07:00 Planning & Scheduling: P&S

2

Quick Look

What Is It?
Planning & Scheduling P&S is a basic process where the project is built and maintained. Project results are atomized down to realizable units (Work breakdown structure WBS), which in turn are set into reasonable project activities. Duration of each activity is estimated and scheduled. Subsequently the costs and cost/benefits are evaluated.
Who Does It?
Planers and controllers are well suited to lead, yet project manager shall be involved, as he later bears the responsibility for the project overall results.
Why Is It Important?
P&S process is a cornerstone of any project. The WBS determines the usability of the project results. Project structure and time schedule determine the overall costs. Cost/benefits' relationship decide about the project fate.
What Are the Steps?
Evaluate the project goals in view of customer expectations and your company strategy. Set the project objectives and quantify the target values. Than break down the planned output (product objective) and simultaneously structure your project. Evaluate time and cost, verify the profitability. If necessary repeat these steps. Initiate few other processes if needed. Repeat this process periodically.
What Is the Work?
Project goals are general, project objectives, despite all efforts, always not enough specific. In a tedious work and several iterations you break down the project product, draft the project structure. You proceed with resources planning and time schedule getting the first financial project evaluation to learn, that yet another loop: WBS-Project structure-Resources-Time-Costs is needed and so on until all stake-holders accept the results.
How Do I Ensure That I Have Done It Right?
Choose the WBS and scheduling methods and techniques best matching the characteristics of the project. Plan sufficient resources for all project needed

B. Lent, *Cybernetic Approach to Project Management*,
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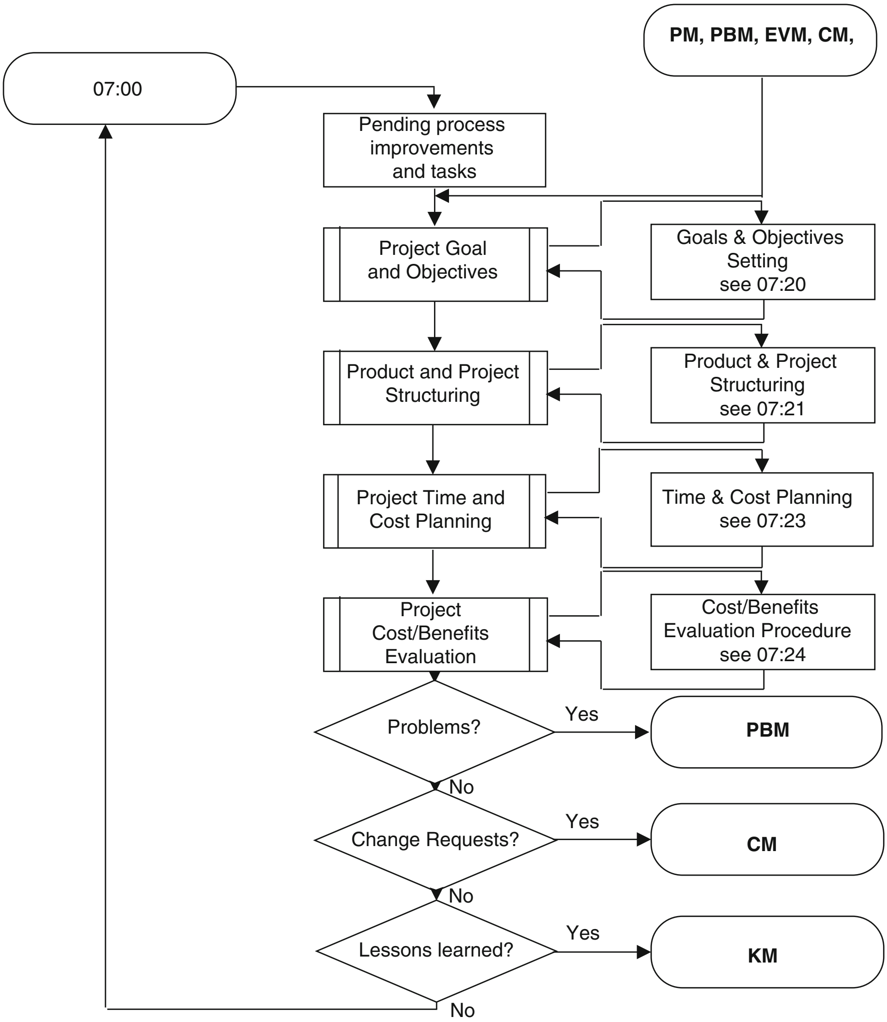


Fig. 2.1 The Planning & Scheduling process

activities: project output (product), tests, integration, human factor. Be honest and do always the cost/benefit evaluation – it pays back in critical project phases.

Process

Project goals and objectives drive product and project structuring, followed by time and cost estimation and cost/benefit evaluation. Problems, change requests and lessons learned initiate proper other processes. Planning& Scheduling process shall be periodically repeated with pending issues treatment; it may be initiated by few other processes, too. Figure 2.1 depicts this process.

07:10 The Goal of Planning and Scheduling

The process of Planning and Scheduling P&S elaborates the answers and maintains their actuality regarding the six "W": What shall be done?, Why shall it be done?, Who is going to do it?, When? Where will that be done?, and Which way (Requirements, Constrains and Methods) shall it happen?

07:20 Methods

The original 5 W, later extended to 5W1H, were conceived by Toyota in strive for better problem management (Kato and Smalley 2011). The "H" meaning "How" we further replace here with the sixth "W" staying for the sixth question "Which (way)?":

- Why is it necessary?
- What is its purpose?
- Where should it be done?
- When should it be done?
- Who is best qualified to do it?
- Which is the best way to do it?

The answers to each of the six "W" are not orthogonal: certain activities provide simultaneously answers to multiple "W"s; a comprehensive approach to each "W" calls for several different actions. Therefore, the sequence of operation in the P&S process is chosen as a backbone of the following considerations, delivering implicitly the answers to the relevant "W".

Planning and Scheduling in the initialization phase develops basic outline of the project called in ISO 21500 standard the Project Charter, what corresponds to the ISO 21500 processes: "4.3.2. Develop Project Charter". This document is in the planning phase refined to a list of project plans ("4.3.3. Develop Project Plans") with several other processes covered (ISO 21500:2012 2012).

- 4.3.11.Define Scope
- 4.3.12.Create WBS
- 4.3.13.Define Activities
- 4.3.16.Estimate Resources
- 4.3.21.Sequence Activites
- 4.3.22.Estimate Activity Durations
- 4.3.23.Develop Schedule
- 4.3.25.Estimate Costs
- 4.3.26.Develop Budget
- 4.3.32.Plan Quality (the initial demands)
- 4.3.35.Plan Procurement

07:21 Project Goals and Project Objectives

There is certain confusion in literature concerning the terms: goal, objective, target, scope, and result in reference to the project course. For the purpose of this book we apply the definitions given in Table 2.1.

Table 2.1 Terms used in project planning and scheduling

Term	Description	Example
Project goals	Focuses on "Why"? and to some extend on "What?" It results from opportunity identification (ISO 21500:2012 2012). Indicate rather a direction of expected results, tends to be general and unspecific. Should not be confused with the process goal	Project shall contribute to improvement in people communication
Project objectives	Specific SMART implementation of the project goals. Addresses "What?", "Where?", "When", and "Which?" and indirectly "Who?"	With a budget of 20 millions the city of 100,000 inhabitants shall get within 2 years complete coverage with 10 MB data network
Project results	Project deliverables, product, "Output" given by the project scope and project quality or target conditions of the endeavour (DIN 69901:2009-01 2009). Addresses "What?" and "Which?"	150 miles of Cat7 cabling and 120 active components with mean grade of service at the level not less than 98 %
Project scope	Deliverables, requirements and boundaries of the project objective "Output" bound to the quality (see Fig. 2.2 and ISO 21500:2012 2012). Addresses "What?"	150 miles of cable and 120 active components
Objectives' target values	Quantified objectives: output, time and costs. Addresses: "What?", "When", "Where?", "Which?", and indirectly "Who?"	The above project results within a budget of 20 millions and 2 years completion time

The particular target values can be defined independently (Grau 1999). However, there is certain interdependence between the target values; by changing one of them inevitable is the change in one or other two. When the project duration is cut, either more expensive will be it's realization or output has to be redimensioned. This interdependence called iron triangle was conceived 1969 according to Weaver by Dr Martin Barnes in a course he developed called 'Time and Money in Contract Control' and until the third edition was an "iron" component of the PMBOK (PMI 2013a). The original source of Barnes iron triangle could not be found. Indirect references are given a. o. by Weaver and by Lock (Weaver 2007; Lock 2007). As few other sources confirm 1969 as the origin date, Lock attributes it to 1980s. The reason may be a migration, done by the author himself from "Quality" in 1969 as a third objective beside time and cost, through "Performance" to final "Output". Figure 2.2 shows the interrelations between all terms listed in Table 2.1.

Grau classifies the Output objectives and target values as the category of project deliverables and time and cost rather as process describing category (Grau 1999). This matches well the later in Chap. 13, 18:00 Balanced Scorecard BSC presented twofold project evaluation scheme of Project Excellence (Project Excellence 2013).

