Chapter 7 | overview

This chapter discusses the front-end development phase(s). First, it is explained why focus on the early project phases is so important and what the front-end phase actually entails. Subsequently, it is questioned whether we could approach all projects in the same manner. Given one of the two main themes of this book (fit-for-purpose), this is obviously not the case. Project complexity is introduced as one of the variables on which you can adapt your project management approach. What are Value Improving Practices (VIPs) and what matters most in applying VIPs is discussed in the next paragraph. Here the second theme of the book (a people process) is clearly recognised. How to further develop project performance is discussed next, on the basis of the VIPs Benchmarking and Lessons Learnt that have their origins in the front-end phases. This chapter is concluded with some particularly interesting (new) focus areas in front-end development: safety and sustainability. Lifecycle thinking and how this connects to front-end development is also elaborated in this paragraph.

Chapter 7 | outline

7.1 Why focusing on front-end?
7.2 What does the front-end phase entail?
7.3 Project complexity
7.4 Value Improving Practices
7.5 Developing performance
7.6 New focus areas
7.7 The Wind Farm

Chapter 7
Front-end development[1]

by Marian Bosch-Rekveldt

7.1 | Why focusing on the front-end?

Think before you act. It is essential and may sound simple, but it proves to be rather difficult. In essence this is what front-end development is about: preparing the future project phases. Various books and articles show how the front-end development phase matters to the project performance (Bosch-Rekveldt, 2011; Flyvbjerg, Bruzelius, & Rothengatter, 2003; Merrow, 2011; Morris, 1994; Van der Weijde, 2008).

What is the goal of front-end development (FED)? As summarised in Bosch-Rekveldt, 2011: '*The main goal of FED is to provide owner representatives with a sufficiently complete image of the project to enable them to decide whether or not the project is worth investing resources in*' (p. 24/25). In the front-end phase, the image of the project is created, starting with the business needs that have led to the initiation of the project and the way to meet these needs. This image also includes objectives, setting the scope, design basis, project planning, required resources and risks involved. How value is developed during the different project stages is shown in Figure 7.1.

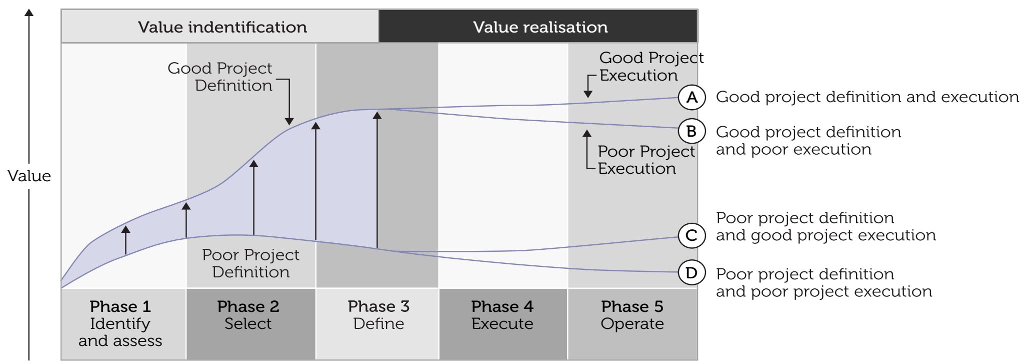

Figure 7.1: The influence of front-end development (Phase 1, 2, 3) on the value of a project according to the oil and gas industry

1 This chapter draws upon the PhD thesis by the author of this chapter, (Bosch-Rekveldt, 2011)

Figure 7.1 shows that value that is **not** created during the front-end project phases cannot be recovered during execution. In other words: optimal project value is achieved with good project definition and execution, where good definition is regarded as most essential. Good definition is the enabler for good project execution: realisation follows identification. For the extremes (indicated with A and D in Figure 7.1.) this seems reasonably true. The final performance of project B, however, might also be lower than the performance of project C in case of a total failure in the execution of B.

Although this chapter deals particularly with the front-end phases of projects, what then could be causing failure in the process of project execution? To mention a few examples, think of:

- Geographical location (more remote, drives modularisation)
- Controlling safety with fewer sophisticated labour forces
- Distributed execution centres (shifting work to low-wage countries)
- Operating 24/7 (stressed time-zones from Asia to North America).

