources aspects.

Interface management

Interfacses are most frequently a hot spot trigger for potential risks. Those facts are experienced on internal as well as on external interfaces.

The external interfaces are towards other suppliers and contractors/sub-contractors as well as client organization receiving the product/services provided from the project in question. A firm clarification of the external interfaces is desired including specification and mutual understanding of the respective roles.

The internal interfaces are largely connected to the development of the product/service. Those interfaces are primarily physical interfaces, but inter-organisational interfaces should also be paid attention.

The majority of larger projects have an interface register in order to cater for critical issues that likely appear during project execution. Some projects even formalize the importance through establishing a specific interface coordinator for recording and adminisatration of the interfaces.

A critical interface may appear as one of the most critical risk elements that continuously are prioritised by the project management team. Interfacses develop and change during the project execution poeriod, a critical source of information for managing the project to performance excellence.

The interface registor is recommended to be a compulsory element on the agenda of the periodic project management meetings.

Managing project changes from a contractor/supplier perspective

The practice of managing changes in project varies significantly, from improper to professional performance. The experienced variation covers both clients induced changes and own internal needs for changes.

The recommended management approach among contractors & suppliers is to follow the main principles & practice outlined in section 3.3.

A critical issue in that context is the lacking registration of plain facts and obtain facts in writing firm documents of facts.

A facts-based storyline connected to the respective changes strengthens the position to the contractor towards the client, and the dialogue between the parties are based on facts and not gut feeling, which is considered as a significant improvement potential in most business segments.

Managing scope growth/ scope creep

The supplier organisation on awarded contracts must demonstrate an organisational robustness, capability and capacity such that a possible scope growth of modest amount may be handled by the existing staff and organisation on the project; a frequent limit is of the order 15 % growth relative the original project scope.

The capacity and capability issues should be assessed in light of the total activity portfolio when considering the human resource capability as both line operations and projects utilize the same resources. The documented resource capability is critical as many clients request that kind of information in order to verify actual capacity in the period in question.

Supplier and contractor organisations are founded on winning new contracts. The awarded contracts are added to the existing contract portfolio and provide you with the possibility of having a well-defined picture on the total portfolio loading.

Managing the current portfolio includes mastering the protfolio risk and the portfolio resources. In addition, the sequence of projects is a variable in the portfolio context (Lereim, 2008, 2). The complexity in portfolio resource management may also increase if there are inter-dependencies between the projects and they are fighting for the same experienced resources.

A particular issue may appear when the scope growth becomes significant and far in excess of what the project organisations are designed for. The complexity increases and the resource capability in the portfolio become critical.

With a volume growth of 40 – 50 % in the single projects may create an unstable and unpredictable condition in the current project portfolio to the suppliers/contractors. There is likely lacking qualified and experienced professionals and the individuals have a hard time of prioritizing their available work hours in between the different tasks they are involved in. A possible consequence is that the quality of as-produced work is not meeting the specified figures.

The desired effect is a dynamic project portfolio control in which planning and control of the utilization of key resources is a critical success factor for achieving the specified product quality.

Dynamic control and management of the expert resource pool becomes crucial. The basic rule for human resource management in the project portfolio is recommended to have multi skill resources, and the organizational design should include competence driven organizational robustness, redundancy and resilience in order to achieve an ever-efficient project portfolio organisastion.

The human resources must be engaged and trained up front such that there is an increased focus on design of high performing teams. The efficiency is significantly reduced if there are too many unskilled resources relative skilled resources, as the skilled resources must supervise the unskilled without performing the tasks themselves. A multi skill strategy among project resources provides you with a necessary robustness and flexibility in the project staff. However, one may not demonstrate the same level of seniority in the various professions. You may be the champion within one profession, whereas you may be less experienced in another discipline/profession. By such an approach you build in organizational robustness, resulting in better handling of unforeseen volume growth and maintaining the product quality.

In summary, human resource management in the project portfolios must demonstrate a firm control of the dynamic state and make sure that there is an optimal prioritization between the respective tasks for the individuals and for the teams.

Quality management and monitoring of the contractor

The contractors/suppliers must document that a satisfactory quality management system is in place in the organisation and supplemented with project sepcific plans and measuring for verification of the as-produced product quality.

The approved project specific quality plan is baseline for performance monitoring of the delivery quality. It should include control measures, assessments and non-conformance monitoring and management.

Clients may request a formal certification of the quality management system to the contractors/suppliers according to ISO standards. Others may not request a formal ISO-certification; however they may request a quality management system equivalenet to the ISO standards. That approach makes it possible for the contractor to choose whether making a full certification route by an authorized independent certification body or designing their own quality management systems to be prequalified by the client in question.

Projects deliver a unique product or service, which is in contrast to regular repetitive line production and manufacturing. The uniqueness characteristics are of importance as you have to do the right things right first time. The conditions are considered more extreme in projects compared to regular production in which the process control parameters make it possible to perform continual adjustments to the desired and prescribed performance values. However, some activities in a number of projects are of repetitive nature in which statistical quality control and monitoring are valid and necessary elements in achieving the specified quality and functionality. Six Sigma and Lean manufacturing methodologies are thus relevant and appropriate tools in projects with repetitive activities.

Examples of repetitive activities in construction projects are such as:

- Mechanical testing of the basic building and construction materials
- Non-destructive testing and measuring
- Temperature measuring and recordings
- Dimensional control and recording during assembly and erection as for the as built structure.
- Performance measures in electrical systems, HVAC and IS/IT networks.
- Performance measures in HSE, Health, Safety and Environments.

Quality control and recordings are of different nature in reorganisation and reengineering projects. The output deliverey is not a physical product or services, but an improved organization with enhanced organizational effiency and effectiveness. For such conditions and projects, ISO certifications as such may have limited value, although certification of work processes may significantly contribute to achieving satisfactory quality performance.

The desired and specified quality on reorganisation projects are to a significantly degree connected to the acceptance of the design solutions, a buy-in to the solutions and the employees satisfaction with the process and the output delivery. A statistical quality control may be utilized in assessment and analyses of the desired improvement on efficiency, preciseness level and effectivess of the organization after implementation of the new solutions for reorganization.

5.4 Impact of accumulated effects on project execution

Introduction

This sub section illustrates schematically some principles and conditions during project execution that are resulting from inappropriate description of scope of work, delays, changes and add-ons to the original scope. It is of particular relevance for construction projects onshore and offshore.

Sketches are shown in figures 5 – 10 through 5 – 17.

Some typical basic characteristics of construction projects

Construction contracts are frequently characterised by the following key information:

- Several interfaces, physically as well as organisational and contractual towards other contractors & sub-contractors
- Delays among other contractors may result in a domino effect on the work to be done by the main contractor.
- Delays due to lacking or slow decision making among the client/customer.
- Significant additional work outside the original scope of work is awarded to the main contractor and to be performed on the same site as for the original contract.
- Completion date is fixed and firm.
- Additional work to be done in parallel to the work in the original contract.

- Additional work is formally established through so called Variation Orders (VO's) from the client and based on estimated figures on cost and time. The total accumulated impact is frequently not fully covered for.
- Introduction of new parties on the site may result in a very compressed and tight site physically, which may lead to extended project construction period.

The elements listed above are challenging for the main contractor who is in charge of the logistics and workflow, coordination and managing sub contractorsand, and inefficient work performance may result. If the final delivery date is fixed and firm, the issue may be overcome by accelerations of the remaining activities, in particular those linked to the critical path. However, accelerations may request intensified efforts in terms of more manhours and resources for fulfilment of the respective tasks in shorter time than initially planned. The likely result is increased costs, and is experienced in anumber of projects in a range of industries. The potential impact is briefly described in various project management textbooks as in for example Meredith & Mantel

Main issues

A rather typical situation description for many projects is as follows, for the client and the contractor:

- Acceleration of remaining work in order to meet specified delivery date.
- The accumulated effect of acceleration on total cost.

Each of the main issues are discussed in the following sub sections.

The impact of acceleration of activities   Key elements in the assessment of project schedule extension alternatively acceleration of remaing work

The final delivery date for the project is fixed and firm. Any delays during execution have negative impact on the execution of remaing work. Contractors are obliged to formally report immediately if a schedule extension is necessary for comleting the work. The consequence of the identified delay is that acceleration is necessary if the final completion date is not altered, unless the scope of work may be simplified or reduced in order to meet schedule target.

The ultimate effect & consequences are increased execution costs of the remaining parts of the original scope of work, since that has to be done on a shorter time frame than initially planned. Reference is given by the original estimate with respect to expected duration and the amount of resources necessary to complete the task. We normalize the figures and define the reference values as 1 on both time and resources. When acceleration happens, the desired execution time is reduced, reflected in a relative figure below 1 on the X-axis in the diagramme. The expected corresponding resources estimate may increase and reflected by a figure larger than 1 on the Y-axis. The extreme condition is defined as “Crash Cost”. At that point it does not help to provide the task with more resources. An opposite effect may appear and the execution time may increase. This is a reality on construction sites in which there are physical constraints such as on working offshore on an oil platform with very limited space. More resources may result in chaos and and actually reduces the capability of efficient work performance. The ultimate figure is the red spot in the diagramme.

The increased costs reflect inefficient work performance. The initial budget estimate represents the specified volume produced over the time period specified. The budgets in the signed contracts are built on the tender estimations done by the contractor who has derived its tender prices on his own performance factors. Each contractor has its own performance factors reflecting their way of doing the work based on their human resources and facilities capability. During acceleration the number of resources necessary to complete the task on a reduced timeline is significantly higher than the corresponding earned value for the task in question. It means that the utilization of the individual human resources is reduced leading to what is defined as ”inefficient production”. These likely effects are schematically illustrated in the figures 5 – 10 and 5 – 11.

The relative productivity is reduced dramatically during acceleration, unless smarter ways of doing the task is introduced. If the requested acceleration should result in half the execution time the relative productivity index is predicted to be of the order 0.25, in other words of the order just 25 % of the budgeted productivity in the tender from the contractor.

The background reference figures are from the text book by Meredith & Mantel, chapter 9.1. The figures are in accordance with facts in other text books plus field experiences from completed projects.

These curves might represent the upper bound of the potential impact of acceleration however there is a general acceptance for increased costs when acceleration is requested. It is worth noticing that the potential impact as shown in the figures 5 – 10 and 5 – 11 are an upper bound of projects during execution, not reflecting new projects.

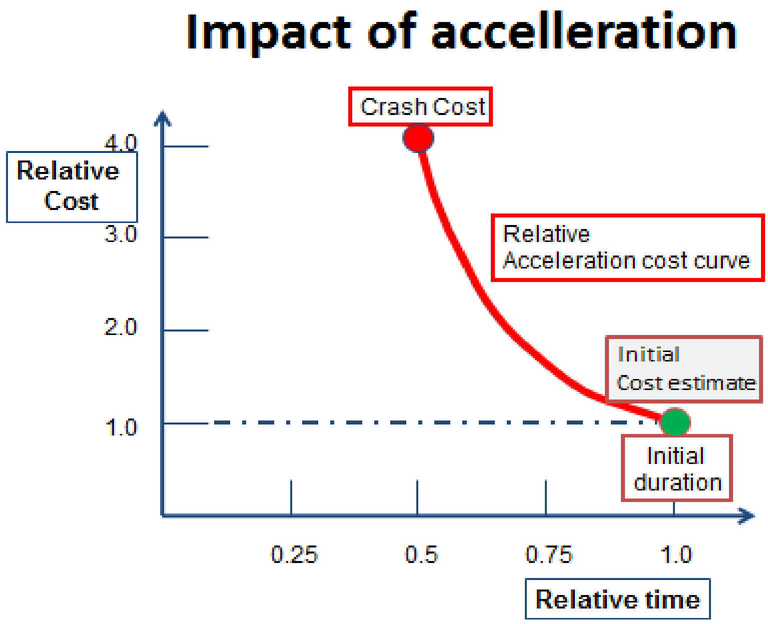


Figure 5-10 Sketches of expected changes in costs/resources necessary in order to complete the task during acceleration. The figures are relative numbers. The original budget estimates on cost and time is given the relative value of 1, derived from Meredith & Mantel.

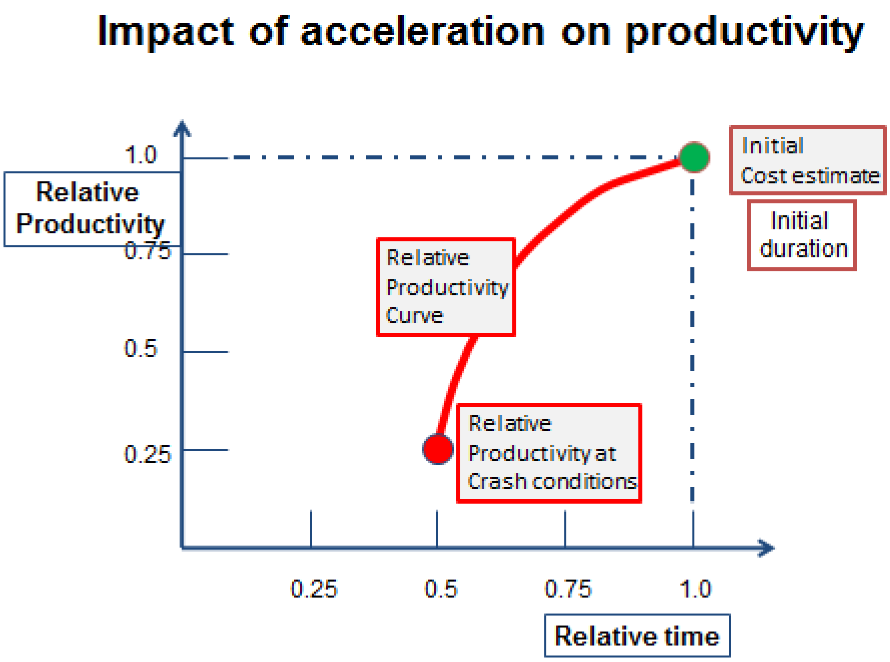


Figure 5-11 the corresponding Illustration of ineffiicient production in terms of a relative productivity performance index.

Total accumulated effects

During the contract & project execution, changes are likely to occur as well as additional scope is provided to the contractor from the client.

Elements of relevance in that context are:

1. The contract volume perspective
2. The change of scope perspective
3. The critical path perspective
4. Additional scope perspective
5. Increased number of interfaces perspective
6. Contract & project administration during execution
7. Increased demand for management control

Each of the perspectives is elaborated in the following paragraphs.

The contract volume perspective

The Contractor organisation is designed to utilize its resources and facilities in an optimal manner on the conditions and constraints by its own resources. There is hardly any slack or redundancy in the contractor organisation. On the other hand, the contractors are committed to design their organisation such that it has capability, capacity and robustness to cater for a potential scope increase up to some certain limit, frequently set to 15 % in addition to the original scope of work. .

These issues are becoming particularly critical when start up of some activities are delayed, which is not limited to the activities and tasks on the critical path.

As a consequence the challenges are escalating for the remaining production when delays appear from the early beginning. The key is the production demand per time period, or the production intensity rather than the accumulated work over the project period. This means that the intensity of work during the remaining period is far higher than the 10 – 15 % accumulated scope creep. The volume increase per month or week on peak level might of the order 50 % higher than planned. That is considered far more critical than an accumulated effect of 10 % increase on total volume.

Figure 5-12 to 5-14 show skematic illustrations of the impact of volume increase and delays relative the planned execution.

The actual resource expenditure during execution may become significantly different from the original and approved budget on cost and schedule. It may lead to a strong increase in intensity during the execution period. These aspects are schematically illustrated in the figures 5 – 15 to 5 – 17. The likely result is drastically reduced productivity during the execution phase of the project.

The change perspective

Any change may have a detrimental effect on the project execution and performance for the client as well as for the contractor. The clients' desire for changes should be analysed thoroughly with well balanced arguments and figures and the business case should be updated accordingly. The client should ask himself: Why should we add the change and what are the benefits?

The contractor must respond to the imposed change from the client when receiving a variation order. The contractor must demonstrate that they have a confident and well functioning change management system for their projects and fully demonstrates the capability of managing changes. Furthermore, changes may lead to a need for altering the sequence of tasks compared to the tender from the contractor which may have detrimental impact on the execution performance, whether it impacts the use of own human resources or facilities/equipment, or deviates from the strategic/tactical considerations done in the tender process.

Project management and execution are to a large extent assessing and handling changes. Managing changes during project execution is challenging for the parties in terms of how to do the tasks and how to utilize the resources available in light of the contractors' capability of handling changes. The consequences for the contractors may result in reduced productivity or delays in the production. Accordingly, the client may experience delays if they insist on imposing the flagged changes. The main parties, the client and contractor, should demonstrate a mutual understanding and perception on what is the impact of the proposed change on resource demand, progress and on the product quality. If the proposed change has detrimental impact on handover date and completion date, the expected effectiveness and business benefit may suffer, and the proposed change should not be realized. More emphasis should be put on the desired effect than on the cost and schedule as such. The project parties are normally very solution oriented, and changes may be integrated into the other project tasks to complete. The assessment of changes should be based on facts as much as possible and not on subjective opinions. Thus there should be a golden rule of notifying changes in writing. That provides you with facts and should be used as a reference point in the dialogue and clarification among the parties.

The critical path perspective

Any main project plan should identify and include the critical path in the project. Delays on the critical path lead to delays on start up of the remaing activities on the critical path. The ultimate consequence is delay of the total project unless actions are taken in order to accelerate the activities on the critical path, alternatively simplify or reduce the remaining scope of work. Acceleration of the remaining tasks on the critical path may be the likely option, however it readily leads to cost increases due to inefficient production performance.

The added scope perspective

Added scope of work is loaded on top of the original scope of work plus the expected scope changes. The consequences are intensified working conditions as more work is to be done in the project. If the completion and handover date is fixed the resource intensity and logistics issues may increase significantly. The intensity may be more according to the planned figures if the client accepts a completion and handover date moved to cope for an expanded scope of work.

The working conditions are more tasks in parallel, which may lead to constraints in choice of methodology and technology solutions as well as affecting the sequence of the respective activities and tasks. In particular, those aspects are reflected in the project supply chain & logistics handling, assembly and erection of building structures, on transportation and assembly of prefabrication components etc.The project overall impact is reduced productrivity.

The increased number of interfaces perspective

Delays may frequently result if more activities are executed in parallel. The immediate consequences are generation of more interfaces, physical, organisational and contractual. The organisational and contractual interfaces are considered as challenging as the physical interfaces. New interfaces may appear as a result of delayed engineering packages, delayed client supplied items, several revisions on the drawing packages for construction, new changes, scope growth, added scope, as well as several contractors working in parallel etc.

The potential and likely development history is schematically illustrated in the figiures 5 – 12 to 5 – 14.

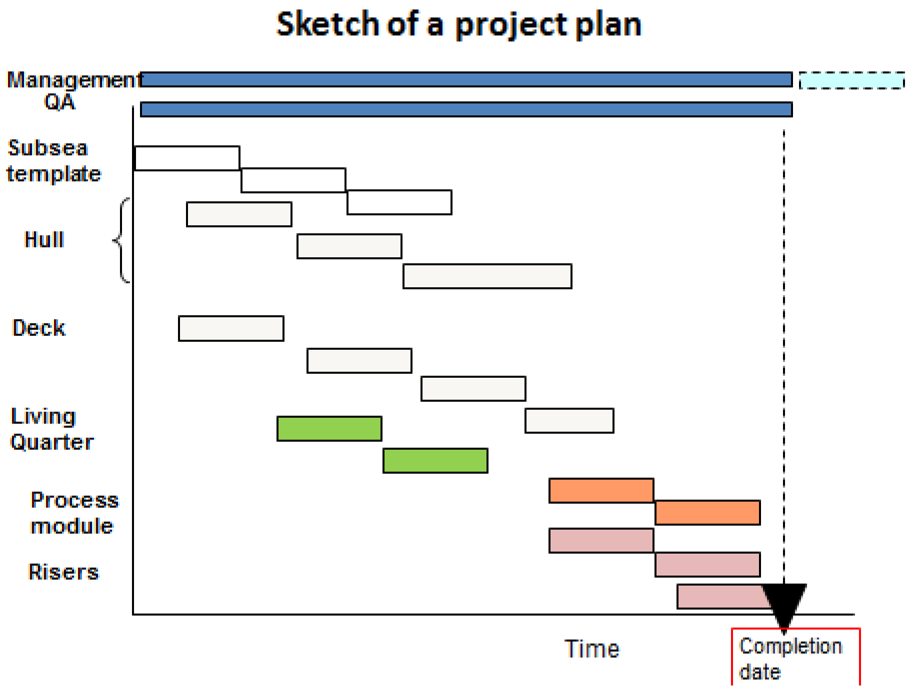


Figure 5-12 Sketch of an initial main project plan, gantt diagram, case offshore oil & gas production facilities

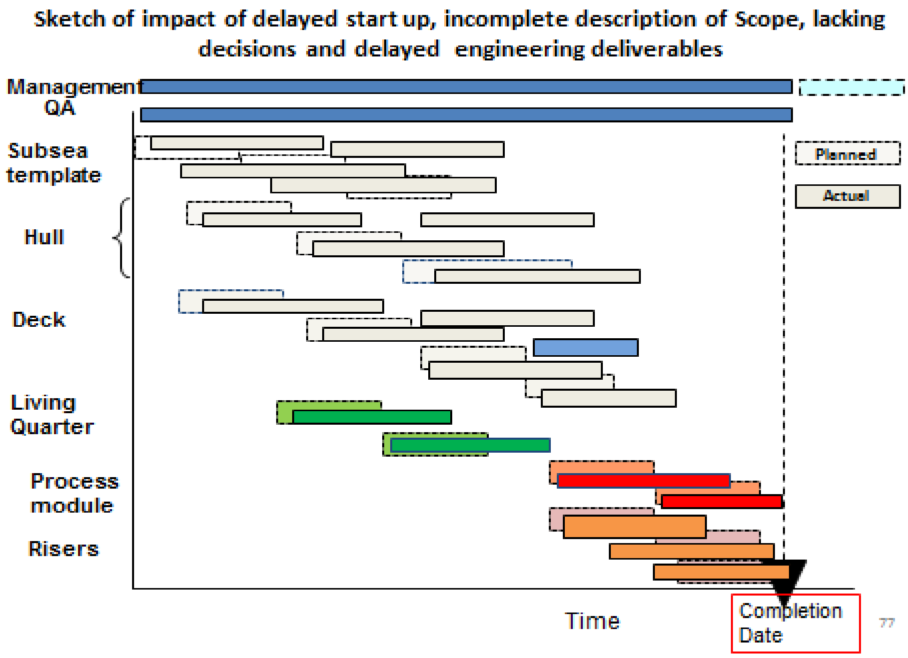


Figure 5-13 the corresponding sketch of delays and scope increases

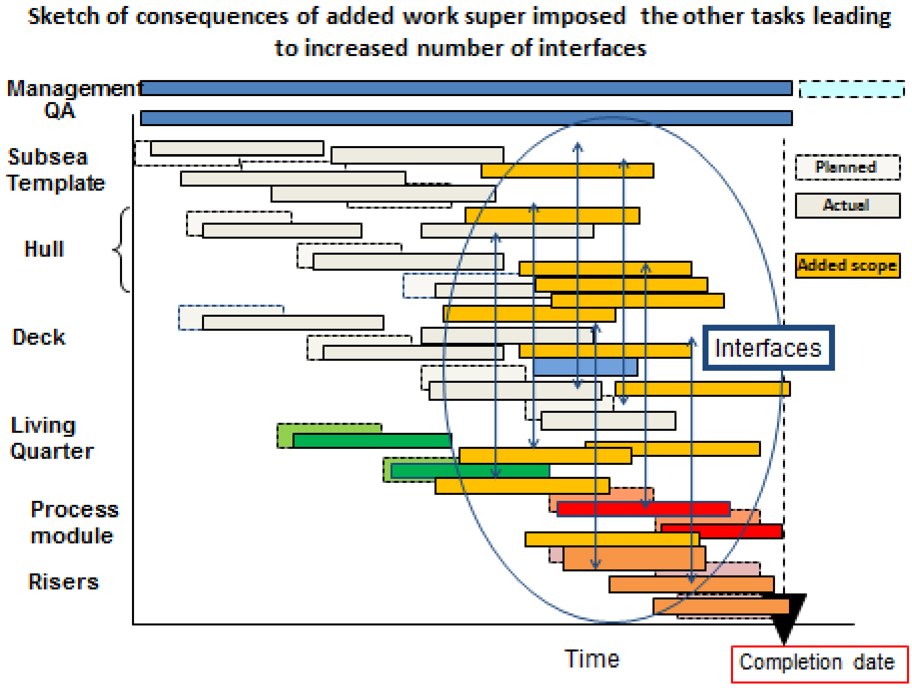


Figure 5-14 Illustration of the impact of added scope of work on the main plan. The intensity increases dramatically as the production per month increases and the number of interfaces are enhanced.

Contract administration and project execution

Figure 5-15 shows a classic curve on accumulated cost and time. The illustration includes four different curves on potential development during execution. These are:

- The planned accumulated cost-time curve, the grey curve in figure 5 - 15
- The planned curve adjusted for delays, but scope remains as planned, the blue curve.
- The planned curve including potential scope growth within the 15 % limit, red curve.
- The planned curve superimposed by changes and ad don scope of work, green curve.

The sketch in figure 5 – 15 does not look very dramatic. The illustration is rather typical for many projects, and the clients expect contractors to master such a route during project execution. Deviation from planned does not seem dramatic when assessing the various accumulated curves. That illustration is often used on the periodic reporting cut off dates.

However, the assessment and interpretation might be different when viewing and assessing the four different scenarios in terms of the intensity curves as shown in the figures 5 – 16 and

5 -17. In the early phases, the intensity is below as-planned due to start up delays, while the intensity is well above as-planned in the later periods in order to catch up the work if the final handover and closing date is maintained.

For the contractor the likely scenarios have a double negative impact, and may be summarized as follows:

- In the initial stages of the project, the contractor is not able to utilise the resources as planned according to the original contract scope of work. See the sketches in figures 5 – 16 and 5 – 17
- During the later phases in the project the tasks are stacked compared to planned, see figure 5 – 14 as well as figures 5 – 16 and 5 – 17. The condition might become more constrained than planned. Several tasks are run in parallel, many interfaces not planned for initially, and an increased demand for acceleration of activities on the critical path as well as on activities not on the critical path. An extreme situation may appear if time extension is not an option. The ultimate consequences are a dramatic cost increase, and a potential risk of delay for the total scope of work to be completed. For the latter issue a reduction in scope of work may be the appropriate action if a delay is not accepted at all. Such conditions are for example representing international sports events like the Olympic Games and various World Championships in which there is no option to move the opening ceremony a single day.
- The impact of added scope in excess of the 15 % scope growth gives extra work intensity, in particular under conditions with no change of delivery date, but even for projects that accept a postponement of the final handover date. See figure 5 – 17.

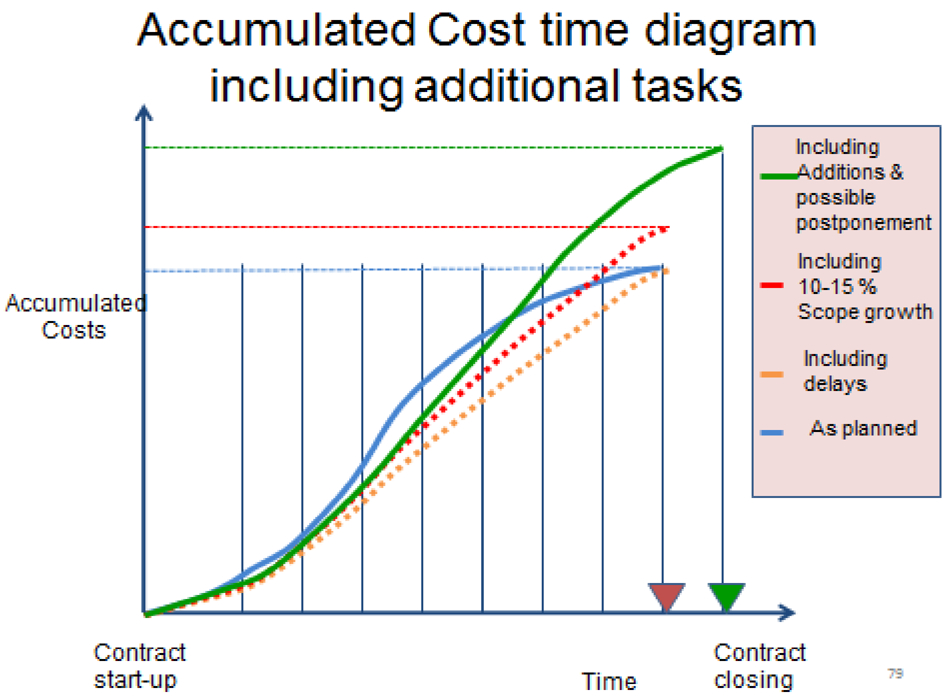


Figure 5-15 typical cumulative cost–time curves; cost on the y-axis and time on the x-axis. Various scenarios are illustrated including scope growth, delays and added scope of work.

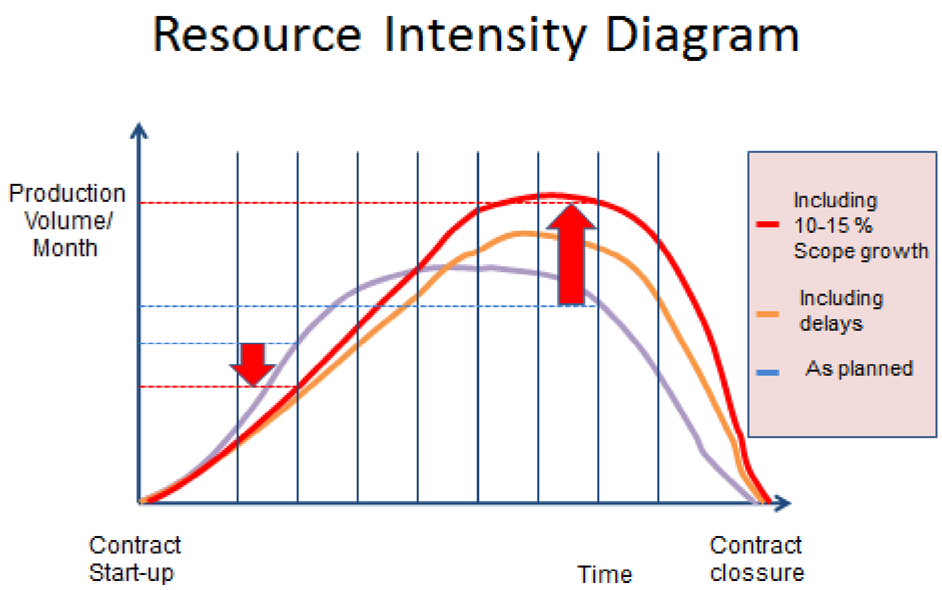


Figure 5-16 Sketches of resource intensity diagrammes (resources per time interval/ period). During the early phases when there is a delay, the resource intensity is below the planned, during the later phases the resource intensity is higher than planned

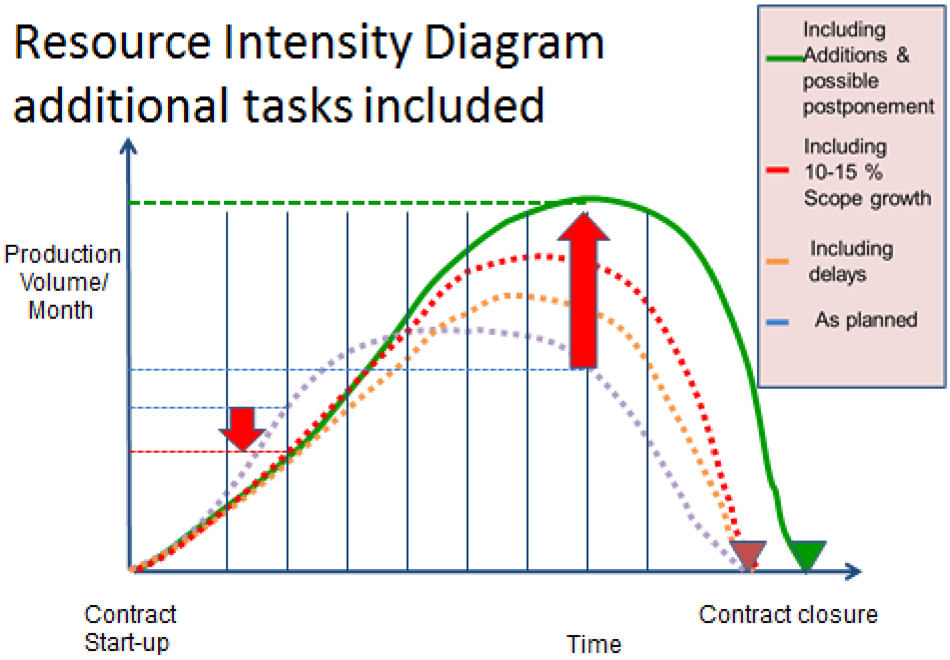


Figure 5-17: The impact of added scope of work on the reseource intensity during the contract execution period – an extreme condition may result during the later phases if the handover date is fixed and cannot be moved.