Beside the main target of defining the project deliverables, the objectives fulfill additional functions in project (Grau 1999):

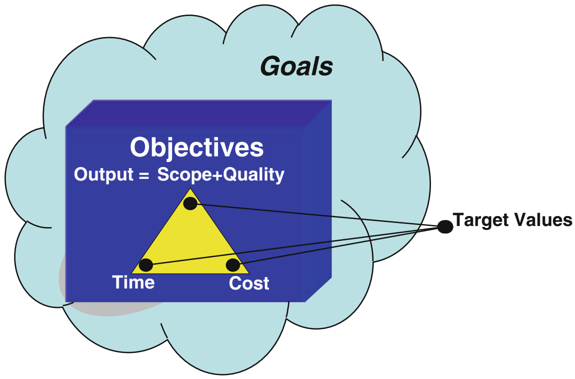


Fig. 2.2 The interrelationship between the project goals, objectives and target values

Table 2.2 SMART project objectives

Abbreviation	Description	Example
S	Specific	With a budget of 20 millions the city of 100,000 inhabitants shall get within 2 years complete coverage with 10 MB data network.
M	Measurable	Network: 10 MB data network
		Budget – 20 millions
		Coverage: the whole city of 100,000 inhabitants duration: 2 years
A	Attainable	Budget is secured by the city, technology is available, provider has technical capabilities to deliver, no obstacles from the inhabitants are expected
R	Relevant	Project objectives contribute towards project goals of improved people communication within the area with a positive impact on local economy
T	Time-bound	Project results are to be delivered within 2 years completion time

- Controlling
- Pointing activities direction
- Communicative
- Coordinative
- Selective

Proper project objectives are SMART. From a vast number of various combinations of meaning of this acronym, author tends to align with Philips and Gordon as presented in Table 2.2 (Phillips 2010; Gordon 2003).

Pfetzing and Rohde suggest further that the objectives shall be compliant to the strategy of major stake-holders (project sponsor and client), non-redundant, free of contradictions and neutral with regards to the possible solution (Pfetzing and Rohde 2001).

Compliance with to the stakeholders' strategy and opportunities identification (ISO 21500:2012 2012) suggests defining the objectives in alignment with the four evaluation strategies of Balanced Scorecard BSC (see Chap. 13, 18.00 Balanced Scorecard):

- Clients,
- Team,
- Processes,
- Company's development (among other things these are economic goals).

Lock extended the "iron" triangle of Barnes with component "people" in the middle between all other objectives making the triangle based objectives and target values compatible with the BSC evaluation. (Lock 2007).

Finally there are several standards and other restrictions supporting the successful objectives' elaboration:

- Company relevant standards
  - ISO 9001:2008 Quality Management Systems - Requirements (ISO 9001:2008 2008)
- Technical standards
  - ISO 10006:2003: Quality Management Systems - Guidelines for Quality Management in Projects (ISO 10006:2003 2003)
  - ISO 10007:2003: Quality Management Systems - Guidelines for Configuration Management (ISO 10007:2003 2003)
  - ISO 21500:2012: Guidance on Project Management (ISO 21500:2012 2012)
  - ISO 27003:2010 (BS/ISO/IEC) Information technology. Security techniques. Information security management system implementation guidance (ISO 27003:2010 2010)
  - ISO/DIS 31000:2009: Risk Management, Principles and Guidelines (ISO 31000:2009 2009)
  - DIN 69900:2009-01: Projektmanagement – Netzplantechnik; Beschreibungen und Begriffe (DIN 69900:2009-01 2009)
  - DIN 69901:2009: Projektwirtschaft, Projektmanagement, Begriffe (DIN 69901:2009 2009)
  - DIN 69901:2009-01: Projektmanagement - Projektmanagementsysteme (DIN 69901:2009-01 2009)
- Project management guidelines
  - IPMA Competence Baseline (ICB) (Caupin et al. 2006)
  - A Guide to the Project Management Body of Knowledge: PMBOK Guide (PMI 2013a)
- Standards concerning environment
  - ISO 14001:2004: Environmental Management Systems – Requirements with Guidance for Use (ISO 14001:2004 2004)
- Design and Exploitation standards
  - CMMI: Capability Maturity Model® Integration, e.g. CMMI for Development, V.1.3 (CMMI 2010/2013)
  - ITIL (ISO/IEC 20000-1:2011): Information Technology-Service management – Part 1: Service management system requirements (ISO/IEC 20000-1:2011 2011)
- Ethical recommendations
  - EU Ethikcharta (EU 2013)
  - PMI Ethics codex (PMI 2013)

To the particular "Which?" may belong e.g. demand of the client to present the project deliverables in a particular form etc.

Table 2.3 Objectives elaboration procedure

Step	Action
1	Search of possible project objectives
	Team's brainstorming
	Analysis of the needs of people who are vital for the project
2	Structuring of the elaborated objectives
	Determination of a catalogue of goals solution neutral
	Separation of objectives ("what?") and restrictions/framework ("which?") conditions
	Verification of the congruence with the project goals
	Elimination of discrepancies concerning the objectives
	Elimination of redundancy
	Searching for proper strategic terms
	Verification and eventual extension of strategic terms
3	Operationalization of the objectives
	Elaboration of the WBS and project structuring procedures
4	Quantification and qualification of the objectives
	Elaboration of the target values
	Qualification of the "must" and "nice to have" objectives
5	Elaboration of the catalogue of objectives
	Evaluation of the results and verification in relation to the project goals
	Prioritization and fine tuning of the objectives
	Time schedule elaboration ("When"?)
6	Documentation
	Final summary of all results and if needed their justification
7	Verification of the achieved results
	Retrospection on project goals and objectives, possible target values and assurance of all project team members acceptance

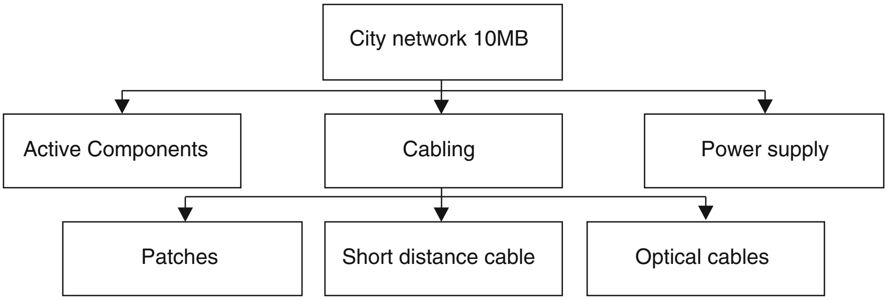


Fig. 2.3 Example of Work Breakdown Structure (WBS)

Whether the objectives are given by the client and/or sponsor in a project charter or only goals are defined and project team has to elaborate the objectives, it is in each case advisable to go with team through the project objectives. Pfetzing and Rohde suggest the procedure as shown in Table 2.3 (Pfetzing and Rohde 2001).

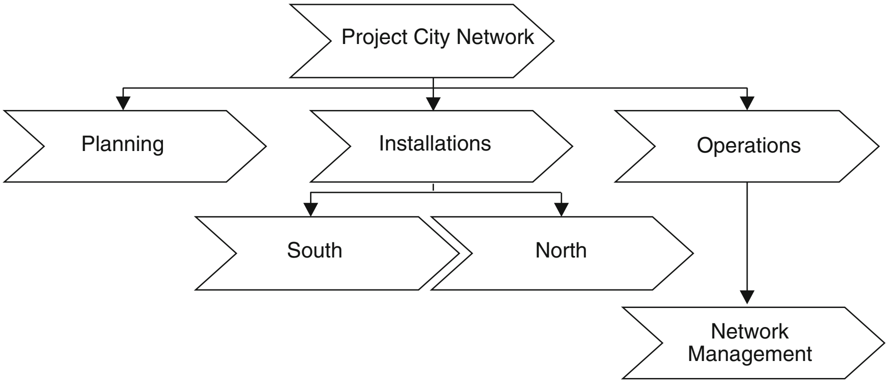


Fig. 2.4 Example of a project structure

07:22 Product and Project Structuring

Product Structure

Structuring of Barnes "Output" called hereafter "Product" and structuring project allow to divide the whole project in smaller tasks and activities with reasonable and manageable interdependencies (Caupin et al. 2006).

Product Structure reflects the technically determined interdependences between the identifiable singular components (see Fig. 2.3). The tree structure is better known as Work Breakdown Structure, WBS and the process which elaborates it is Process 4.2.12 Create Work Breakdonw Structure (ISO 21500:2012 2012). Yet the notion of "Work" implies certain misleading concepts of task breakdown – and this is the subject of project structuring. The criteria of structuring in both cases are different: product structure is determined by technical aspects, while project structure by organizational and capability based approach. Yet for the compliance reasons with ISO 21500 Work Breakdown Structure (WBS) is hereafter further used.

Project Structure

Project Structure is defined according to DIN 69901 standard as the overall of relevant relations between project elements (relations in organization as well as in project processes). Here ISO 21500 clearly names this process 4.3.13 Define activities (ISO 21500:2012 2012). An example related to the above WBS is given in Fig. 2.4.

Project Structure Plan PSP

According to DIN 69901 Standard the Project Structure Plan (PSP) is the description of a project with a hierarchical layered presentation of project activities (DIN 69900:2009-01 2009). In PSP we address "What?", "Who?", "When?", "Where?" and indirectly "Which?". Each task includes keywords of description, indication of attained results, eventually objectives, and the contents such as deadlines, duration, necessary resources, preliminary works and costs (Lewis 2011; Caupin et al. 2006).