Value management or value engineering particularly focuses on value development throughout the project, see for example the DACE website (www.dace.nl/value-management).

7.2 | What does the front-end phase entail?

In most companies nowadays, a stage-gated project management approach is implemented throughout the project lifecycle. It is recommended to implement formal stage gates to mark the different phases through which the project is defined more precisely (McGee, DeFoe, Robertson, & McConnell, 1999; Turner, 2008). Such a structured stage-gated project management process is assumed to ensure that the right steps in the process of generating the information that is required at the final investment decision (FID) are taken in the right order. In other words: a structured process is followed to make sure that the right information is available at the right moment. As the project matures, uncertainties are likely to be reduced and it is important to reconsider if the right project is undertaken in the right way. If some aspects of the project are not well developed, this can be resolved before expenses have been made in areas that build upon this aspect. And, most important: projects that do not meet the capital investment requirements or that do not have a fit with the desired portfolio can be filtered out at the gates.

Each of the front-end development phases builds upon the previous front-end phase and prepares for the next stage gate. The typical front-end development phases, in the process industry for example indicated with front-end development phase 1, 2 and 3 (FED1, FED2, FED3) are named differently in literature, see Table 7.1 (and also Chapter 1).

In the front-end development phases, a clear scope that optimally suits the project objectives needs to be developed. The scope is preferably frozen (as much as possible) early in the project, ultimately when the final investment decision is taken (Love, Holt, Shen, Li, & Irani, 2002). Note however that new, important inputs from the business perspective should not be discarded by definition. In case of very high-tech projects, a certain percentage of unidentified scope might be accepted and seen as a given for the project.

Table 7.1: Names for typical FED phases (Bosch-Rekveldt, 2011)

Source	FED1	FED2	FED3
(Turner, 2008)	Concept	Feasibility	Design
(Morris & Hough, 1987)	Prefeasibility	Feasibility	Design
(De Groen, Dhillon, Kerkhoven, Janssen, & Bout, 2003; Oosterhuis, Pang, Oostwegel, & De Kleijn, 2008)	Define business case	Do conceptual design	Do basic engineering
(IPA, 2009)	Appraise	Select	Define
Oil & Gas industry	Identify and assess	Select	Define

Note that a plea for the opposite of early scope freeze, flexible and resilient projects, was observed in recent literature (Priemus, Bosch-Rekveldt, & Giezen, 2013). The idea is to develop (mega)projects that can cope with changing circumstances, for example by keeping options open as long as possible and developing different parallel alternatives. Also recent developments from ICT management agile project management or SCRUM methods, (Chow & Cao, 2008) seem better able to flexibly deal with changing circumstances, although the performance figures of ICT projects are often disappointing so far (Van Dijk, White, & Comley, 2013). For the scope of this chapter, however, primarily the concept of early scope freeze is adopted.
For each of the FED phases, suggested key deliverables and key activities are determined; see Table 7.2 for an example from the process industry. These key deliverables and key activities together comprise the 'standard' front-end activities in the process industry.

Can parallels to other industries be drawn? The majority of the activities in Table 7.2 can be found in project management handbooks such as PMBoK (PMI, 2008), APM (APM), The Gower Handbook of project management (Turner, 2014) or can be recognised in standard project management methods including PRINCE2 (Murray, 2009); ICB (IPMA, 2003), etc. See also the introduction chapter of this book on general definitions of and developments in project management. Note the strong influence of systems engineering in current project management methods, throughout. To some basic level, the majority of the activities seem universally applicable.

An important question that arises is to what extent one should perform all possible activities in a project, regardless of the project's characteristics. Compare a multibillion greenfield initiative with a small product development project. Could or should the front-end approach be the same? Projects are by definition unique. How can a universal approach ever be adopted? Rather, a contingency approach is proposed, in which the management approach is adjusted to specific variables or project characteristics (Bosch-Rekveldt, 2011; Howell, Windahl, & Seidel, 2010; Sauser, Reilly, & Shenhar, 2009; Shenhar, 2001). In the next paragraph, project complexity is considered a factor based on which the front-end development phase can be adapted.