An increased demand for coordination and management resources

Many projects experience a stackup of activities and tasks during the late parts of the execution period as illustrated in the figures 5 – 14 to 5 – 17. The resource intensity is heavily altered relative to the as planned project baseline. The mobilisation of resources and equipment may happen prior to the actual conditions leading to sub utilisation of the resources in the early phases. The resources are not activated according to the original plan, which lead to waist in terms of waisted manhours as facilities not utilised in the period. The opposite situation appears when everything must be performed simultaneously. An over exposure is likely to happen during those time periods, and the production efficiency performance is below the requested and specified level. A sub performance is the case.

The monthly production during the late stages of a contract is significantly increased relative to the planned figure and the scope volume is well above the tolerance limit of 15 % scope growth accumulated. In reality, the scope increase of the order 50 to 100 % higher than planned in the period in question as the intensity is fierce. The necessary management tasks increase accordingly. These realities in combination with an increased number of interfaces request more management resources in order to cope with the total situation which is far more demanding than expected at the planning and tender stages. Never cut costs on management resources under such conditions; that will return with detrimental consequences for the execution performance.

The management resources should thus be strengthened for the remaining project period as a result of the following two fundamental issues:

- Resource intensity, workload per period.
- Number of interfaces.

In regular construction contracts the management expenditure is regulated with reference to scope growth and not on the complexity issues. Thus, the desired management capability may not be met.

The total accumulated effect and the impact on cost

The total accumulated effect is reflected in three categories of added cost of execution:

1. The demand for enhanced capability of managing the tasks.
2. Inefficient production due to delays, changes, and scope growth.
3. Inefficient production due to additional work outside the contract specified scope of work.

1. The demand for enhanced capabililty of managing the tasks

The curves in the figures 5-16 and 5-17 fully demonstrate that the workload per month may dramatically increase in the latter part of the execution phase. More tasks are postponed or delayed resulting in a heavy increase in activities run in parallel and stacked. The number of interfaces increase and the complexity is being escalated. Such a scenario requests more and better capabilities of handling the issues of the managerial aspects of execution. The consequences are a demand for more resources on management as well as better qualifications of those resources holding a management position with a thorough understanding of the complexity issues and the corresponding actions to be taken.

The enhanced complexity, due to an increased number of interfaces and more work done concurrently, results in an increased volume of the management scope in the contract. These effects are appearing in both the client organization and the contractor organization.

However, on classic execution contracts, the contractor is normally compensated for the impact of scope growth on the demand for management and overhead resources, not for the enhanced complexity as such.

2. Inefficient production due to delays, changes of any kind, and scope growth

Industry experience has shown that the main contractors have demonstrated the capability of keeping the progress in the majority of the contracts in spite the fact that many of the awarded contracts are postponed or delayed due to waiting for neighbouring activities to be completed. Penalty milestones are influencing the practice of making work complete as planned, however the contractors are committed to put on extra resources in order to complete the respectice tasks according to the overall milestones plan. Achievement of the milestones is obtained through adding more resources, in order to make necessary accelerations. An example is outlined to illustrate the issue:

Assume that available remaining time to completion is reduced by 20 %, which requests acceleration if the completion date is fixed and cannot be altered. Using the illustrations in the figures 5 -10 and 5 – 11 indicates an additional cost in the range 10 to 30 %, an expected average of 20 % additional costs due to delayed start up, conditioned that no particular management actions are taken to resolve the issue. The latter is normally not the practice as contractors demonstrate willingness to being innovative, smart and agile in order to utilize their resources in an efficient way in the effort of minimizing the potential detrimental impact on additional cost. Consequently, the real additional costs due to inefficient production are balanced and may lead to a moderate cost escalation, of the order 10 – 15 %.

The client and the contractor influence the complexity issue and have a joint responsibility to minimize the additional costs in which a split of the additional costs is a recommended approach and practice.

3. Inefficient production due to added tasks awarded to the contractor

Additional tasks awarded to the contractor are frequently requested to be performed concurrently with the tasks in the original scope of work on the main contract. The result is that the additional tasks are run in parallel to the tasks in the original scope of work, escalating the intensity and complexity during the project execution. The result is likely an inefficient production creating additional costs for completion.

A brief sum up of potential cost increases due to the total effects listed

Aproximate predictions of possible cost increases on total effects are summarized in the table below:

Topic	**Background**	**Brief description of potential additional costs**	Approximate prediction of additional costs from total effects, (in monetary figures)
1. Management	The management & overhead paragraph in the contract document	A predicted demand for 50 % more management resources during the later tages of the execution phase due to added complexity and more interfaces	
2. Inefficient production due to lack of completeness	Real increase in resources spent relative planned	10–20 % additional costs	5 % additional costs of total workload
3. Inefficient production due to changes and added tasks	Extra tasks superimposed the tasks in the contract scope of work	10 % added work with associated 10 % additional costs	5 % cost escalation
4. Sum of element 2 and 3			5 % additional costs of actual work performed
Total cost effect			XX,xx mill. Euro

Section 6

Business Driven Quality and Risk Management in Projects

6.1 The business benefit and desired effect goals

Project success is frequently focusing primarily on the project delivery and the efficiency during the project execution and the corresponding achievement of the specified product quality. However, it is of limited value to deliver a perfect project if the desired benefit and effects are not fulfilled when using the output product or service from the project in question.

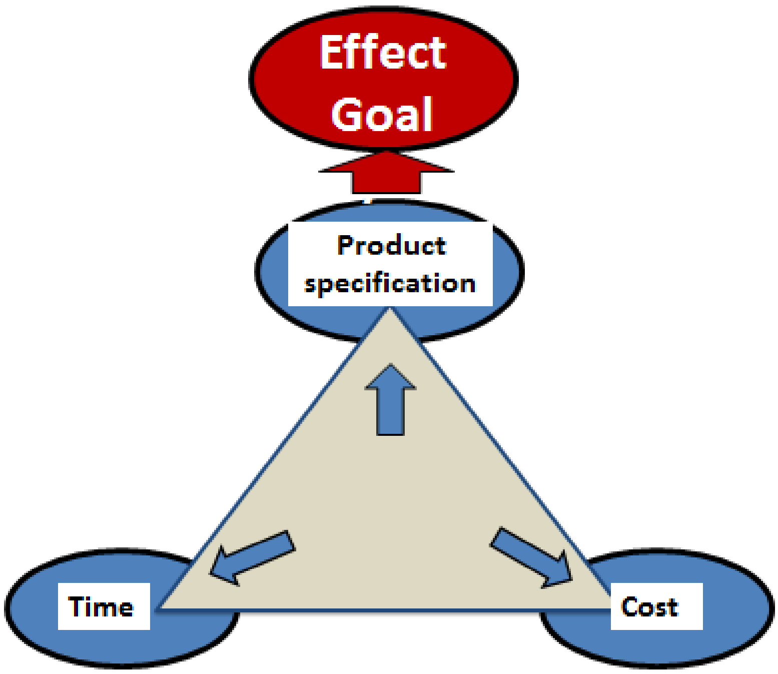


Figure 6-1 a sketch showing the interaction between the desired effect goal quality and the quality in the underlying basic project control parameters, cost, time and product quality.

The effect goals are are appearing after handover from the project to the users and the project team is no longer responsible for the application of the delivered product or service. Thus there is a need for a post project period for measuring and recording whether the specified effects are achieved or not. This may readily be done by the user organization, alternatively let the project owner be responsible in the start up and initiation phase of operation.

The desired effect goals need to be formulated and specified sufficiently firm and concrete, and should be summarized in the associated business case document, including the conditions, constraints and premises defined for the project. It is a challenging task as you need to fully understand the demand and the business potential in order to achieve superior performance of the delivery from the project in question. The very early predictions are normally rather uncertain due to lack of complete facts at time of up front estimation, and a recommended practice is to build in robustness in the estimates.

Likely examples of effect goals are:

- Project economics in terms of NPV and IRR
- Improved cost benefit ratio
- Reduced break-even price on the product
- Increased market share
- Increased production capacity
- Better capability of performing the scope and task
- Enhanced efficiency and effectiveness on the services and use of the delivery
- Enhanced functional and operational reliability on the product or service as a result of the specified improvement initiative.
- Enhanced competitiveness.

Superior quality on the effects may be achieved by a combination of high ambitions and realism, in which they should be controllable during the operation and use of the project delivery.

The ISO 21500 Standard has established an integrated connection between the effect goals to be achieved, the business case and the project scope and its constraints. That is schematically shown in figure 6 - 2. The model shows a closed loop from idea & feasibility stages through to conceptual assessments summarized in a business case hand over to the project organization and finally the project delivery & handover to the user, whether it is the internal line operation or an external client organization.

The principles outlined in the basic model in the ISO 21500 standard are generic and valid for any type of project and organizations. For IT-development and implementation projects, the line operation is normally an external client and user of the implemented IT-system. The client & contractor roles are similar for design and building a house, vessel or oil installation offshore.

In reengineering projects the client is most frequently internal, and the desired effect goals are an improved and more competitive organisation with higher efficiency and improved effectiveness. The achieved quality in reorganization type projects is depending on the execution capability securing ownership, perception and acceptance for the changes to be implemented. The management team of reorganization type projects should preferably consist of internal resources. They normally know where the shoe hurts. External resources may be utilised in plain analyses, benchmarking and as coaches. The execution quality is considered best taken care of when internal resources are in the driver's seat.

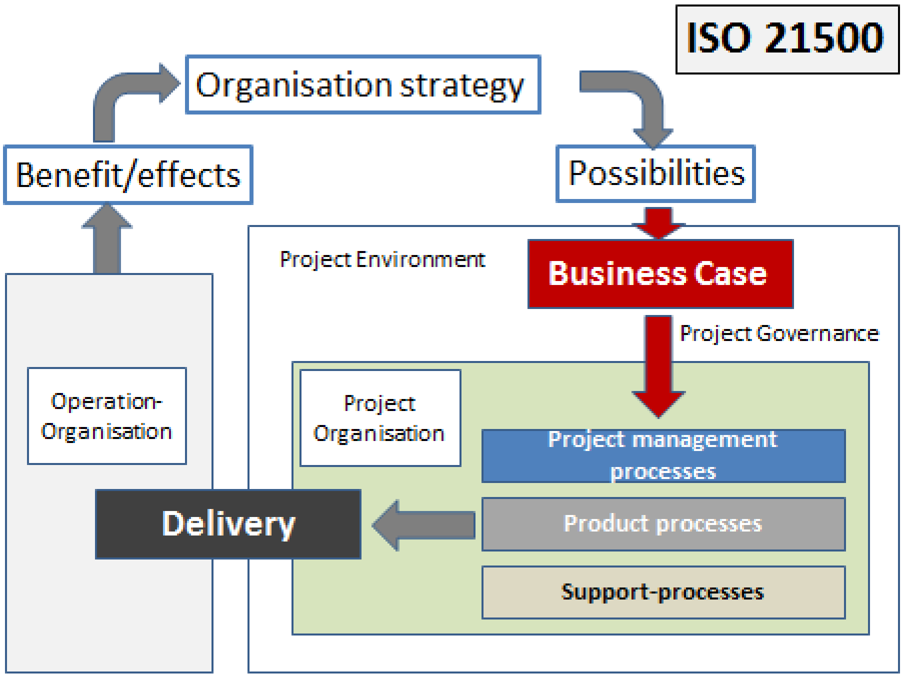


Figure 6-2 Generic model for quality in project management according to ISO 21500

Project success is depending on well formulated and well specified effect goals. The specified effect goals are particularly important in projects with moving targets in their result goals. This is typical for research projects, product development projects and IT system projects.

The solution might not be firm and clear at the start up and the product development matures over time. When the effect goals are stable, it opens for a dynamic development and execution route as a change journey. With that approach it opens for a gradual development and the technology solution is updated and altered iteratively through the project execution phase. The agile principles and scrum methodologies are considered attractive and relevant in order to perform efficiently and achieve high preciseness in the output. See Chr 6.4.

6.2 Uncertainty estimations and project economics

Superior quality management in projects are based on making confident decisions regarding the business potential as well as governing the execution processes such that the output delivery complies with the specified features and the corresponding expected benefit in use.

The project estiamtes are uncertain and normally highest at time of decision whether the initiative should be launched and sanctioned or not. Estimation uncertainty is associated with the project economics, NPV & IRR, as well as in the underlaying investment figures, CAPEX, the operation figures, OPEX, and the timeline. The estimation uncertainty is normally following a route of reduction in the uncertainty figures as more information is achieved and activities and tasks are completed. Completed and approved activities do not contribute to the accumulated uncertainty as firm figures are settled in the as-complete condition. The impact on the total estimates is reduced standard deviation.

The business value of a project is normally expressed in terms of the Net Present Value, NPV, which expresses the present value of the sum of periodic incomes and periodic expenditures, both the investment figures, CAPEX, and the periodic operation expenditures, OPEX. Time is a key issue in the NPV estimations, reflected in the discount rate and when the income starts to appear relative to the investment. Eventual delays in the completion date mean normally that the expected income period starts later and has a detrimental impact on the associated NPV.

In many projects the estimations of the "investment costs" and the timeline are done separately and frequently considered independent of each other. The reality is different. Frequently the total cost accumulated is strongly depending on the timeline and progress which should be reflected in the estimations. Current software tools in project control does not automatically couple plan and cost estimations, and these realities may be overlooked by inexperienced estimators.

Of remark is the socalled “carry over work” which is activities and tasks not completed during the previous phase and transferred to the next phase during execution. The carry over work is added on top of the planned activities in the phase resulting in an enhanced complexity and reduced efficiency.

Sometimes there are some step-functions describing the sudden shift in cost level depending on which project phase you are in. This can be illustrated by the construction and installation of an offshore oil & gas platform. The construction is normally done at one main yard with possibly some sub-contractors for parts of the construction. There may appear risks whether the construction and assembly is completed at the prescribed completion milestone at the yard. Eventual non completed work is then transferred to the next phase, whether it is mating at shore or during installation offshore. In both situations the unit costs are excalated significantly and a multiplier on the respective cost figures of carry over work should be reflected in some step function or transfer parameter. Accordingly, there are dependencies on the technical solution and the features developed during the execution of the project. This means that the estimation phase during planning shall cater for the dependencies that are present for the prospect, on timeline, cost and solution.

Figure 6-3 gives an illustration on the possible uncertainty in the NPV estimate in terms of an accumulated uncertainty curve for the NPV. The illustration shows two alternatives, A & B. The alternatives have a significantly different uncertainty profile. Alternative A has the largest spread, represented by the largest standard deviation, plus the highest estimated expected value, whereas alternative B shows a small spread but lower expected value.

The dilemma might be as follows:

- Which alternative should be selected?
- Should you decide solely based on the expected value and the standard deviation?

The two alternatives have curves that intersect. The illustration firmly shows that alternative A has a higher expected value than alternative B, the same is for the up-side potential, in which the P90 percentile demonstrate the difference in favour of alternative A. Assessing the lower end of the curves demonstrate an opposite situation. At the lower P10 percentile the estimate for alternative B is higher than for alternative A.

What should be the preffered alternative? It fully depends on the risk profile and attitude in the organization. The judgement should approach the P90 as well as P50 and P10 percentiles. If you have a risk willing attitude, alternative A is the natural choice. If the organization is rather risk averse, alternative B might be the recommened solutionas P50 and P90 are higher for alternative A relative alternative B. Alternative B has a lower expected value than alternative A, the P10 is higher for alternative B relative A and the standard deviation is significantly lower and "safer". You lose the up side but the confidence in the figures might be higher.

Prior to the estimation efforts on various alternatives, the organisation/project of concern needs to derive a set of selection criteria. These should reflect the risk attitude of the organization; it could be based on the expected value/P50 solely, a combination of P50 and P90 (risk willingness) or primarily on P10 (risk averse). The three percentiles derived in the estimates could also be weighed differently. When the selection criteria are established, the estimations of various alternatives can be analysed and a recommendation may be derived.

By establishing the selection criteria first, you are in a position to be more objective than what you may be when analyzing the various estimations for the alternative scenarios without up-front considerations of what are most important, safe predictions with alow degree of uncertainty, alternatively judge the importance of up-side potential overruling the downside.

The sketch in figure 6 – 3 may also illustrate different development scenarios. Alternative A may represent a full stage development, whereas alternative B may reflect a step wise development of a project. For development and implementation of a new IT system, alternative B might reflect the impact of using pilots prior to a full rollout in the organization. That is a rather typical approach on development and implement of new CRM and ERP systems. (CRM: Customer Relationship Management; ERP: Enterprise Resource Planning)

Why do you want to perform pilot testing prior to full rollout in the organisation? The pilot test will provide you with valuable facts on the use and functionality under realistic conditions. Many select pilots that may represent the most challenging conditions in the organisations. If the system works at the most extreme conditions, one may expect that it also function at more normal conditions too. The estimated uncertainty is expected reduced, and a higher confidence and reliability are expected. The global rollout is however delayed untill the results are present from the pilot sites. As a consequence, the time dimension in the NPV estimations leads to a reduced expected value/P50 as well as a reduced standard deviation/uncertainty in the estimates.

Similar consideration may be done regarding oil & gas field development. A pilot production is done in order to gather more facts and knowledge of the reservoir characteristics. A higher presicion level is achieved for the reservoir estimates and the associated standard deviation is expected reduced, at least a higher confidence level in the predictions. Earlier stochastic uncertainty analyses have demonstrated that approximately 90 % of the uncertainty in the NPV estimates is linked to the income side, ie the price and reservoir volume. As for the IT case, the main field development might be delayed when starting with a pilot production and the corresponding P50/expected value is reduced compared to full field development in one step.

The corresponding value drivers in the NPV estimations are illustrated in figure 6 – 4. In addition, the sketch shows links and interdependencies between the respective value drives that illustrate the complexity in the estimations. Furthermore there is also illustrated a link to the portfolio of projects within the same business area/asset. The latter is important as it links the single project to the portfolio and business considerations; it provides you with the possibility to perform proper project governance through prioritization, selction and optimization of the asset project portfolio. The project governance and project portfolio management should have impact on the product solution and product quality. The desire and efforts for achieving a high degree of standardization may have direct impact on the product quality in the single project as well as on the production regularity in the facility portfolio.

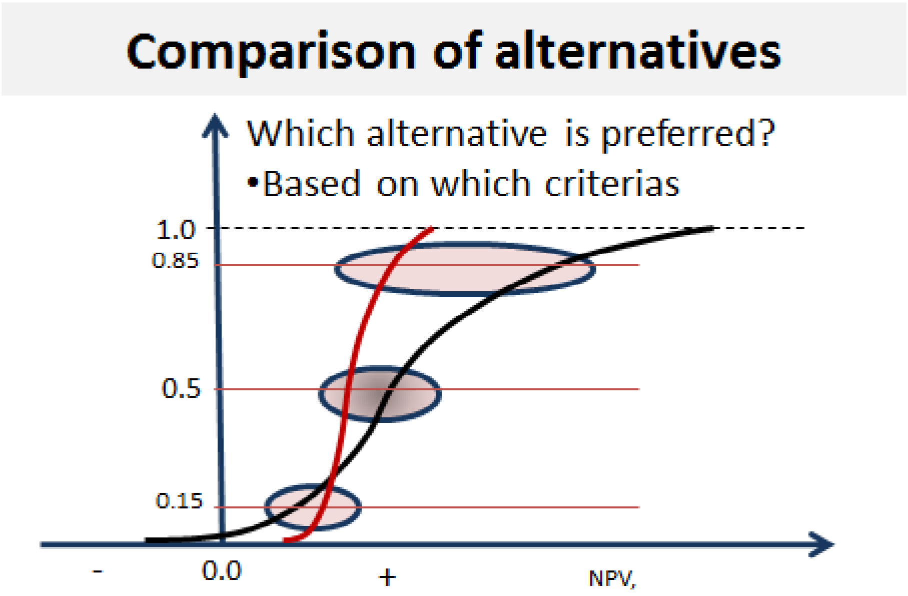


Figure 6-3 Illustration of uncertainty estimates in terms of the accumulated probability of the NPV – the black curve represents alternative A, and the red curve alternative B

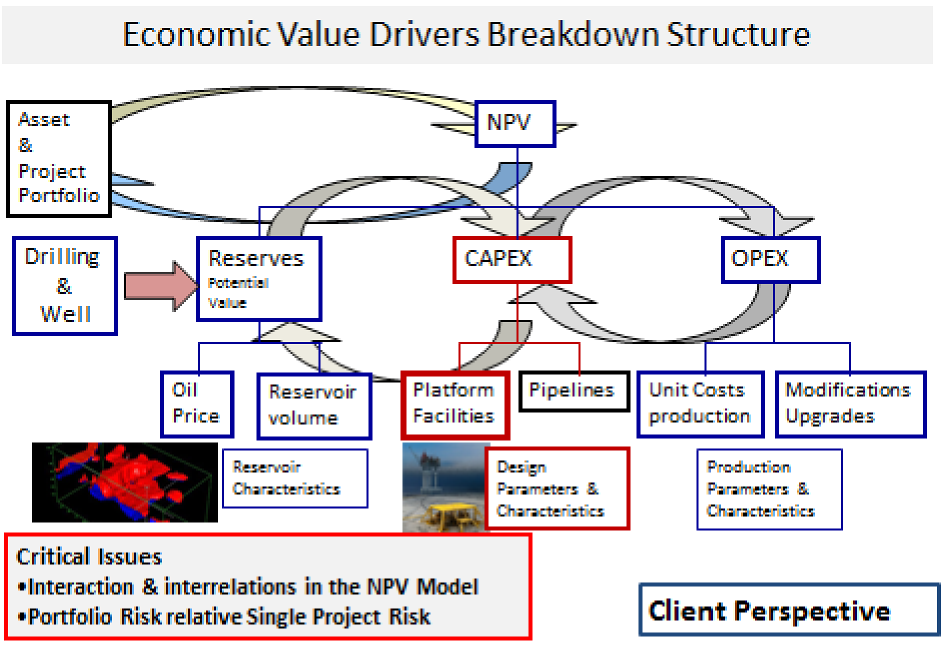


Figure 6-4 Illustration of the economic value drivers breakdown structure for upstream oil & gas field development

The uncertainty estimates of the business potential in terms of NPV and the corresponding investment demand in terms of CAPEX are normally performed in connection with the development of the decision facts basis and most frequently included in the business case document.

The value driver's breakdown structure in figure 6 – 4 may be applied for sensitivity analyses and to expose the relative impact of the single variable on the total uncertainty in the NPV estimate. This may be done by setting a single variable to a fixed value instead of including the uncertainty range for the parameter in question. The result of such sensititivity assessments shows the effect of removing the uncertainty in the single parameter on how much the reduction in the uncertainty & standard deviationfor the total NPV estimate. A management priority ranking is possible based on the relative impact from the various parameters on the total estimate.   This approach is considered very valuable for the project management team in order to derive sound actions on the most influencing parameters for reduction of the uncertainty level. Forecasts and prognoses should be made during the project execution period, as illustrated in figure 5 – 4.

Such considerations are relevant for the client/user as well as for the contractors/suppliers of the project delivery whether it is a product or service. If deviation of any kind appears during the execution, delays, functionality or investment cost, it may be simulated and reflected in the NPV estimates, which is recommended used in the dialogue between client and contractor on alternative actions to be taken.

The pricing in the tenders from suppliers are based on previous experience and on as-finished data on completed projects, categorized and stored in their company specific project data base. A key variable in cost estimation is the productivity norm for the various categories of tasks and objects in the project reflecting the relative efficiency in the single work processes. In that context it is of importance to know the validity range of the respective productivity norms. An application of productivity norms outside its validity range may have detrimental impact on the cost and execution time for completion of the project, and accordingly on the predicted business benefit (NPV, Net Present Value).

6.3 Stage/gate project execution models

Common practice in planning and execution of projects are through application of well-established project execution models. One of the most widely known is the waterfall model in which the idea or prospect is gradually developed through different phases, from the idea phase, through feasibility and conceptual design, through construction, completion and commissioning to final testing prior to handover to the user. The waterfall model has demonstrated success in a range of projects that are structured with a well-defined scope of work.

A key issue in project work and project management is the demand for clarification, understanding and perception of the roles and split between roles inside and outside the project organization. Unclear roles have caused numerous cost overruns and delays.

There is a general trend to request enhanced preciseness level in the project processes and project output which is dependent on firm description of roles inside and outside the project as well as making proper planning with a following systematic execution. Sometimes, new projects appear without knowing where it comes from. It is not clear who is the project sponsor or project owner, and the oberall business benefit and objectives may be questionable or only loosely specified. The organizational interface between the project owner and the project manager should be highlighted and exposed more in detail than what has been the tradition in classic project execution models.

During the last two decades alternative project execution models are developed with clearer role definitions and split of of roles compared to the classic execution approaches. During the 90'ies professor Cooper developed the so called Stage-Gate project execution model. (Cooper) The stages represent the project phases, and the gates are the decision point whether to proceed or not into next phase. The gates are defined as decision gates and are looking forward whether it is sound and right priority to proceed into next phase. A milestone in contrast, is by definition an achievement of a new state as a result of the accumulated work completed in the past. The milestone is a sum up of completed tasks providing you with a new state. In other words, it is linked to what has been done and completed, whereas the decision gate is looking forward and based on a total assessment of what is the right priority for the organization, not only for the single project isolated. The differences between a milestone and a decision gate are shown in the sketch in figure 6 – 5. There is a need to understand the purpose of a milestone relative to a decision gate. The milestone focuses primarily on the work produced internally in the project and confirms & documents the achievement of a new state.

The decision gate serves several functions. Initially it shall provide you with facts whether the project is ready to move into next phase or not, a readiness report is normally made confirming that all activities related to the phase are completed to date and the output meet the specified level with respect to product quality and features. That is the internal focus in the respective projects.

However is it optimal to continue with the project in question instead of launching other initiatives? The decision gate assessment will link the considerations to the portfolio selection and prioritization from a strategic and operational business perspective. Is it the right decision to continue with the project in question and loading the key human resources to that instead of reallocation of key resources to alternative initiatives? These considerations should be done in a project portfolio perspective covering both the business benefit and organizational aspects.

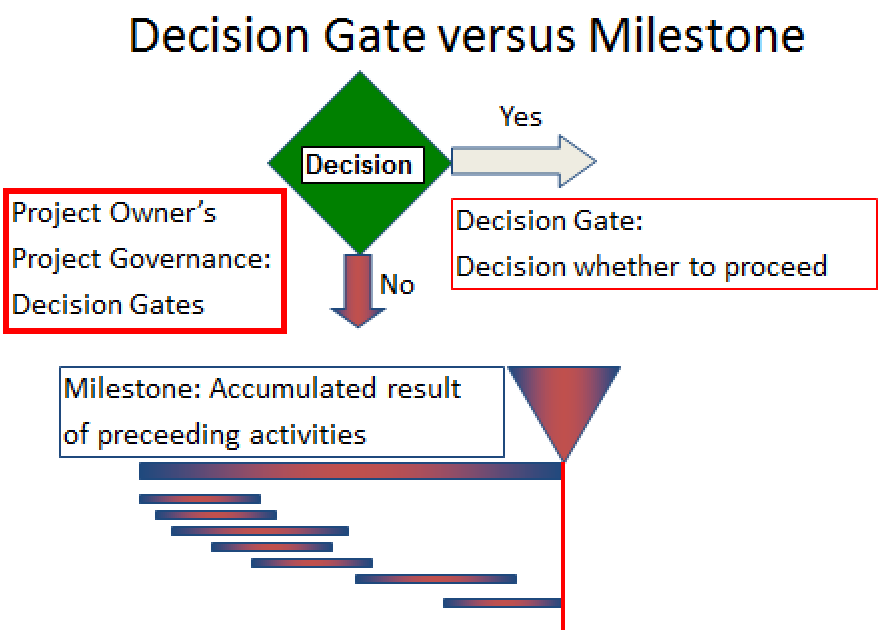


Figure 6-5 Illustration of the difference between a milestone and a decision gate

The following question is who should decide what during the project execution. The stage/gate execution model makes it possible to distinguish between the duties to the project manager and the project owner respectively.

The project manager & management team are accountable for the value generation and eficiency during the execution. The project manager shall be dedicated and focused on the project deliverables, in light of potential impacts of external factors influencing the project execution. It means to concentrate on the realization of the scope of work and tasks to complete and cater for an execution performance according to the requirements with respect to product quality, delivery quality and project quality/efficiency.

The project owner has another role. The project owner shall do proper project governance and control in order to secure as-delivered features in accordance with the specification requirements as well as recording and assessing the project execution within the framework of project portfolio management plus other committed line operation tasks. Project governance and the role of the project owner are elaborated in more detail in section 6.4.

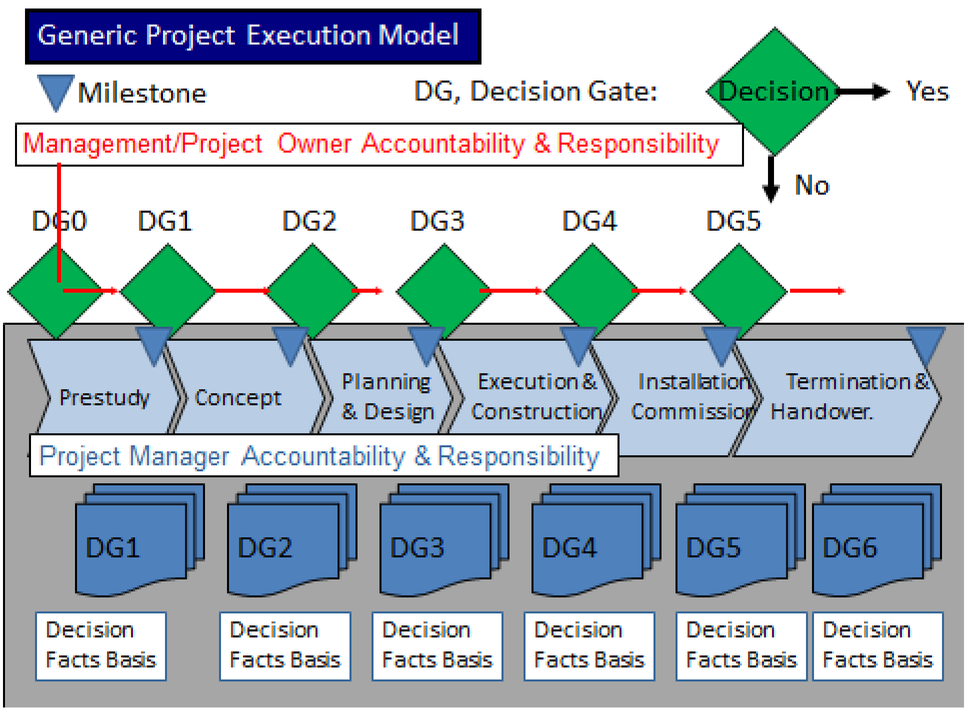


Figure 6-6 shows a sketch of a typical stage gate project execution model that firmly differentiates between the milestones and the decision gates.

The split of roles are also shown in figure 6 – 6. The project owner is linked with the decision gates, whereas the project manager is in charge of the value generation and progress. The project manager shall also collect and generate the decision facts documentation for the respective decision gates.

What kind of documentation should be included in the decision facts basis? The amount and the detailing level is depending on the type of project, complexity of the scope of work as well as on the application range of the output deliverables.