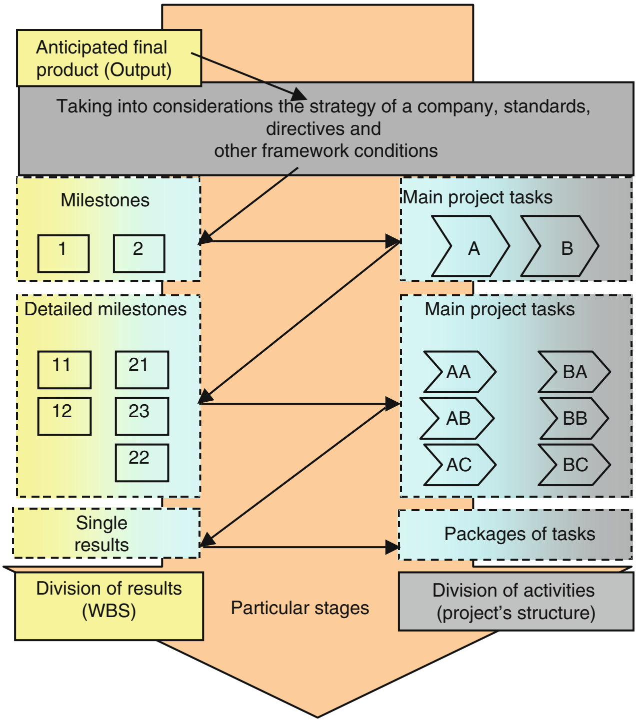


Fig. 2.5 Example of the recommended project structuring procedure

PSP may be either product (derived from Example Fig. 2.3) or project (derived from Example Fig. 2.4) oriented. Combinations of both leads in most cases to competence frictions and process deficiencies and therefore is not recommended.

The Goal of Project Structure Planning

In the PSP activities are hierarchically ordered i.e. the sum of lower level activities compose to the upper level group of activities, which may in turn build together with other group of activities another level of aggregated work and so on. ISO 21500 name this process 4.3.21 Sequence Activities.

Depending on the needs, the aggregated activities are divided back into single activities which allow to estimate time and costs of single activity in a good and unambiguous way (Lewis 2011). The critical path (longest time chain) helps to assess the project total time CPM, (Kelley and Walker 1959). The process is 4.3.22 Estimate Activity Duration acc. to ISO 21500.

The level down to which the structures have to be broken down is relative and depends on experience and knowledge of the team in charge of the structuring. It is advisable to go iteratively and in parallel with structuring of the product and of the project down to the level, where the heuristically estimation of the complexity, effort, methods and time needed may be done. Products structuring allows to define milestones, when specific component should be done. Figure 2.5 illustrates this case.

Table 2.4 Rules for PSP development

Pragmatic structuring	The division of work is done in a heuristic way. Tasks are organized according to certain hierarchy and divided into smaller units. We should also take into consideration project goals, framework conditions and the experiences of project participants
Taking into consideration personal resources	Tasks packages must be determined in such a way that it is possible to assign them to certain people or teams. We make such a choice of employees that we are able to use their abilities and professionalism in order to guarantee proper task completion
Proper level of expansion	Tasks should be divided on the basis of their complexity and innovative character of a project. In chase of innovative and groundbreaking projects it is advisable to present the issue in more details since it allows to keep flexibility during the project realization
Hierarchical analysis and synthesis of elements	The PSP shall be actualized concurrently with the following actions:
	Hierarchical analysis of tasks (goal, main tasks, packages of tasks),
	The synthesis of not systematized elements (tasks, restrictions, vital information) together with the results of hierarchical analysis into one, possibly cohesive, structure which result of hierarchical analysis
Using the technique of visualization	The creativeness and cohesion of team work are efficiently supported with techniques of visualization
Internal cohesion	A project should be divided in such a way so as the groups in a project and partial tasks do not have too many common points with external to project structures
Completeness of the tasks	In planning we should take into consideration as early as possible a complete list of tasks, since it has influence on the course of other connected undertakings
Task objectives	We should define objectives of each particular tasks. The objectives shall fulfill SMART criteria
Periodical PSP verification	The PSP shall be periodically (e.g. with L-Timer® trigger) verified and updated

Preparation of the Plan of Project Structure

Preparation of the PSP takes place during project's realization. Preparation of the first plan of project structure takes place already in the phase of the first ideas to take up a project (Project charter). The project structure plan is continuously updated according to the actual requirements in each phase of a project. According to ISO 21500 it is the part of the Process 4.3.3. Develop Project Plans ((ISO 21500:2012 2012). The effectiveness of work, reduction to a minimum of the inter-task dependencies and processes optimization are here the criteria.

Table 2.4 presents several practical rules which should be taken into consideration while preparing the PSP, modified and extended from (Pfetzing and Rohde 2001).

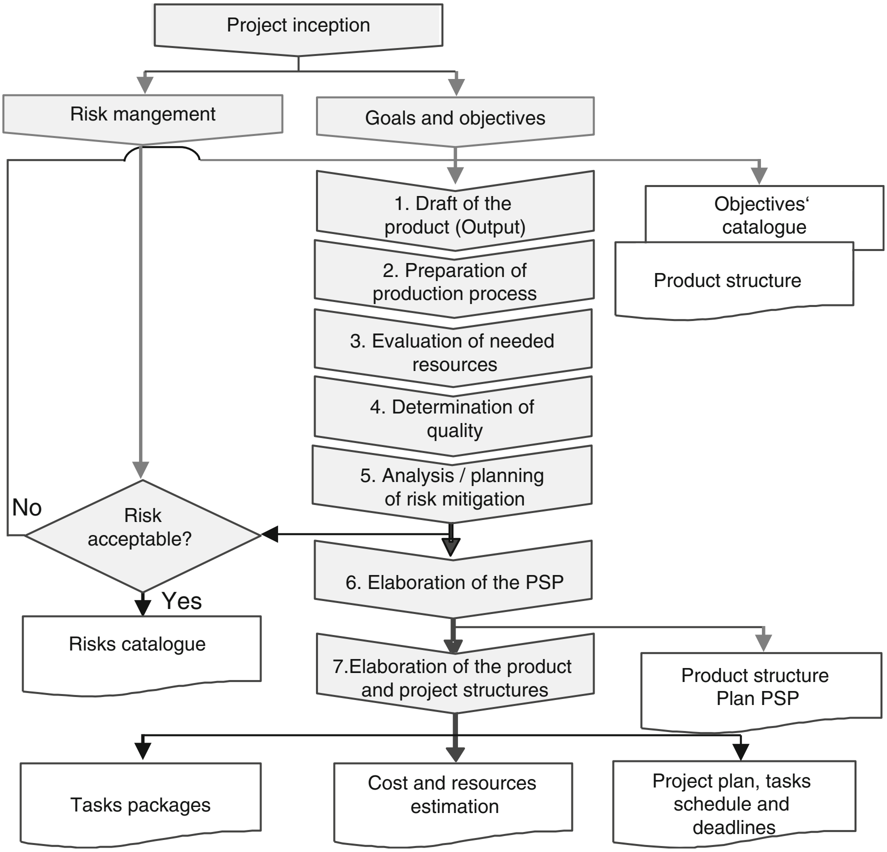


Fig. 2.6 Project structuring

Project Structuring

Project structuring is carried out in five stages. In the first stage tasks are planned according their functional interdependence. The first PSP is created. In the second phase (Chap. 3, 08:00 OM Process) we examine the following:

- Human resources,
- Necessary tools,
- Technical conditions,

and their impact on the first stage PSP (Process 4.3.16 Estimate Resources acc. to ISO21500). The third stage (Chap. 6, 11:00 Quality Management QM) focuses on quality (Initiation of the Process 4.3.32 Plan Quality acc. to ISO21500), and the fourth one on the risk mitigation (Chap. 8, 13:00 Risk Management RM, Processes 4.3.28 Identify Risks and 4.3.29 Assess Risks) and again their impact on the PSP. In the fifth, i.e. the last stage we verify if the final product, both project and PSP structures if they mutually match each other (Process 4.3.3 Develop Project Plans acc. to ISO21500). All stages are presented jointly in Fig. 2.6.

07:23 Conceptual Models of Project Work Planning

4-Phases-Meta-Model/Rubicon Model

Several conceptual models of project work planning are currently in use. Their common denominator is the meta-model of four phases of product elaboration, known in the psychology as Rubicon Model (Cadle and Yeates 2008; Heinz Heckhausen and Gollwitzer 1987):

- Initiation and consideration phase,
- Planning phase,
- Implementation phase,
- Closing and evaluation phase

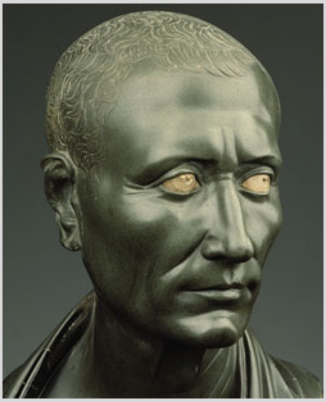
Each project phase is clearly separated from the rest of project phases and is characterized by (Caupin et al. 2006):

- Planned time of realization,
- Detailed list of activities of a given phase,
- Detailed list of results of a given phase.

The only and major differentiation between all models is:

- The granularity of the meta-model
- Level at which the recurrence take place
- Number of iterations.

Selection of the appropriate conceptual model is project objective dependent: different for construction work and different for software development. Common models are evaluated hereafter.



Veni, Vidi, Vici: I came, I saw, I won
Gaius lulius Cesar (100–44 B.C.)

In the year 49 B.C. Gaius lulius Cesar while being in the Province of Cisalpina (today's more or less northern Italy) was confronted with the unacceptable to him dictator Pompeius in Rome. The River Rubicon was a natural border between Cisalpina and those days Italy. Gaius lulius Cesar was aware, that after crossing Rubicon there was no way to return and that the home war became inevitable. So he collected his legions and asked each soldier if it is worth for him to cross the river Rubicon. This objective consideration left all options open. The decision generated deep intrinsic motivation, needed to succeed. The initiation and consideration phase (later named just the Initiation only) was closed with famous Alea iacta est (the die is cast). The subsequent planning phase was subjective: all wanted to cross the Rubicon and conquer

Rome; the question was only "how?", "which way is the best one?" This motivation build-up, based on objective considerations, against subjective success-oriented planning is the key differentiating factor and makes basic difference between the Initiation and Planning Phases. With the crossing of Rubicon the Implementation Phase begun. . ... And ever since than the ruler of Roman Emporium bear the title of Cesar. . ..