Table 7.2: Standard recommended front-end activities in the process industry (Bosch-Rekveldt, 2011): Key deliverables and key activities in the different FED phases, based upon (Oosterhuis et al., 2008)

Key activities	Key deliverables
	FED1
Translate business objectives into required project performance Preliminary cost and revenue assessment Prepare level 1 schedule Analyse safety issues Risk identification and management Determine contract strategy Feedback to and from stakeholders Plan the FED phases Set up the FED organisation	Business goals Project objectives Requirements on project premises Front-end loading strategy Cost estimate (± 40 %) WBS level 1 schedule Initial Hazard and Operability study (HAZOP) Risk register Contracting strategy Technology review Project execution plan (incl. human factors, alliances, benchmarking, innovation)
	FED2
Define the scope Select the site Select technology Define main equipment Identify critical unit operations Cost and revenue assessment Prepare level 2 schedule Analyse safety issues Risk identification and management Compose the project team	Evaluation report stage gate previous phase Basis of design Process design basis Cost estimate (± 20 %) WBS level 2 schedule Update HAZOP Update risk register Project execution plan (incl. human factors, alliances, benchmarking, innovation)
	FED3
Basic engineering Cost and revenue assessment Prepare level 3 schedule Analyse safety issues Risk identification and management Define project funding strategy Prepare the contracting plan Define project strategic interfaces Team building	Evaluation report stage gate previous phase Basic design engineering package Cost estimate (± 10 %) WBS level 3 schedule Update HAZOP Update risk register Project implementation plan Execution schedule

7.3 | Project complexity

In the 2000s project complexity was assumed to be the cause of lots of management problems in (large) engineering projects (Neleman, 2006; Williams, 2005). Project complexity was often not well understood or underestimated, while projects at the same time were (and are!) becoming increasingly complex. What this complexity actually comprised of, was unclear. Research was undertaken to improve the understanding of project complexity (Bosch-Rekveldt, 2011; Geraldi, 2009; van der Lei, Kolfschoten, & Beers, 2010; Vidal & Marle, 2008); or to attempt to, after understanding project complexity, even play with the project's complexity (Hertogh & Westerveld, 2010; Bosch-Rekveldt, Jongkind, Bakker, Mooi, & Verbraeck, 2011).

One of the research results was the TOE (Technical, Organisational, External) framework to grasp project complexity (Bosch-Rekveldt, 2011), see Figure 7.2. The TOE framework distinguishes 47 potential complexity sources that are clustered in the three categories T, O and E. It can provide

Technical Complexity (17 elements)

- High number of project goals
- Non–alignment of project goals
- Unclarity of project goals
- Uncertainties in scope
- Strict quality requirements
- Project duration
- Size in CAPEX
- Number of locations
- Newness of technology (world–wide)
- Lack of experience with technology
- High number of tasks
- High variety of tasks
- Dependencies between tasks
- Uncertainty in methods
- Involvement of different technical disciplines
- Conflicting norms and standards
- Technical risks

Organizational Complexity (17 elements)

- High project schedule drive
- Lack of Resource & Skills availability
- Lack of Experience with parties involved
- Lack of HSSE awareness
- Interfaces between different disciplines
- Number of financial sources
- Number of contracts
- Type of contract
- Number of different nationalities
- Number of different languages
- Presence of JV partner
- Involvement of different time zones
- Size of project team
- Incompatibility between different pm methods/tools
- Lack of trust in project team
- Lack of trust in contractor
- Organizational risks

External Complexity (13 elements)

- External risks
- Number of external stakeholders
- Variety of external stakeholders' perspectives
- Dependencies on external stakeholders
- Political influence
- Lack of company internal support
- Required local content
- Interference with existing site
- Remoteness of location
- Lack of experience in the country
- Company internal strategic pressure
- Instability of project environment
- Level of competition

Figure 7.2: TOE framework to grasp project complexity (Bosch-Rekveldt, 2011)

a 'complexity footprint' of a project. In several industries (process industry, construction industry, ICT and high-tech product development), it was investigated which elements mostly determine the complexity of a project. From a comparative study (Bosch-Rekveldt, Hertogh, Bakker, & Mooi, submitted), some complexities seem to appear 'universally' in projects throughout the different sectors, for example high pressure on the project's schedule and the involvement of (a lot of) external stakeholders with very different perspectives. In the comparative study, other elements of the TOE framework appeared only in one sector, like the long duration of projects in the construction industry, the high technical risks in projects in the high-end product development industry and uncertainties in the project goals and un-alignment of these goals in projects in the process industry.