A recommended practice is to establish a set of check lists for each decision gate covering the following issues:

- Updated business case
- Is the specified maturity of the concept and product according to the state requested for the phase completed?
- Is the achieved product quality as specified per phase?
- Is the productivity and value generation as planned?
- Could other human resources perform the job?
- Are the human and material resources applied properly?
- Are there any deviation and non conformance on the output so far?
- Is a quality control and monitoring performed in order to confirm that the the product delivery is accordance with the specified and purchased object or service?
- Is an experience feed back made covering both
    - The scientific and technical tasks performed so far, and on
    - The actual productivity/efficiency
- Is there any collection of experience from other projects completed?

The check list above represents primarily the internal readiness of the project whether to proceed into the next project phase or not.

A corresponding project external focus should cover aspects that the project owner is accountable for in connection with the decisions at the the decision gates. Those aspects should reflect the business environment and the project portfolio considerations linked to prioritization and efficient operation of the portfolio. Likely check points are:

- Does the project comply with the overall strategies and prioritized focus areas for the organisation?
- Are the organisation’s key experts applied in an optimum manner and are the priorities still sound?
- Assessment of the current project portfolio and the associated portfolio risk

Appendix 1 contains some examples of checklists at the decision gates in figure 6 – 6.

One of the successfull features of a stage gate based project execution model is the involvement and commitment by the project owner during the project execution, not limited to launch date and completion date of the project. The model characteristics requests tha the project owner is involved all the way during the execution. The project owner should be so much involved that he/she has ***"the hands-on, not hands-in or hand-off".*** The "hands-on" approach means that the project owner is committed and can perform project governance and control without interferring with the project manager, as if he/she is taking over the job of the project manager. The project manager should be happy when having a project owner demonstrating a "hands-on" approach. It makes the leader role easier in the project as the project owner may help the project manager to get access to and get priority with respect to mobilization of key resources if they do not show up as planned and agreed upon. Furthermore the "hands-on" approach makes it possible to continually address the purpose and objectives of the project.

The decision making is also more formalised when moving from one phase/stage to another. A spinoff effect is that the specified output from one phase to the next may be firmer and more precise due to improved specification requirements for the respective output from each phase, accordidng to the principles outlined in section 2 and illustrated in figure 2 – 4.

At first the design of the stage gate project execution model may be considered as rather rigid and formal in its structure with initially a sequential pattern of the phases/stages. The roles and functions are clearer than in classic project execution models. However, the split of milestone and decision gate opens up for flexibility that is attractive and necessary when more agile and dynamic approaches are requested. There might be situations that request the option of starting the next phase although the previous phase is not yet completed. Those desired features are achieved when there is a split between decision gate and milestone. The latter is the characteristics of typical software development projects, reorganization type projects and product development projects that should be capable of handling agility, changes and dynamics through the entire project execution period. Such conditions are often the case also for modification projects and upgrading projects to be completed within a fixed and firm time period. The consequences on executing the work tasks are that a range of activities have to be run partly in parallel, concurrently, and decision must be made under uncertainty and non complete facts in order to make progress.

A critical issue is to establish sufficiently confident decision facts in order to being able of making sound decisions on non-complete facts.

The decision on start-up of next phase is made prior to completion and achieving the maian milestone in the previous phase. Intensified focus is put on the decision facts. Two critical quastions aappear:

- Are the facts of sufficient quality and confidence and do they cover most considerations necessary?

And not least:

- Who is qualified to make decisions on non-complete facts?

Such situations may appear in many different projects, not only at the formal decision gates, but also for any decision to be made. How to achieve satisfactory confidence in decisions when there is lacking firm data? A bare minimum of facts information must be available. However, an important issue is the qualifications of the project owner who is the ultimate operational decision maker to the project. The dilemma pinpoints a critical issue that fully demonstrates the need for sound and relevant experience on the kind of projects in focus. The individuals must have the capability and notion of making confident judgement and interpretation of even the vaguest facts and figures for the issue of concern. Fresh graduates from the university do not have the necessary experience to make decisions on non-complete facts, although they have first rate analytical skills. The desired profile of the project owner must include the requiernent of having similar experience and skills for the project in question.

An experienced key human resource or business manager is in a situation that she or he can cope with the situation, conditioned upon that the right attitude and a holistic approach is demonstrated. Such a person should be capable of assessing rather diffuse facts and figures and generate a confident and sound decision, including cause consequence assessments. As a result, satisfactory and safe decisions may be achieved although not all data facts and figures are available at time of decision.

When running the concurrent approach the decisions for moving into next phase are made prior to completion of the total work in the previous phase. The added facts and figures may then lead to a need for an adjustment of the decision made and the iterational approach should be utilised during the execution. Consequently the characteristics and features of the stage gate model are considered fully appropriate and attractive for coping with the need for agility, dynamics and flexibility during the project execution. The statement is further elaborated by Cooper & Sommer (Cooper & Sommer 2016).

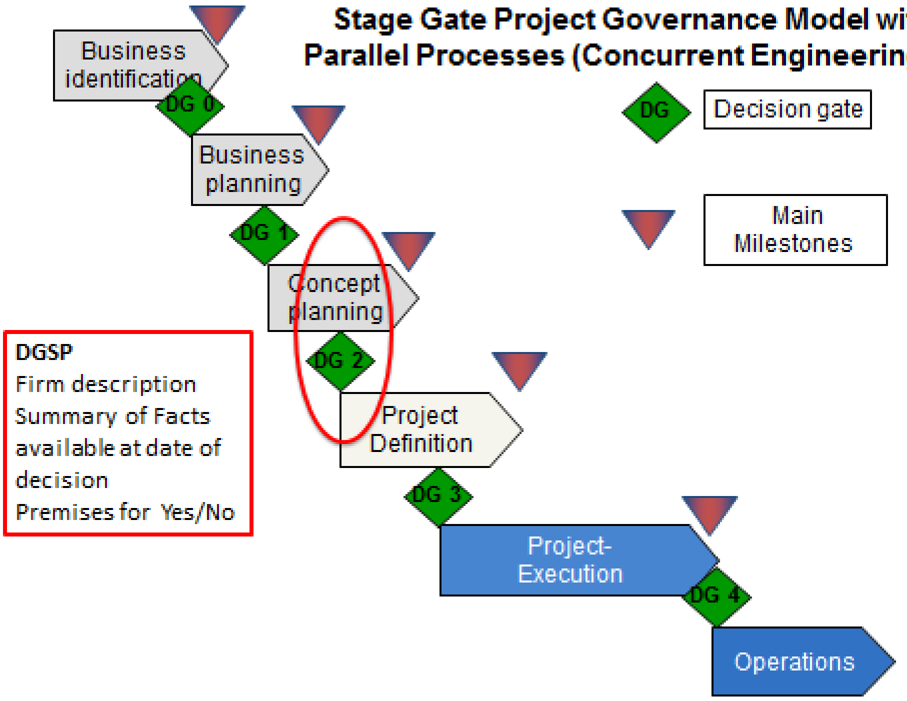


Figure 6-7 Sketch providing the capability of «concurrent engineering» through split of milestones and decision gates

The illustration shown in figure 6 -7 is rather typical for engineering work, in which area engineering can start prior to completion of the system engineering. The similar practice applies when doing construction and assembly work. Construction of standardized components and sub systems may be completed although the overall system layout and design is not complete to date. The model outlined in figure 6 – 7 is in agreement with the work by Cooper (Cooper & Sommer 2016) and with Van Oorschot (2013 & 2017).

Fast track projects may become real if they are run concurrently and possibly with an agile and lean approach. Then there is a demand for decision makers that are capable of making confident decisions under uncertainty, on non-complete facts. The organisations should make sure that the gate keepers representing the project owner role have these qualifications necessary at the respective decision gates in the model.

The transition from one phase to the next may create some increased uncertainty and risk. These considerations are valid for the output delivery from the phase, the compatibility of the solution, changing roles when moving from one phase to the next, lack of continuity with respect to resources etc.

The stage gate project execution model is considered to add value and confidence to the execution whether the project is run sequentially or concurrently. The hypothesis is based on the following three statements:

- There is a formal decision and approval process heading for the next phase in the project.
- The output delivery from each phase is firmly specified and checked according to specific check lists for the respective decision gates.
- Firm and clear role split between the project manager, accountable for the project development and execution and the project owner, the ultimate decision maker at the decision gates.

Numerous corporations in many countries have developed their own project execution models that have adopted the principles and design features from the original stage gate project execution model launched by Cooper in the early 90'ies.

Among the first industries was the Swedish telecommunication company LM Ericsson that developed their PROPS-model fully in compliance with the principle outlined by Cooper. Other corporations adapted the same, as for example, BP with their Capital Value Process, a business driven model, Statoil, and a range of oil service companies. Also maritime industry developed and implemented the approach such as Wilhelm Wilhelmsen Shipowners. Land based building and construction industries have also implemented models with features and characteristics derived from the original Cooper model as recognition on making the model, roles and decisions more firm and clear resulting in better project performance and output.

6.4 Project governance and impact on project & product quality

Corporate governance became a hot topic around year 2000, as there was a need for better control from the owners' point of view. The Athur Andersen and Enron scandals accentuated the need for intensified corporate governance. Today corporate governance principles are well known and widely implemented in the majority of private and public enterprises. The primary focus has been on corporate governance, and until recently not as much on project governance.

What is the status regarding project governance? The principles and practice have not developed to the maturity level typical for corporate governance. There is thus a need for clarification and further development of a set of standard recommended practice related to project governance. There is a wide range in practice related to project governance, some are very conscious about the need for proper project governance whereas others have hardly heard about it. Lacking project governance may likely lead to extensive cost overruns and delays with a corresponding detrimental impact on the desired effects and business benefits.

A rather unfortunate case & story regarding lacking project governance was the rebuilding and upgrading of the Holmenkollen Skijump in Oslo prior to the Nordic Skiing World Championships in 2012. The municipality of Oslo City was not prepared to fully perform the role as project owner. The project manager in the client team reported issues to the owner and experienced that lack of a fast response was often the reality. As a consequence, the project ended in a squeeze timewise and the construction costs escalated. The particular characteristics of international sport events are that the dates of the events are fixed with no room for moving it one single day.

Project governance is defined in ISO 21500 as follows:

> "*Governance is the framework by which an organization is directed and controlled. Project governance is concerned with those areas of organizational governance that are specifically related to project activities.*
> *Project governance includes aspects such as defining the management structure; the policies, processes and methodologies to be used; limits of authority for decision-making; stakeholder responsibilities and accountabilities; and interactions such as reporting and the escalation of issues or risks. The responsibility for maintaining the appropriate governance of a project is commonly assigned either to the project sponsor or to a project steering committee."*

Project governance means that the project owner is actively involved in the project development. The term «hands on» is considered necessary for achieving satisfactory project governance. The consequences are that the project owner shal be close to the planning and execution processes and partly an integral part of the process. That may be readily achieved by using stage gate project execution models and fullfill the requirement to the roles connected to the model. The stage gate project execution models are considered attractive for achieving satsfactory project governance.

The main reasons are:

- Firm roles and clear role split between the project management and the project owner
- The project manager has accountability for the project execution.
- The project owner shall perform the governance function on the project.
- There is a single point of contact when focusing on project governance.
- Project owner is normally the ultimate operational decision level connected to the project, and the steering group is the ultimate decision level regarding strategic business considerations.
- The assessments at the decision gates are done in light of the entire organisation or business area, not limited to the internal readiness considerations for the single project. It shall include the perspectives of strategic and operational project portfolio management in order to ensure that the right priorities are made.
- A proactive project owner is providing support to the project manager and project team; in particular on access to the human resources if they do not show up as planned and agreed with the base organisation,
- A proactive project governance adds value to the quality assurance processes in the project, which is considered as a further support and not post control and recording of the project results.
- Ensures that the project strategies comply fully with the overall corporate strategies.
- Better dialogue between the line organisation and the project regarding:
    - Human resource management and mobilization/demobilization
    - Individual performance feed back
    - Systematic competence development and management
    - Systematic experience feedback learning during the project execution
- A formalised assessment at the respective decision gate in light of:
    - The internal readiness of the single project to proceed to the next phase.
    - The portfolio of projects and other line tasks within the respective business area and for the corporation
    - The portfolio uncertainty
    - Continued priotisation and possible need for reallocation of resources
    - Productivity and effectiveness in the respective areas.

Project governance should also cover the life cycle perspectives connected to the use and demolition of the product deliveries and the operation close down of the product delivery from the project. That approach widens the scope of work significantly and the role of the project owner should cater for focusing on implementation and user-friendly systems. Furtehrmore, the life cycle perspective means that the there must be focus on achieving excellent constructability (building projects of any kind), user friendliness, HSE and CSR plus not the least what is economically most sound in a life cycle. The consequences are that the project owner must be involved in making the premises and conditions for the project and product in question, and what are the fundamental design conditions and desired functionality of the product. Some of the control functions to the project owner will during the project execution phase be to make sure that the life cycle perspective and life cycle quality are fully included in the design and execution work.

A key issue in achieving superior project governance is the actual quality and confidence on the decisions and the associated decision processes. Factors of importance are:

- Who shall make the decision and are qualified & capable?
- Who shall be involved in the decision-making processes?
- How should the involvement be?
- What are the decision criteria for selection and prioritisation?
- The requirements to the background decision facts documentation
- The competence requirements to the decision maker in the project owner role

The project owner and the associated steering group are normally the ultimate decision level in the project.

In order to achieve an efficient project execution, it is strongly recommended to establish firm roles and responsibility matrices. The RACI approach is widely applied and an example is shown in the table including various roles inside and outside the project(RACI; R: responsibility, A: Accountability, C: Consulted, I: Informed). The RACI matrix must clearly define what kind of decision may be made by differnt roles. Of particular remark is that the RACI matrix must be updated periodically as the project organization changes over time and the RACI matrix must be adjusted accordingly. Both project owner and project manager need to focus on the application of the RACI matrix in their roles at managers and leaders. .

A typical RACI matrix is shown in table 6 – 1.

Role	Steering Group	Project owner	Project manager	Part project manager	Project member	Controller	QA
Task							
Portfolio & comm. Strategy	A	R	-	-	-	-	-
Appointing PM	(A)	AR	-	I	I	I	I
Approve business case	A	A	R	C	I	C	C
Approval at decision gates	C(A)	A	R	C	I	C	C
Project strategy	I	A	R	C	I	C	C
Control & performance reporting	I	C	A	C	I	R	I
Overall milestone plan	I	(A)	AR	C	I		
Main activity plan		I	A	R	C	I	C
QHSE-plan & Control		I	A	R/C	C/I	I	R
Production plan		I	A	R	C	I	C
Activity performance			I	R	A	I	C

Abbreviation

A: Accountable; R: Responsible for execution; C: Consulted; I: Informed

Table 6-1 Example of a possible RACI matrix with particular focus on the project governance

The RACI matrix illustrates what kind of decision may be made at different organisational levels. The project governance is covered by the roles of the steering group and the project owner. The tasks addressed in the table demonstrate that the project owner role ensures that there is a link between the respective project and the enterprise and organizational issues.

The requested type of involvement for the various roles is stated firm and clear in the RACI matrix. Concerning strategic business issues, it is primarily the steering group and the project owner who are in charge whereas the other roles in the project environment are informed, eventually consulted. On operational issues the project manager and the project team have the accountability and responsibility, while the steering group and project owner are informed only.

Any decision in the project should be rooted in documented and traceable facts. The decision support facts should include the conditions and characteristics necessary for making a decision. These are common rules for any formal decision connected to the project, whether it is minor issues internally in the project or it is related to overall strategic and organisational aspects. Particular attention must be shown at the formal decision gates for the transition from one phase to the next, included in a stage gate project execution model. The DG decisions must reflect the business strategic perspective and assessment of the priority for continuation of the project into next phase, alternative stop it and reallocate the resources to other initiatives. The facts support package should also include updated uncertainty analyses, covering risks as well as opportunities. In addition, a quality control report is recommended completed prior to the decision at the actual decision gate.

These aspects are considered challenging in projects predominately run with a concurrent approach, as outlined in more detail in section 6.2, and see figure 6 – 6. Under such conditions the project owner and the project management must demonstrate high attention and concern about the reality of having non-complete facts at time of decision. Several issues, interests and topics interact and counteract. First of all, the decision support package must demonstrate confident quality of the facts available. However time pressure may influence the demand for high quality facts support. The key question is thus:

- What is sufficient amount of facts and of a good enough quality for making a sound decision at the respective decision gate?

It is important to notice that the prescribed decision support package summarizes on what ground the decision will be made covering available relevant data and the associated ruling premises. Furthermore, the decision facts support package should identify possible adjustments necessary during the next phase as a consequence to completion of the overall milestone in the preceeding phase. Those characteristics demonstrate the need for project execution approaches with a fully dynamic nature that is made possible by using the principles in agile and lean project management and execution through scrum and similar dynamic and feature focused approaches. The project execution becomes a continual change journey, and the project owner should demonstrate the capability of being "hands-on" during the change processes through knowing the primary conditions and constraints present during the execution. The sketched project profile is rather typical for IT projects and business development projects. Those types of projects are recognized through having result goals that are changing over the project life cycle, while the desired effect goals and corresponding business benefits remain stable during the project planning and execution phases.

Similar conditions are present to some degree even on modification and upgrading projects. For such projects there is often a prescribed window of time available for the change however the solution may not be possible to design in detail prior to the actual execution. The latter is due to lacking information of AS-IS condition of the existing facilities or system, that may be significantly different from AS-designed and AS-built. Such characteristics and conditions can be met when planning and performing the project execution accoring to agile and lean project management principles with primary focus on the features and desired effects rather than detail control on cost and schedule. See section 6.6

What is the necessary competence profile and capability of those individuals holding the project owner function?

The role of the project owner is primarily to ensure that proper project governance is obtained during all phases in the project, from the idea generation and feasibility considerations through to completion and handover to the user of the product or service. The governance function requests control of the desired business strategic aspects in an overall framework for the enterprise. The qualified individual must fulfill the requirements with respect to relevant competencees and experiences, as well as skills and capability of making firm decisions. The qualification requirements are so high that fresh graduates normally do not fulfill those.

In the most business and organisational strategic projects there may not be many representatives in the organisation that fullfill those demanding qualification requirements. Business area leaders should be capable of matching the desired qualification requirements. Furthermore, it is desirable that the project owner demonstrates a cross functional and holistic attitude in which the entire organisation is in his/her mind, not only the single business area where the project is linked. The totality aspects should be strengthened when establishing a steering group with members that represent differant parts of the organisation in order to ensure the presence of a cross functional and holistic approach.

The project governance and role of the project owner are briefly covered and reflected in the PMBOK, Project Management Body of Knowledge; however, PMI addresses the topics more thoroughly in the associated guidance of project portfolio management.

The British PRINCE 2 recommended standard is designed on the basis of proper project governance and the importance of achieving the project effect goals.

ISO 21500 includes project portfolio management as well as project governance and project ownership, see figure 6 – 2.

Project governance is furthermore linked to managing the project stakeholders, in particular the external stakeholders who may have strong impact on the project initiative and the success. There might be an organizational & political agenda among the stakeholders that must be managed to the satisfaction of the organisation and the project. Consequently, stakeholder management and leadership are recommended as important tools in the tool box to the project owner and the project manager. The project owner could focus primarily on the external stakeholders, whereas the project manager must cover both the external and internal stakeholders.

A project support office might be an appropriate instrument as administrative support to the respective project owners. The recordings and administration of the project portfolio selections and the recordings of the existing project portfolios can readily be done by the Project Management Support Office. The PMSO may also perform the requested assessments for performing the governance function in the role as project owner on the single project as well as on the portfolio assessment. The PMSO unit may thus ensure that project governance and project port folio management are done consistently throughout the organization and based on established common standards and procedures. The role of the PMSO unit is thus an efficient and professional support for the project managers and the portfolio managers, not acting as “audit police control”.

6.5 Managing quality & risk in project portfolios and project programmes.

Brief definitions

Many organisations, and the business management in enterprises are performed through planning and executing a range of projects – for innovation, improvements, upgrades, product development as well as reorganisation projects. Some of the projects are interlinked and depend on each other, while others are essentially independent of each other.

Two distinct different categories are:

- A true project portfolio
- A project programme

A project portfolio is a group of projects and programmes that are essentially independent of each other. Managing the portfolio may be obtained by a joint portfolio management that bridges the gap between the single projects and the overall business objectives and enterprise management (ref. Aarto et al., and Archibald).

A project programme consists of a set of projects with common overall purpose and objectives, and the projects build on the out put results from other. There is a strong dependency between the projects, on development of solutions and not the least regarding key resources. The output result in one project affects the results in other projects and a socalled “Knock-on” effect is likely.

Management of a project programme is considered more challenging than managing a true project portfolio of independent projects. The domino effect may readily apper in managing a project programme, and a deviation in one project may have an escalating impact on the other projects in the programme. A project programme may be linked in a project portfolio together with other independent projects as indicated in figure 6 – 8.

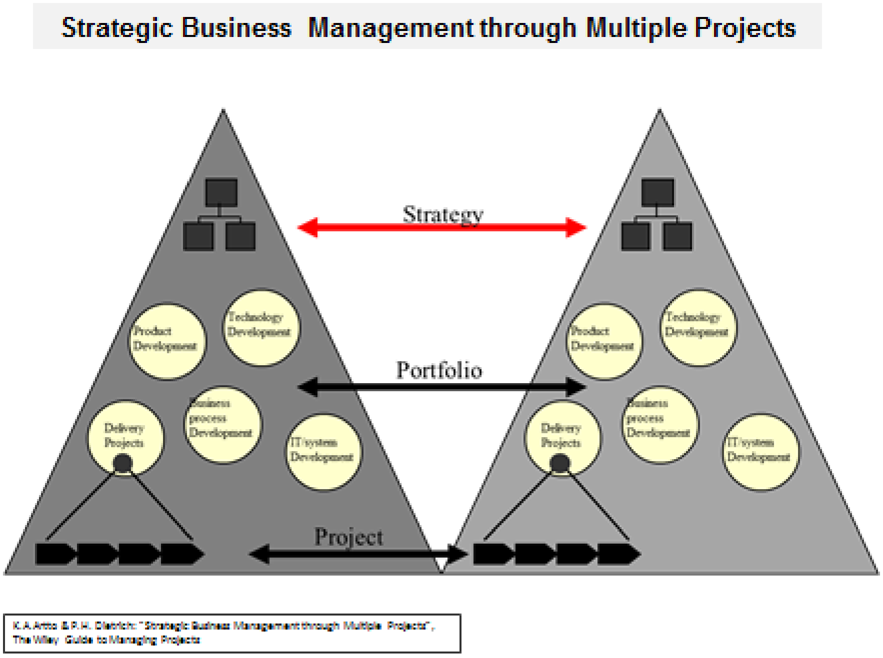


Figure 6-8 Sketch of the links and interactions between single projects, programmes and portfolio according to, K.A. Artto og P.H. Dietrich ”Strategic Business Management through Multiple Projects”, in The Wiley Guide to Managing Projects

Management and control of a project portfolio may be classified at three different levels as follows (Lereim 2008b):

- Level 1: Portfolio reporting
- Level 2: Portfolio control
- Level 3: Strategic portfolio management.

Most organisations are well qualified regarding management of single project, while the experience and practice vary significantly in the areas of portfolio and programme management. Portfolio reporting, level 1, is established in a range of companies contributing better overview of the total activity portfolio in the respective organisations. Fewer companies have developed and implemented satisfactory portfolio control, and a fraction of these has designed and implemented the level 3, strategic portfolio management. The level 3 approach, strategic portfolio management, provides you with a toolkit and the capability of making decisions and priorities in the portfolio in compliance with the overall business strategies, both with respect to selection of the right project as well as efficient control and management of the current project portfolio. Those aspects are illustratedin figure 6 – 9. Key variables in that context are portfolio uncertainty and portfolio resource management. (See Lereim 2008b)

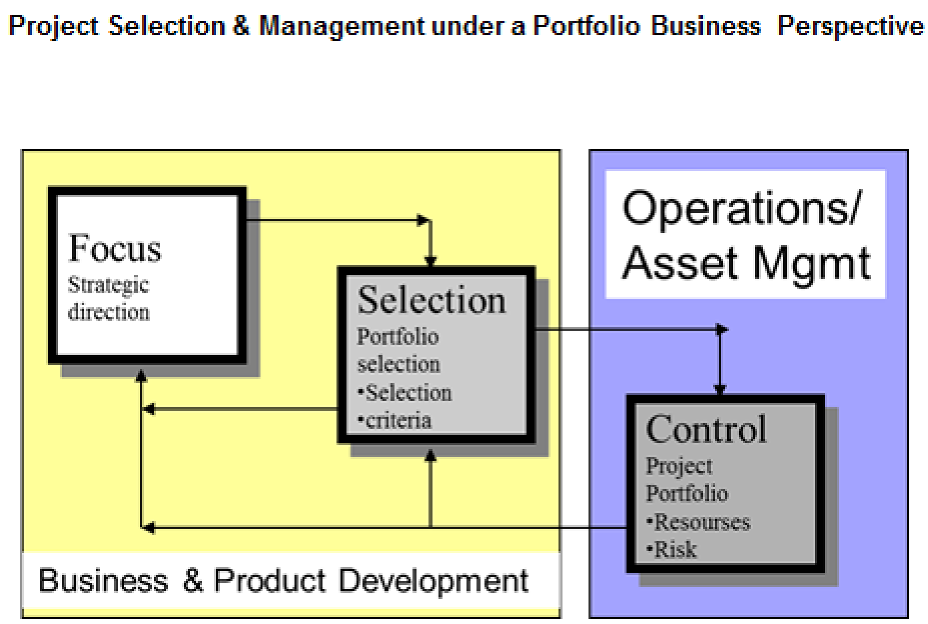


Figure 6-9 Example of a project portfolio model including focus on the strategic aspects in selection and efficient management of the current project portfolio.

Project portfolio management is demanding, but important for achievement of consistency in prioritization and optimization of the total value creation in an organization. Those perspectives may be better taken care of if there is consistency of the use of common portfolio models at different organization levels. Connected to that, there should be established a mechanism that trigger escalation of those projects that impact the organization in more broadly. It means that the top priority project on department level may be escalated to business area level if it impacts the business area, not only the single department. Similarly, the top priority projects on the business area should be escalated to the corporate level if they have significant impact on the entire corporation, see the sketch of an escalation structure in figure 6 – 10. By that approach, you achieve the following:

- Consistent methodology on project portfolio management at the different organizational levels
- Corporate management may focus on the vital few that impact the performance of the entire organization.

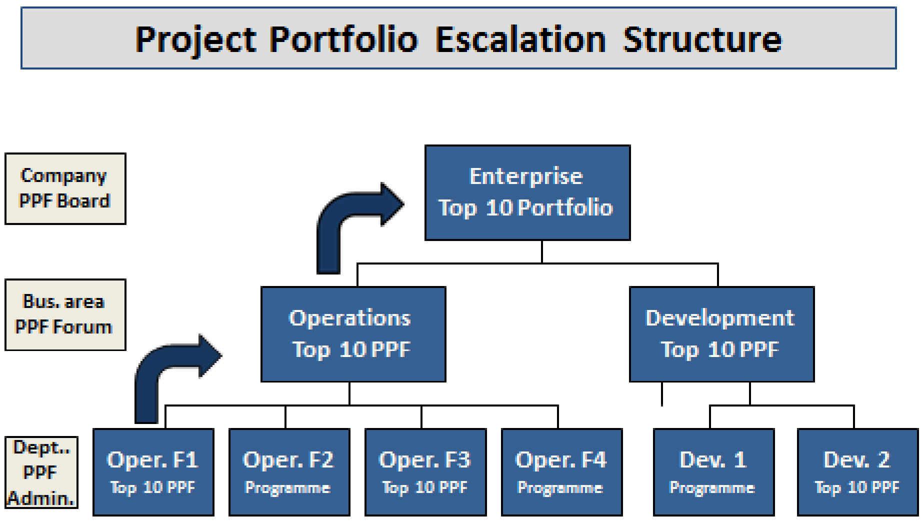


Figure 6-10 Sketch of a portfolio escalation structure in an organisation

Quality management in the project portfolio

What should be covered in quality management in a project portfolio?

Quality in project portfolios shall address elements on enterprise and business level as well as confidence and quality in the single projects in the portfolios.

The overall aspects are linked to the business and enterprise issues in which the critical elements are to select the initiatives/projects that add to the quality and business potential of the portfolio, ie select the right projects that contribute to maximization of the business benefit from a strategic and operational point of view. The second element on an overall and integrated portfolio perspective is to optimize the use of human and material resources in the portfolio and perform operation management of the current portfolio such that value maximization is achieved in the portfolio including uncertainty, both on risk and opportunity.

The basic quality assessments in a project portfolio must cater for superior quality in the single projects covering product quality, delivery quality and project quality as defined in section 1.2. The explicit product specification requirements in the single projects must be met in all projects included in the portfolio in order to achieve the desired product quality for the portfolio.

The corresponding delivery quality in the single projects must be met in order to satisfy the portfolio delivery quality with respect to time of completion, handover and the precision level at handover. That approach should be the basic rule for achieving satisfactory delivery quality in the portfolio. However, the nature of a true project portfolio is different from a project programme that may generate different approaches for the portfolio relative a programme. These aspects may be assessed briefly by use of some elementary principles and analogies from system reliability theory.

A true project portfolio may be classified as a parallel system. That means the portfolio reliability increase with the number of projects loaded into the portfolio, and the associated robustness in the portfolio increases. You are not that vulnerable and dependent on a single project. Superior system reliability/project portfolio reliability may be achieved with modest component reliability if sufficient number of projects is loaded into the portfolio.

Let us apply the term reliability as an expression for project delivery quality. Furthermore we use the term R for the reliability. The single project is defined as Ri, and the system reliability as Rs.

The portfolio delivery quality may then be expressed in terms from reliability theory in terms of the system reliability.

The system reliability, an expression for the portfolio delivery quality is as follows::

Rs = 1 – (1 – R1)(1 – R2)(1 – R3)(1 – R4) ……. (1 – Rn)

n is the number of projects. Assuming the same reliability level on each component/project, the expression may be simplified to the following: expression including first order elements only:

Rs = 1 – (1 – Ri)n**

The output characteristics are that the system reliability becomes larger than the component reliability. The interpretation in the project portfolio is that the portfolio system delivery quality improves when more projects are added to the portfolio.Rs> Ri. The portfolio delivery quality may be specified in frame agreements typical for maintenance and modification work.

Quality in project programmes

A project programme has another character than a cluster of independent projects. According to the definition, the project programme consists of projects that are directly linked and depending on each other.

In many ways a project programme may be similar to a major project consisting of several sub projects in which the total solution is based on integration and assembly of the deliverables from the respective sub projects.

The projects included in a project programme have common objectives and common overall effect goals. One project builds upon the results of another. There is frequently an economy of scale achieved by organising a cluster of dependent projects under a common umbrella of a programme. The analogy from reliability results in an understanding and perception that a project programme may be treated as a series system. Let us again consider that the reliability is an indirect expression of the delivery quality.

There are two vital features of a series system:

- The system reliability is governed by the weakest link in a chain. In a project programme it means that the single project that underperforms has a knock-on effect on the other projects in the programme resulting in reduced system reliability.
- The uncertainty in one project may lead to an escalated effect on the uncertainty in the project programme. The consequence is that the total uncertainty in a programme increases relative the single project.

Again let us use the term reliability as an indirect expression for the project quality, and let the system reliability be expressed as Rs and the single project reliability as Ri.

The system reliability for a series system, conditioned upon that all components have the same component reliability, may be estimated through the following simple expression:

Rs = R1*R2*R3*R4……….*Rn = Rin**

In this case **Rs < Ri**

If one single project dominates and has significantly lower reliability that the others it is the weakest link, and that governs the system reliability. It does not help to achieve superior reliability and associated quality in the other projects if the one critical project underperforms.

In that case the system reliability is dictated by the weakest link, ie the one project that underperforms.

Rs = Ri min

A typical example on a project programme is a renewal of an IT system like CRM or ERP type projects. Such a renewal consists of a series of projects including the following typically:

- Development of a system functional specification requirement
- Coding/programming of software
- Testing, FAT and SAT
- Implementation
- Training of super users

These sub projects are directly correlated and build on each others output.