Waterfall Model

Most common model of project work planning is a sequential waterfall model (Boehm 1981). In this model the phases do not necessary close before the next one starts; they may overlapped as shown in Fig. 2.7. As in the case of HERMES 2003 and HERMES 2005, the planning phase is split into the pre-analysis and concept phases (HERMES 2003 2003 and HERMES 2005 2005) (Table 2.5).

V – Model

V – model (see Fig. 2.8) allows to separate the production from control activities (Jenny 2001; Cadle and Yeates 2008) (Table 2.6):

Agile Model

Despite all the efforts in elaborating best possible business input, the indeterminacy in demanded features and subsequent realization led to number of agile models, targeted in better consistence of business requirements and project ("useful") results (Beck et al. 2001/2013; Jenny 2001; Cadle and Yeates 2008; Pressman 2010). The numerous iterations are in authors' view still better represented by the spiral model, which reflects the fact of inclusion of previous results, rather than e.g. SCRUM models, which awake an impression, that only the actual "sprint" is elaborated and tested. Table 2.7 and Fig. 2.9 give an overview of agile model approach.

Activity/Role Model

In a activity/role model all processes which occur in a project lifecycle are considered in the project structure and assigned to specific roles. The planning and realization phases in this model are not necessary strictly separated (see Fig. 2.10, Table 2.8). Depending on the project size one person (team member) can care about one or multiple roles.

07:24 Activity and Cost Planning

Work Breakdown Structure and project structuring delivered logically and unambiguously interdependent modules and activities (see section "07:22 Product and Product Structuring"). To develop the activities schedule (4.3.23. Develop

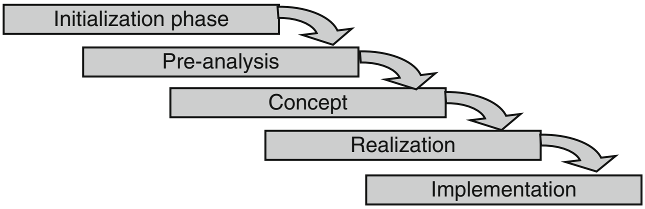


Fig. 2.7 Waterfall model

Table 2.5 Characteristics of waterfall model

Granularity	Single chain of phases
Level of recurrence	Highest level, realization in stages often practiced
Number of iterations	None on the highest level, few minor iteration in realization phase sometimes practiced
Initiation Phase	Initialization
Planning	Pre-analysis and concept
Implementation Phase	Realization and Implementation Phases
Closing and Evaluation Phase	-
Characteristics	Simple, clear,
	Sequential execution of the phases,
	Each phase is completed before the commencement of the next phase,
	There are certain results for each phase, the phases complement one another,
	Lack of correlation between the phases,
	Static,
	Does not take into consideration the changing goals and external conditions,
	Changes in the course of project realization have negative touch
Application	to HERMES 2003 and HERMES 2005 Project Management Method, construction projects, IT projects etc
Risks	Faulty results of one phase can lead to further mistakes of the subsequent phase,
	Cost consuming management of change process, hindered changes implementation,
	Late availability of the results impacts the users's acceptance

Schedule Process acc. to ISO 21500) and to assess the critical path (longest time chain) the following questions shall be answered (Jenny 2001):

- Which activities can be realized independently regardless of the other?
- Results of activities are necessary for other activities?
- Which activities take place directly after each other?
- Which activities can be grouped?
- Which activities can be incorporated into certain sub-projects?

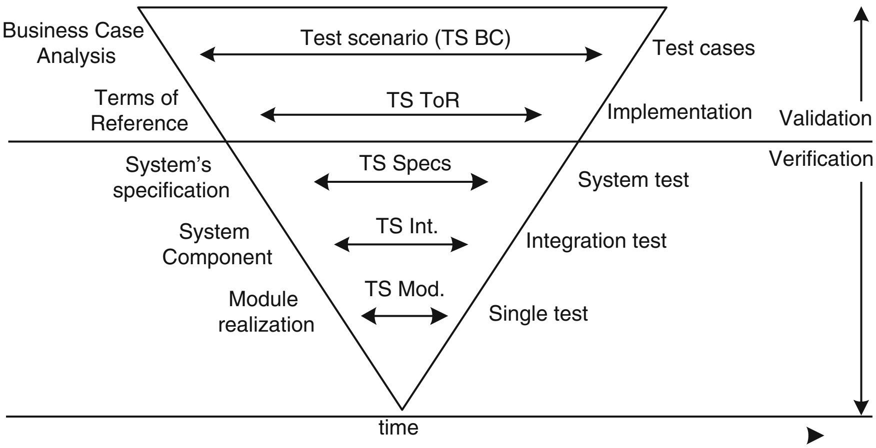


Fig. 2.8 V – model

The resulting modified Project Structure Plan PSP can be further modified according to the selected criteria (also Pfetzing and Rohde 2001). Few most commonly used are:

Scheduling of Activities

- Criterion of deadlines. The critical path (CPM) is optimised to meet the deadlines. Other tasks are scheduled to support the deadlines. Costs and ressources play secondary role
- Criterion of costs minimization. The costs of resources and overall investment is evaluated and optimized to deliver the project product at minimal cost
- Criterion of optimal deployment of the available resources. Either material or personal resources are balanced against the project needs and the activities are scheduled accordingly

Time Schedule Elaboration

Now the resulting PSP is again evaluated and with the use of some techniques presented hereafter in section "07:30 Techniques and Tools", final planning can be approached (see 4.3.23. Develop Schedule Process acc. to ISO 21500) (Klose 2002; Lewis 2011).

- Elaborate the sequential list of tasks and tasks' packages
- Assign the time necessary for the realization of each task and tasks' package.
- Plan the independent tasks in parallel as far as it is feasible from the resource's point of view
- If you use other than task/role models, add global task of project management with 10–20 % personal/cost and time resources evenly distributed in a project
- Set the deadlines in the planning
- Draft first sequences of the tasks and packages and verify if the partial results meet the deadlines
- Add 10–15 % time reserve to reach each deadline

Table 2.6 Characteristics of V – model

Granularity	Single chain of phases
Level of recurrence	On system component level and below several iterations to reach positive tests results practiced
Number of iterations	None on the highest level, increased number of iterations with the decreasing level practiced
Initiation Phase	Business case analysis
Planning	Terms of reference, system specifications
Implementation	System components and modules specification, elaboration, testing
Closing and Evaluation Phase	-
Characteristics	Sequential, rather static down to system level, multiple iterations on sub-system and module level,
	The product is structured under criterion of the verification and validation testing,
	The requirements are paired with test criteria
	The knowledge gained on lower levels supports the efficiency on higher level testing
Application	Systems manufacturing,
	Volume production,
	High reliability systems,
	V-Modell/XT (BBI 2013)
Risks	Late detection of system design errors,
	Laborious corrections of system errors
	Reluctance in improvements

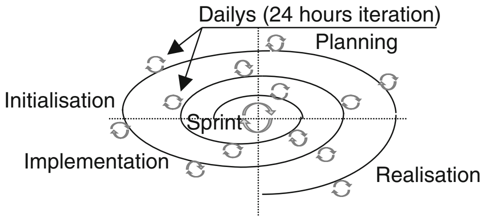


Fig. 2.9 Agile model

- If necessary redesign the PSP to meet the deadlines with necessary reserves or negotiate new deadlines
- Set the redesign plan and schedule the tasks
- Introduce milestones to measure project progress

  Figure 2.11 drafts this scheme.

Planning According to Milestones in Project Realization

Milestone is an event, usually marking the achievement of major result in project, after specified period of time, specified resources used, having a significant

Table 2.7 Characteristics of agile model

Granularity	Very high, up to all meta model phases in 1 day
Level of recurrence	Very low, down to single features, what is realizable in 1 day
Number of iterations	Very high, 30 for each 30 days sprint, numerous sprints in a project
Initiation Phase	Product backlog elaboration
Planning	Sprint backlog extended by the team with necessary support features
Implementation	Sprint/dailys initialization, planning, realization, implementation
Closing and Evaluation Phase	-
Characteristics	Product made gradually in multiple versions,
	Short term planning of the next sprint/current day activities,
	Every iteration is basically carried out in four phases,
	The risk mitigation management occurs in short dailys loop
	Highly flexible delivers useful results contrary to the initially planned results,
	Knowledge from the predecessor daily used in the following cycle,
	Changes are immediately implemented.
Application	Software development,
	Projects with numerous changes,
	Groundbreaking, innovative projects,
	XP, ASD, DSDM, SCRUM, Crystal, FDD, AM (Pressman 2010)
Risk	Still higher requirements,
	'Never ending story',
	Costs explosion, time unpredictability
	High requirements for the project management board

influence on the course of project realization (Lewis 2011; Klose 2002; Caupin et al. 2006; Lock 2007).

Basic milestone characteristics:

- Event with special meaning
- Beginning or end of project phase, task or package of tasks, relevant event with major impact
- Measurable
- With specified time deadline
- Explicit event
- Limited in number (in most cases between 4 and 20).