Based on the expected project complexities, the additional effort in specific front-end activities could be determined. For example, in the earlier mentioned research in the process industry (Bosch-Rekveldt, 2011) it was found that in case of a technically complex project, specific attention could be paid to goal setting, alignment and monitoring, risk management, and timely involvement of the stakeholders. In case of an organisationally complex project, specific attention could be paid to goal setting and alignment, timely involvement of the stakeholders and teambuilding. In case of a project with expected external complexity, specific attention could be paid to risk management and, again, teambuilding. For other projects with different (combinations of) complexities, another set of activities could be highly beneficial; this is a topic of on-going research. These specific front-end activities are known as Value Improving Practices, which are further explained in the next paragraph.

Note that project complexity as such is highly dynamic and subjective: it will evolve throughout the different phases of the project and is heavily based on prior experiences and knowledge. What is considered as very complex by one practitioner could be perceived as very simple by others. Being aware of each other's complexity perspectives turned out an eye-opener in recent research (Kool, Bosch-Rekveldt, Hertogh, & Kraneveld, 2014).

How fit for purpose project management then could look like in practice, is, again, topic of on-going research. Complexity could be a selection criterion to decide what management activities to undertake in order to manage the project 'fit for purpose', but also other project characteristics could be made decisive. The fundamental difficulty and even tension is that fit for purpose project management, by definition, is adapted to the specific project context and hence cannot be simply generalised. Probably this is where the people aspect comes across: an experienced project manager is able to make the right decisions about fit-for-purpose project management, if there is freedom to take these decisions.

7.4 | Value Improving Practices

In case a company has a project management system in place, key deliverables and key activities will be similar to those presented in Table 7.2. Next to these 'standard' front-end activities, also so-called *Value Improving Practices* can be applied. Value Improving Practices (VIPs) are the 'out of the ordinary activities' that provide input and add value to the standard activities and deliverables (IPA, 2014). VIPs could be seen as the normal practices of the (near) future.

Because of the special nature of VIPs, IPA recommends to facilitate the execution of these practices by a person *external* to the project team, who possesses the skills to maximise the outputs that can be gained (IPA, 2014). Despite IPA's own interest in external facilitation, external facilitation could indeed add value because of the 'fresh' external view. VIPs would be best suited for application in the front-end phase of a project, to maximise the value that is created (De Groen et al., 2003).
Different organisations have developed lists of value improving practices, sometimes confusingly also referred to as *best practices*, see Table 7.3. These organisations only list those practices for which they have gained evidence that indeed the practice adds value to projects. They however use different datasets (not publicly available), which explains the differences between the lists.

Table 7.3: Value Improving Practices as identified by IPA and CII

IPA VIP's (IPA, 2014)	CII Best practices (CII, 2014)
Strategic Business Objectives	Alignment
Technology selection	Benchmarking and metrics
Classes of facility quality	Change management
	Constructability
Capital cost (Scope)	Dispute prevention and resolution
Process simplification	Front End Planning
Value engineering	Implementation of CII research
Design-to-capacity	Lessons learnt
Customizing standards and specifications	Materials management
	Partnering
Execution efficiency (Cost and Schedule)	Planning for start-up
Constructability review	Project Risk Assessment
3-D CAD	Quality management
	Teambuilding
Operating cost (Uptime, Utilities, Maintenance)	Zero accidents Techniques
Process reliability modelling	
Predictive maintenance	
Energy optimisation	
Waste minimisation	

Several of the CII Best practices would better fit the base practices from Table 7.2, but most of the proposed activities in Table 7.3 go beyond the important base practices like start with a good project definition and implement project controls. Regardless of the specific content, the lists have one thing in common: they only can add value if they are applied correctly and by the right, competent, people (Chapter 4). In earlier research, the application of VIPs in engineering projects was investigated (Bosch-Rekveldt, Smith, Mooi, Bakker, & Verbraeck, 2011). Results showed a wide variety in the level of application of the VIPs. Specifically the way how VIPs were applied seemed to make the difference for achieving good project performance.

Like one of the main themes of this book: it is all about the people involved. It seems that a formal structure of performing VIPs, or best practices, is necessary, for example in company work processes, but this is not necessarily sufficient to achieve a good project performance.