The quality of the system functional specification is governing the total delivery quality, as any of the out put from the other sub projects are. Sub standard functional specification may result in a knock on effect connected to the system quality. Similar consequences appear if underperformance is present on the coding sub project, as for the testing sub project, implementation and unsatisfactory training of the super users.

In a project programme the product quality, the delivery quality and execution quality of the system is solely depending on achievement of the specified quality in all projects included in the project programme. The project programme quality will thus be reduced and the specified quality for the system may not be achieved, and ultimately it will affect the achievement of the desired effect goal, result goal and process goal.

A key issue in successfull management of a project programme is to have firm control on mobilisation of human resources planned used in the programme. It is the duty of the programme manager to generate an optimal utilisation of the human and material resources including providing work conditions that make it possible to deliver quality as specified. Confident and committing mobilization and demobilization plans should reflect those issues in order to achieve the specified product quality efficiently. There are no acceptable alternatives.
In summary, management of project programmes is considered to be demanding and among the largest challenges in project based organisations.

6.6 Quality management in projects with moving targets and use of agile and lean methodologies

Many projects are characterised by the fact that the detail technical solution is not known at official launch of the project although the desired effects and business potentials are firmly described. Typically, the solution development is a change journey and the associated result goal is a moving target. Such conditions are considered best taken care of by use of agile principles and methodologies that are feature and value driven, not cost control and time driven as such.

A range of IT software development projects have used the spiral model to cope with the need for continuous changes and iterations during the development and execution.

The iterative design and development process briefly makes repetitive activities of the kind:

1. Plan
2. Code
3. Test

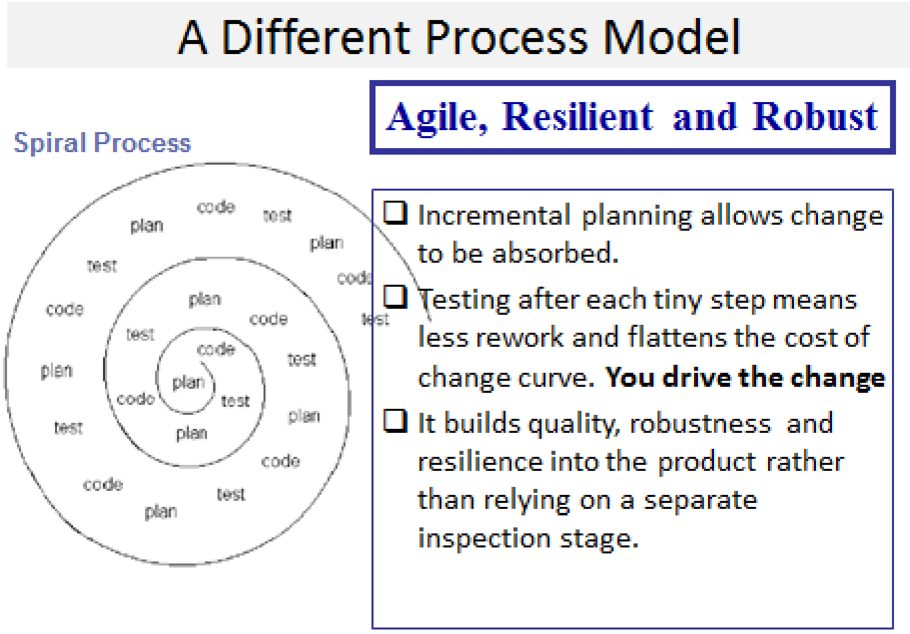
The process is running iteratively until the specified preciseness level is achieved.

A sketch of the spiral model is shown in figure 6 – 11.

In figure 6-12 an illustration is showing how the result goal is developing and changing over the project life period, initially as a diffuse goal that is gradually moving laterally and becoming gradually more firm and specific. .

How can you plan and execute the change journey?

The basic characteristics in the spiral model are that you achieve a gradual improvement and increase the preciseness level continuously during the project development. In some cases you may not be able to identify and specify the product quality up front and prior to project launch. However, you may briefly describe the desired features and functionalities of the product to be developed during the project execution phase. Accordingly the iterational development should result in achievement of the desired and specified effect goals. The actual quality is then connected to the quality and confidence in the achieved effects and business benefits by using the output solution from the project.



Figur 6-11 sketch of the spiral model for iterational development of the specified features and product quality

The principles outlined in the spiral model are to utilize the small steps and iterations for gradual changes with a minimum of effort. Management of an iterational change process is considered attractive and efficient, as less resources are expected used in the adjustment and improvements of the solution. The key is to be in the drivers' seat for the change journey, the opposite is when you are forced to change direction by external constraints and the resource consumption may normally increase significantly.

The dynamic iterationaøl approach opens up for a stepwise quality control and monitoring during the development, and not limited to the quality recording of the as-finished solution, and the opportunities identified in the dynamic model is in accordance with the recommended practice concerning verification underway during the project execution, see section 3.4 and figure 3 – 3.

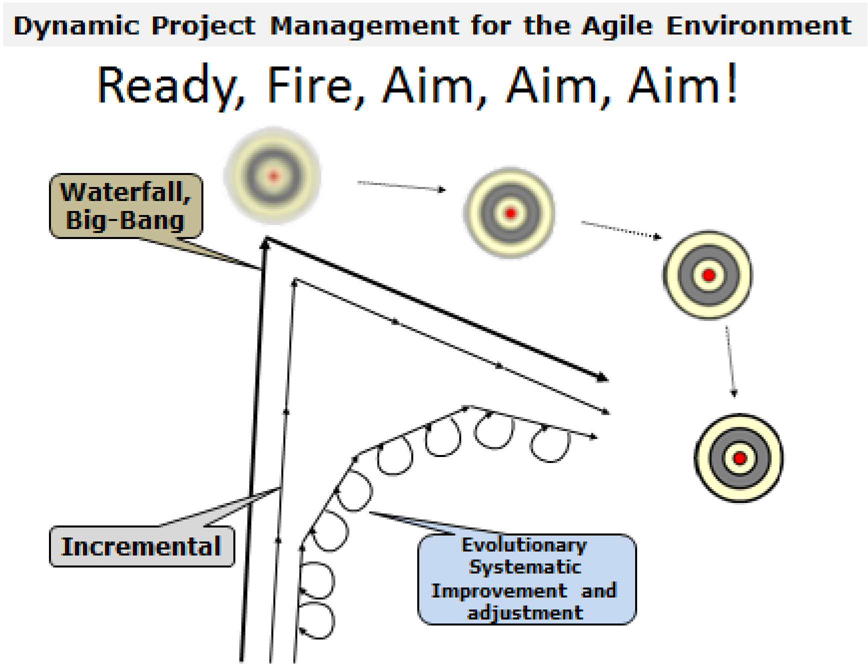


Figure 6-12 sketch of a dynamic process through utilisation of the agile process that is considered more cost efficient than traditional water fall models for project execution

Two fundamental questions appear:

- How are the agile principles applicable on classic projects when using a sequential project execution model?
- Is it in conflict with the principles outlined for the stage gate execution model?

Further understanding and knowledge about the stage/gate project execution model actually opens up for the use of agile and dynamic methodology. In fact an iterational and lean development process is easily combined with the stage gate execution model when the main mailestones and decision gates are split. It provides you with the capability of making a concurrent process route with an execution phase allowing for shooting towards a moving target. The use of agile approaches through the scrum methodology you are capable of including the eventual necessary adjustments in between the decision gate and the closing milestone in the preceeding phase when the phase processes are run partly in parallel. Agility means that you are able to move fast, and change directions very quickly with high degree of efficiency and precision. The features of agility are attractive in the innovation processes as well as during the design and construction phases. Agility also cover the need for being light footed and smart, resulting in an efficiency and flexibility that is not achievable in more traditional execution models with corresponding formalistic bureaucracy that slows down the progress in the project. The agile principles are creating a fundamental mindstep change on how to plan, develop and manage projects. It is built on absolute and mutual trust among the parties in which the client is actively involved in the processes of iterational development of the solution. That is in brutal contrast to the traditional project and contracting work that creates unnecessary and rigid reporting between client and contractor creating a bureaucratic and formalistic nature in the collaboration among the parties. The efficiency in the project execution is thereby much lower compared to an approach following the agile principles. The agile approach is briefly described in an agile manifesto and is summarised in table 6 – 2. (Ambler & Larman)

Individual & collaboration	Instead of processes and tools
Software that functions	Instead of extensive protocols and documentation
Extensive collaboration with the client	Instead of contract negotiations and disputes
Fast response to changes	Instead of being constrained by a plan

Table 6-2 the agile manifesto

The role of the project owner is to make sure that the gradual development and maturisation of the solution fullfill the desired and specified effect goals and features requested. That principle is considerd far more important than detail control and recording of cost and time development.

The main agile principles are summarised in table 6 – 3 for software development projects.

If agile approaches have a motto, it encompasses change. If agile approaches have some unique strategic characteristic, it is manouverability. The agile approaches have their roots in software developments, and are normally organized as product development projects.

Key issues are the development route on the solution and how to manage variable affecting the execution process – from technology to people and team. Priority is paid on the project constraints and boundary conditions including continued efforts for achieving high customer satisfaction and performing superior project stakeholder leadership.

Number	Agile prinsiples
1	Highest priority is made on customer satisfaction through early and continual rollout of software packages
2	Be open minded on changes in specification requirements late during execution. Agile approches master changes that adds competitive advantage to the client
3	Steady production and provision of deliveries, with a recommended frequency of two to four weeks
4	The business accountable and the software developers must work closly together on a daily basis througout the project
5	Establish and build the project team composed of motivated and dedicated individuals. Make a good team spirit providing support and full trust.
6	Face to face conversation and dialogue inside a dedicated team achieve the highest impact on the performance and output results
7	Rollout of part deliverables is the primary measure of progress in the project
8	Agile processes stimulate sustained improvements and continual development
9	Sponsors, software developers and users shall be self motivated to keep the pace and speed during the entire project period
10	Continued attention of searching the ultimate technical solution and the most attractive design stimulate to a work environment of flexibility and agility
11	Simplicity – the capability of maximizing value through simplicity is essential
12	The most brilliant system architects, the most appropriate specification requirements and ultimate design solutions are best created in self organized teams
13	Frequently, the project teams should perform a self assessment whether there is potential for improvement in efficiency, enhanced capacilty and capability, and review the capability to make corrective actions for achieving the desired improvement potentials

Tabell 6-3

The two most important characteristics of agility are:

- Flexibility (manouverability, change and resilience)
- Simplicity (less documentation up front, a high degree of standardiseation and lean principles & thinking)

In light of the two main characteristics above the way of managing the projecet become different than in classic project management and control. Classic project management and control is focusing on confident control and measuring of the progress with respect to accumulated costs to date and the associated actual progress relative the timeline in the project baseline in the generation of a product with an upfront specification of the product quality that normally remains through the project period.

The shift in management and control are considered as a fundamental paradigm shift – from static and reactive control and measuring towards a dynamic management and control towards the achievement of a target that has developed and changed over the project period. In the latter approach, there is primary focus on achievement of the desired effect goals and associated business benefits through use of a system or product with the developed features and functionalities during the project period. The scrum methodology is particularly relevant for the planning and execution of the dynamic change journey.

Some of the features of Scrum are:

- The product development happens through several iterations.
- There are two categories of feedback loops – the product back log and the sprint in which the product back log typically lasts over a period of three to fours weeks while the sprint typically lasts over a period of 24 hours in order to test the achieved functionalisty to date. Any deviation to the desired functionality is documented and adjusted for the necessary improvements.
- The roles are firm and mutually understood and the respective team members work on complementary tasks

The Scrum-methodology is schematically shown in figure 6 – 13.

Scrum: Value and feature driven

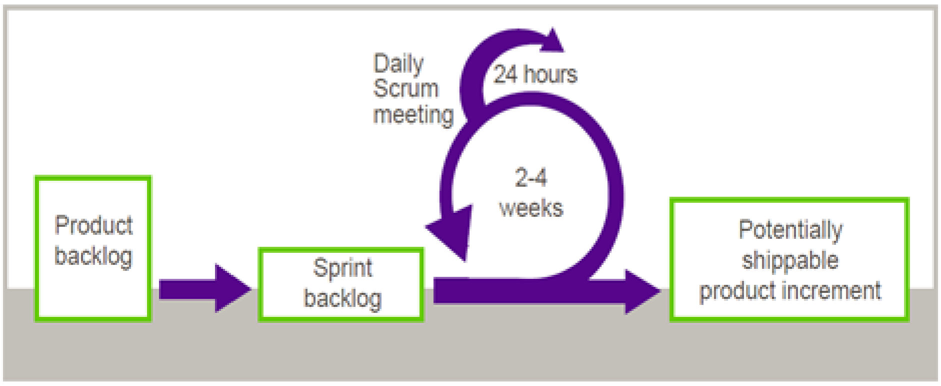


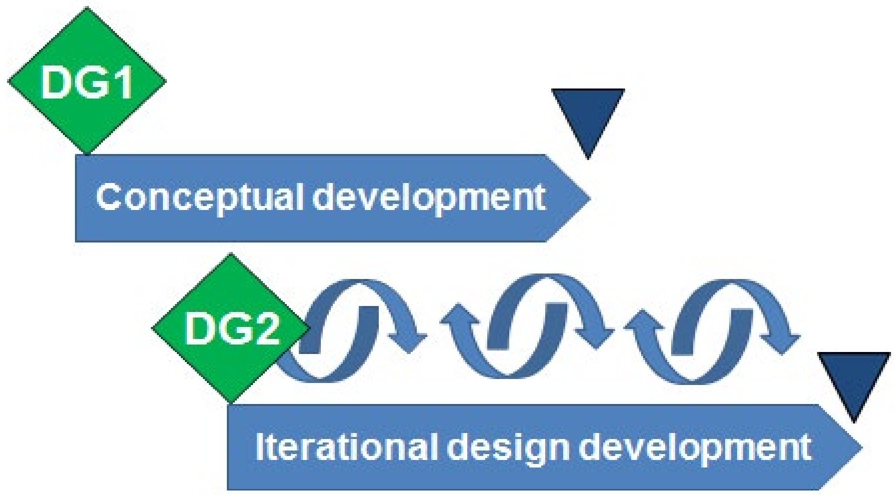
Figure 6-13 product back log, the sprint back log and the two loops for the product development, the long term 2- 4 weeks development process plus the 24 loop assessed in the daily scrum meetings resulting in a potentially shippable product increment of specified value

The expected results of using Scrum methodology are:

- Better solutions and imroved product quality
- The results are achieved faster and more efficiently than by using the waterfall models.
- The roles are better defined than in the waterfall model, contributing to less confusion among the team members and the efficiency is in excess of what is typical for using the waterfall models.
- The scrum methodology brings you quickly into the production and delivery mode with focus on the desired output from start-up of the process.
- The established work practice and principles are brought forward to the customer at an early stage in the project, which makes it possible for the customer to control and review the solution generation process and have the conditions of introducing changes without disputes with the contractor/supplier.
- The final output delivery is in full compliance with the customer needs as the customer is directly involved in the development process.

- Results in achieving ultimate benefit and value for the customer through a continued response to proposed changes made in real time.
- The earn value control is made easy in the scrum methodology as the value of each element in the product back log are specified and you record when the respective elements are completed and adds to the summation of value earned.

How to combine agility and scrum with stage/gate project execution models?
The stage/gate project execution models open up for flexibility and changes if there is a split between the decision gates and the completion milestones for each phase. It provides you with the capability of doing proactive project governance where the project owners are "hands-on" towards the project under development and execution. It makes room for running the work processes dynamically and with several iterations as a continual change process in each phase. Thus agility may be well integrated into the stage/gate model as schematicallly illustrated in figure 6 – 14.   That statement is also supported by Cooper & Sommer (2016) and by Van Oorschot et al (2011, 2013 and 2017).



Figur 6-14 Sketch of the capability of using an agile approach with scrum methodology in a stage /gate project execution model.

The logic behind the illustration in figure 6 – 14 is to apply agile principles and associated scrum methodology for managing and mastering the changes during the various project phases. The likely demand for changes may appear due to the results produced for completion of the activities to achieve the main phase milestone in the preceeding phase when running a concurrent route as in figure 6 – 14. Also the clients' introduction of new changes may appear and should be handled through the scrum approach. Thus the combination of a stage/gate project execution model with scrum methodology integrated provides you with an attractive and efficient way of managing projects with the need for dynamics and change capability and at the same time having firm project governance through the project period.

The combined agile and stage/gate approach sounds attractive and fascinated, however project execution sucess according to the principles outlined is depending on the following key issues in order to obtain the product quality as specified in a smart and cost-effective way:

- Customer and supplier work integrated and in a close collaborative way characterised by mutual trust and clear roles.
- The contracts awarded to the service provider must include real incentives such that the work environment stimulates to achieve a win-win situation for both parties.

Is the methodology and approach applicable on software development projects only? Has it relevance and attractiveness on business development projects as well as for design and construction projects in industry, on land and offshore?

A project survey was done in a project thesis for Statoil (Hyvik et al). They concluded that agile methodologies are well suited for application in the project work on exploration, design and construction of upstream offshore field development facilities. In particular, the agile approaches are attractive in the early phases of the capital value process and the main results of the survey and assessments are summarized in table 6 – 4. It is in full compliance with the more extensive introduction of design thinking into the project management and execution.

As shown in table 6 – 4 the agile methodologies are particularly attractive in the early phases from feasibility through conceptual development and conceptual maturisation prior to sanctioning the project. During the execution phase, covering both the design, construction, commissionsing and installation, the use of agile principles are considered medium or modest. They concluded that the majority of the conditions were settled and the actual project constraints during execution could not fully utilize the potential of the gaile principles. The applicability of agile principles may however increase in the execution phase if the design and solution philosophy are based extensive use of component standardization and system flexibility making it possible to apply the option design into the execution processes.

In summary there is an uppside potential for further expansion of agile approaches and agile thinking into the execution phase.

Project phase	Idea & innovation	Feasibility Phase	Conceptual phase	Concept maturisation	Execution
Product/ scope description	No	No	Medium	High	High
Scope changes	Medium	Medium	High	Medium	Low
Complexity	Low	Medium	High	High	High
Info-sharing	Low	Low	Medium	High	High
Change control	Low	Low	Medium	High	High
Constraints	Low	Low	Medium	High	High
Size of team	Small	Small	Medium	Large	Large
Agile project-management Value potential	Modest	Medium	High	High	Medium

Table 6-4 Summary of the potential impact and benefit of using agile methodology in large compex field development projects for offshore oil & gas industry (Hyvik et. al.)

6.7 System flexibility and component standardisation

Several paradoxes are associated with project development and the desired output delivery. Among these are:

- The business environment and markets are more and more characterized by high Volatility, high Uncertainty, enhanced Complexity and Ambiguity (VUCA-world)
- The need for managing ever more complex projects to cope with the VUCA-world.
- The need for differentiation

- The need for establishing common and general approaches in managing projects within the organisation.
- The need for customization and individual client adjustment
- The demand for simplification
- The demand for increased flexibility and options
- The need for standardisation and reuse of technology when relevant
- The need for superior management performance connected to the continued assessment of risk and opportunity in the projects.
- The need for improved project governance
- The need for a dynamic leadership approach in a stocastic and unpredictable business environment.

In that context, challenges in project and quality management are connected to, but not limited to:

- Manage the paradoxes and contradiction in the future business & project environment.
- Manage increased complexity
- Manage the need for a dynamic approach in a world of Volatility, Uncertainty, Complexity and Ambiguity (VUCA)
- Master the dynamic leadership perspective necessary for making successful projects.
- Demonstrate performance excellence in mastering an integrated approach to a business-driven quality management that cater for all the quality dimensions associated with the solution and product, the handover and the execution efficiency leading to sound business results for the customer and the supplier.

How can you meet these challenges that are present in the single projects as well as in project programmes and in a project portfolio?
A system approach may be an attractive way of managing the VUCA-issues related to projects. A business system model is developed and the main features in the business system model are (Lereim 2013):

- A high degree of system flexibility
- A maximum use of component standardisation

The initial considerations are made on the term product quality. In that context, the system flexibility is linked with the desire for flexibility in design of system solution. Option design is a key in that respect. A maximum use of component standardization is, connected to the principle of using the identical basic components as possible in a range of applications. A well-established practice is developed over the last two decades in many industries and has improved product quality as well as efficiency and competitivess. Some industries have tradition for component standardization more than 50 years back in history.

There have been arguments that a high degree of component standardisataion reduces the flexibility of the system solution and the total product. In reality the system flexibility is likely to increase as a result of a high degree of component standardization. The number of alternative versions of components can be drastically reduced. The component product quality can be controlled better and the variations in product component quality are reduced. That will again contribute positively to an improved system product quality. The effects are real in single projects as well as in a portfolio of projects as the same standard components can be applied in a range of projects. Such development trends have happened in many different industry segments, and some randomly picked examples are summarized.

What are the impacts of component standarisation on the product quality of deliverables from the single projects and for the project portfolio?

A positive impact on the total product and system quality is obtained due to the folowing elements because of a high degree of component standardisation:

- A drastic reduction in number and versions of basic components provides you with a better overview and a simplified logistics. The uncertainty regarding which version of a component that is relevant is removed. That is highly beneficial on physical components like flanges, bolts and nuts.
- The purchase ofcomponents can be done with larger batches in which common specification requirements are valid for the entire delivery. The result is a positive impact on the product quality in a single project as for a portfolio of projects.
- The corresponding standardised assembly and installation procedures generate reduced variation under execution and assembly as the number of various components are minimized.
- System product quality is easier maintained through the operating life cycle as all spare parts are standardised and identical versions as in the as-built product.
- A high degree of component standisation ensures the same high product quality for a range of system configurations and layout.

Industry segment	Product with high degree of component standardisation and high system flexibility	Characteristics
IT & telecom Apple	• iPhone & • iPad	Component standardisation introduced in version 1 and opens up for system flexibility in later versions
Furniture IKEA Ekornes (norwegian furniture maker)	• Billy bookshelf etc • Stressless	All basic components are standardised. Creates almost an infinite number of system solutions for total product
Land based building industry Office buildings Estates	• Standard element walls • Standard bath room cabins • Standard windows & doors • Standard location of pipe & cable racks	Lego principles
Oil & gas Subsea installations Topside process facilities Living quarter	• Standard X-mas tree • Standard flanges & spools • Standard workover-system • Standard process trains • Standard control system • Standard cabines • Flexsible system layout	Reuse of technology solutions
Automotive industry Cars Trucks	Common platform for a familly of models • Standardised components • MQB platform for VW-group • Component standardisation since 1938 for the Swedish Truck manufacturer Scania	Common & standardized components provides added flexibility for a generation of new models

Table 6-5 examples of component standardization combined with system flexibility.

Correspondingly, a high degree of component standardisation is likely resulting in a higher delivery quality on the single project as for the portfolio, in which the delivery quality comprises the product quality as well as time of delivery and location of delivery; see the definition in section 1.2. The larger batches purchased may achieve a higher priority in the order log among the component manufacturers than a minor batch for a single project. The expected effect is an increased confidence in achieving the standardized components according to the specified requirements, delivered when requested and at the right site. .

The corresponding project quality, comprising product quality, delivery and execution quality, are furthermore expected enhanced as the efficiency during project execution should increase due to more streamlined logistics and supply chains and higher confidence and reliability in the execution stages.

How does the high degree of component standardisation affect the quality of the desired effect goals and business benefit? The considerations must cover both the degree of component standisation and the desire for achieving high system flexibility.

A high degree of component standardisation generates firm improvements in cost efficieny. The larger batches purchased should first of all lead to reduced unit prices for the components, economy of scale in the purchase; second, the delivery time is expected firmer (delivery quality) and third, the execution efficiency is improved, the productivity in the project during execution. The expected effects are reduced execution costs and reduced execution time, both improving the effect goals and the business benefit, as the NPV may increase. The high degree of component standardization contributes to easier implementation of lean principles for development, construction and and manufacturingexecution. Waist may be minimized and Lean methodology contributes to minimization of waist and rework in the projects. Accordingly, the Lean principles provides you with a positive effect on execution through achievement of more precise processes, and on the business benefits through enhanced productivity and cost efficiency during the project execution phases.

In addition enhanced system flexibility generates features that make it easier to customize the total project delivery in full compliance with the customer demand with better product quality delivered faster and with higher cost efficiency. A higher confidence and reliability are expected on the desired effect goals and the corresponding business benefits.

Within the framework of the business perspectives, Lereim developed a specific model for business-driven system agility. (Lereim 2013) The model combines the dimensions of system flexibility with the degree of component standardisation, which is considered a necessity for achievement of dynamic capability, see figure 6 – 15.

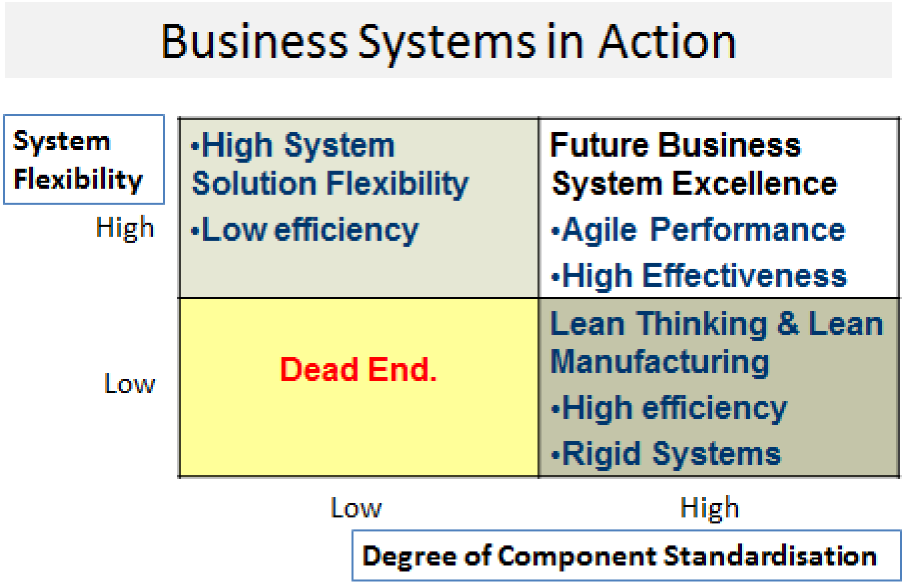


Figure 6-15 Model for business-driven system agility providing dynamic capability.

The model is applicable at different levels in an organization, on enterprise level, on business area level, on a project portfolio level and on project level. The uniqueness of the model is to combine the desire for system flexibility with the demand for a high degree of component standardisation, two dimensjons considered necessary for achieving superior performance and dynamic capability, critical in a business environment dominated by high volatility, large uncertainty, high complexity, and ambiguity (the VUCA characteristics).

On the project portfolio level, the tool is particularly relevant in the project selection process and should be considered as a compulsory and supplementary assessment tool for evaluation and selection of new initiatives.

On project level the model may contribute to achieve a project solution that combines system flexibility with standardization on components. These features reflect the necessary characteristics for an agile approach in handling complexity, uncertainty and change together with achieving high efficiency through high degree of component standardization, the lean thinking element related to resource efficiency as well as time.

An integrated index is derived as an expression of the agility of the system and product. It is named as the Business System Agility Index, BSA, reflecting dynamic capability.
It is a simple expression as follows:

$$\mathbf{BSA} = \mathbf{S}_f * \mathbf{C}_s$$

In which the $\mathbf{S}_f$ represents the system flexibility, and $\mathbf{C}_s$ is the degree of component standardisation.
The BSA-index may then be used as an indirect reflection of the business performance with high dynamic capability.
The degree of component standardisation may readily be derived. The system flexibility in a business environment is more complex. From a product point of view, the system flexibility covers the product system layout and flexibility in the development in the final solution categorized as internal system flexibility. However, those issues do not cover the full range of elements considered linked to the system flexibility. There are external aspects that may heavily influence the total flexibility, defined as external system flexibility.
The total system flexibility combines the internal and external system flexibility as follows:

$$\mathbf{S}_f = \mathbf{S}_{Fi} * \mathbf{S}_{Fe}$$

The external system flexibility, S_{Fe}, reflects political systems and the degree of flexibility in various markets and governmental regimes. You might have situations where the flexibility in the product or system solution generated is of highest level, whereas there are major constraints and political obstacles in the country or region where a new project development is desired. The BSA index will then reflect that kind of issues, as the political constraints is reflected in the parameter for system flexibility. Furthermore, the political regimes may change over time and may consequently lead to a changed flexibility.
Accordingly, the business system agility may be altered over time. Such assessments are valuable in the selection and prioritisation of new projects, influencing the project success for the single project as well as influencing the project portfolio. The BSA index may then act as a supplementary assessment parameter for which ideas and iniatives should be approved and launched for execution.

6.8 Fast track projects - a quality and risk issue?

In section 6.7 there is a list of likely challenges and issues related to the future business and project environment.

The competition is increasing and there is a pressure to complete projects faster than ever, and a socalled fast-track approach is a frequent used term in the project world. The rationale behind is to get the project results into operation or service as early as possible in order to improve on the desired effects and business benefit.

In addition, there is a steady pressure to reduce costs, first of all the investment, CAPEX, but also the request for reduction in life cycle costs. There is an intensified search for smarter and cheaper solutions without compromising on the specified product quality. Lean manufacturing methodologies and principles may contribute significantly in the efforts to reduce costs and execution time, and there is almost allways room for improvement on work performance as well as on progress. Reduced execution time is further an option when running the execution by use of concurrent engineering and agile principles. .

Are there limits in the improvement potentials?

There are some issues that should be addressed thoroughly. Experience from classic approaches in project management and execution is showing that there is often a cost increase if accelerated or request for a significantly shorter project period; a negative impact on cost level may likely appear.

The situation becomes even more extreme if the request for a shorter execution time is combined with the requirements of reduced project costs. Is there some limit where it may impact the specified product quality?

The combination of «Fast Track» and «Commercial Mindset» may become undesirable if the commercial aspects mean only focusing on the lowest cost and no other parameters affecting the project performance and the associated output. The control questions should be: Does it affect the specified product quality, or do you have to make compromises with respect to the actual product quality and features of the out put delivery? In projects with a well-defined scope and a well defined output product there is normally room for improvement. Application of lean and agile principles is obvious actions for significant improvements on schedule as well as on total completion cost for the project. A mature and well-defined scope of work and a firm production specification create a work climate that could stimulate for improvements. If a novel concept is introduced, the situation may alter, and the uncertainty in the basic project control variables may increase. Is it likely to achieve the specified product quality on a novel product under a regime of “Fast Track” and minimum investment cost (minimum CAPEX)?

A novel concept may mean a totally new concept or product as well as utilization of well known concepts in new and unproven environment. The latter needs as much attention as the introduction of a new concept, since the new application may happen beyond its experience range.

Considerations of different scenarios are shown in table 6 -6.

Effect goal & business benefit	Project cost (CAPEX)	Time	Product quality	State
Project economics increase, NPV increases	Reduced investment cost, CAPEX	As planned	Specified standard equipment & well known concept	OK
Project economics increase, NPV increases	Reduced investment cost, CAPEX	Reduced execution time	Specified standard equipment & well known concept	OK? Uncertainty increases?
Project economics increases, NPV up, but enhanced risk of delays and reduced confidence on product quality?	Reduced investment cost, CAPEX	Reduced execution time	Novel concept and new applicability range	Unacceptable?

Table 6-6 Illustration of different scenarios of the combinations of the basic project control parameters

The summary in table 6 – 6 Clearly illustrates the difference for altarnative scenarios. Reduced investment cost, CAPEX, improves the project economics, NPV, provided that the planned timeline is achieved aad the product quality is achieved. The state is positive.

Second line shows a scenario like scenario # 1 plus a specified reduced execution time. That combination has an escalating positive impact on the project economics, provided that the specified product quality is achieved. Is it realistic to achieve the specified product quality under such constrained conditions? It will depent on which ambitions are included in the revised figures for reduced CAPEX and reduced execution time for a well-known concept. The state might be questionable.

The situation is accentuated to the extreme in the scenario # 3 on the lower line in table 6 – 6, in which reduced CAPEX and reduced exetion time is combined with a novel concept. Experienced project owners and managers may normally react negatively towards proposals with conditions of the kind as listed in the lower line in table 6 – 6. That scenario is generally not recommended and should be avoided if possible, unless radically new solutions make a break through on execution performance leading to reduced costs and shortened execution time.