Milestones aim at:

- Verification of project activities, accepted solutions and achieved results
- Enabling control of project progress,
- Structuring of the project
- Documentation of results
- Self-control
- Enabling decision concerning:
  – The beginning of the next phase
  – Repetition of the last or several last phases
  – Discontinuation of further project realization

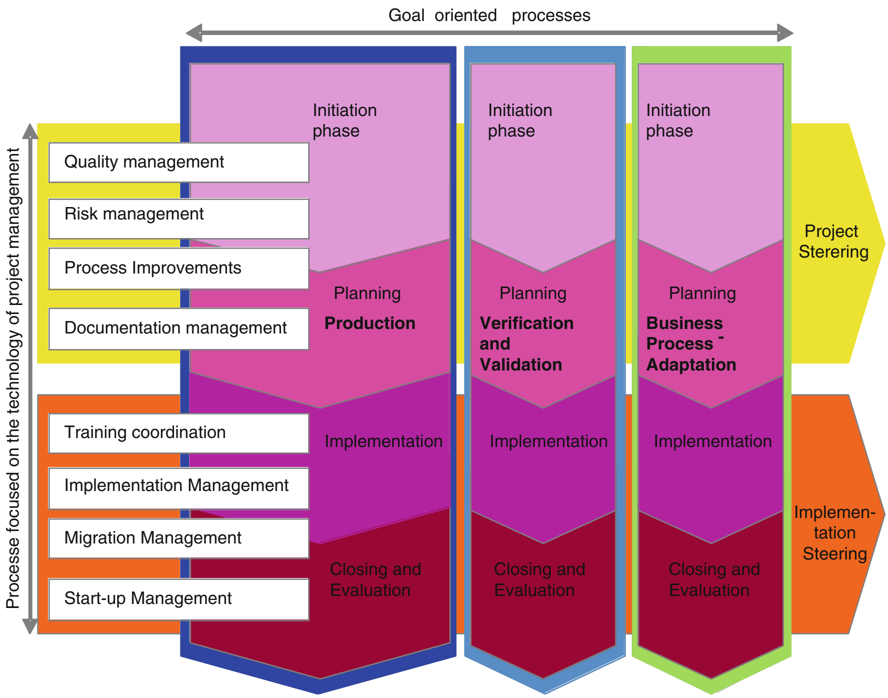


Fig. 2.10 Activity/role model

To reach the above objectives milestones should comply to the same SMART criteria, which are applied to project objectives (see section "07:21 Project Goals and Project Observations" above). While determining the milesstones it is advised to:

- Plan them in accordance with reality
- Plan them after the task completion in due time
- Plan the time needed for documentation
- Set the milestones in a clear structure
- After the achievement of every milestone it is purposeful to verify the plan. The third dimension of the project objectives are costs.

Top-down Cost Estimation/ROM Costs

Relatively early, in most cases prior to any initiation of the project first estimates of project costs are done (Process 4.3.25 Develop Costs acc. to ISO 21500). Costs origin mostly from the business objectives and expected project profitability. The estimations usually base on some reference models and thus contribute to the completeness of the considered costs (Lock 2007). These estimations are frequently called ROM: Rough Order of Magnitude, or Ballpark Estimate, and may deviate from the final costs by 50–100 %. (Schwalbe 2010).

Table 2.8 Characteristics of activity/role model

Granularity	Single chain of phases, planning and realization may occur recursively
Level of recurrence	On system component level and below several iterations to reach positive tests results may be practiced (agile approach)
Number of iterations	None on the highest level, increased number of iterations with the decreasing level practiced
Initiation Phase	Initialization phase
Planning	Concept
Implementation	Implementation
Closing and Evaluation Phase	Closing and Evaluation Phase
Characteristics	Model reflects all project occurences,
	High parallelism of 5 main processes,
	Every process includes several operations and takes into consideration one or more roles,
	Planning and realization may follow iterative recursive cycle,
	Each particular processes can be realized asynchronously,
	Every phase is completed before the commencement of the next phase, at least basic planning precedes realization begin
	Results of each phase are a basis for the next phases,
	Changes in the project are handled by asynchronous process
Application	Best suited for bigger, comprehensive projects,
	Undertakings characterized by significant changes introduced by a user,
	Undertakings with a required high level of integration with the environment,
	L-Timer® approach
Risks	Acceptance by the customer/sponsors of non-productive processes
	De-synchronization in case of deficient cooperation between the team members

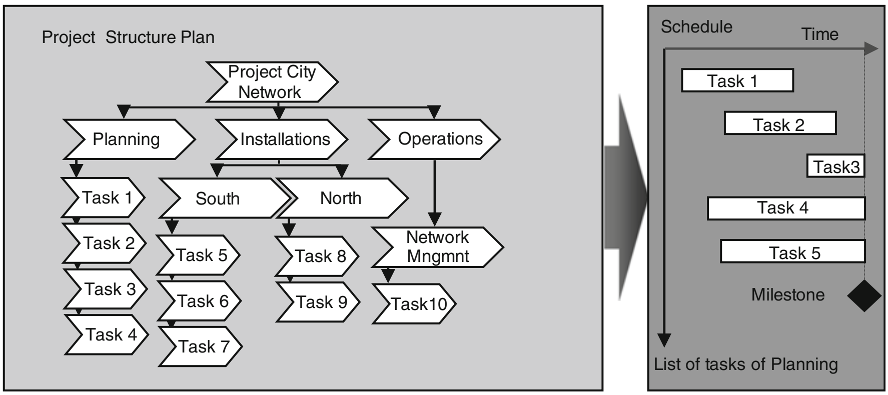


Fig. 2.11 From the PSP to a project time schedule

Bottom-up Cost Estimation/Budgetary Costs

Complementary approach of bottom-up cost estimation is done usually in the initiation phase and further precised with the progress of the project. These so called budgetary costs base on product WBS, project PSP, and schedule (Process 4.3.26 Develop Budget acc. to ISO 21500). An estimation of +/− 20 % is targeted. Several components of projects costs are listed below:

Tangible Costs

Tangible (monetary) costs are cost which can be expressed in financial means.

- Direct costs

  By calculating an effort of each task in hours, multiplying by hourly rate, than adding all investments needed to perform the task, and adjusting the result over the years with interest rate we obtain roughly the total tangible cost of the project. In estimating the cost of single task learning effect of persons performing this task may positively impact the cost. On the other side, the unpredictability and unknown obstacles cause additional unplanned expenditures. So altogether it makes more sense to abandon the speculations about learning curve and calculate the project in fix indexed rates.

- Indirect costs

  Beside those direct costs there are also indirect costs like electricity used, cleaning staff, and shared services in tangible costs.

Intangible Costs

Project causes also other, intangible costs. These are the costs which can not be easily expressed in financial means: like image win or loss, motivation gain or reduction. It makes sense at least to list those costs in risk catalog, as they may impact the tangible costs.

Reserves

Whatever technique will be chosen (see sections "07:30 Techniques and Tools" and "08:32 Project Role Description") to estimate the costs, the unpredictability of the project might exceed the gains of potential learning curve effect. So it is most recommendable, and simultaneously most difficult to gut through the project sponsors and client, to build a contingency reserve of arbitrary set at least 5 % of total tangible costs. The analysis of 200 projects done by HP in the early 1990 identified poor project cost estimation as the second major reason of massive costs overrun (Kendrick 2009).

Cost Baseline

The allocation of budget costs to project phases is called cost baseline. This time-phased budget serves primarily project cost control (Schwalbe 2010).

07:25 Costs/Benefits Evaluation

An investor expects some tangible or intangible returns from the project he finance. As a rule of thumb we may claim, that the higher are the returns from the project, the higher is the sustainability of the project and the security of it's completion, at least from the financial point of view.

Therefore, it is most recommendable to elaborate profound estimation of all possible benefits from the project, and obtain the acknowledgment from the project sponsors /clients, in particular in all projects were seemingly intangible returns are expected. The weaker the financial tangible gain for an investor, the higher is a chance that project will be dropped at the first best occasion.

Several indicators and calculation techniques for cost/ benefit evaluation are used (see section "07:30 Techniques of Structuring"). Their actual deployment depends on the strategy of the investor. Therefore, no universal one-fit-all solution may be given here.

07:30 Techniques and Tools

07:31 Techniques of Project Objectives Identification

Creativity is needed on various stages of project definition. Few most common techniques are introduced hereafter. Further readings may be found in Ninck (Ninck 2004).

Intuitive Techniques

Brain-Storming

The technique was conceived by Osborn to stimulate the generation of ideas (Osborn 1957). The goal of 'Brainstorming' is to find possibly vast number of creative, sometimes unusual or new possibilities of a certain problem solution through mutual stimulation in a group. According to Osborn four to five well conditioned participants can generate 50–100 ideas within 30–60 min session.

In this procedure firstly the moderator, who collects the ideas and stimulates the work, is to be chosen. Then participants began to name their ideas related to the subject. It is important, that neither moderator, nor any participant attempt to evaluate the presented ideas. They should just be written down on a flipchart or any other suitable, visible for all mean. Moderator may drop few abstract yet real objects terms to forge the cognitive creativeness of the participants.

In the second phase moderator with participants analyze each particular idea, eliminate it's multiple occurrence, structure and evaluate it's usability (Schnitker 2007; MindTools 2013).

'Brainstorming' in groups should comply with the following rules:

- A moderator directs the brainstorming in such a way, that he at any time remains in control over the goal of the whole process. Longer discussion on one idea should be avoided. The moderator is also obliged to motivate the participants to contribute and to assure that the creativity of new ideas will get noticed.
- In order to acquire a maximum number of ideas the team should include people representing different disciplines.
- Moderator and participants should be careful so as not to kill their creativity in the germ. Thus, it is advised to create such conditions, in which every participant

do not have the feeling of domination of any other participant of ‘brainstorming’, hindering his own creativity. Playing ‘brainstorming’ can be helpful.

- Except creating new ideas partners can carryout analysis of already existing ideas in order to perfect them.
- In case of need we can visualize ideas. The notes and drafts of the moderator and the participants, also e.g. recordings of a session of ‘brainstorming’ can serve as a protocol.