The keywords are *integration* and *involvement*. Integration refers to integration of the results of different VIPs, integration of the different disciplines in a multidisciplinary team and integration of the different parties involved, for example close collaboration between contractor and project owner. Involvement refers to involvement of team members in the execution of the VIPs: jointly setting project goals, jointly performing risk workshops, etc. Preferably, the same parties (and even better: persons) are involved in the different phases of the project lifecycle, including technical specialists and future users. Of course the specific needs, in terms of required skills and knowledge in each project phase, should be carefully looked at.

Spending joint efforts in executing VIPs, with an integrated project team, enables the development of trust within such an integrated project team. When working together, interpersonal relations are built that can be helpful in solving problems later on. It is not only about the result of applied VIPs, but also about the fact that joint awareness is created by performing a VIP with a truly integrated project team.

Turner already stated: '*To a large extent people are the key elements and yet so many books concentrate on methods, tools and computing capability*' (Turner, 2003). People are the key in projects. Still, formally and truly (e.g. not as 'tick the boxes' exercises) applying VIPs is beneficial as these VIPs provide the guidance in performing activities that are relevant for achieving project success. These lists of VIPs to some extent could be considered as 'just' checklists, but the people factor then plays an important role in how the different VIPs are applied and how results of the VIPs are implemented and integrated in the project. Integrated teams, in which the parties trust each other, seem more open to share knowledge and seem more alert to anticipate on changes in the highly dynamic and challenging project environment (Bosch-Rekveldt, Smith, et al., 2011).

So a formal structure of performing VIPs can be considered as a first step in professionalising project management. Necessary, but not necessarily sufficient. What else, with origins in the front-end phase, could help improve project performance?

7.5 | Developing performance

This paragraph discusses two relevant activities that can take place in the early project phase and which do have demonstrated positive influence on project performance. First, the ins and outs of benchmarking are presented and second, the challenges and opportunities in applying lessons learnt in early project phases are discussed.

7.5.1 Benchmarking

Benchmarking is widely applied in several industries. A study originating from the construction industry reports that benchmarking can support project management, by learning from best practices of others and by stimulation of continuous improvement within the organisation (Luu, Kim, & Huynh, 2008). In the process industry, application of benchmarking is rather common nowadays. Project owners might even oblige their contractors to show (external) benchmarking results in their projects, in order to assure project performance. That is the idea of benchmarking: looking where you are in terms of performance, compared to others in your company / sector / industry / database of comparable projects. It is about introducing an external view on your project in order to assess the performance throughout the project lifecycle.

There are different forms of benchmarking: internal benchmarking consisting of company-internal reviews and external benchmarking, in which another company or independent party is involved in the review process. The 'outside view' in the case of internal benchmarking might seem limited, but since a company is likely to perform comparable projects, still this can be helpful in improving project performance: it opens the project for other views. Companies might choose internal benchmarking because they are not willing to share their intellectual property or competitive advantage with the outside world and the benchmarking company, they are afraid of the additional effort external benchmarking requires and/or they simply do not want to spend additional money on external benchmarking companies.

Some companies do not choose any form of benchmarking, because in their opinion their projects are unique and do not have any comparable counterparts. Nonsense, most often. Even the most unique projects do have certain aspects or activities that are comparable to what has happened in other projects. Still the value of benchmarking should exceed its cost in order to be effective, hence small projects might not be a logical target group for external benchmarking. Several commercial companies nowadays completely focus on performing benchmarks for the industry, of which IPA[2] is the most prominent example of such a company. Lessons learnt from performing benchmarks during the last decades are widely discussed in the book Industrial Megaprojects – Concepts, Strategies, and Practices for Success (Merrow, 2011). These lessons learnt are a valuable result of their benchmarking activities.

The Construction Industry Institute (CII) has developed the Project Definition Rating Index (PDRI) which can be used as a tool for measuring the degree of scope development during the front-end development phases in industrial projects (Dumont, Gibson Jr, & Fish, 1997). Using the PDRI by both clients and contractors, and preferably as a *joint* activity as was argued in the previous paragraph as well, could ensure better awareness of quality and completeness of project scope in early project phases.