Is there a chance to shift from unacceptable to acceptable state in the scenario in the lower line? If so, what are possible solutions?

The issue could be resolved if the principles of highest degree of component standardisation and system flexibility are implemented into the project process from the feasibility stage and onwards. That is however conditioned upon that the system solution is thoroughly proof tested as a total system, not just parts of it. Part systems may demonstrate satisfactory performance, but novel application of an integrated total system may not appear satisfactory.

6.9 Excellent HSE performance pays off.

An intensified effort is put on Health Safety and Environment, HSE, during the last two decades. HSE is first of all critical issues in construction projects with physically challenging work tasks, but HSE is also paid higher attention in service and office organisations.

It is of utmost importance to highlight that the accountability for HSE as well as for the quality is on the shoulder of the project and line managers, not on the HSE support and coordination function.

There are many similarities between HSE-management and quality management, and in many organisations are the issues administered by the same support role in the project and in the line operations.

The commonalities between HSE and Quality issues are among others:

- Contribute to enhanced prevention attitude and approach.
- Establish firm plans that hinders non-conformancies and incidents to happen.
- Qualitative event-oriented risk is managed essentially the same way.
- Changes are handled and assessed similarly.
- Assessment of undesirable incidents use the same principles for cause & consequence analyses for deviations and non conformances.

These elements are relevant in regular operations as for projects. The HSE management has an added dimension in the requirements for investigation when serious incidents and accidents happen.

Construction projects are vulnerable in that context as an accident may require full stop in the project work until the accident is fully analysed including identification of the cause and analyses of the consequence. During the investigation also corrective actions are to be derived and implemented.

Excellent HSE performance in projects is depending on two main perspectives. These are:

1. HSE optimal design that creates a construction friendly and operations & maintenance friendly solutions – A design thinking approach.
2. First rate HSE management & control.

<u>HSE optimal design</u> The HSE work in many projects focuses primarily on a professional handling of HSE plans and recordings in order to fullfill the ambitions and requirements given by the authorities and the organization itself. However, it does not help to have established a state of art and first rate HSE management system if the solutions are fundamentally wrong. Thus major influence in improvement on HSE may happen by designing the solutions such that it actively minimizes the risk of incidents and accidents during construction and installation, as well as in operation. In addition, the optimum design solutions should cater for minimization of the consequences if an incident and accident happen. "The design thinking

approach" has been recognized as a primary condition for success, on the project performance overall and explicitely on HSE issues.

In order to achieve an HSE optimal design, the mind set of the designers must pay attention to the HSE issues from day 1 of the development work, from the feasibility stage through to operations. It is considered to become a significant improvement potential in bringing in the HSE perspective already from the feasibility stage, as many designers in the past were more dedicated to creating smart and advanced solution with chances of just marginal attention to the HSE issues.

<u>First rate HSE management & control</u> is characterised by a predominantly preparatory and planned approach. There is a firm interest in doing the right things right first time and with a performance that fullfills all requirements to the key HSE-parameters in any activity in the project work. That contributes to the achievement of the specified product quality, the corresponding delivery quality as the project execution becomes more efficient.

The control and recording aspects are normally covering key HSE parameters of the type "number of days since last serious injury", expressed in a calculated frequency injury index. In addition the HSE recordings include parameters linked to the recording incidents. The rationale for recording the incidents are to learn from them and make improvements through corrective actions in order to minimize the chance that similar incidents appear in the future and may escalate into an accident. The intention of recording incidents is to achieve a continual improvement in the work performance leading to superior HSE results. However, one should be aware of the potential reservation that some employees may demonstrate regarding the identificantion and recording of incidents, as it may be perceived as a reporting on one of your colleages not doing the job according to the HSE requirements. Thus, there must be established a project culture that strives for continual improvement.

Furthermore, the HSE periodic reporting includes a parameter reflecting the number of proposals for improvements regarding HSE that are recorded during last peiod. The proposal must become realistic and not just some fake or unrealistic proposals in order to improve on the statistics connected to innovation and creation of new ideas on HSE. In some environments there has been some tendency to create new ideas for improvement on the statistics which is considered as an unacceptable mind set on HSE. The proposal must be real and established in light of the athmosphere and culture of striving for real improvement in management and control within the HSE area.

The HSE management & control is depending on clarification and definition of roles with respect to the HSE issues. The project manager has the full accountability on the HSE results, whereas the HSE coordinator/admistrator is in charge of establishing an HSE plan, HSE procedures and reporting routines to apply during the project work. The HSE coordinator is also in charge of making the internal HSE requirements at any time fully compliant with the governmental regulations and requirements.

<u>Cost/benefit of excellent HSE performance</u>

Any production stoppage in a project means loss of value earned. Cheap and simple preparatory activities and actions will pay off with a multiple figure.   A brief cost benefit analysis readily shows a rather brutal negative economic impact if the the project is instructed by the organisation or local authorities to stop all work due to an accident on humans or a serious pollution has happened. An approval for continued work may not appear until the issue is resolved, analysed thoroughly and necessary corrective actions are made.

The economic incentive of excellent HSE preparatory work is obvious and should have the highest attention from the project manager and the management team. During the last decade, there is established an acceptance and recognition of the importance of excellent HSE performance as the management is faced with and is accountable for the HSE performance and the associated detrimental economic impact in the respective projects.

These considereations are particularly relevant in construction projects in which incidents and the external environments are key topics, but the work environment in software development projects and reorganization projects should also undergo assessment of the work environments with respect to ergonomic perspectives as well as social aspects in work teams.

The prevention focusing aspects in HSE is crucial in management and control, as documented by Karlsen (Karlsen).

The following HSE-related factors may have positive impact on the cost benefit and project efficiency performance:

- Formalised HSE periodic recordings and reporting stimulate a better HSE attitude and culture.
- The reduced number of HSE incidents and accidents contribute to improved business and project performance.

- Proper HSE planning and control procedures lead to reduced costs when an accident or incident appears since the decision-making actions can be triggered faster.
- Less waist according to the Lean approaches and reduced pollution
- The energy efficiency is increased
- Reduced production costs by doing the right things right first time in a safe and controlled environment.
- Cost efficient operations.
- A high reputation on being a project that pays highest attention on HSE.
- An improved collaboration with the respective authorities
- A good reputation in HSE may attract the first-rate employees with improved performance levels, resulting in higher market shares
- More attractive for new customers and awarded new projects more readily.
- A high performance HSE results in competitive advantage.

In some industry segments, the HSE performance figures are among the primary evaluation criteria when new projects are awarded to a qualified contractor. Lack of appropriate HSE performance may even exclude contractors from being prequalified and invited to tender from the client.

Section 7

Organisational Perspectives and Quality Management

7.1 The quality organisation and quality culture

An organization may be categorized in terms of its structure & systems as well as the culture. The structural parts are to some extent covered in the sections 1 to section 6 regarding quality issues in project work.

Section 7 is focusing on the organisational and cultural aspects in quality work and quality management.

A general perception and experience from many projects are that the structural aspects are possible to develop and implement to satisfaction. However, the organizational and cultural aspects are considered more demanding. It deals with forming a quality focused organization, characterized by achieving a dedicated quality culture in any activity in a project, from idea generation through to completion, implementation and handover to the users.

A holistic perspective on quality in projects must include the performing project organisation, customer relationship, team design and team performance, culture, leadership, stakeholder leadership and not the least learning & continued competence development in order to being capable of deliver an output object or service according to the product specification reqyuirements achieved through an efficient, lean and agile approach. These perspectives are considered as critical success factors for achieving a real, documented and perceived quality that delights the customer.

Two main questions appear:

1. What characterises a quality organisation in a project?
2. What is a holistic quality culture in a project?

These questions are initially discussed in general terms, followed by the eventual differentiation on various project organisation types.

A project is by definition a temporary organization, with its duration between a few weeks to several years. Regardless of the timeline, there will be an official start, followed by aplanning phase and an execution phase through to termination – whether it is three weeks or three years.

Many organisations have experienced that a good project culture is among the primary aspects for success in projects and for achievement of the desired and specified quality.

What characterises a good project culture?

A good project culture is an integral of and a result of the following:

- Firm and dedicated management and leadership
- The project management highlights and thoroughly describe the project effect goal and corresponding expected business benefit, the specified result goal, the established project strategies and the complexity and challenges expected in the scope of work; followed by a thorough explanation for the background and rationale for the specified goals and strategies
- There is a mutual understanding and agreement in the project team about the project goals and strategies
- Good team spirit and moral
- Developing teams
- Acceptance of using untraditional methodologies for achievement of desired and specified goals
- There is acceptance for making mistakes but learn from them and do not repeat the same mistake over again.
- The joint project team culture is in compliance with the company values and builds on the individual team members' experience from earlier projects.
- There is room for fun and humor in the daily work
- The team members and the project management are professional, but relaxed and without the attitude of being "the one and only" that can master the tasks in the project.
- The capability and skills to deliver on time and according to the specification requirements .

- The individual team members are challenged in resolving demanding tasks, and within a framework and work conditions that they are confident in mastering the challenges.
- A culture that stimulates to learning from own tasks and from others, on skills and on social aspects in the teamwork.
- Identification of improvement potentials and derive proposals for realising and implementing the respective improvements.

The elements listed above are important elements in creation of a quality organisation in a project and are pinpointed in a many textbooks on project management. (See Jessen, Koltveit et al, Turner etc).

In addition the following elements are considered necessary in order to categorise the project organisation as a quality organisation:

- The quality terms and definitions must be fully understood by all team members in the project organisation and the associate impact on the tasks for the individual.
- The project quality plan and quality system are integrated in the overall project management and control system, and shall cover all parts of the scope and activities in the project.
- Quality should be reflected in any perspective in the project.
    - A firm and clear mandate
    - A firm and precise scope of work
    - A firm and well documentted decision facts support package at the decision gates in the project model.
    - Firm and well defined milestones
    - An ambitious but realistic timeline
    - Execution according to the planned activties
    - A high precision level on reporting, management, control and estimating of forecasts.
- Quality and confidence in the change processes and way of managing changes.
- Well defined and well perceived roles & responsibility matrices with the associated individual roles.
- Performance excellence on managing internal and external stakeholders.
- A performance culture characterised by supporting each other and deliver according to specified at the right time.

the list above is not complete but reflects the challenges you should be aware of regarding quality issues.

A particular challenge is the facts about temporary nature of a project organization, as it shall close down when the project is finished. How can you motivate to achievement of quality excellence performance in organisations that are established for a temporary and modest life time? Do you bother to put all efforts into the team and team culture when you know that the project team is demobilized in a few weeks or months?

Projects with short- or medium-term duration (less than a year) need particular attention on these matters in order to shape a sound and satisfactory project team culture catering for achievement of quality excellence from day one of the project. The project manager and team must steadily focus on achieving a quality culture due to tha recognized facts that the culture aspects are prime conditions for achievement of the respective quality measures in the project. This is schematically illustrated in figure 7 – 1 telling that the achievement of the respective quality goals is hard unless the project organization and team is demonstrating a firm quality culture. Thus the organizational and cultural aspects encompass the basic quality gand project control parameters.

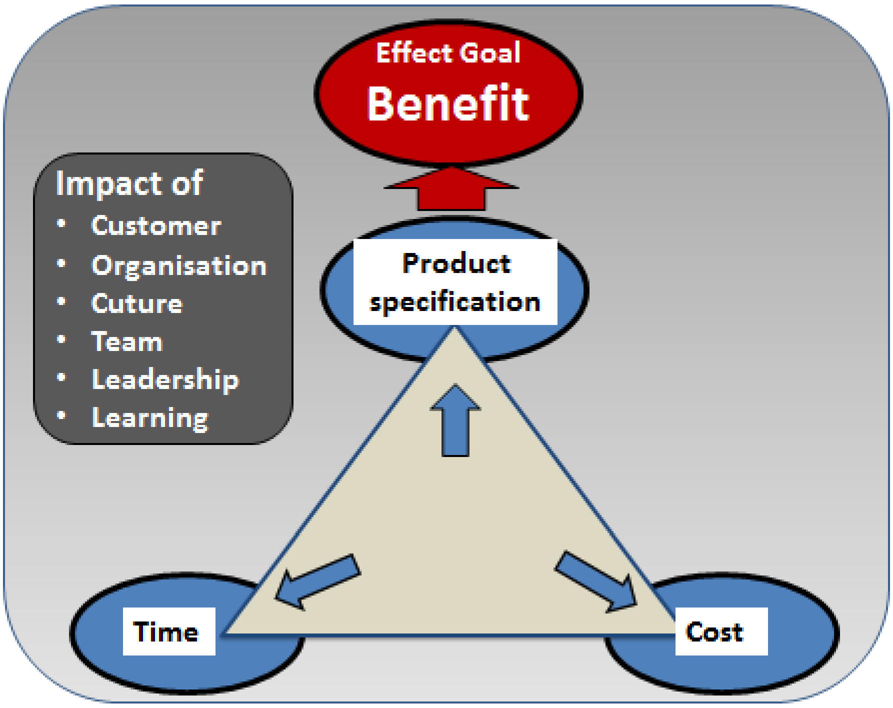


Figure 7-1 a holistic approach on quality and impact of organisation and culture

The temporary nature of the project organisation requests prioritized focus on the project culture since the organization culture affects the perception of the importance of quality and way of working efficiently. A relevant tool could be to design a project team development process according to the sketch shown in figure 7- 2.

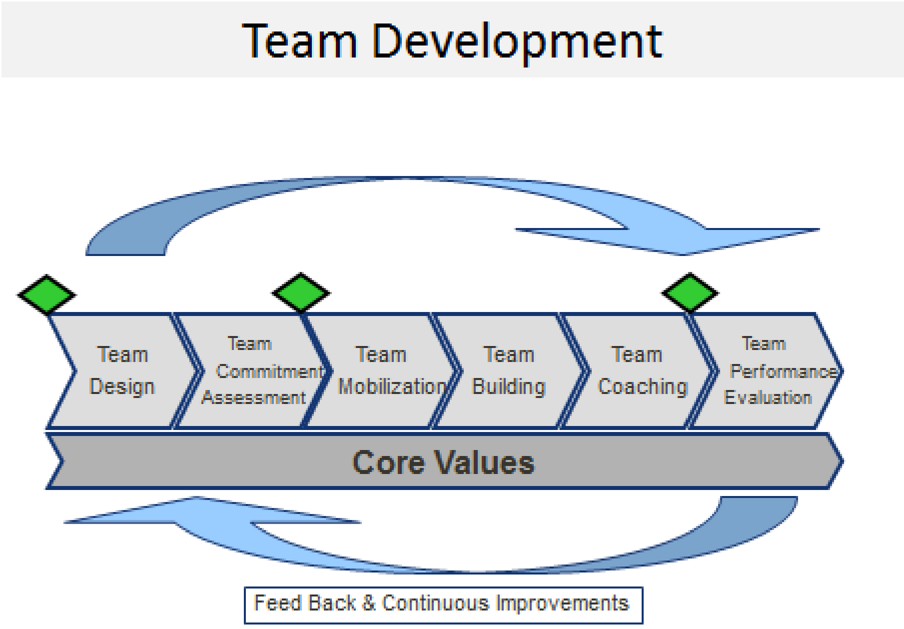


Figure 7-2 Systematic team development process

The first step is to design the desired profile of the team. Is there a need for multidiscipline professions, and should there be a combination of senior resources and fresh graduates, internal resources only etc? A firm team design strategy is recommened prior to recruiting and mobilization.

The next step is to assess and check the attitude and approach among the potential candidates to the project team. Is she or he dedicated to the tasks and genuinely wants to contribute to reach the goals for the project? Is there a willingness to share experience and support other team members, and is there a willingness to collaboratively contribute to building the team? These simple questions are critical with respect to establishing a winning team in the project and the three control questions should firmly discover whether there is a potential team member that truly wants to contribute to the success for the project and the project team, which is a desired profile far from the egotistical and selfish attitude.

Step 3 in the team development process is to mobilize the appointed team members according to an established mobilization plan. That needs particular attention by the project manager, and eventually engages the project owner if the agreed resources do not show up as planned.

Step 4 is the daily team building with frequent feed back on the performance on the tasks given, but also how the individual fits into the team and collaborate with other team members. The project manager needs to apply the so-called situation dependent leadership style, as the individual team members have different background and experience as well as different personalities. For some it is suffieicieent & appropriate for you being essentially a coach, other needs you as an advisor and other again just need you as a mentor in performing their tasks.

Step 5 in the model is a performance assessment of the individual and the team, addressing strengths as well as areas for improvements. A good advice is to start with the assessment feedback on the individuals' strengths, since that may create a more open mind towards listening to identified areas for improvements.

The perspectives above are further elaborated for different types of project organisations and may address particular issues related to the organisation culture and quality qulture in these.

Project organisation types may be categorized in three distinct alternatives, see Kolltveit et al & Jessen:

- Internal project organization type without changes in the line organisation
- Autonomous project organisations
- Matrix projects with project members working on tasks in the line as well as in the project, and there is a dual authority in the project.

An internal project organisation type means that it is run within the organisation unit of the permanent line organisation, and the project manager reports to the line manager who is also the project owner for the project.

The quality culture in an internal project organisation will essentially reflect what exists in the respective line organisation. That makes it possible to achieve a rather common and consistent quality approach and culture between the project in question and the line organisation as well as among the other internal projects in the same line organisations. The quality system and quality control in each project are under the regime of the line organization but adjusted to the project specific constraints and needs. The line organization should perform quality control.

An autonomous project is essentially independent of the line organisation. It is a separate organisation uit and the project manager has full accountability covering the project performance and results on quality, efficiency, progress, HSE and CSR (CSR: Corporate Social responsibility). The project culture is often a stong and united culture as the project members essentially shall work full time in the project. The team members are totally dedicated to the tasks in the single project which creates a high degree of ownership to the project and its output. The autonomous project creates an internal world and the ties back to the line organisations may in some cases feel vague and without commitment.

Does the organisation culture in an autonomous project focus on quality matters, and may the autonomous project organisation be classified as a quality driven organisation? The conditions for being classified as a quality driven organisation are that the development and design of the quality plan and quality system is built on the overall quality and management system for the entire organisation, and that the project specific quality issues are reflected in the work processes in the project and reflected in the project specific quality control recording and measuring. A management audit on system level may confirm that the project specific quality system and plan are founded on the overall quality and management system for the company.

A matrix organisation type is the third category. This is defined such that the project members normally work part time in the project and part time on other projects or tasks in the permanent line organisation, and there is a dual authority between the line managers and the project manager. A key issue in a matrix organization is who can decide what.

One of the main arguments for using the matrix organisation is that the human resources may be very efficiently utilised, as the project team members may work on both project tasks and regular tasks in the permanent line organisation. It sounds very attractive if it works as intended, but the reality may appear differently.

Each project member should demonstrate committment and ownership to the tasks he or she is responsible for in the project. In order to achieve these positive characteritsics, each team member must have sufficient time spent in the project in order to both physically and mentally be fully dedicated to the tasks. It is hard to achieve with just “10%” members in the project team. A team member that is involved of the order 10 % has a hard time to identify him self or her-self with the project, and there is sufficiently demanding to catch up on what has happened since last time. Consequently, the efficiency is significantly reduced if there is a majority of “10 %” participants in the project team.

Another characteristic of the matrix organisation is the tendency of frequent replacement of key resources. Lack of continuity among key resources is a firm quality issue and the matrix projects are experienced to become vulnerable due to the priority challenges between the matrix project and a series of line tasks and other projects simultaneously.

Another critical issue is the dual authority between the project manager and the line managers in a matrix project organisation, and the questiona rises: Who is in charge of what? A firm split of authority should be established up-front and included in the project mandate or project baseline. The project manager is accountable for the project output results and the project performance covering the product quality, the efficiency during execution, the progress, the HSE performance and the CSR. The line manager on the other hand, is the personnel manager to the respective team members and oversees the talent development and competence development to his or her project team members. Furthermore, the line manager is in charge of updating and upgrading the corporate quality and management system implemented and adjusted to fit the demands within own organization unit. Quality is thereby a hot and critical topic to address, and the following questions appear:

1. How to shape a quality organisation and a superior quality culture in a matrix project organisation with several functions included and team members on part time plus their line managers affecting the priorities?
2. Who cater for satisfying and matching the specified quality requirements and do the desired quality control & recording in the matrix project?

These issues and challenges in many organisations/companies are lack of clarity between roles that has resulted in an inefficient execution performance due to misunderstanding among the parties involved and unclear priorities beteen different line tasks and the obligations in the matrix project.

A well functioning and common project culture is hard to establish in matrix projects as there are several organizational units involved, with their own priorities and habits.

The single team members are handling several tasks and activities simultaneously, and may not have sufficient time to contribute in the creation of a common and unique project culture.

Mentally you may become at distance to the culture and the organization structure may not being involved in the shaping of the matrix project organization culture and profile. You may end up with a «laisse affaire» or a care less attitude; you do your committed tasks and do not proactively contribute to establish a winning performance team spirit. Those considerations should include the assessment whether the “10 %” participants should participate in the execution matrix organisation or not as responsible for producing their tasks. Resources in an expert advisor role is different since they may serve several projects, but they are not responsible for the project results, just providing advice to the performing and executing project team.

In a matrix project organization several line organization units may be involved through provision of human resources within the respective disciplines or professional areas, as well as their own local expert management systems and approaches influencing the quality in the work. This is basically a positive asset in the organization with a high value potential. On the other hand it is also a challenge in creating a real quality organization with a genuine common and mutual quality culture.

Creation and development of a quality culture is among the prioritized management tasks in matrix organisations. Resources from different organisation units may create diversity that contribute positively to the project culture provided you are able to extract a unitied and unique project and quality culture. That is considered as a rather challenging task for the project manager due to the spread in background and experience of the team members on part time which may have a detrimental impact on the product quality and the requirements to deliver a steady and even quality performance with a minimum in variation.

The quality & management plan and system must be in place and implemented in the start-up of the project, such that firm quality control requirements are communicated throughout the project team from day 1 during execution.

The matrix project organisations frequently are facing a particular challenge connected to interface and cross functional quality control, as a matrix organisation may be perceived more complex than internal and autonomous project organisations, partly due to the number of line organizational units involved. The enhanced complexity is thereby a quality challenge.

The single discipline or professional group may establish their own quality control procedures and guidelines including monitoring and control plans that fully satisfy the need for quality control and management. However, the quality challenges may be identified with issues at the interfaces and linked to the necessity for cross functional control and management. The interface issues should reflect the organizational, the contractual and the technical matters at the interfaces and satisfactory system quality must encompass compatibility and integration in the processes and solutions. The quality of the integrated total solution may not necessarily satisfy the specification requirements to the entire product or system, although sub systems and components satisfy the specified and desired quality levels.

The matrix project organisation should thus establish a quality plan that pays particular attention on cross functional quality control and interface quality challenges. In that context the cross functional quality control is a part of the duty as the project manager, and not for the managers in the line organization.

The single discipline check is the basic building block in quality management and control. The single discipline quality control is likely done in two steps: first by your colleague next to you, and thereafter by the respective line manager. That caters for the single discipline checks. It is a desirable approach resulting in the following:

- The line organisation is involved in the quality check within each discipline.
- Consistency in the quality performance in compliance with the overall approach and requirements within the disciplines
- The established technology strategy is followed in the projects as the line management control should make sure that there are no deviations.

The product or system delivery from a project frequently consists of a mix of part systems and/or components. Accordingly, a cross functional quality control is a necessity and is considered as an appropriate way of controlling the entire product or system quality in the project.

The matrix project organisations are also facing particular challenges related to the delivery quality and the project execution quality.

The dilevery quality, see the definition in section 1.2, may readily suffer since the key human resources work part time only in the project and are occupied with duties in other projects and tasks. The progress may slow down due to lack of priority and not available at the time of mobilization as planned. .

Accordingly, the project quality and the execution quality may suffer due to the efficiency challenges and issues. The efficiency in the project work is declining if there are too many "10 % "participants instead of human resources on at least 50 % involvement in the project. One of the reasons for the reduced efficiency is that the "10 %" project team members are not mentally present sufficiently long in order to being dedicated and committed to the solutions and tasks in the project.

An additional issue in project matix organisations is the split of authority between the line manager(s) and the project managers. Most organisations experience at times that lack of clarity on split of authority creates confusion and reduced eficiency. In order to achieve a further clarification, one should notice the difference between various matrix alternatives. These are:

- Functional matrix
- Balanced matrix
- Strong matrix

In the functional matrix the line manager has more power relative the project manager, typically 80/20 split. For the balanced matrix the authority split is 50/50. In the strong project matrix the project manager has the majority of power relative the line manager, typically 80 % in the project manager role, 20 % in the line manager role. These differentiations are illustrated in figure 7 -3. The three basic project organisations are shown along the X-axis while the Y-axis reflects the authority range. A line is made for demonstrating the difference in split of power between the line manager and the project manager. In the internal projects the line manager has the absolute majority in power as the line manager is in charge of the human resources. An opposite situation is for the autonomous projects in which the project manager essentially owns all authority in order to make his/her duty with total accountability.

In between the extremes are sketched the three different matrix project types. The strong matrix organisation is recommended if the project is a typical delivery project, like development and implementing a new ERP or CRM project. Under such conditions the project manager must have the necessary power to drive the project process and progress. The delivery quality benefits by choosing such an organisation design. On the other hand, internal strategy and innovation intiatives may be planned and executed more by using the functional matrix as there is a strong desire to achieve high dgree of participation, commitment and ownership to the proposals.

Derivation of a firm quality culture in project matrix organisations is considered particularly challenging due to the likely high complexity resulting from a large number of resources involved, several stakeholders, the number of interfaces and the desire for cross functional control and check.

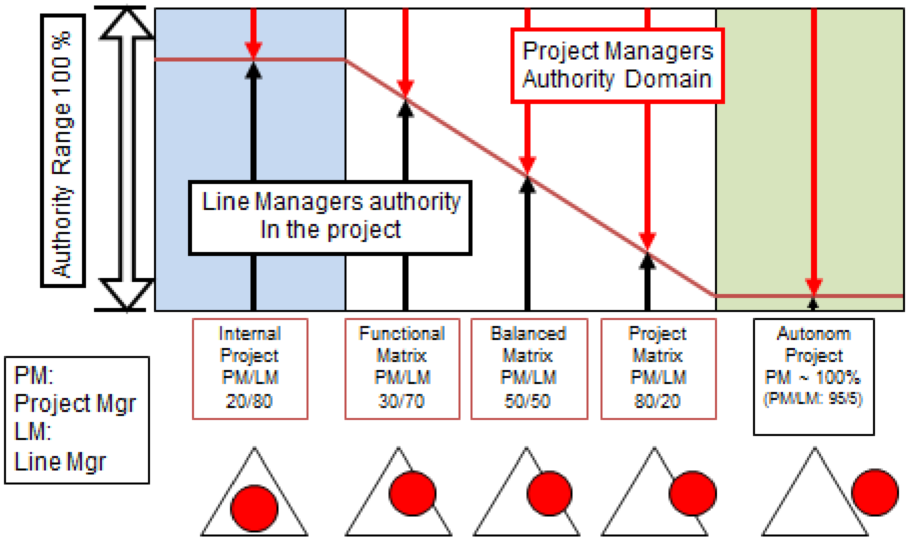


Figure 7 – 3 the split of authority as a function of project organization type

The interface issues may be handled by use of modern software for clash checks and control of cross functional activities and tasks. Three dimensional models of the product delivery are stong tools for quality & control. Examples of these are the CAD/CAM-models and the BIM in engineering and manufacturing industries. BIM, Buidling Integration Model, is an efficient tool for architects, engineers and building contractors in their work for planning design and erection of buildings. The BIM tool is object oriented and can be operated in real time due to the recent capability increase through use of big data and extensive digitalization. The 3D three dimensional models should also be used as a decision support tool in the sense that logic failures are easier discovered in a dynamic and interactive 3 D model.

7.2 Risk based manning in design and the high reliability organisations

Manning and human resource management in projects are considered as critical topics in present and future project organisations in light of the demand for higher efficiency and faster delivery, which is more and more predominant in projects. It is allways a question of mobilization of resources that are suited for the tasks and roles in an organization, and mobilized at the right time according to an established manpower mobilization plan. Such mobilization plans are standard practice in larger projects, on the client side as well as on the contractor side.

The overall goal for human resource planning in projects are to make sure that the project organization is characterized by robustness in terms of planning and executing the activities and tasks to the specified quality level, and according to the desired efficiency during execution. Organisational robustness is closely linked with the term's organizational redundancy and resilience in order to have an organization is responding and performing as planned for the project execution.

Critical elements in resource planning in projects are:

- Determine the type of human resources that is necessary for doing the project, the range of professions and expertise level necessary.
- Determine the number and volume of resources necessary.
- Establish a firm manpower projection plan, MPP, for mobilization and demobilization of the respective resources.
- Mobilise according to the MPP with respect to competence, time, number etc.
- Introduction to new members in the team about the project objectives and purpose, scope of work, project strategies and timeline.
- Team building and integrate new team members in the project.

Experience in many projects deviate from the the list above. A classic issue is lack of human resources with the prescribed qualifications and competencies needed to plan and execute the job.

How can you build in organizational robustness, redundancy and resilience under conditions lacking the desired resources? Three possible options may help you to resolve the challenge:

1. Provide challenging tasks to individuals and to teams that they initially may be qualified to do but does not have the real-life experience on the specific tasks
2. Make "competence families" with built-in organizational redundancy.
3. Establish a risk based manning approach.

Each option is briefly described in the following paragraphs.

Concerning option 1, it is amazing what is possible if you let people perform tasks that they are not initially experienced to do but are given the trust to try. The built-in potential in the individual and team is remarkable, and there is an upside which is often not utilized. There is however a balance about the complexity of the task and the project managers' capability of performing excellent leadership in that context. The self confidence must never be threatened among the team members, thus the project managers' skill in fine-tuning the task to the actual competences and experience is crucial and success may be obtained when the challenge may be perceived as tough but still possible to achieve. A too wide gap between the task complexity and the competencies to the team member may lead to a situation that they even do not try to resolve them.

Concerning option 2, design of "competence families", and organizational redundancy are realistic means of compensating for lacking qualified resources, and the desired product quality, delivery quality and efficiency may still be reached.

The discipline redundancy may be achieved by having three individuals representing the same discipline/professional area. They could however have different experience and competence level as one may become the champion, the next a talented senior resource and the third is in the training mode. Although they represent different seniority, they may partly replace each other in the project team, if for any reason the person involved in the project is not available or moved to another task. Not all organisations can afford to have three individuals within each discipline. That can be resolved through establishing resource agreements with another organization with individuals that may step in if needed.

A multiskill or dualskill person qualification profile is a supplementary way of building organizational redundancy. It means that any project team member should be capable of handling more than one profession or discipline. An example from a shipyard is as follows: The welders of plates must be capable of welding pipes, and among the administrative staff there is a requirement that the system responsible also could function in the controller role. In that way it makes the project team flexible, redundant, robust and resilient.

The organizational redundancy is further enhanced when focusing on the desired competence profile to the individuals. It is dealing with a way of expansion of the qualification to the individual efficiently and to the desire for the individual and the organization. We may illustrate the issue with an example from the accounting department in a company. Accounting and invoice recording and registration have over the years being taken over by modern ERP systems and the group of accountants may be reduced significantly. The redundant accountants however are most frequently characterized by being systematic, accurate and very loyal. These individuals may have a perfect personal profile and experience for a range of other jobs in the company. In the project organisations, they may act perfectly in the role as project controller; provided they are given a fast-track add-on education in project control. Organisatioonal redundancy is achieved.

Option 3, risk-based manning may help in a systematic way of designing a high performance and ultra high efficient project organization through an organisational criticality ranking of the project organisation. In an arena of lacking qualified resources, the risk-based manning becomes an attractive approach.

Risk based manning is here defined as follows:

- *"Risk based manning is the mapping of the organizational criticality ranking of various organization units, roles and functions providing the facts about which roles and functions are most critical for the project organization and execute a prioritized manning according to the organizational critical mapping".*

The definition above has its similarity from technical development projects where the principle of risk-based inspection is an established practice.