635 Method/‘Record of Thoughts’

635 Method, or in other words ‘Record of thoughts’ has been conceived by Rohrbach in 1969 (Rohrbach 1969). 635 functions similarly to ‘brainstorming’. The ideas are not presented in oral form, but noted down by each participant, Therefore, they match well nowadays social network communities. The method functions in the following way (MethoDe 2013):

- Six participants writes down on a piece of paper three possibilities of solutions for one problem,
- Then the piece of paper is passed further and each participant tries to crystallize the ideas of the other one,
- Then the pieces of paper are passed further until every participant receives again the paper with his/her ideas,
- At the end the ideas are analyzed and the best ones are chosen as a solution for a problem.

In order for the presented procedure to function without a negative influence on the creativity we should take into consideration the following points:

- It is not allowed to talk during a session. We should write legibly in order to eliminate additional questions which disturb the course after the pieces of paper are passed around.
- During the whole process it is necessary to stick to the set time frames in order to avoid waiting and breaks in the access of creative ideas.
- To prepare a draft of three proposals being a solution we need 3–4 min. Then each participant receives at each phase two additional minutes to read the written text. Tight time frames allow to use the short-term memory better.

Discursive Technique

Morphological Matrix

Swiss astronomer Zwicky created morphological matrix for systematic problem solving (Zwicky 1948). His method is particularly well suited to elaborate a solution build from several components, each of which may have different qualities.

Zwicky conceived four steps:

1. Problem formulation.
   This is the project goal or part of it. E.g. City network example introduced earlier in this chapter.
2. Schematic representation of alternative qualities.

Table 2.9 Morphological matrix of the city network

City network	Source of power	Network design	Structure
Cable	Distributed	Star	1 Level
Radio	Centralized	Mesh	Multilevel
Satellite	Redundant		Structured
			Mix-structured

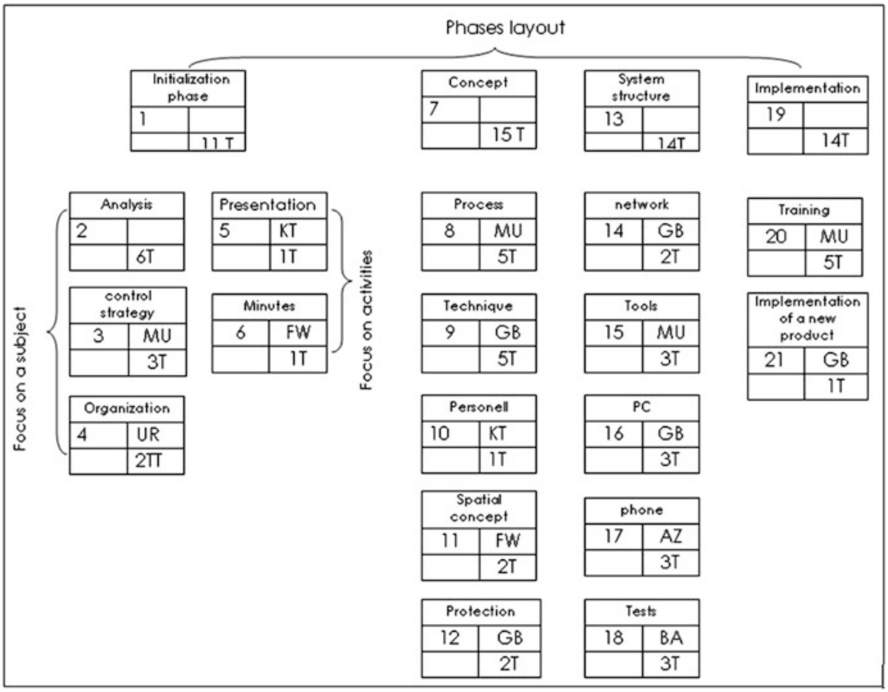


Fig. 2.12 Example of a project structure plan

All qualities of each component are listed and reasonable combinations of qualities of each element are built, e.g. Cable, centralized power supply, mesh network, structured (see Table 2.9).

3. Performance analysis of the selected combinations. Based on the adopted evaluation scheme all combinations are qualified and best is chosen.
4. Direct Action.
   Consequence of decisions taken in Step 3 shall be taken.

07:32 Techniques of Structuring

Project Structure Plan PSP

Project Structure Plan is a clear, planned, often graphical or text form of presentation of all activities, vital for project goal achievement. Vital activities are those which are necessary to make or achieve the project goals. Fig. 2.12 presents an example plan of project structure (Heeg and Friess 1999).

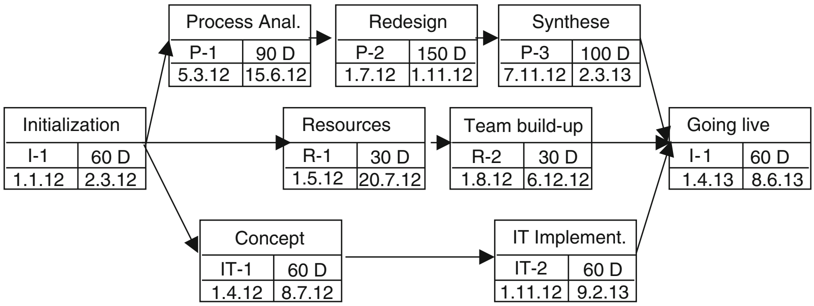


Fig. 2.13 PERT diagram

The criterion to prepare the PSP might be:

- The Work Breakdown Structure (WBS)
- The vital activities' structure
- Phases of a project.

The PSP Structure along WBS is typical for agile models. The additional for project realization necessary activities are at risk to be omitted. Structuring the PSP according to the project phases is a most often chosen model in the sequential models and V – model. In this book the structuring along Activity/Role Modell and L-Timer® processes is recommended for their completeness.

07:33 Scheduling Techniques

PERT Diagram

The research team, which worked in the late 1950s on Navy's Polaris Nuclear Submarine Missile Programme, developed tool for easier presentation of the interdependencies and time progress (Sharma 2006; Stires and Murphy 1962). Known as PERT: Program Evaluation and Review Technique tool views the individual activities as events. Various parameters may be associated with each activity:

- Identification number (mostly in certain numbering system)
- Short denominator/name
- Deadline
- Start date
- Duration
- Optional fields like risk assessment, resources etc.

An example is given in Fig. 2.13.

Beta Time Estimation

Beta process of time estimation was used in PERT to elaborate an approximate duration of a task or package of tasks on the base of an experience of an expert. For each activity the following three time assessments are done (Schwalbe 2010; Sharma 2006):

- Optimum time (OT) of activity realization: it determines the necessary time minimum (assuming optimal work conditions),

Approximate duration of activity ‘‘i’’

$$Ti = ((OT + WT)/2 + 2MT)/2 = (OT + 4MT + WT)/6$$

- Most likely time (MT) of activity realization: indicates most likely time needed under standard work conditions,
- Worst case time (WT) of activity realization: time spent in case of simultaneous occurrence of all negative factors at the same time.
- The mid-point (OT + WT)/2 is considered only half weight of the most likely time.

Time for one activity is estimated as follows:

This equation results in a curve which reflects the frequency of particular time estimations (Beta distribution). We should also point out that the MT value does not have to reflect the arithmetic mean of OT and WT. Thus, it is highly possible that the curve will be dually asymmetric.

Estimation of the overall time needed for a single sequence of activities can be made as a sum of standard estimations with summary deviation of time estimations with the assumed level of probability.

Standard deviation of each single time estimation:

$\sigma i = (WT - OT)/6$

Variance $Vi = \sigma i^2 = ((WT - OT)/6)^2$

Total time of chain of activities

$Tt = \sum Ti$

Summary deviation in a single sequence of activitie:

$\sigma = (\sqrt{\sum} \sigma i^2)$

Standard normal deviate:

$Z = (T - Tt)/\sigma$

Approximate total duration time estimation with 99.74 % level of probability:

$T = Tt +/- (3\times (\sqrt{\sum} V^2))$

Table 2.10 illustrates the exemplary Beta calculation for a sequence of three activities. Values OT, MT and WT are given for three activities in working days. The result of the calculation is the average time of the realization of all activities, in total 1,040 h. The total approximate time of realization of all activities will most likely be 1,040 +/– 172 days with the probability at the level of 99.74 %. The reason of such significant deviation is the accumulation of average values and variances.

Table 2.10 Example of beta process (all data calculated in days)

Package of tasks	Optimum time OT	Most likely time MT	Worst time WT	Average time T_i	Standard deviation σ_i	Variance $V_i = \sigma_i^2$
A1	260	300	400	310	23	544
A2	350	400	540	415	32	1,003
A3	220	300	470	315	42	1,736
Total	830	1,000	1,410	1,040	97	3,283
Standard deviation σ						57
Estimated time assessment with the probability of 99.74 % (interval) T				1,040	+/−	172

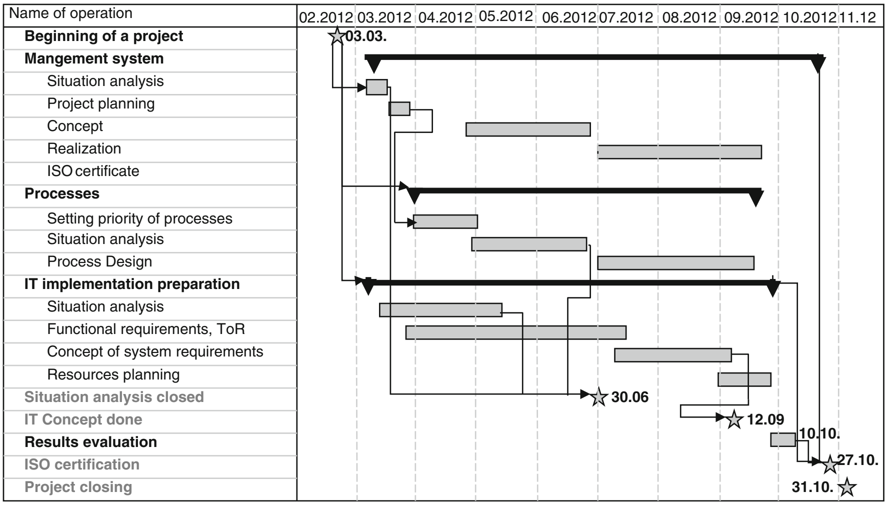


Fig. 2.14 Deadlines planning with the Gantt diagram

The other more sophisticated time assessment methods demands higher efforts (e.g. Schwalbe 2010). However, the indeterminacy of project scope and it's realization make these higher precision tools obsolete.