The risk based manning approach is relevant for the client organization as well as for the contractor/supplier organization. It essentially means that mobilization of human resources should be differentiated, and the highest criticality ranked roles are the positions and/or functions that are absolutely necessary for making the project. The risk-based manning is further in full accordance with lean thinking and design of lean project organisations with superior work flow efficiency.

In particular, the principle may be attractive in client organisations that are in the position of governing the project process, whereas the supplier organization is the producing organizational body. With a limited number of human resources in the client team it is crucial that the positions to be filled are the ones with highest impact on the project performance and that the necessary qualifications are met for these positions.

Also, the contractor/supplier organization may benefit by using the approach as it is a sound guidance for which positions or functions is most critical in the contractor project team. The contractor could furthermore utilize the principle of risk based manning in the consideration of which parts of the project could be subcontracted, as organizational critical positions and roles should normally not be subcontracted; those positions should be in the hand of the main contractor.

7.3 The QRM role in project organisations

The project manager has the accountability for the project results, including the quality of the product/service as well as the performance during the project execution. The accountability in the project is delegated in the line to the respective part project managers or producing team members, and quality and risk controls have frequently been performed through management system audits in connection with management reviews.

In larger EPC type projects (Engineering, Procurement Construction) a specific manager role is introduced and implemented in many project organisations over the later years. It is defined as the QRM role which is the Quality and Risk Manager, an integrated role in the project organization. It is a support function in the project organization as illustrated in figure 7 – 4.

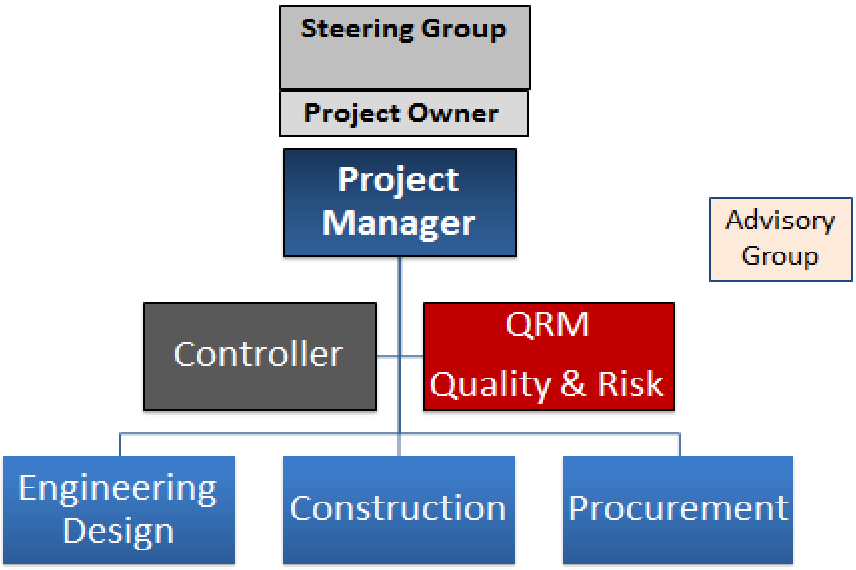


Figure 7 – 4 A brief sketch of a likely organization chart for an EPC type project illustrating the position of the QRM role as support and staff.

The firm roles of the QRM is a supporting role, and not as a “procedure police” identifying non conformances with a formal return in terms of an audit report requesting the demand for corrective actions only. The QRM support role as such is to provide to the executing and producing organization the right tools and standards for dealing with quality and risk issues, and are in charge of updating the internal management system on quality and risk when governmnental or company specific elements need an upgrade or new legislations are introduced and launched by the authorities. The support role is an internal supplier of system and tools as well as performing analyses on quality performance and risk performance and providing that to the project management team accountable for the actual project performance.

Why is there a need for an integrated QRM role in the project organisations, and not covered by a separate Quality Manager and a separate Risk Manager, that has been the frequent format and practice in the past?

The rationale is built on different perspectives, and the main elements are:

- The business environment is experiencing an increased volatility, larger uncertainty, enhanced complexity and the desire for mastering the ambiguity (the VUCA characteristics) with disruptive developments
- The need for mastering the dynamic states that becomes more and more the characteristic of projects and its environments in the future as projects are no longer static with minor changes and the organisations must have dynamic capability to meet the VUCA-environment and characteristics.
- The project execution pattern and approaches are often the kind of a change journey.
- The QRM analyses and assessments should be utilized as primary decision support facts continuously during the project execution, not solely as a post project evaluation
- The ISO 9001: 2015 version is essentially risk based containing features to master the uncertainties and changes during the life cycle of a project.

The characteristics listed requests a fundamental paradigm shift in managing quality and risk; from inspection and post evaluation supplemented by management audits on quality and risks, towards an integrative and proactive decision support role, which is considered critical for achieving superior project performance under changing, disruptive and dynamic environments; the typical business and project environment in the future.

7.4 Quality models

There are several general models developed concerning Quality Management and control. The ISO standards and system is the foundation for a wide range of models covering quality issues and quality control. The process approach is predominant in order to secure a defined standard and level on the work processes and quality systems in order to achieve superior workflow efficiency.

Three outstanding personalities have dominated the development on quality management: Deming, Juran and Crosby. The intentions were the same for the three persons, but the approches varied, and are briefly summarized in this section with primary reference to Oakland. (Oakland)

Deming had 14 elements for managing quality:

1. Create a steady pressure on the desired objectives for continued improvement in the product or service.
2. Adopt the organization to a new mind set. There is no room for acceptance of delays, and substandard workmanship.
3. Gradually reduce the dependency on massive inspection and recordings. Request statistical evidence such that quality is built into the production and work processes.
4. Stop recognition on business based on a price tag.
5. Identify the critical issues. It is the responsibility of the management to generate system improvements.
6. Institutionalise modern learning and training methodologies on-the job.
7. Institutionalise modern coaching and training guidance for the production workers. The role of the foremen is shifting from recording numbers to creating real quality.
8. Stop fear in the organization such that anybody may work efficiently for the corporation.
9. Minimize barriers in between departments and avoid the silos.
10. Avoid quantitative measures and goals for the work force thar are steadily enhanced with respect to productivity and efficiency demand without providing the staff with thorough explanations and appropriate tools.
11. Eliminate work procedures that determine firm quantitative statements.
12. Remove barriers that hinder the workers to demnstrate pride and confidence for their work and output.

13. Institutionalize an extensive program for further education and training.
14. Create a mutual quality culture in the executive management team that has a continual focus on the 13 items above on a daily basis.

A similar systematic approach was established by Juran containing 10 steps for quality improvements:

1. Build awareness of the need and opportunity for improvement
2. Set goals for improvement.
3. Organise to reach the goals (establish a quality council, identify problems, select projects, appoint teams, designate facilitaators).
4. Provide training
5. Do projects to solve problems
6. Report on progress
7. Give recognition
8. Communicate results
9. Keep score
10. Maintain momentum by making annual improvement part of the regular systems and processes of the company.

Accordingly, Crosby had four absolutes on quality management:

- Definition – conformance to requirements
- System - prevention
- Performance standard – zero defects
- Measurement – price of non-conformance.

Crosby offered management in 14 steps to improvement on quality:

1. Make it clear that management is committed to quality.
2. Establish quality improvement teams with representatives from each department.
3. Identify where current and potential quality problems lie.
4. Evaluate the cost of quality and explain its use as a management tool.
5. Raise the quality awareness and personal concern of all employees.
6. Take actions to correct problems identified through previous steps.
7. Establish a committee for the zero defects program.
8. Train supervisors to actively carry out their part of the quality improvement program.

9. Hold a «zero defects day» to let all employees realize that there has been a change.
10. Encourage individuals to establish improvement goals for themselves and their groups.
11. Encourage employees to communicate to management the obstacles they face in attaining their improvement goals.
12. Recognise and appreciate those who participate.
13. Establish quality councils to communicate on a regular basis.
14. Do it all over again to emphasize that the quality improvement program never ends.

The three quality gurues have a mutual focus on the organisation's capability of achieving a quality culture founded on the basic principles of continual improvement and committment in all work processes and at all levels in the organisation. The basic principles of continual improvement and firm committment in the quality work are considered as valid and sound today, although the derivation of the three approaches on quality culture is made in classic industry production firms. Of particular remark, Deming, Juran and Crosby pinpoint the importance of personal committment and dedication to the work. In addition, there is addressed the importance of planning and the desire for prevention of issues to happen in order to create a sustained focus on quality and continual improvement in the organisation and the associated activities. Those characteristics provide you with the chance of building a true quality organization.

The most well-known quality models are established for production operation enterprises and organisations in general and not explicitly for projects.

The quality models all have an overall and holistic perspective on organisational, cultural, strategic, commercial, and social political aspects are covered and reflected. They have a totality approach and comprise the importance of business performance excellennce on quality, exposed through a multi dimensional organizational perspective. Thereby, the various quality models include elements and measures related to customer satisfaction, business performance both financial and non-financial, employee satisfaction and impact on society. They are designed and developed based on the philosophy that quality is shaped and prioritised when the entire organisation is focusing on and prioritising performance excellence in all activities with a united quality culture.

Among the general quality models are the Malcolm Baldridge Quality Model, Oakland's TQM-models, and the EFQM Business Excellence model (EFQM: European Foundation for Quality Management).

These models have in common a multi dimensional approach, in which work processes and the customer/supplier relationships are key elements. The multidimensional approach is also reflected in the Balanced Scorecard by Norton and Kaplan. (Norton & Kaplan)

Each quality model is briefly described in the following sections.

The Malcolm Baldridge Quality Model

One of the most widely used quality models is the Malcolm Baldridge Quality Model, an american model developed for the annual quality award to the organisation that are ranked highest in a total quality assessment.

The intention and objectives of the model is to contribute to quality excellence and performance in organisations. The assessment criteria in the Malcolm Baldridge Quality Model are as follows:

- Visionary leadership
- Customer driven performance and capability
- Organisational and personal learning
- Recognition of employees and collaborating partners
- Degree of agility and flexibility
- Desire for the future
- Manage and stimulate innovation in the organisation.
- Results and facts-based management & leadership
- Degree of corporate social responsibility
- Focus of achievement of specified goals and value creation
- Firm development of systems.

It is put into a framework consisting of seven categories that are directly applied in the quality assessment of organisations:

1. Leadership
    - Organisational leadership
    - Corporate social responsibility, CSR
2. Strategic planning
    - Strategy development
    - Strategy implementation

3. Customer and maarket focus
    - Customer and market knowhow
    - Customer relations and customer satisfaction
4. Information and analyses
    - Measures and analyses of organisational performance
    - Information management
5. HR-focus
    - Work methodology and systems
    - Employee education, training and development
6. Process management
    - Product- & service value generating processes
    - Business processes
    - Support processes
7. Business results
    - Customer focused results
    - Financial results and market results
    - HR-results
    - Organisational efficiency and productivity

Figure 7–3 is an overall brief sketch of the Malcolm Baldridge Quality Model showing the interaction among the 7 elements listed. The MBQM model consists of three basic categories of elements: the organisation profile, the system, and the information and analyses. The overall objectives are to achieve customer satisfaction excellence and market success, providing improved business results.

The MBQM model shows how the framework integrates and interact the seven categories. Customer focus is predominant with respect to achieved performance as well as on strategy and action plans.

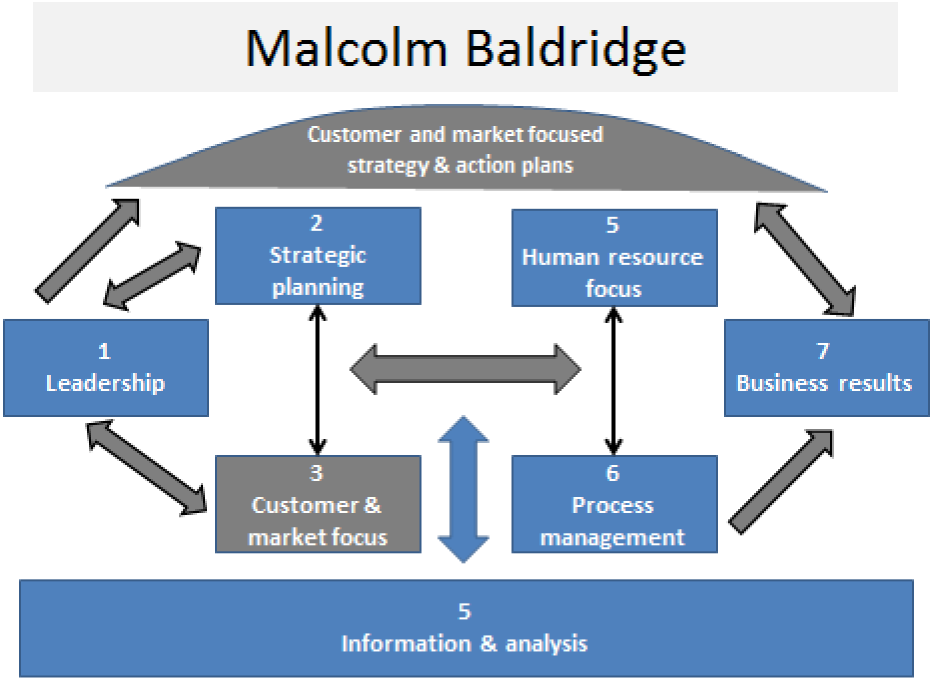


Figure 7-3 Brief sketch of the Malcolm Baldridge Quality Model

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Oaklands' TQM-model

Oakland's model on Total Quality is very attractivve and includes both hard and soft issues related to quality. It includes tool, systems and processes, combined with communication culture and commitment. Furthermore, the Deming quality improvement cycle, the PDCA cycle, is visible and included. (PDCA: Plan Do Check Act)

Particular attention is paid on the customer/supplier chain, internally and externally. The specified product quality is reflected in the processes and in the customer supplier/chain. The necessary system and tools shall ensure and document that the actual quality achieved complies and satisfies the specification requirements. The probability of achieving the specified quality requirements is increased if the organistaion and culture are dedicated towards the quality issues in any activity and function in the organisation. The organizational perspectives are considered to become ever more important, in which team, culture, communication and commitment shall be paid particular attention.

The original TQM-model by Oakland has interfaces towards the external environment through culture, communication, and commitment as well as through the continuous customer/supplier chain. A key issue is concerning the internal culture and patterns in an organization that could be addressed through the following questions:

- How can you document and demonstrate that it is a quality organization?
- How can you achieve continual improvement in all activities and parts in an organization?

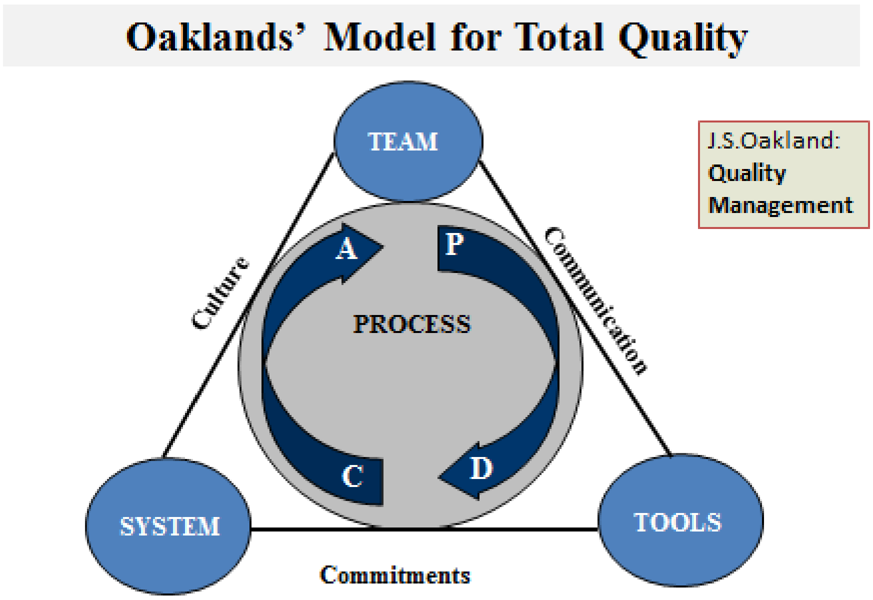

Figure 7-4 Oaklands' original TQM-model (TQM: Total Quality Management)

Most organisations do treat the external customer/supplier relations professionally and with satisfaction. What about the internal customer/supplier chains in the organisations? Do we take it for granted that the internal customer/supplier relations and commitments are managed as planned and agreed upon?

The current practice on internal matters is frequently such that you act as if everybody understands each other without a firm request from the internal customer. Lacking a clear specification creates uncertainty with respect to what should be delivered. The unclear and diffuse situation results in confusion with respect to roles as well as what to deliver; the consequences may readily lead to reduced product quality and reduced project quality and productivity/efficiency. The TQM model by Oakland pays particular attention to commitment which is considered as a critical success factor for achieving a quality culture delivering performance excellence.

The EFQM Excellence model

The EFQM model was established as a European alternative to the American Malcolm Baldridge Award. (EFQM: European Foundation for Quality Management).
The EFQM- model was initially named a Total Quality Management model, whereas it later was relabeled to EFQM Excellence-modell. The initial version was established ultimo the 1980'ies and included a holistic and multidimensional approach on quality in organisations. The organizational and cultural elements are essential for achievement of superior performance and delivery quality. The multidimensional approach is considered as valid today as when the model was established. The EFQM Excellence model covers various aspects of organizational performance, covering customer satisfaction, employee satisfaction, impact on society and business results.
Of particular remark is the focus on achievement of satisfactory business results, both financial and non-financial results as an indication of whether it is a true quality organisation or not.

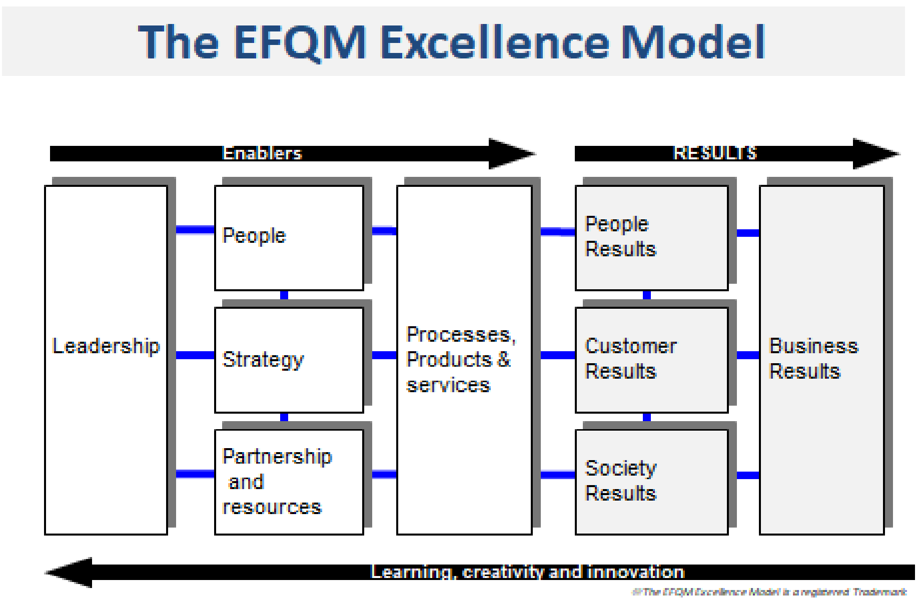

Figure 7-5 the EFQM Excellence-model

The EFQM model consists of 9 elements, in which 5 elements are enablers and 4 elements are results. Key issues in the model are the processes, customers, strategy and leadership which are in full compliance with the ISO 9000 standards and guidelines.

The results elements are reflecting the multidimensional perspectives of an organisation performance and include the following:

- Element # 6 Customer Results
- Element # 7 People Results
- Element # 8 Society Results
- Element # 9 Business Results (financial and non-financial)

The customer result is the key element like what is covered in the other quality models as well as in the lean methodologies and principles. The EFQM model explicitely includes the people results as an important result element; the same with the society results (impact on society) as there is a firm and sound understanding that business excellence is highly dependent on these dimensions in addition to the customer satisfaction element. The business excellence results are thus achieved through high performance on the three result elements on customer, people and society. Each element has several sub criteria.

High performance and business excellence are generated through systematic use of a set of enablers in order to deliver the desired quality of the product or service and to obtain a true quality organisation.

The enablers' part of the EFQM model includes in total 5 elements, and they are:

- Element # 5 is representing the processes, products and services covering business and work processes which is in accordance with the prioritized focus on processes in the ISO standards. Brief experience from a range of industries and organisations confirms that supreme quality may be conditioned upon that the work processes are properly mapped optimized and followed during the operations in the organization in order to achieve superior flow efficiency according to the basic principles in lean operations.
- Element # 1 is covering leadership. The foundation for the EFQM model is good leadership which is considered to become critical for achievement of a high-quality organisation resulting in quality excellence of the output and value generation. The rationale behind this element is that without good leadership it may become extremely difficult to establish a satisfactory quality culture and a high performing quality

organization. The element exposes the importance and impact of good leadership through setting direction and creating a motivating organization culture resulting in performance excellence.

- Element # 2, People, represents the human resources covering capability, skills, capacity and accessability.
- Element # 3 , Strategy, is covering the organisations' policy and strategy. It shall reflect the understanding perception and attidude regarding policy and strategy and how that impact the quality achievement in the organisation and the output deliveries to customers.
- Element # 4, Partnerships and Resources, represents partners and material resources. It covers financial strength, equipemt, patents and intellectual property rights, as well as established collaborations with sub contractontractors and suppliers.

All enabler elements have sub criteria like what is included for the results elements.

The DEMING-circle is visible and integrated in the EFQM model through the experience and feed back loop from the results elements back to the enabler elements and includes learning, creativity and innovation. If the desired results are not achieved, the EFQM model addresses the importance of making corrective actions in the most relevant enablers for making the necessary improvememt in order to satisfy specified quality goals. The basic principles of lean manufacturing fully comply with these characteristics catering for a systematic approach on continual improvement and superior workflow efficiency in the organisation.

The four result elements in the EFQM model are essentially synonymeous with the parameters in the Balanced Scorecard by Kaplan and Norton. (Kaplan & Norton) Integrating the Balanced Scorecard and the EFQM model demonstrate the relevance of the EFQM model in strategy work as well as on the assessment of the operating performance periodically.

Practice in many industries is that the Balanced Scorecard is primarily been used for performance monitoring and reporting periodically, whereas the EFQM model is most frequently used annually for self assessment of the entire organization on quality performance.

Application of the EFQM model

The EFQM Excellence model may be utilized and applied differently. Self assement by using the EFQM Excellence model har been widely accepted in many organisations, which is a kind of health check of the organisation capability and performance on quality matters whether there exists a genuine quality culture or not, and that the organization demonstrates that it is a real quality-based organization.

A self assessment may readily be planned and executed by use of the EFQM Excellence model. Assessments scores are made for the single elements in the model and provide a total score.

The EFQM Excellence model is applied in an award competition for the annual EFQM Excellence award. Both private enterprises and public sector organiusations are previous award winners.

Another application of the EFQM model is to assess the state of the organisation AS-IS that is a necessary step towards designing and executing identified improvement initiatives. These activities are important input to the annual strategy and operating planning.

The self assessment scoring by using the EFQM Excellence model is a likely input to the business development and strategy processes in an organisation providing you with a multi dimensional perspective on the organisational performance. Furthermore, in the context of the strategy analyses and activities the self assessment is an indirect measure of the competitive strength of the organization and the EFQM Excellence model is an attractive supplementary strategy tool.

Particular attention should be given to result element # 9 that shall reflect the busness results. It is split into two parts, the financial and the non-financial results. The financial results are covering the classic figures to be included, whereas the non-financial results cover market share etcs. Application of the EFQM Excellence model in the public sector requests other key performance parameters in the result element # 9. The financial results are replaced by typical efficiency figures for the operations.

Oaklands alternative model in quality management

Oakland has extended his initial quality model as shown in figure 7 – 4. It is a simplified model focusing on 4P's and 3C's. The 4P's are processes, planning, people and performance, and the 3C's are culture, communication and commitment, illustrated in figure 7 -6.

The alternative model by Oakland is a simplified framework for quality management with particular attention given on processes. Further elaboration on the 4 P's is as follows:

- Planning – development and deployment of policies and strategies on quality, establish partnership and resources, and design for quality (design thinking)
- Performance – establish a framework for performance monitoring; a multi dimensional score card of key performance indicators for the organisation to be used for self assessment, audits, review and benchmarking.
- Processes – understanding, management, design and redesign; quality management systems and continual improvements
- People – management of human resources, cultural changes, team, communication, innovation and learning.

Successful implementation of these principles is achievable through efficient leadership.

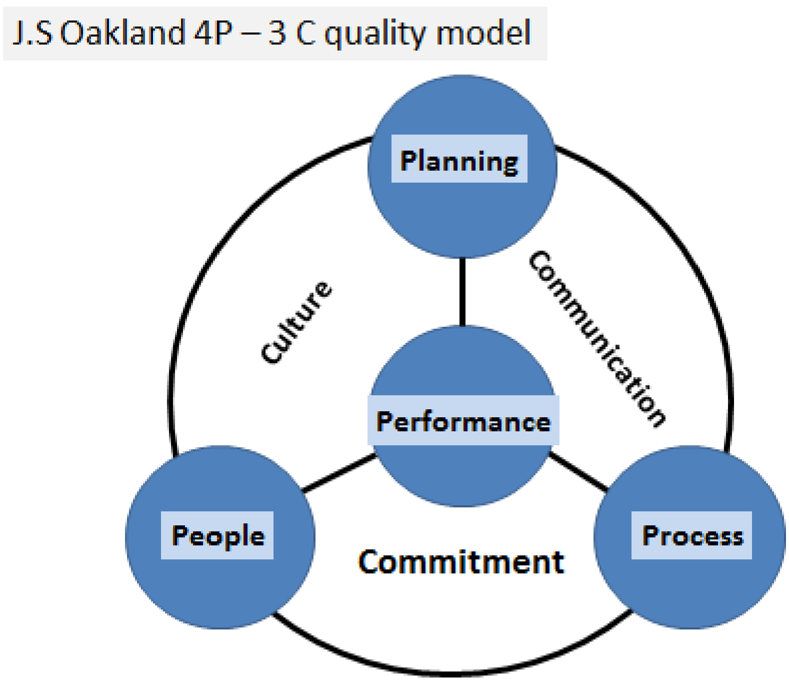

Figure 7-6 Oaklands' alternative quality model the 4P – 3C model

Application of quality models in projects

The general quality management models are in principle equally relevant in projects and in ordinary operations. The traditions are however different, and the work environments are different between the line and the projects.

In operations management, the output is frequently a repetitive service or product based on a predefined specification requirement. Any variation and non-conformance shall be identified in the statistical quality control and measuring.

The project environment is different. The project is a one-time event with a unique output. The typicals aret hat there are tough constraints when running a project; you shal deliver in spite of too little time and lack of qualified resources. The time pressure may easily lead to an execution period without proper planning up front. The consequences may readily be sub standard quality of the work and product under development in the project, and there is a risk of the need for rework or delays. The project format and the environmental characteristics are considered more extreme than in regular operations, as it is a one-off delivery and not a repetitive effort. More than ever there is a desire and request to do the right things right first time and in the right sequence.

Commercial management of projects becomes more and more predominant, both with respect to enhanced demand on efficiency improvement and a desire for reduced investment costs as well as on higher perfomance capacity of the delivered system or product from the project. During the last decade, there is an awareness and further understanding of the project economics in terms of higher Net Present Value of the use of the project deliverables, and not only focusing on the investment demand isolated, the CAPEX, the capital expenditure with reference to section 6 and figure 6 – 2. Managing quality in projects is considered more important than ever. It addresses the demand for designing and building in the the right quality from day one in the project and creating a genuine quality culture that "guarantees" an output delivery that satisfies fully the specification requirements on the product or service.

In the project world the ISO standards regime provides you with the following key documents:

- ISO 10007: 2003 Quality management systems – Guidelines for quality management in projects
- ISO 21500: 2016 Guidance on Project Management

In addition, there is developed a project specific excellence model by the International Project Management Association named the IPMA Project Excellence Model

These guidelines and standards are briefly described in section 7.6.

7.5 The impact of leadership on achievement of performance excellence

Good leadership is a critical success factor for shaping a quality organisation characterised by a superior quality culture that prioritizes learning and continual improvement.

Is there a need for good leadership capabilities in the modern society in which the majority of the population has higher education on university level? Absolutely, leadership is more critical than ever in order to set directions, be visionary and create enthusiasm among the employees aligned towards common goals in an organization.

What are the likely root causes for that?

Knowledge and skills are isolated of limited value for an organisation unless it is capable of utilizing it to create real values in the operations and in the projects. The leadership challenges are to put the knowledge and skills of its employees into the organizational context contributing to realise the specified goals through setting direction by thorough explanation of strategies and goals and how to implement these in the organization.

Management consists of both structural (tasks) and cultural (relational) dimensions.

The structural elements include typically planning and control that are well established in most organisations. The corresponding cultural elements are covering leadership, teams and organisation. The experience on the cultural elements of management varies. Do the teams function well, and what characterizes the leadership attitude?

The structural aspects shape the foundation on how to run organisations in which all management and quality systems are implemented and governing the operations. Achievement of superior performance on business and quality is fully depending on creating and managing the cultural aspects in an organisation in order to establish a sustainable quality culture.

The leaders' attitude and priorities become critical as they are the individuals that must demonstrate a true quality culture, and they are role models in any of their activities. Many underestimate that facts of being a role model, and any activities and actions are noticed by the employees and in the environments.

The perspectives listed above are firm requirements to fullfill managing roles in line operations and even more so in projects as the project environment is frequently characterised by severe constraints such as too little time, lacking qualified human resources and high ambitions on capacity and functionality of the out put delivery from the project. Strong and good leadership is considered to be a key success factor for achievement of performance excellence with respect to quality and efficiency.

Turbulent and disruptive times may request a paradigm shift in leadership style and focus. Transparency requests traceability and monitoring of any activity and decision made internally and in collaboration with other partners. Firm governance is a part of those aspects. However, the volatile, uncertain, complex and ambiguous characteristics request a dynamic leadership style shaping and managing the changes appearing; the leaders must demonstrate the capability of changing and moving fast combined with high efficience performance that create superior effectiveness and values to the customer and partners involved; dynamic capability is required. The business environment becomes ever more intense and complex and the leaders must demonstrate the capability of having the awareness and strength to shape the future under uncertain and disruptive environments. The recognition of the importance of excellent leadership is reflected in a number of project evaluations and health checks in the projects see section 7.8.

Dynamic and situation dependent leadership styles are crucial for achieving the desired project goals according to the specified quality requirements, combined with high execution performance on efficiency and delivery on time. A high performing quality culture is easier obtainable when there is established a mutual trust among the team members and that the project leader tries to set direction make confident decisions and creates a motivating and stimulating team profile, in which learning and continual improvement are vital issues.

7.6 ISO 21500 Guidance on Project Management & IPMA Project Excellence Model

ISO 21500

ISO 21500 Guidance on Project Management was launched and published in 2012. It is generic in nature and is applicable on any type of project. The generic characteristics means it is designed on an overall level and covers definitions of project management, programme management and project portfolio management. Furthermore, the project context is addressed focusing on the the project external environment and the organisation corporate strategy. That is fully illustrated in figure 6 -2.ISO 21500 addresses in broad terms management in projects and quality management, whereas managing the product quality in projects are covered by the technical specifications and standrads on the products, their functions and features combined with the capability of making the desired and specified product quality. The capability of making the specified product quality relies on having the right organization and work processes with skilled people being able to organize and develop the product or service specified.

The approach is illustrated through the following steps:

1. Identify and establish strategic goals
2. Identify opportunities
3. Develop alternative solutions for the identified opportunities.
    a. Option a
    b. Option b
    c. Option c
    d. ..
4. Select the most appropriate conecpt
5. Project execution for realisation of the selected concept
6. Assess and document the contribution to the corporate business benefit.

ISO 21500 is an overall framework that makes the project and project management as primary and strategic enablers in an organization for achievement of the specified project results. Application of ISO 21500 is straight forward, and specified processes, procedures and other quality activities are linked to the overall framework.

Of particular remark is the prioritised attention on project programmes and project portfolios as well as on single projects.

ISO 21500 is purposely designed and developed on an overall functional level, providing you with the freedom on how to achieve the desired and specified quality and business goals.

The corporate strategy is setting the direction and ambition on business development and new opportunities. Within that context common practice is to derive a business case for a range of alternatives. With firm and established selection criteria, the screening and selection process should lead to the realization of the most appropriate concept relative the established purpose of the initiatives. A professional and objective selection and screening process is possible when a set of approved selection criteria are established up-front.

ISO 21500 also includes configuration management that describes the ways of application of procedures for management and control of the specifications and corresponding attributes in the project.

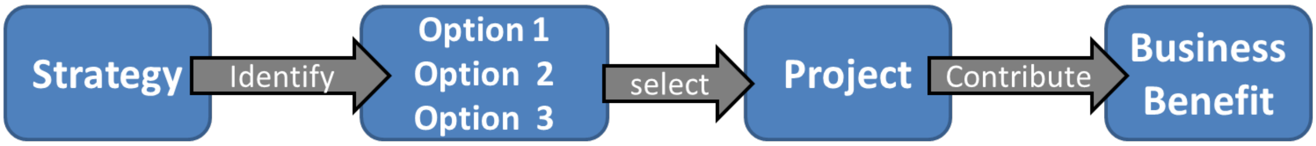

Figure 7-7 strategic realisation process for projects according to ISO 21500

In addition, the ISO 21500 Guidance exposes the importance on handling and managing the stakeholders to a project, the internal stakeholders as well as the external stakeholders. In complex multi discipline projects the project success is largely a result of good stakeholder leadership and management. This is a particular issue in international and global projects facing a range of cultures and governmental bodies in different countries.

The ISO 21500 is firm and clear regarding the formal competence requirements to the human resources invloved in the project and the competences are categorized as follows:

- Technical competences and skills for delivering the project in a structured way
- Social competence linked to attitude behaviour and team fomation
- Contextual competence, the capability of bringing the project into the right context in the corporation and the society.

Particular attention si further paid on the actual premises and constraints for the project in question. The guidance ISO 21500 pinpoints the importance of creating a joint understanding and perception among the respective stakeholders under which conditions should the project being realised. Collaboration and dependencies are key issues in that context.

In total five process groups are described that are as follows; initiation, planning, control and termination. These process groups are synonymous with the process groups according to PMBOK, The Project Management Institute Body of Knowledge guidance.

IPMA Project Excellence Model

The German Project Management association, GPM, introduced in the late 1990'ies a Project Excellence model that was a slight variation of the general EFQM Excellence model. That model was later launched as the IPMA Project Excellence Model, in which IPMA is the International Project Management Association.

The initial IPMA-model provided you with a multi dimensional characteristic on the project performance in full compliance with the principles and design philosophy outlined from the EFQM Excellence on general management.

A novel model is launched and introduced by IPMA. The current IPMA Excellence model is an integrated model reflecting both internal and external aspects.

The core in the IPMA Project Excellence model is focusing on the following elements:

A. People & Purpose
B. Processes & Resources
C. Project Results

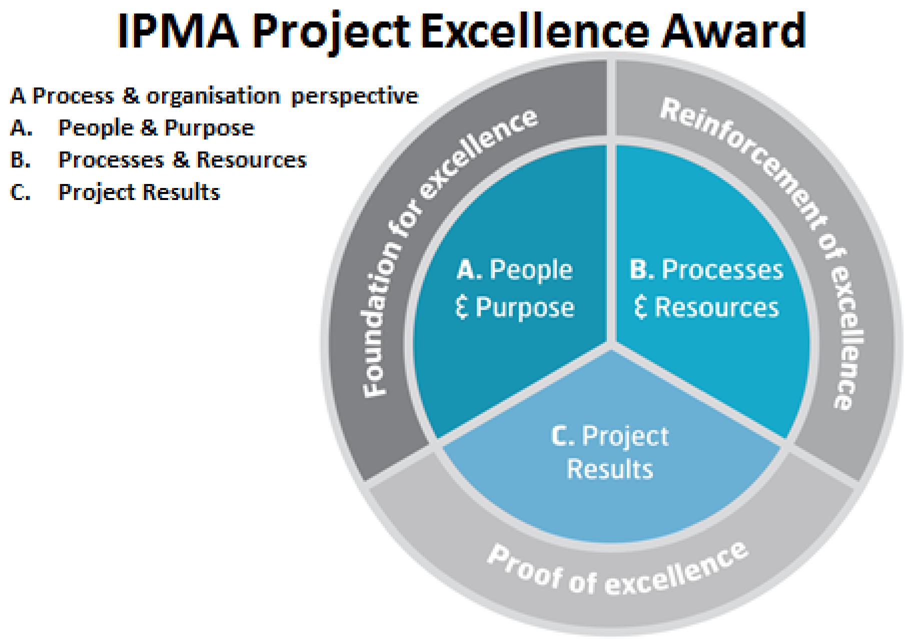

Figure 7-8 IPMA Project Excellence model

There is a sound philosophy built into the model. The foundations of excellence are linked to the purpose and people. A firm and clear purpose makes it easier to deliver excellence and provides a better foundation for making a well-defined scope of work and associated project plans. However, the foundation of excellence is fully depending on having the right people on board the project and how they collaborate internally and externally to the project.

The reinforcement of excellence is built on having appropriate work processes with high workflow efficiency that is conditioned upon having the right resources to manage the processes and delivery the specified output.

The proof of excellence is built on the project results in which both the output product result as well as the desired effects of the use of the project results should be reflected.

7.7 PMBOK – totality perspectives

PMBOK, The Project Managament Institute Body of Knowledge is referred to several places in ths textbook. In total, PMBOK includes 9 knowledge areas, and has formed the basis for the project management and control practice in thousands of projects world wide.

The 9 knowledge areas are:

1. Project integration management
2. Scope management
3. Time management
4. Cost management
5. Quality management
6. Resource management in projects
7. Communication management & control
8. project risk management
9. Procurement

Some companies have supplemented the 9 knowledge areas by a 10th knowledge area in HSE, health Safety and Environment.
Each knowledge area is described by a set of defined processes that strongly contribute to achievement of a totality approach on quality development and control in projects.

For each project phase the activities are categorised in five management processes:

- Initiation process
- Planning
- Execution
- Monitoring & control
- Termination and close out

The relative intensity may vary from phase to phase and in between the processes. The initiation process has its peak in the beginning of the phase followed by a decline in intensity. The planning process takes over when the initiation process is diminishing.

The planning processes have normally a rather high intensityi through the entire project phase as you readily do iterations and changes in the planning during the exeution. The subsequent execution processes are timewise at its highest intensity later than the planning processes.

Monitoring measuring and control processes are among the key enablers when aligned and syncronised with the execution processes. Monitoring and measuring in parallel with the execution open up for periodic or continual evaluation of the execution performance and corrective actions may be triggered when needed. In that way extensive rework late during the project execution may be avoided, as corrections are made underway.

A separate termination process is included in order to cater for the totality within the respective project phases. The termination processes typically include the final documentation and integration.

PMBOK is generic in nature and structure and may be applied for a wide range of project types. It comprises the demand for a common set of key processes in project management. It may however be discussed whether PMBOK is ideal in project characterized by dynamic patterns and moving targets, typical for environments characterized as a VUCA world, volatility uncertainty, complexity and ambiguityrly withich is typical for many IT projects. Under such conditions, scrum and agile project models are considered more appropriate, see section 6.6.

Still however, there is a significant improvement potential if the PMBOK was implemented and used even for dynamic projects with moving targets.

7.8 A Contract based excellence model for projects.

An alternative excellence model for projects is developed by Lereim. (Lereim 2013)

The objectives are to cater for the the particular challenges related to a balanced approach on performance excellence reflecting the quality and risk issues in light of the contractual relation between client and contractor.

The design of the model is founded on empirical work experience in a range of large projects.

The model is illustrated in figure 7 – 9. Again, it is a process-oriented approach to achievement of performance excellence.   In addition, particular attention is paid to the client contractor roles, the customer and supplier roles. The ambition is always to satisfy the customer demand, regardless of whether the customer is external or internal.

In total the model consists of 9 elements that are:

1. The customer request
2. The project delivery
3. The business benefit of the project delivery
4. The scope and specification requirements
5. Cost
6. Time
7. Project organisation and human resources
8. The contract
9. Project leadership

The internal part of the model comprises the classic project management & control parameters cost, time and scope of the tasks to being done. These variables must cover the entire life time of the project. The scope is linked to the request from a customer in terms of characteristics, capacity performance figures, functionality requirements and technical specification requirements. At the delivery stage, the the customer voice, response and customer satisfaction are key elements, schematically noted on the right-hand side of the model. The customer focus in the model should make it easier to delight the customer as the specified and expected demands are prioritized. The specified product quality should thereby be met as precisely as possible in an efficient way according to utilizing the lean principles during execution.

The delivery quality is catered for through integrating the progress monitoring in the basic project control variables. The corresponding execution quality is accounted for through the assessment of the performance efficiency when comparing the progress/value earned with the actual cost to date at cut off reporting dates.

The contract based performance excellence model includes the business benefit/ effect goals in order to continually assess and evaluate the performance and enablers to achievement of the desired delivery with satisfaction of the customer. With that approach you are triggered to consider action on progress or resources if deviationas appear of any kind, on quality, risk or efficiency. Supplementary enabling elements in the model are the awarded contract, the contract/project organization of the supplier and the corresponding roles.

The structural perspectives are exposed through the elements Contract and project organisation. The organization issues shall cater for establishing an appropriate and efficient project organisation that is adjusted and modified during the project execution. The project organization is intended to show a dynamic pattern to meet the changing demands during project execution. The contract perspective is included as it is the key tool in the relation between the customer and the supplier. The contract addresses and regulates the the pattern between the parties, what is the scope, under which conditions, the contract model, the risk and uncertainty split between the parties, the compensation format, systems for managing changes and deviations, managing sub suppliers etc.

The project leadership element is included, as good leadership is considered is a primary condition for creating a high performing project organization with superior value generation during the project execution satisfying both specified and perceived quality under dynamic and uncertain environments.

Leadership covers both task leadership and relation leadership. Projects are by nature task focused as there is a concrete out put in terms of a product or service. Accordingly, task leadership is readily identified in projects. The task focus in projects may make them rather robust organization wise in the sense of doing problem solving. There is frequently accept of using utraditional methods and patterns in order to achieve the specified product quality in the project compared to regular line operations; it is first of all the end delivery that counts in the relation to the customer.

Many organisations are in such a condition that you are not in the privileged situation that you may pick and choose the human resources you want. That is just a fictious dream scenaario. The reality in most organisations is that you have to develop a high performing team with the resources made available. That is possible through consistent and motivating leadership in which synergies are developed and the team performance exceeds the sum of the performance of the individuals. The winning high performing project team may become a reality through excellent project leaadership. In that context the degree of relation style leadership may become the critical success factor.

How to create a winning team with the human resources provided to you? The relation leadership style includes elements such that motivation, inspiration, creating trust and giving challenged that is syncronised with the individual’s capability and ability.

The relation between the project leader and the individual team member becomes critical elements for shaping a winning high performing team focusing on excellent quality and mastering the uncertainty in a turbulent environment.

It is worth noticing that the relation leadership style becomes more predominant and critical in global and international projects in order to handle the various stakeholders to satisfaction. Expectation management is a part of these efforts and leader activities. The task oriented leadership must be in place in terms of proper structure and systems, and that the specified product quality may be achieved. The achievement of the specified and perceived quality is however hard to reach unless the relation aspects are fully catered for. These statements are supported by the research work by Aarseth, see (Aarseth)

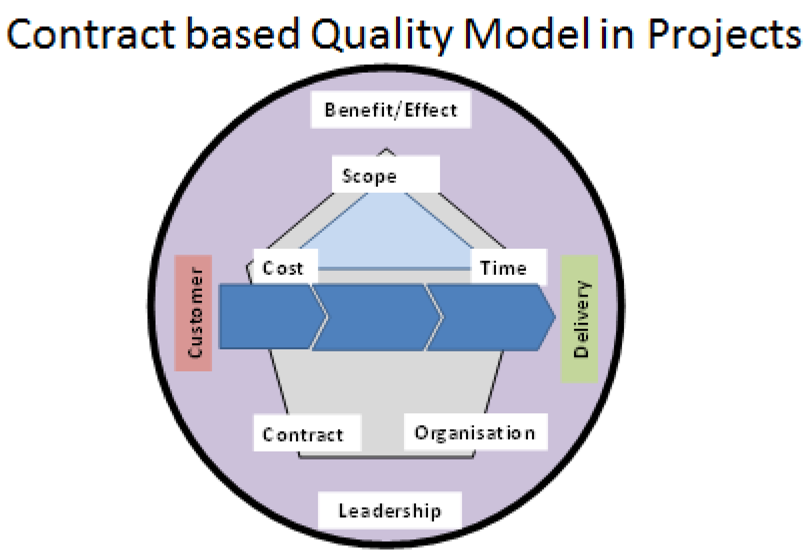

Figure 7-10 Contract driven quality excellence model.

7.9 Utilisation of risk analyses in quality and business management of projects

The event based qualitative uncertainty analyses and management tool is described in chapter 2.6 deliberately applied to improve the project performance and the associated product quality of the output delivery. That methodology and tool are common practice in most organisations utilizing the approach for assessmenet of the potential risks with respect to likelihood of occurrence and the consequence if it occurs, however primarily being focused on the technical issues of the project delivery.

The risk issues are as important on any activity in a project, and the highest potential threats for successful project delivery may rather be of an organisational matter, of human resource or related to lack of leadership skills.

Typical potential threats on organisational nature may be:

- Lack of firm clarification on split of roles between line organisation and the project organisation
- Unprecise roles and responsibility matrices
- Diffuse project organisation type
- The decision-making processes are vague
- Lacking qualified key human resources
- Delayed mobilisation of criticaal key resources
- Unclear communication lines
- Lacking a common project culture
- Cultural barriers inside the project organisation
- Cultural barriers between customer and supplier (client & contractor)
- Cultural differences between the various project organisation units when there is split location domestically or abroad
- Lacking a common set of project management terminology, within project management and on HSE, Health Safety and Environment
- The business and commercially related risk elements may be assessed and ranked inside the simple format of the risk analysis smatrix in qualitative terms judging the likelyhood of occurrence and the consequence if it occurs.

The identified potential risk elements as listed above should be assessed and ranked similarly to the technical issues. The corresponding corrective actions may become more challenging and more extensive than resolution of a technical issue.

Similar approaches should be taken on the opportunities related to organization, human resources, leadership, stakeholders, decision making and communication.

Likely opportunities are:

- Alternative use of human resources when laccking key resources
- Innovative competence development through fast-track add-on competences on the basic competence and education to the individual
- Alternative organising and split of tasks through providing sub tasks / work packages to other organisation units.
- Access to external expertise in niche area where it is not appropriate to have the expert competence in question inhouse.
- Evaluate possibilities for simplifications with respect to project status reporting and control.
- Consider use of agile methods in execution of any kind of projects with scrum methodology.

7.10 Management health check in projects

The holistic approach in quality management is vital in the evaluation of the issues connected to organisation and leadership. A range of different assessment models exist, the most widely known and applied is the OPM3 from PMI, The Project Health Check by Buttrick, and the PEVS model by Andersen & Jessen.

OPM3 fokuses primarily on the organisational maturity and the corresponding key issues, whereas the PEVS model by Andersen & Jessen includes the project baseline, the desired goals and the capability of planning and control. Furthermore, The Project Health Check by Buttrick includes the ability of managing the project stakeholders.

Specific check lists are derived for each of the project management evaluation models. The quality elements are not explicitely covered in any of the models.

They all cover essentially the same area of evaluation and which model is the recommended is more a function of knowing the respective model, its basic content and experience in using them.

An alternative project management approach related to project evaluationof maturity and precision level may be done by assessing the project status in two main categories of issues such as:

- Structural perspectives
- Cultural perspectives

The structural perspectives or processes cover typically the managerial process such as plaanning, execution and control, which are normally covered by project management and control. A project management evaluation in that context shall check the project's capability business benefit and suitability with respect to the structural processes, frequently named the cybernetic processes.

Planning	Execution & Control
• The project effect goal & business benefit • The project delivery/resultgoal • The project scope & specification requirements on quality/functionality • WBS, Work Breakdown Structure • Overall milestones plan • Main activity plan • Detail plan • Cost estimation & budget • Time estimation • Risk & opportunity analyses • Project Execution Model	• Baseline • Reporting format • Actual cost to cut off date • Progress/Earned Value to Cut off date • Derivation the CPI, cost Performance Index and the SPI, Schedule Performance Index • Monitor the product quality development, preferrably through a QPI, Quality Performance Index • Monitor continually the critical path • Table of corrective actions • Interface control • Forcasts of total cost & time • Review risks and opportunities

The cultural perspectives frequently categorised as the social processes cover topics related to organisation and team, leadership, motivation and inspiration, decision making and managing stakeholders. Examples of social processes are listed in the table below.

Organisation & team	Leadership & motivation
• Selection of project organisation type • Roles and responsibility matrix • Decision making processes • Organisational understanding • Degree of systematic team development • Resource efficiency • Organisational robustness and resilience	• Setting direction • Explain, expose and communicate vision, goals and strategies • Managing external stakeholders • Motivate the empolyees • Performance focus • Capability of prioritisation • Capability of making decisions • Capability of mastering uncertainty and complexity • Capability of uniting the project team

An alternative health check assessment model of project teams

In addition, there is a separate model for assessment of the project management team. The approach is to make observations and categorise these according to a list of basic categories. One simply makes observation of the activities and participation in the dialogue and discussion among the project management team members. The tool is derived from elements used in negotiations and may be applied in regular management meetings and other status meetings.

Each of the categories included in the modell is briefly described in the following sub sections.

The observer listens carefully to the dialogue and discussions in the meeting or the event o finterest and records every time the single person when he or she is active and categorises what kind of statement or contribution was given. The experienced observer makes his or her judgement in what category the statement belongs and marks in the box for the person and the respective category. You note with a single mark every time a specific statement is given by someone and marked in the respective category.

That approach has been applied with success in a range of management teams on corporate level, on operational business unit level and in the project management teams.

The profiles vary from individual to individual as well as differ for each person depending on the kind of meeting that is under observation. The overall purpose with the model is to identify and summarize the range of activities and involvement for the individual as for the whole management team/group.

The experiences vary significantly depending on the context and the composition of the respective management team. However, there is some general observations that likely appear for any management team or group such as:

- The majority of management team members seem to ignore the need for successive summarizing during the meeting; what did we agree upon sofar and what remains of particular issues not yet resolved.
- Too few exposes emotional reactions during the meeting. Most participants are very formal and do not show their personal character which may contribute positively during the discussions.
- There is an improvement potential in actively bringing in others in the dialogue. A recommendation is to utilize questions of the kind: “What do you mean Peter on this particular issue?”
- Some individuals are rather dominant; that is easily recorded when marking their activity during the meeting in the category assessment table. The leader challenge is then to activate other group members in the meeting in order to achieve a more balanced involvement.
- The recording and monitoring of activity show quickly who is the opponent, who consistently disagrees, who is the idea maker, who builds and support others’ ideas etc.
- The activity profiles would most likely differ whether there is a regular status progress meeting or an important management meeting with cases that request decisions on som important strategic issues.
- Corporate strategy development and working meeting should trigger a high level of involvement among the persons in the meetings and processes and the recorded activity level should ideally be on an almost even level amongst those participating.
- The completed activity profile is used as a primary source for derivation of improvement actions and mitigations in the management teams assessed.

Description of categories

A brief description is made for each of the categories used during the observations.

Makes a proposal: Recordings of ideas of any kind, of technical, organisational, administrative etc

Builds: Recording and monitoring whether a person builds on an others' idea/proposal and improves it further

Supports: Recording of who actively expresses his/her support to an others idea or proposal

Disagrees: Gives a statement of disagreeing

Testing and understanding: Testing what others mean about this, raising questions of the kind: «What do you mean?" or "Does it mean that ..?"

Summarizing: Explicitely summarizes where you are at any time, in a case, in a discussion, in a negotiation etc.

Give information: Recording of when a person provides you with information to the other participants in the meeting.

Emotional statements: Recording of whether the ME approaches is applied in the dialogue. Typical examples are such as: "I am personally deeply concerned about the issues on the accumulated resources spent as per today in the project" or "I have a feeling that the group does not function as intended". It could even be excessive joy and pleasure.

Bringing In: Recording of whether one actively asks another in the group and conciously encourages others to participate in the dialogue

The notorious opponent: Recordings of whether a single person deliberately interrupts others, disagress, critisizes others, give long monologues that irritates the others, does not listen to others etc.

Cuts off: Cutting off others when they have an argument or story to tell

NB! These observations are recording facts of the type of activity in the dialogue and participation in the meetings and are not any kind of sensitivity assessments.

Template for observation and recordings of activity

PERSON (examples of roles/name)	**Project Leader**	**Part-Project leader # 1**	**Part-Project leader #2**	**Project member**	**Project member**	**Project-controller**	**QRM**
Makes a proposal							
Builds							
Supports							
Disagrees							
Testing & understanding							
Summarizing							
Give information							
Emotional statements							
Bringing In							
The notorious opponent							
Cuts off							
Sum							

Application of the table is to register the activity to each project team member in a meeting and summarize the extent the single person has been involved in the dialogue.

Section 8

Particular Quality & Risk Issues in Some Project Types

8.1 Quality & risk management in reorganisation projects

Reorganisation projects are considered complex and have quality issues and challenges. Most reorganization projects impact the work life of individuals and groups of people.

A critical success factor for reorganization projects is to thoroughly assess and identify the organisational needs; what are the desireded effects of a possible reorganization. Reorganisations are painful and there must be firm conclusions whether it is necessary or not. When that is concluded the management must develop the scope of work and associated specification requirements of the organisation's efficiency and performance. Appropriate quality management in that category of projects is to define relevant quality performance parameters.

Likely quality performance parameters are:

Product quality is defined as the desired level of precision, reliability and efficiency including derived organisation type and structure, the requested competence level and profile as well as achieved enhanced flow efficiency in the work processes in the new organization model.

Delivery quality is a quality performance measure whether the new organisation is implemented in due time, and associated degree of ownership to the new organizational solution among those persons affected by the reorganization.

Execution quality, project quality: Are the work processes logic and efficient, and is there achieved commitment and dedication among the human resources affected regarding the design of the reorganization and the corresponding implementation plan?

Effect quality is a performance goal whether the specified business benefit and effects are achieved within a specified implementation and operation time after completion of the project. The desired effect may be a specified cost effectiveness improvement in %, cost benefit or improved reliability level and enhanced organisational capacity and capability on services or product deliveries.

The nature of reorganisation projects is such that an ISO certification does not necessary provide you with the right solution. The process mapping and standardization of work processes may contribute in the changes and reorganization. However, the ultimate solution is to cater for the humans affected by a reorganisation. Superior leadership performance is the key through the ability and capability to generate acceptance, ownership and belief in the redesigned organisation. It is highly recommended to actively involve those affected by the reorganisation in the design and solution development; a necessity for achieving satisfactory quality in the processes and in the output results of the reorganization project, ie the redesigned organization structure and reformulation of roles.

A reorganisation project may be executed with a project model consisting of three distinct phases in a stage gate-based execution model such as:

1. Diagnosis
2. Design og solution
3. Implementation

A stage gate-based project execution model may readily be used as illustrated in figure 8-1.

The execution model for reorganization is made of three distinct phases as the topics and extent vary significantly between the respective phases.

The output results of the diagnosis phase should be as objective as possible to the best of the organisations needs. The recommended approach is to establish a small project team as an autonomous project in which the project members are experts and core resources in the organization. Preferably there are inhouse resources that are appointed to the project team, eventually supported by a few carefully selected external reorganization experts. The appointed project manager must be appointed among internal resources as the reorganization process should be owned and managed by internal resources in the organisation. That provides control and governance over the changes by the organization it self and not being pushed by external management consultancy companies. However, external analytics resources may support the team on dedicated services.

When the project is moved into the design and solution phase, the project team is recommended organized as a matrix project organization. In this phase key human resources from the environments facing reorganization should actively contribute in the design and solution development. The main rationale is that they know «where the shoe hurts» and what are feasible solutions for achieving the expected improvements. A range of resources may be involved and the classic matrix resources dilemma appears with respect to prioritization among different tasks and projects.

If a decision is made regarding implementaytion of the developed design and solution, a plan for implementation must follow and be fully satisfied. The recommended project organisation design is as an internal project organisation type. The main reason is that the suucess of reorganization is depending on full ownership, commitment and governance from the managers of the reorganized units. The derived implementation plan is best realized when integrated in the approved operating plan for the organization unit in question and not as an add-on to it. By that approach the leaders are committed to execute the implementation and realisation activities for making the reorganisation real. If not, there may be a risk of delays and down grade in prioritization.

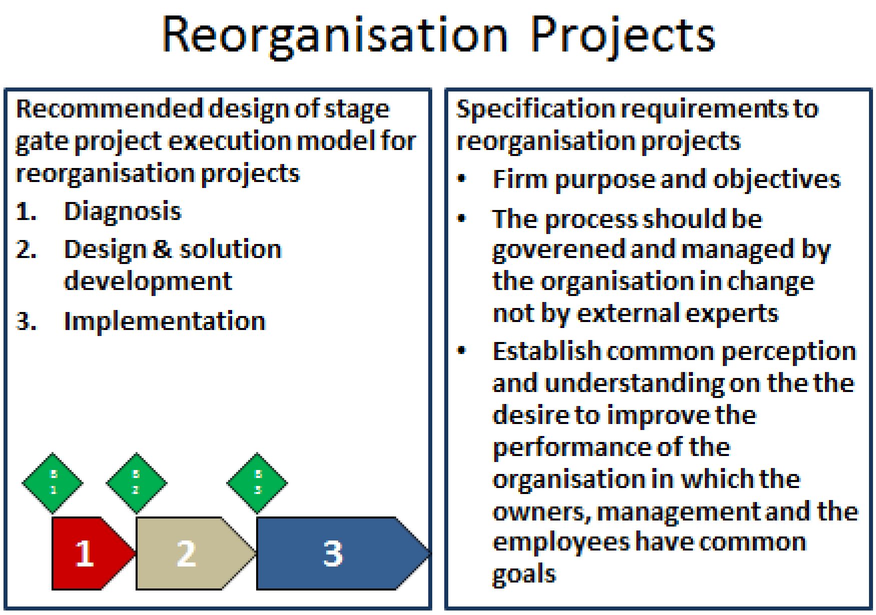

Figure 8-1 Project execution model for reorganisation projects including formal decision gates at the start of each phase/stage.

Management and leadership of reorganization projects – how to do that?

During the diagnosis phase the intensity is high within a small appointed and dedicated expert group, likely less than 10 resources involved. The project reports on the executive &

corporate level and the project governance function may be catered for by the project owner of the project. The project owner is typically an executive manager on strategic level. The message is to keep a high speed with a leadership capability of performing confident decisions for proceeding into action and implementation.

The situation is different in the next phase, the design and solution development stage. A steering group may be appropriated and recommended for the design phase with steering group members that cover the problem areas and issues. The design of the steering group should be such that the cross-discipline aspects are fully covered by the members of the steering group. However, the number of members in a steering group should be limited in order to demonstrate speed and accountability as well as decision & execution power.

During the implementation phase a steering group may be utilised as a strong governing tool relative the derived mitigations and the actual implementation in the affected environments.

The project governance and project execution should prioritise the output quality of the product or service. The desired delivery from a reorganization project is an organization with achievement of the specified changes, including acceptance and ownership to the developed solutions. Second, there should be attention on the progress, conditioned that the specification requirements are met.

Reorganisations or reengineering are physically as well as emotionally challenging tasks and should if possible be executed as quickly as possible when a decision is made on reorganisation of the unit in questioon. The predicted business benefits should be prioritized rather than the cost reduction isolated. The cost effectiveness and business benefits should focus on value optimization not cost reduction initiatives alone.

The output product quality on reorganization type projects may be strengthened through a real and active dialogue with the unions and the employee representatives and gaining benefits through utilisatioon of their unique and valuable organization competence and experience with the organization as an eco-system.

The employees and the corporation have common goals in making the organization better and improve the competitiveness. A revitalized and reshaped organization is to the benefit for the owners, the executive team and the employees.

The corresponding process regarding compensation and actions for those affected must be run as a separate process, not integrated in the design and solution development.

A frequent approach and perception in many organisations is that cost effectiveness & improvements are reflected in actions resulting in cost reductions with a linear development over time for the reorganistion. The question appears whether that approach provides you with the desired results.

A rather rapid reduction in unit costs may be linked with cost reductions. It may lead to positive impact on short term until the organization becomes dysfunctional without energy and vitality for improvements. The organization may be categorized as an "anorectic organization" without sustainable strength, effectiveness and competitiveness. At that point in time the unit costs may again increase as illustrated in the dotted line in figure 8 – 2, and the final effect is negative and critical whether the origanisation unit survives or not.

Reorganistion should be considered as a critical strategic investment. In order to obtain the predicted effects on improved effectiveness and benefits, the unit cost may initially increase during the change and implementation period followed by a decline to the desired level representing the specified sustainable level. That development scenario is schematically sshown in the solid line over time in figure 8 – 2.

The strategic sustainable approaches request that the executive management team is fully aware of the desire for the long-term effects, and not limited to the short-term cost cutting. Cost cutting is a part of the reorganization, when necessary, but that is not enough. That represents only the initial step of a total turnaround.

In the energy industry there is a need for turnaround of many of the companies in power generation as well as within upstream oil & gas. Due to the rapid decline in oil prices in 2015 many of the upstream oil & gas companies must undergo a total turnaround. Such a total turnaround is reflected and illustrated in the developed Business Driven Reengineering model, and is illustrated in figure 8 – 3. The business driven reengineering model plots the desired development in Business Performance Excellence as function of time. The initial step is cost cut, followed by process mapping process improvements, dynamic and commercially goverened process control, towards the desired leadership approaches in future organisations characterized by the need for agility, flexibility efficiency and resilience in a stochastic and unpredictable environment with volatility, uncertainty, complexity and ambiguity, (VUCA).

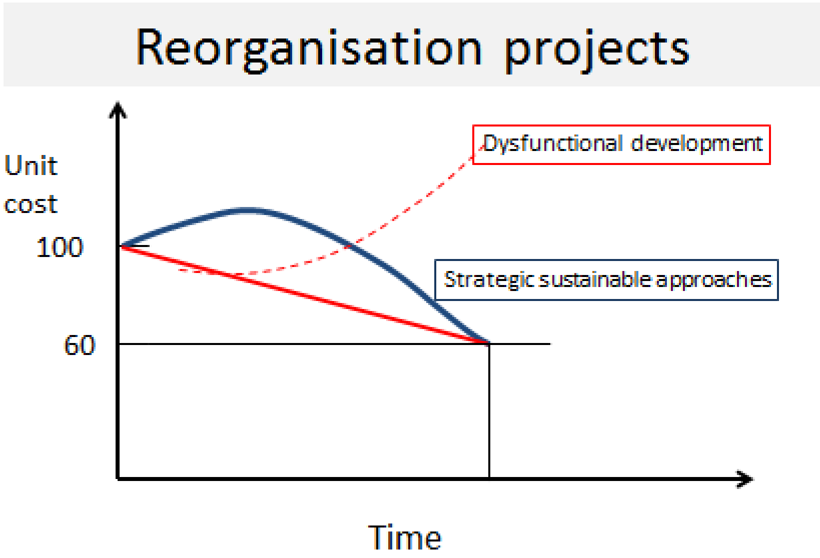

Figure 8-2 Illustration on possible development on cost effectiveness over time for a) the linear cost reduction approach, the dotted line, and b) the strategic approach though sound strategic investment initiatives resulting in a sustainable improvement, the solid line.