GANTT Time Diagram

Once the duration of each single activities is determined and their mutual interdependence is set, the time schedule diagram may be drafted.

Most popular and widely used is GANTT diagram (Clark et al. 1922; Lock 2007). On the horizontal axis is the time scale drawn, and the vertical axis individual activities. In the next step the interdependencies are noted, either in a column (like in e.g. MS Project), or directly by binding predecessors with successors. An example is shown in Fig. 2.14.

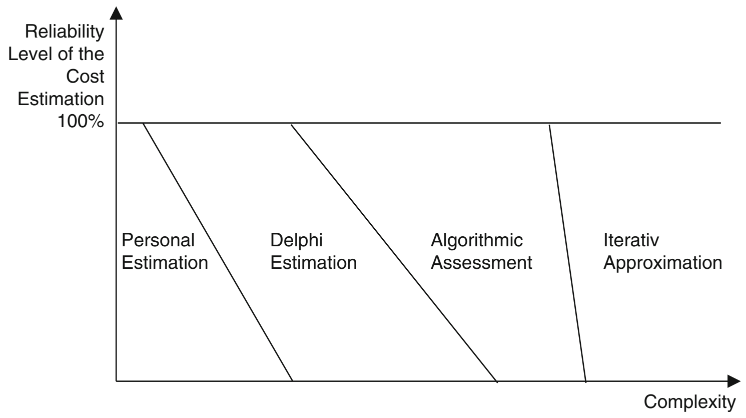


Fig. 2.15 Reliability of cost estimation techniques

Several commercial and open source products support the development of Gantt diagrams. Free of charge complete package supporting project management is available from the Swiss Governmental IT Authority (ISB 2013).

07:34 Project Cost Estimation

An effort in cost estimation shall be in some relation to the total costs under consideration and the associated risks.

Small projects, where project manager or someone, who conceive the endeavor feel competent, can be with reasonable reliability estimated by that person. However, with the increasing complexity the reliability of the estimation is decreasing.

Complexity is determined by it's cybernetic nature (see Chap. 1, Introduction, here above), emergence and unpredictability (Erdi 2008). Therefore, the more complex they are, the longer is their description and their analysis is more challenging (Gell-Mann 1994) (Fig. 2.15).

Delphi Procedure

So as the complexity increases an involvement of additional experts might help to assess reliably the costs. In so called Delphi procedure at least two experts shall be consulted. Variations include independent anonymous opinions and open dialog Delphi procedure, where experts mutually can exchange their views (Häder 2009).

COCOMO® II

Also Delphi approach reaches it's limitations with still increasing complexity, the algorithmic assessment might be in place. Their accuracy of estimation judged by the evaluation of numerous projects is high enough: e.g. in so called COCOMO® II approach (Constructive Cost Model (Boehm 1981)), the in 68 % of cases, the deviation of budget and real costs was less than 20 % (Hummel 2011).

Typical approach is the definition of certain mathematical formula with some variables and some constant parameters, which are set to customize the case.

The procedures are business specific. In the above mentioned COCOMO®II algorithm for systems' and software evaluation the formula is as follows:

$$E = C*M^{0.91+0.01*\ \Sigma SFi} * \Pi\ EMt$$

Where:

- E is en Effort in Man-months
- C is yearly updated Calibrating constant (currently 2.94)
- M Size of system (software) in units (lines of code)
- SFi – scale factors
- EMt – effort multipliers.

Sackman's Second Law

Both SFi and EMt are taken from the tables which assess the factor or multiplyer value in dependence of the complexity assessment on the Lickert scale. What is relevant, is that COCOMO®II include in the total cost estimation also the impact of human factor (Sackman's Second Law, (Sackman et al. 1968))

COCOMO®II calculators are available free of charge (a.o. Research Methods Consortium 2013; University of Southern California 2013).

Putnam Myers Estimation

Universality character has the formula of Putnam and Myers (Putnam and Myers 1992).

$$\text{Effort} = (\text{Size}/\text{Productivity}) * (1/\text{Development time})*\beta$$

Where:

- Productivity varies and is business specific
- β is a value derived from comparable projects and is size sensitive (in Software: 0.16 (small project)– 0.39 (big one))

In the above estimation the project costs excluding the production and series manufacturing are considered.

Whereas there is a relatively broad area of ambiguously efficient personal estimation/Delphi and Delphi/algorithmic assessment, relatively sharp is the limitation of the algorithmic assessment in complexity surmounting. Up from certain level of complexity the cognitive capability to assess the inaccuracy and variability of the project limits the reliability of any of the above estimation techniques. Examples are innovative or research projects.

In this case the estimation may be done in the learning process of iterative approximation adapting the Putnam Myers formula.

In the specified period of time the productivity of team is carefully assessed. Than the total size is divided by the productivity to assess the unconstrained effort needed.

In the next step the development time is verified. If shorter than the effort of the available resources allows, arbitrary β shall be set and the estimation of the next phases may follow. Procedure is biased with the short term observation and missing reference models so shall be repeated iteratively to obtain best possible cost estimation.

07:35 Project Business Case

Project manager is frequently facing the task of delivering the project following an arbitrary investment decision. It is highly recommended particularly in these cases, where clear financial evaluation of the endeavor has not been performed before the project start, to elaborate the project benefits and, in the best case, to obtain an acceptance of the results by project sponsors. The praxis demonstrates, that those project, which has been initiated without a prior cost/benefit evaluation are first to be dropped upon any obstacle.

In a survey of Graham and Harvey, 392 CFOs choose always or almost always the capital budgeting techniques as presented in Fig. 2.16 (Graham and Harvey 2002). These techniques will be further briefly presented hereafter.

It shall be noted, that the popular Return on Investment ROI is not among those most frequently used anymore. The reason might be that it is too static and under performs as compared to the other techniques, listed in Fig. 2.16.

Internal Rate of Return IRR

Internal Rate of Return IRR is a measure of profitability of a project before the costs of capital are considered. If IRR is higher than the cost of capital – project shall be accepted. It reflects the discount rate on investment obtained during the period of it's total compensation by the achieved revenues.

It is calculated by setting the Net Present Value NPV to zero (see below NPV).

- $0 = CF0 + CF1/(1 + IRR)1 + CF2/(1 + IRR)2 + \ldots. + CFn/(1 + IRR)n$
  Where:
- Index 1,2, . . .n is the year of project life cycle
- CF – cash flow
- CF0 – initial capital engagement
- IRR – sought Internal Rate of Return

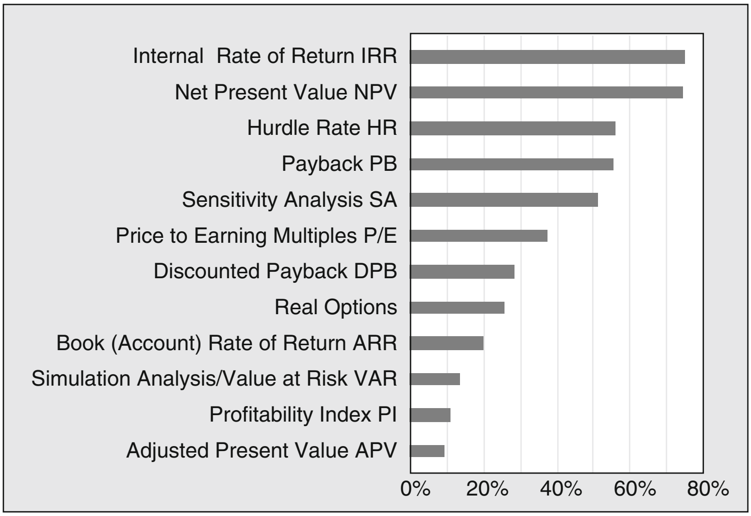


Fig. 2.16 Capital budgeting techniques and percentage of CFO's who always or almost always use a given one (Graham and Harvey 2002)

IRR takes time value of money and risk into account. IRR is unreliable in projects where negative cash flow e.g. major investment in one of the project phases: IRR has different values each year – it may be below cost of capital in 1 year, above in another. However IRR seems to be better to communicate: it is easier to understand the potential return of x% instead of the future value in today's money. Therefore most likely, it is the preferred technique of capital investment evaluation (Hawawini and Viallet 2011; Bitz 1998).

Discount Rate DR

Cost of capital engaged in a project is expressed by it's discount rate DR. Discount rate reflects the risk assessment: the higher the risk, the higher the discount rate. It is set for a specific period of time, usually 1 year (e.g. 10 % p.a.).

Discount Factor DF

The discount factor reduces the value of specific amount over the period of considerations:

$$DFi = 1/(1 + DRi)$$
for the period i.

Present Value PV

Present value PV of the project is the future value FV (e.g. cash flow) at the time if it's (present) evaluation.

PVi = FVi /(1 + DRi)
for the period i.

The Net Present Value NPV is a total of initial capital engagement and present values of all future values FVi at the cost of capital at that given period (Heldman 2009; Webb 2000; Hawawini and Viallet 2011; Schwalbe 2010).