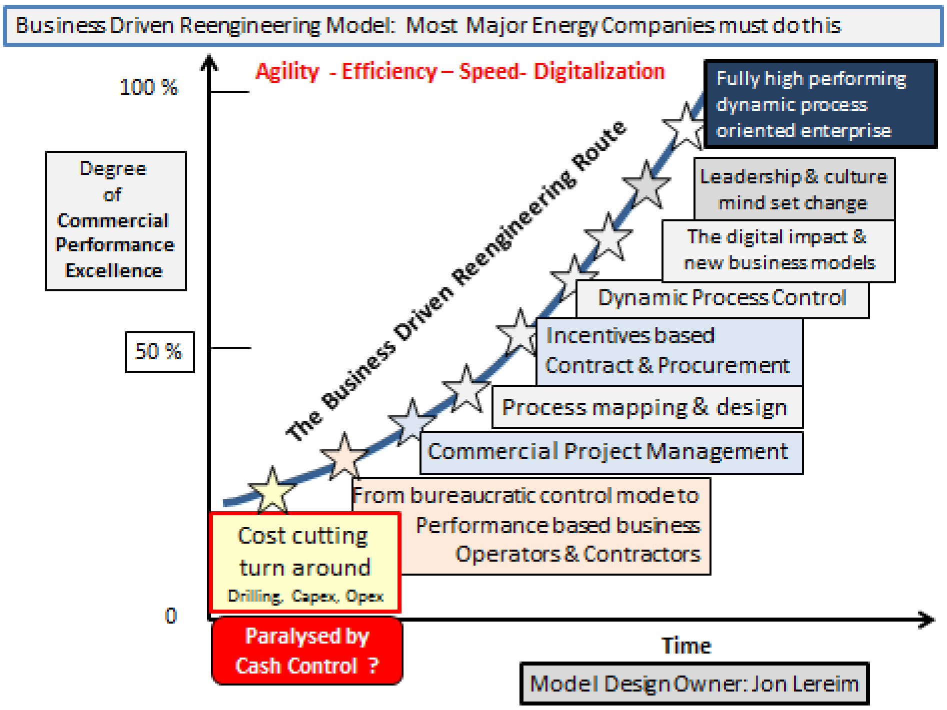

Figure 8 – 3: The business-driven reengineering model in which the Degree of commercial performance execellence develops over time resulting from the series of steps in the model.

8.2 Quality & risk management in construction projects

Construction projects are frequently characterized by several physical activities that are partly depending on each other.

The end product, the result goal, is the physical unit including the corresponding documentation of the work peformed. That provides you with the possibility of monitoring and measuring the physical progress which reflects the value generation accumulated to the cut off reporting date.

The product quality is linked to all the physical activities and the finished product. Assurance of the achievement of the specified quality is obtained by producing a quality plan including plans for monitoring and measurements in alle physical units, as single elements and as assembled and erected.

Examples of likely plans for measurement and monitoring may comprise the following for construction projects:

- Measuring and recording of dimensional tolerances
- Measuring and recording of straightness of decks
- Measuring and recording of the position of the reinforcement bars and reinforcement grids in concrete structural elements
- Measuring and recording of surfacae roughness
- Testing of compression strength of as cast concrete
- Testing of tensile strength and fracture toughness in metallic materials
- Weld procedure testing
- Producing mock-up tests
- Deflection monitoring
- Weld defects detection, embedded and surface defects
- As installed capacity measures on equipment
- Cross functional clash check in structures by use of BIM or equivalent electronic modelling (BIM: Building Integration Models)
- Etc.

The quality check on buildings should likely include the following elements:

- Check of as received construction drawings alternatively the as-designed building ready for construction with particular attention on correct revision number.
- Check of receival of materials
    - Right material and batch
    - Log of the actual temperature of received concrete.
    - The actual manufacturing and production methodology as specified.
    - The right amount
    - Correct location of delivery

The performance control of the product quality and delivery quality shall be developed in accordance with the organisation's quality and management system but made project specific.

A key issue related to the product quality is the design and development of the work processes within the respective disciplines and products/objects.

The organisation in question should have a common database for work processes that are generic and cover any condition or project. However, the work processes and associated work procedures should include issues that firmly describe project specific elements to be included. The derived project specific work processes and work procedures should not be approved for application in the single project until a process control loop is included for evaluation whether the project specific issues influence the production and manufacturing methodologies.

8.3 Quality & risk management in modification projects

For installations and facilities in operation, there is likely that modification and major changes/upgrades are necessary for furthrt oprations at specified safety level with improved capacity performance.

On many installations and buildings, they have undergone a significant change from "As Designed" to "As Built" to "As Is". In particular there is likely a major difference between As Built and As Is, resulted from a series of minor and major modificationsa and upgrades during the operation phase. Full documentation may be lacking and the condition for doing high quality modifications and upgrades are challenged by the lacking As Is documentation. That situation results in uncertain conditions and uncertainty in the scope of the modification, which may generate product quality challenges of the modification tasks to be done. The description of the Scope of work becomes difficult, as vital information may be lacking and uncertainty is present in the project from planning through execution.

Within the challenging framework of modification and upgrading tasks, the product quality and quality management of modification projects must cater for and master the following:

- Define what is the purpose and objectives with the desired effects specified for the planned modification.
- Fully understand the consequence of the non complete AS-IS documentation of the actual performance of the installation or system to be modified or upgraded.
- Search for robust and viable solutions that builds on the AS- IS condition and documentation.
- The time frame is frequently fixed and defined within all modification/upgrade work must be completed.
- The main effect performance indicators are enhanced benefit, improved functionality and increased capacity as an effect of the delivered and implemented. modification/upgrade.
- Ensure compliance and compatibility between existing systems and installed/implemented modification/upgrade.
- The project ambition should contribute to be back in operation as soon as possible, which is a critical success parameter for the business benefit in terms of the enhanced project economics, NPV.
- Modification work may frequently happen on existing facilities in operation, a socalled «hot platform». It should be differentiated between modification work that can be done on a hot platform, and what requests shut down for performing the modification work.
- Modifications on facilities may frequently happen under physically constrained conditions that makes the modification work more difficult.
- There might be limitations on how many can work simultaneously with modifications due to facilities in operation as well as physically constrained areas.
- For offshore oil installations and floating vessels, the limitations on number of beds on board may cause severe constraints. The modification team is present in addition to the permanent crew on board, and the regular operation has priority relative modifications and upgrades
- Be prepared for the unexpected and the unpredictable; conditions that were not identified or specified in the AS- IS documentation.

- For mobile offshore installations and rigs, do as much of the modification work in shore and at a yard and preferably during the planned annual shutdowns.
- Be prepared for the need for customized solutions developed during the modification.

The list of elements above are primarily a check list for buildings, facilities on land or offshore, but the majority of them are as valid for modification and upgrades for IS /IT system solution.

Primary project control performance parameters are:

- Upgrade product functionality and develop functionality according to specified reliability and regularity level in order to achieve the specified product quality on upgraded installation or system.
- The delivery quality is met through control of achievement of delivery milestones for the upgrade/modification.
- Project governance and control on milestones rather than on single activities
- Extensive use of risk and opportunity analyses for prioritisation and management execution during the modification work.
- Firm resource management and control for mobilization and demobilisation
- Perform Site Integration and Site Acceptance Tests of the modified/upgraded system prior to startup of operation of the modified system or facility.

8.4 Quality & risk management in study and evaluation projects

The quality challenges for this type of projects are to develop a firm and confident facts basis for the idea or issue of concern to be used as primary facts support package whether the idea or issue should be realized and implemented.

The key is product quality – how detailed and precise is it possible to make the evaluation?

The corresponding delivery quality is also of interest since an evaluation is requested to deliver at at specified date. However the product quality superceeds the delivery quality but is situation dependent. Delivery on time is not first priority if the required product quality cannot be reached unless some extra time is available for completion of the tasks. The potential dilemma should be assessed on each case.

What may provide you with the desired quality on expert evaluation type projects?

To a large extent quality is connected to the team composition you are able to generate. Do you get access to the expert resources you need to fullfill the tasks on such a project?

The quality assurance will thus be connected to the screening assessment and mobilization of the right resources with respect to competence level, availability and competence redundancy or resilience.

A general advice is that an expert group should be composed or more than 3 experts with complemenmtary competences in order to master the complexity issues of cross functional character in a holistic and totality perspective.

The overall objectives for that kind of projects are to develop and generate an independent assessment as objectively as possible satisfying high scientific standards. The number of manhours is of less importance in that context.

Likely performance control parameters may include the following, in prioritised order:

1. Product quality of asessment or service, the desired quality level of the assessment and evaluation
2. Managing the primary stakeholders
3. Milestones
4. Human Resources, the access to the experts necessary for the execution of the tasks

An assessment and evaluation project may have stakeholders that dislike the tasks and try to fight against the scope and progress in such a project. Thus, there is a need to identify and map all relevant stakeholders, whom has the power and how to lead and handle the strongest opinion makers related to the project. Focus on identification of the supporters of the projects and let them have a pereception of maximum benefit of the project results, and simultaneously reduce the relative impact of those environments and individuals who are against the project.

Stakeholder analyses are becoming a primary decision support tool for the project manager as equally important as the risk & opportunity analyses. Experience in a range of projects has demonstrated that some of the most important stakeholders are among the largest risk elements in the project.

The corresponding execution quality or project quality is to a large extent the ability to perform excellent expectation management towards the primary stakeholders, during the project execution as well as when utilization of the project results. Proposed actions and mitigations must be sufficiently concrete and realistic that achievement of the specified quality is made with high confidence.

Communication of the output results is a part of the expectation management when the project delivery is complete.

8.5 Quality & risk management in IS/IT & ERP delivery projects.

Quality & risk challenges in IS/IT & ERP delivery and implementation projects are present for both the client and the supplier organisations.

The primary foundation for achievement of satisfactory product quality in such projects is depending on a firm and thorough identification of the organization needs and predicted benefit of the implementation and application of the project results.

Key questions are related to what the client want to achieve, which business benefits and other effects should result following the development implementation and use of the project delivery. The identification and description of the organization needs should be established prior to making the functionality-oriented specification requirements. Of utmost importance is that the organization needs should overrule the actual IT solution not the opposite.

The clients should use their most experienced system expert competencies and system architects in the derivation of the corporate business and organisation needs, followed by derivation of functional specification requirements that are firm and direction setting but at the same time provides you with flexibility.

Functional specification requirements are of particular importance for any IS/IT project since the technology development is moving faster than the corresponding technical standards and protocols.

With a sound and well formulated description of the desired effects and business benefits, combined with committing functional specification requirements, the project execution may happen as a value creating change process.

The product quality at time of delivery is directly a function of the project organisations' ability and capability of managing the series of changes during the project execution.

The client is in charge of assessing whether a change proposal is necessary or not. The client induced change should be evaluated in light of what is the desired benefits, economivc value added or higher reliability or enhanced precision level in the corresponding services resulting from application of the new or upgraded IS/IT or ERP system.

The design and development process is recommended to follow the main principles according to Scrum and agile methodologies which is based on a close and integrated collaboration between client and supplier. See section 6.6.

The executing project organization could be like a fully integrated project organization with client and supplier in the same team, in which there is an ultimate requirement to put the best man in the respective positions, regaradless what is his or her mother company. The maximum benefit may be achieved when the contract form and the contract compensation format lead to balanced incentives for all parties; ie. Create real win-win conditions.

The suppliers of IS/IT & ERP systems are challenged severely the approach to combine solution design & development, testing and implementation of the deliveries but not the least do satisfactory training and testing of the application among the super-users and other primary stakeholders of the use of the new system. The key resources in the supplier project team must possess a core competence within system architecture and process work flow design combined with the knowledge and perception of the implementation and integration issues with other systems in the client system portfolio. The ultimate requirements are to achieve a fully compatible platform portfolio utilizing the features of the various systems seamlessly. The interfaces between the respective systems are a potential risk source and attention should be paid to make the interfaces with no or a minimum of obstacles in the communication and operation of the systems. Testing of the compatibility is a critical element in in the quality work.

Proper configuration management is vital in the effort of achieving the specified product quality in the IS/IT & ERP projects. Furthermore, the suppliers are experiencing particular challenges connected to the factory acceptance tests (FAT's) that are representative and cover all functional specification requirements from the client.

The ability to deliver on time, the delivery quality, according to the settled contract agreements is frequenetly a challenge in many IS/IT projects, as there is a series of changes during the project execution. The scrum methodology is particulary attractive as the changes are managed in the integrated team and testing is done continually.

The corresponding execution quality, the project quality, is reflecting the suppliers' internal productibility and efficiency on how to utlise their own resources and their capability of mastering the demand for continual improvement in the work flow and work processes in order to achieve superior work flow efficiency.

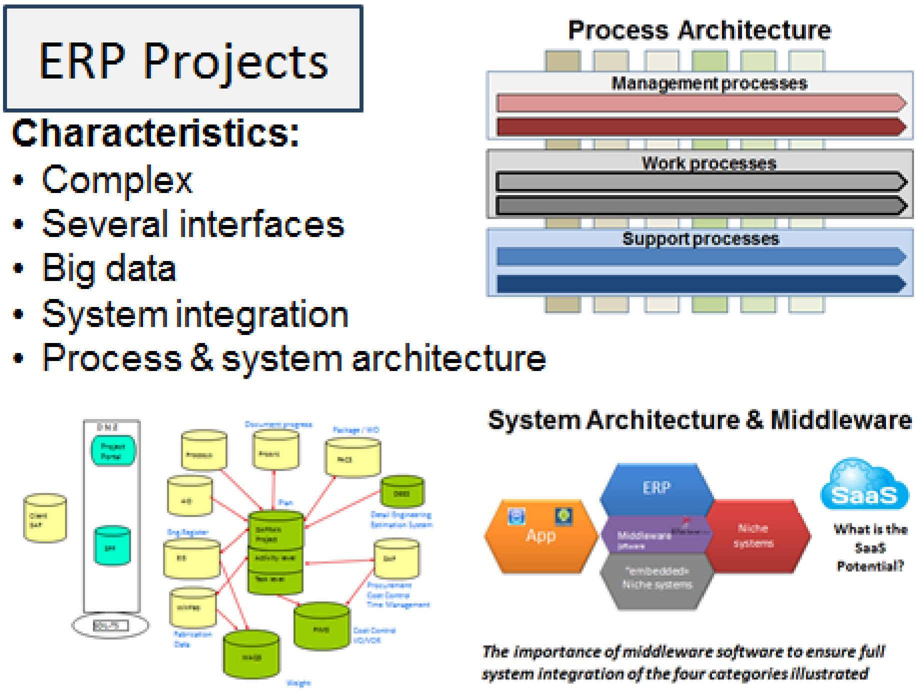

Figure 8 – 3: The issues in ERP type project with high degree of complexity

8.6 Quality & risk management in business development projects

Business development projects are to some extent like IS/IT & ERP type projects. The project development process is typically a change journey with moving targets. Initially the idea may look rather diffuse that undergo a transformation through a gradual maturisation and results into a firm concept. The recommended design and solution process is to follow the main principles and methodologies in scrum methodology leading to an agile approach.

A business development project should demonstrate the following characteristics:

- An idea is launched internally in the organisation. The idea owner should briefly document the idea, and make sure that project governance is handled by a project owner for the feasibility study.
- The initial stages of the innovation process is internally in the organisation for realisation of a new potential opportunity
- The feasibility and concept development are briefly described in a business case document including realistic but ambitious estimates of the business benefit in terms of Net Present Value and or Economic Value Added. Supplementary benefitial effects are for example enhanced capacity of the product delivery, higher reliability level in the services etc.
- The business case shall fully demonstrate the link and alignment with the enterprise overal business strategies, and the product/service delivery must be syncronised with the overall corporate business strategies. .

The desired primary performance measure in a business development project is the achievement of the estimated and specified effects and business benefits. Likely performance measures are the expected net present value supported by product quality fulfilling the product specification requirements, with on-time delivery and launch of the finished business idea to the market.

The corresponding execution quality reflects the resource intensity for development and realisation of the product. A high resource spending reduces the expected net present value of the business idea but may still be acceptable as long as the launch date is met.

Additional quality performaance indicators are extracted from market analyses and forecasts and how to approach the future market demands. The selection criteria in the concept screening are critical parameters for achieving the optimal solution with the highest business potential.

The market analyses must be periodically updated in order to identify the latest trends and prognoses in the respeective markets. That information is important for screening and prioritization of alternative business ideas and concepts. A differentiation is likely in order to cater for a range of local demands.

Business development projects may cover two distinct different conditions that are:

1. New products or upgrades into a market segment you are in, or
2. Entrance to a new market segment, either with current product portfolio or with brand new products designed and developed for that market segment.

For the category 1, the market segment is known and challenges are to maintain the competitive edge by delivering new generation products into a market segment you are familiar with.

For category 2, the situation is challenging. Entering a new market segment is one dimension, success with new products or services into a new market segment is extremely tough and request extra resources, financially, competence wise and with respect to necessary capacity and capability of realizing the business in new market segments.

For both categories, the business case and the corresponding business development projects must demonstrate robustness, flexibility, and agility in order to cater for the unknown and unpredictable conditions during the development stages of the ideas.

In the screening phase of alternative ideas, the selection criteria should bbe established prior to the innovation and idea generation. Why so? When the selection criteria are established up front and communicated to everybody, the actual screening is based on more objective selection criteria than when a core group decides which idea to select. That approach may hinder that *"the pet idea"* to anyone is pressed through the selection and approval. The result of the objective approach should lead to launch of the best idea selected upon a set of established and well communicated selection evaluation criteria.

The developed selection criteria should be communicated and explained thoroughly in the organisation such that any idea is judged and assessed on a common set of criteria, regardless of who is the owner of the business idea. It leads to a consistent approach for assessment and selection of new business ideas.

The selection process of new ideas should preferably be made by a group of people with knowledge in the field that are capable of making the assessment in a broader picture than the idea isolated. The assessment and evaluation of the business ideas should reflect the totality in the portfolio of new business development initiatives including prioritization between alternatives.

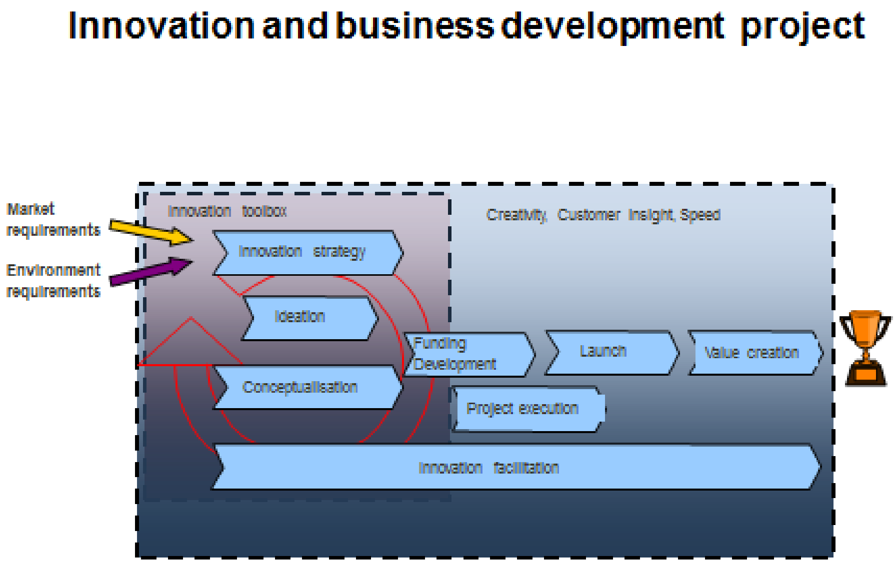

Figure 8 – 5: A sketch of the innovation and business development project

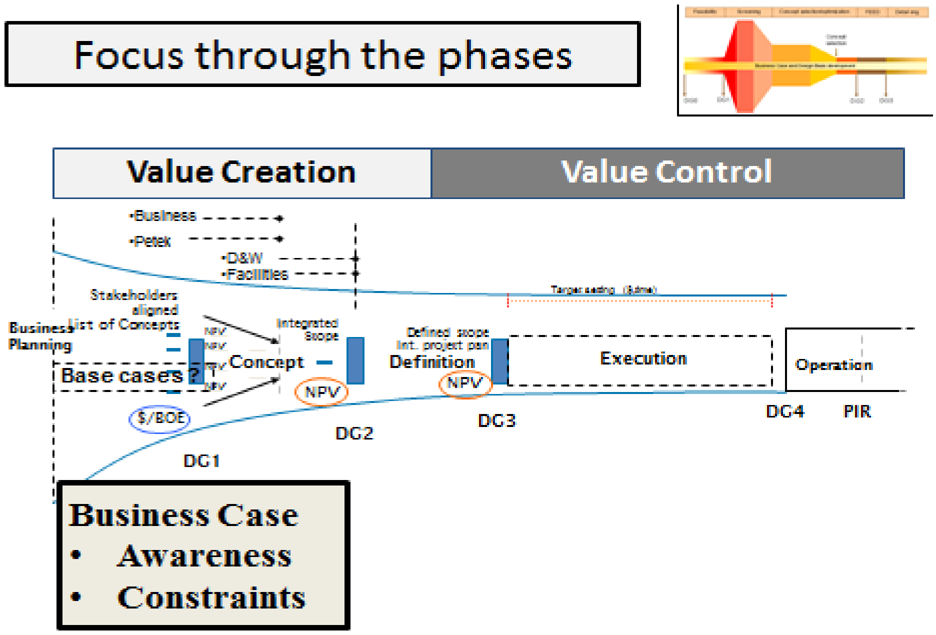

Figure 8 – 6: The sscreening process of different alternatives of solution

Nomenclature and abbreviations

The following nomenclature and abbreviations are supplementary terms to the basic defintions on quality in general, quality in projects and definitions on risk as outlined in part 1 of this book.

The following terms and definitions are not listed alphabetically, but more grouped as families of terms and definitions.

Basic project definitions

Net Present Value, NPV: Expresses the discounted net present value of the cash flow in a project.

IRR, Internal rate of return: The discount rate at a value when the NPV is equal to zero.

CAPEX, Capital Expenditure: The estimated investment figure for realisation of a product or service

OPEX, Operating Expenditure: The estimated operataing expenditure during the operation/use of the delivered product from the eproject

LCC: Life Cycle Cost; The sum of CAPEX and OPEX.

Present Value LCC: The discounted value of the LCC.

Crash Cost: The estimated cost for the shortest possible execution period through acceleration of a specific work task

WBS: Work Breakdown Structure. The split of the total scope/task into handable sub tasks, preferably object focused

PMI: Project Management Institute.

PMBOK: Project Management Body of Knowledge.

Scope of Work, SOW: A brief description of what is the delivery, what to do and how to make it.

Interface: The interface between one part of the project and another, physically, contractually or organisationally.

The project portfolio: a group of projects essentially idependent of each other, but may be managed by the same team of leaders.

Project programme: A group of projects with common objectives and interdependent in which the project results build on each other. A project programme may be a part of a total project portfolio.

Decision gate: A gate at which a decision is made whether it is correct and sound to move into the next phase of a project, evaluated and assessed in light of a prioritisation in the entire project portfolio for the organisation.

Internal project: A project organisation type without change in line organisation structure.

Matrix project: A matrix project organisation structure in which the project members work in the matrix, partly in the project, partly in the line organisation. A differentiation in the matrix project organization is made through a functional, balanced and strong matrix. There is a dual authority between project manager and line manager(s) in matrix project organisations.

Autonomous project: The project organisation is separate from the line organisation and operates as an autonomous unit. The project manager has full accountability for the project performance.

Milestone: A new state, not a date as such.

Milestones plan: A series of milestones documenting the logic chain of milestones.

Gantt-diagram: A diagram illustrating alle the activities displayed in time and linked to the respective milestones. Activities are also linked to the work breakdown structure, WBS, and form the main elements in the project baseline.

Critical path: The identified chain of dependent activities that creates the longest duration of the planned project execution.

RBS: Risk Breakdown Structure: a hierachy of the risk elements in the organisation.

RES: Risk Escalation Structure: The bottom-up escalation of the risks elements in the organisation

OBS: Opportunity Breakdown Structure: A hierarchy of opportunity elements established in a format similar to the Risk Breakdown Structure

OES: Opportunity Escalation Structure: A bottom-up escalation of the opportunity elements in the organization

Pilot Project: a test project launched in order to collect facts and enhance confidence to the desired features of the main project deliberately run in order to reduce the uncertainty and the conditions in the rationale and the facts basis prior to formal decision on sanction, rollout and execution of the main project.

Other supplementary technical definitions and abbreviations

Mock-up-test: a scaled model test of a structure or solution that aims at simulating as closely as possible to the real conditions of the structure design or solution.

Weld procedure: A procedure/ description on how welding shall be done under different conditions and constraints.

Weld prequalification test: A formal and specified test program for assessment and approval of the actual welding performance of the welders

BIM: Building Integration Model; Object based 3D interactive simulation model of a building structure or production facilities. It is used for logic clash checks and not the least as a primary decision support & dialogue tool for the project management.

CAD: Computer Aided Design.

NDT: Non-Destructive Testing.

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Standards

Ericsson: “Basics about PROPS”,(1994) Ericsson Information Consultants,

EFQM: European Foundation for Quality Management, EFQM Excellence Model

Norwegian Ministry of Finance: The Norwegian State Quality Assurance Principles on major governmental investment project to be approved by the Parliament, so called KS1 og KS2, QA1 and QA2

IPMA: International Project Management Association, IPMA Project Excellence Model

ISO 9001:2015

ISO 10007 : Quality in Project Management

ISO 21500 : 2012 : Guidance on Project Management

ISO 31000 : 2018 Risk Management – Principles and guidelines

NF07: Norwegian Fabrication Standard

NTK07: Norwegian Total Contract (EPC- contract)

PS2000/2010 IS/IT Contract Standard

PMBOK: Project Management Institute, “Project Management Body of Knowledge”, latest edition

PRINCE 2: “Projects IN Controlled Environments”, Office of Government Commerce, UK

Wilhelmsen Maritime Services (WMS): GIMS, Global Integrated Management System, Governance System for WMS

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Appendix 1 Check lists at decision gates

The appendix includes a set of check lists relevant for the decision gates as shown in the stage gate-based project execution models described in section 6.3.

Note: A decision gate is at the start of a stage/phase, not at the completion/end.

Decision Gate DG1: The decision on start of the conceptual development phase

Question #	Brief description	Approved Yes/No	If No, explain why, the consequences and identify necessary actions
Project Internal matters			
1	Is the business case established including the value proposition and potential in terms of Net Present value, other desired effect goals, risk and opportunities, investment level, other critical resources, stakeholders etc?		
2	Is the business idea described to the necessary preciseness level making it possible to start the conceptual development?		
3	Are alternative ideas considered?		
4	Are initial surveys and investigation done whether competing products or services exist?		
5	Is the idea realistic and are the conditions present in the organization making launch real?		
6	Is Patent application an issue?		
7	Is a list of critical success factors derived?		
8	Is search for experience on previous idea realisation processes done, internally and externally?		
Project external enterprise focus & strategic project portfolio			
9	• Is the idea in accordance with the strategies, goals & priorities?		
10	• Is it right to use critical human resources on this initiative?		
11	• Is the idea assessed in perspective of current project portfolio?		
12	• Does it satisfy the requirements of a balanced portfolio risk?		

Decision Gate DG2: Start Up of the design development phase

Question #	Brief description	Approved Yes/No	If No, explain why, the consequences and identify necessary actions
Project Internal matters			
1	Is the business case established including the value proposition and potential in terms of Net Present Value, other desired effect goals, risk and opportunities, investment level, other critical resources, stakeholders etc?		
2	Is the business idea described to the necessary preciseness level making it possible to start the design development?		
3	Are alternative ideas considered?		
4	Are initial surveys and investigation done whether competing products or services exist?		
5	Is the Concept realistic and are the conditions present in the organization for making launch real?		
6	Is Patent application an issue?		
7	Is a list of critical success factors derived?		
8	Is search for experience on previous idea realisation processes done, internally and externally?		
9	Is feedback performed on the conceptual development work done, on the quality of the conceptual description and solution as well as on the project performance efficiency on resource expenditure and progress?		
Project external enterprise focus & strategic project portfolio			
10	• Is the concept in accordance with the strategies, goals & priorities?		
11	• Is it right to use critical human resources on this initiative?		
12	• Is the concept assessed in perspective of current project portfolio?		
13	• Does it satisfy the requirements of a balanced portfolio risk?		

Decision Gate DG 3: Start up on Construction Phase

Question #	Brief description	Approved Yes/No	If No, explain why, the consequences and actions
Project Internal matters			
1	Is the business case updated including the value potential in terms of Net Present value, other desired effect goals, risk and opportunities, investment level, other critical resources, stakeholders etc?		
2	Is the design basis described to the necessary preciseness level making it possible to start the construction and assembly work?		
3	Are there alternative methods of construction and assembly in the construction strategy?		
4	Is cross disciplinary quality checks performed periodically during the design development?		
5	Is the AS-Designed documentation and digital integration model customized and in compliance with specified requirements from construction?		
6	Is there carry over work from design to construction? (Non completed tasks in design work to be done during construction phase)		
7	Are risk and opportunity analyses utilized pro actively as a manager decision support tool in the design phase?		
8	Are stakeholder analyses updated?		
9	Is best practice from previous design work collected and utilized?		
10	Are quality plans for construction establisehed and communicated to the construction team?		
11	Are the quality recordings and measuring ongoing during the comstruction work for verification that the specified product quality is met?		
12	Is interface quality check performed to necessary detail across the disciplines during construction?		

13	Is a quality performance review done of the out put of the design phase regarding design solution capability and oganization efficiency performance		
Project external enterprise focus & strategic project portfolio			
9	• Is the design solution in accordance with the company strategies, goals & priorities?		
10	• Should you use internal human resources on this initiative during construction?		
11	• Does the developed design solution fit into the product portfolio?		
12	• Does the design provide you with a solution that is within the acceptance limit for portfolio risk?		

Decision Gate DG4: Start up on commisioning implementation and installation

Question #	Brief description	Approved Yes No	If no, please explain why, consequences and actions
Project internal focus			
1	Are the prognoses for project completion as planned?		
2	Any deviations from design basis on as-finished solution?		
3	Is the efficiency during construction as planned?		
4	Is the as built solution ready for testing?		
5	Is there any carry over work to be completed in the commisioning phase?		
6	Are the risk and opportunity analyses performed periodically during the construction phase as management decision support?		
7	Are the stakeholder analyses updated?		
8	Are experiences from earlier construction work utilised?		
9	Were the quality plans and quality control & monitoring followed during the construction phase?		
10	Is ongoing quality monitoring and measuring performed during construction in order to confirm that the specified poroduct quality is achieved?		
11	Is interface control performed as an ongoing quality activity during construction, and is a full cross functional quality assessment performed periodically?		
12	Is the construction work assessed and evaluated with respect to as- built solution, as well as the achieved efficiency during construction? Are the key figures and characteristics reported to the respective technical		

	disciplines and project control/ project management office?		
The project external business focus and the strategic project portfoilo perspective			
13	• Is the as built product/service in compliance with the overall strategies, goals and priorities of the organisation?		
14	• Are internal key reseources used in the commisioning and implementation phase?		
15	• Has the project generated synergies towards other projects in the current portfolio?		
16	• Is the as built performance within the specification limits of acceptance regarding portfolio risk?		

Decision Gate DG5: Handover to client, internal or external

Question #	Brief description	Approved Yes No	If no, explain why, consequence and actions
Project internal focus			
1	Is a thorough FAT (factory acceptance test) performed with satisfactury performance results of the product?		
2	Is a firm SAT (site acceptance tests) performed providing you with product capability and capacity in accordance with the specified figures on the performance and product quality?		
3	Are there identified any deviation from design basis that need to be documented?		
4	Is the as-built documentation formatted and structured for application as background to the derivation of inspection and maintenance plans for work during use of the delivered product or service from the project?		
5	Are there any activities remaining that are not completed at time of handover?		
6	Are risk and opportunity analyses used for the planning activities for testing and implementation?		
7	Are stakeholder analyses updated?		
8	Are previous experiences from testing and implementation made accessable and utilised as reference documentation?		
9	Are quality plans followed during the testing and implementation?		
10	Are quality & performance recordings done continually during the test activities that could confirm the specified product quality is achieved?		
11	Are interface testing a prioritised activity during the FAT and SAT activities?		

12	Is the achieved performance during the testing and implementation assessed and evaluated with respect to the as delivered solution or product and with respect to efficiency, reported back to the technical disciplines and to project control?		
Project external focus and project portfolio perspective - the project owner accountability			
13	Are tests and implementation performed with standards fulfilling the overal strategies, goals and priorities in the organisation?		
14	Are internal resources used for the FAT and SAT activities?		
15	Are you within the accepted tolerance limit on portfolio risk?		