NPV = CF0 + Σ PVi = CF0 + Σ (FVi x DFi) = CF0 + Σ (CFi x DFi)=
CF0 + CF1/(1 + DR)1 + CF2/(1 + DR)2+ . . .. + CFn/(1 + DR)n
Where:

- Index 1,2, . . .n is the year of project life cycle
- FV – Future Value (e.g. cash flow)
- CF – cash flow
- CF0 – initial capital engagement (usually subtracted value)
- PV – Present Value
- NPV – Net Present Value
- FV – Future Value
- DF – Discount Factor
- DR – Discount Rate

Table 2.11. shows an example of a project, where 3 years investments brought positive revenues from the fourth year onwards. The total project life cycle is 7 years.

NPV is in this example positive – project shall be started. However, it shall run at least 6 years as only then the NPV reaches the positive values.

NPV is the measure for value creation (if >1). It adjust to time capital expenditures, with discount factor adjust to the project risks, is additive, favours investments with faster cash return. It's drawback is certain resistance to change adjustments in project (Hawawini and Viallet 2011).

Hurdle Rate HR

Whenever the cash flow varies and have several ups and downs (non-linear) the Hurdle Rate HR is applied. HR defines the minimum total gains on the engaged capital. It may be e.g. expressed as NPV at certain value related to the capital engaged or cumulative discount rates against the cost of capital (Bragg 2011).

Payback PB

In Payback PB the total of all capital outlays is related to the total of gains in subsequent years. The period until the year, when PB reaches zero is called payback time.

In our example total capital outlays are:
ΣCFi = 1 + 1.8 + 0.5 + 0.2 = 3.5 (Mio.)

(continued)

Total gains in the fifth year: 1.8 + 2.5 = 4.3 (Mio.), what would indicate, that project already in fifth year reaches payback. However, as payback does not account the discount, ignoring the risks and the time value of money, the real net benefits starts first in the sixth year (see NPV).

Sensitivity Analysis SA

At any selected model of financial project evaluation Sensitivity Analysis SA allows to predict an outcome as a consequence of certain changes. The independent variables are modified and an impact on dependent variables is tested, e.g. discount rate impact on NPV (Fridson and Alvarez 2011).

Price to Earnings Multiples P/E

Price to Earnings Multiples (also Price/Earnings Ratio) P/E is a benchmark of market values of the companies, in our case of a project (Brigham and Ehrhardt 2011). As projects are unique and seldom sold during their life-cycle, is this measure not truly considered as useful in the project profitability evaluation.

Discounted Payback DPB

Much more valuable and close to the reality is the discounted payback. It is still the static view of the project, yet with the expenditures and earnings are rated with the applicable cost of capital engaged (rate). (Brigham and Ehrhardt 2011).

In the example from Table 2.11, with cost of capital equal to discount rate 10 % we add the capitals revaluated each year with 10 % until the positive cash flow is registered. In this example we obtain after 4 years 5.9 Mio. Of discounted capital balanced by cash back first in the sixth year (it was fifth year in regular payback calculation).

DPB corresponds with the NPV project evaluation. Yet for the difficulty of explaining how the discount is calculated is this techniques less frequently used.

Real Options RO

Next in the series of applicable tools is a comparison of real options. This classical approach in make-or-buy decisions is helpful also in assessing various project implementations. Here various other techniques are used to evaluate and compare the options.

Book (Account) Rate of Return ARR

The average (meaning arithmetical mean) operating profit of a project is related to the book value (account) of the investment. It has to be noticed, that the assets are after depreciation and amortization, while future profits are speculative. It

Table 2.11 NPV calculation example for a project

Year	Cash flow CF (in mio.)	DF @ RF = 10 %	Present value PV (in mio.)	Net present value NPV (in mio.)
0	−1	1	−1.000000	−1.000000
1	−1.8	0.9091	−1.636380	−2.636380
2	−0.5	0.8264	−0.423200	−3.059580
3	−0.2	0.7513	−0.150260	−3.209840
4	1.8	0.6830	1.229400	−1.980440
5	2.5	0.6209	1.552250	−0.428190
6	2.5	0.5645	1.411250	0.983060
7	0.9	0.5132	0.461880	1.444940
Estimated NPV of 7 year project @10 % RF p.a.				1.444940

resembles the payback calculations, however due to underestimated risks, favours higher risk decisions as opposite to rather conservative decisions taken by payback evaluation (Needles et al. 2011).

In our example 3.5 Mio. Investment over 4 Years gives about 0.9 Mio./Year. Average income 7.7 Mio., also over 4 years, gives 1.9 Mio./Year. The ARR is over 200 %.

Simulation Analysis/Value at Risk VAR

Value at Risks VAR measures the volatility of investment to various factors and therefore is usually performed through simulation. With usually higher level of confidence (95–99 %) the potential worst case negative influences on project financial outcome are examined to assess the risk of the project (Brigham and Ehrhardt 2011).

Profitability Index PI

Useful yet seldom used is the Profitability Index PI. It reflects the present value at the time of the evaluation related to the initial capital engagement (Hawawini and Viallet 2011; Brigham and Ehrhardt 2011):

$$PI = \left((CF1 * DF1) + \ldots + (CFn * DFn) \right) / CF0,$$

If PI is bigger than one project shall be continued. PI is relative same as IRR, contrary to the absolute value NPV. It may be compared to benefit-to-cost ratio; the benefits shall exceed the costs. PI expresses monetary this ration.

Adjusted Present Value APV

The last of the most frequently used techniques: the Adjusted Present Value APV is the NPV financed solely by equity and present values, allowing to include the additional effects of debts, like tax-deducible discount rates (Brigham and Ehrhardt 2011). This instrument is applicable if financing is mainly secured with external sources.

Intangible Attributes Balance

Business case of certain projects can not be measured satisfactory with the financial instruments only. All public administration investments can only partially be financially justified. Higher level of clients' satisfaction through faster service, new markets potential, but also a danger of losing motivation by the employees or being dependant on a sole supplier are to be mutually weighted. These intangible attributes may substitute the project financial evaluation. Both advantages and disadvantages have to be assessed and balanced.

Functional Value Analysis

In some projects the achievement of certain functional benefits can be more important then the achievement of economic results. Certain methods of the analysis of functional value are presented in Chap. 7, 12:00 Problem Management: PBM, section "12:33 Solution Assessment and Selection Techniques" hereafter.

07:40 Templates

07:41 Project Documents

Planning and Scheduling process shell answer all 6 "W". It is useful to verify the mapping: which "W" where treated is and if the answer is satisfactory. The Table 2.12 below shall help to trace the achievements.

7:42 Documentation of the Project Results

The basic output of this process is Project Charter, refined to Project Plans. Project Charter has several inputs. It contains the name of project manager and authorizes him to deploy the resources. Main outputs define the project. The last section provide the space for those responsible to sign-off project to sign it off and to put their comments. As the INPUTS and OUTPUTS might be several voluminous documents themselves, it is suggestible to make the Project Charter in a form of Guide documents with references to individual composing files (Table 2.13).

07:50 Activities and Deliverables of Project Phases

07:51 Initiation Phase

Tasks

- Determine the goals and their relation with the strategy of a company and overall results assessment
- Analyze the goals and identify the objectives

Table 2.12 Example

No.	Result	What?	Why?	Who?	When?	Where?	Which?
1	Goal						
2	Objectives						
3	Output						
4	WBS						
5	PSP						
6	Schedule						
7	Costs						
8	Profitability						
9	. . ...						

- Identify the stakeholder needs, restrictions and limitations
- Draw a draft of product and project structures
- Draw a draft of basic methods, key techniques
- Identify core capabilities and core roles
- Formulate the target values of objectives and criteria of their achievement
- Carry out the assessment of economic profitability and secure the financing of the project

Results
- First Project Charter with outlines signed-off
- Drafts of Product and Project Structures accepted by the client
- Core Roles and Responsibilities defined

07:52 Planning Phase

Tasks
- Reevaluate the objectives
- Carry out the changes in the results of the Initialization Phase
- Develop the Work Breakdown Structure WBS (structuring of a product)
- Analyze of the procedural dependencies between the tasks and packages of tasks
- Develop a plan of production processes operations
- Develop a plan of validation processes operations
- Develop a plan of operations in the business process modifications
- Develop a plan of project management processes
- Develop a plan of project implementation processes
- Develop schedule and milestone deadlines
- Develop the Project Schedule Plan PSP
- Define all roles and responsibilities
- Carry out the assessment of economic profitability and secure the financing of the project
- Elaborate the definitive Project Charter

Table 2.13 Example

No.	Object	Ref. document	Updated	Comments
1	Project title			
2	Project manager			
INPUTS				
3	IN: Project statement of work SoW			
4	IN: Business case			
5	IN: Contract			
6	IN: Enterprise environment			
7	IN: Organizational assets			
OUTPUTS				
8	OUT: Objectives			
9	OUT: Costs			
10	OUT: Time schedule			
11	OUT: Profitability (business need)			
12	OUT: Success criteria			
13	OUT: Who is authorized to accept and sign off project			
14	OUT: Stakeholder needs met, restrictions,			
15	OUT: Roles and responsibilities			
ACCEPTANCE				
16	Sign-off section			
17	Comment section for stakeholders			

Results

- Project Plans (revised Project Charter) with all due documents signed-off
- WBS and PSP accepted by the client
- All Roles and Responsibilities defined
- Project business case revised and accepted

07:53 Implementation Phase

Tasks

- Carry out the changes in the results of the Planning Phase
- Secure the Project Charter and Project Plans Conformity

Results

- Validation of the results of planning phase and their appropriate adjustment according to the decisions in the Implementation Phase

07:54 Closing and Evaluation Phase

Tasks

- Carry out the changes in the results of the Implementation Phase
- Evaluate the conformity with the Project Charter and Project Plans

Results

- Validation of the results of planning phase and their appropriate adjustment according to the decisions in the Implementation Phase

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