From a case study, performed with five projects selected from companies active in the Dutch NAP Network (Bosch-Rekveldt, Smith, et al., 2011), it was concluded that although application of benchmarking at the time of research was relatively poor (in quantity and quality), external benchmarking still showed potential to contribute to success of projects. Details about this research are given below.

> ***Case research into application of benchmarking*** *(Bosch-Rekveldt, Smith, et al., 2011)*
> *The application of certain Value Improving Practices (VIPs) in the Front End Development (FED) phase of five engineering projects was investigated in-depth. One of the VIPs under consideration was the VIP External Benchmarking. Semi-structured interviews were held with 11 project managers and team members from 5 projects across different companies. Each project was considered a case in a multiple-cases explanatory case study approach. The cost estimates in these projects ranged in size between € 7 – 100 million.*

2 IPA: Independent Project Analysis, Inc. www.ipaglobal.com/

Although to some companies external benchmarking is an important tool to improve themselves, it was substantially applied in only three of the five cases. And from these three cases, only in one case it was directly contributing to improving the project results, in view of the interviewees. In this case, the outcomes of the benchmarking study were beneficially used to prepare optimally for execution in the later project phases. In view of the interviewees, the external party, objectively assessing the project fitness, contributed to the development of trust in this truly integrated project team. The project, seen as the result of joint effort of contractor and owner, was objectively evaluated on its performance by this external party. Another project case illustrated a more traditional owner – contractor relation. Here the contractor did not see the value of applying external benchmarking: it was applied simply because it was requested by the project owner. In case of real integrated teams (not present in this project), more feedback of the benchmarking results and integration of these results in the project is to be expected. In one other case, external benchmarking was applied but it seems the application in that project was simply too late to be effectively included in the project itself.

The reason why, in the remaining two cases, external benchmarking was not substantially applied was either that it was not a common practice in the industry or it was not desired to benchmark because of the patented and unique products involved, in view of the interviewees. Still, applying external benchmarking could have enabled early anticipation in the FED phase on the negative developments in a specific case and hence would, most probably, positively have influenced its performance. For example, an external benchmarking study could have recommended paying more attention to interface and stakeholder management.

The VIP External Benchmarking is closely connected to another important VIP, the VIP Lessons learnt. An organisation will only optimally benefit from applying Benchmarking if the benchmarking results are implemented in the organisation and are used in the (subsequent) projects. Hence it touches upon learning from previous experiences – Lessons learnt.

7.5.2. Lessons learnt

The relevance of applying lessons learnt of previous projects in the early project phases seems obvious from practice as well as literature (Bosch-Rekveldt, 2011; Cooke-Davies, 2002; Williams, 2003). Still there seems something to gain when it comes down to truly applying lessons learnt. When a project is completed, a next project is calling the attention of the project team (if the project manager not already had left the team, even prior to completion).

The VIP Lessons learnt implies '*a structured process for capturing, interrogating, analysing, making systemic corrections, archiving and implementing lessons learnt during the inception, development and execution of an engineering project*.' Hence it is about capturing lessons learnt, but also about implementing those lessons learnt, throughout all project phases. Too often lessons are captured, but not truly used, learnt nor implemented.

In complex engineering projects two types of knowledge play a role: explicit knowledge and tacit knowledge (Geisler & Wickramasinghe, 2009; Hertog & Huizenga, 2005). Explicit knowledge can be stored, it is concrete, formalised and transferrable. Tacit knowledge, however, cannot be stored: it is implicit knowledge, routed in the experiences, expertise and abilities of an individual, it is more difficult to communicate. Converting tacit knowledge into explicit knowledge is seen as a major challenge to modern organisations (Jashapara, 2011).

The VIP Lessons Learnt obviously catches the explicit part of knowledge obtained in a project, but also explicating tacit knowledge is aimed for. For example, at project close-out (see Chapter 13), a project team might be obliged to perform a project evaluation including written lessons learnt (sharing explicit knowledge) but the team might also be asked to demonstrate some of the project findings (sharing tacit knowledge).

The main question to be answered remains how an organisation can motivate its employees to actively share and use lessons learnt. Just providing a tool or database to store lessons learnt is not sufficient, more important is the culture involved. An employee should be rewarded for sharing any mistakes, rather than being punished for her openness. Again it comes down to the people side of project management.

A nice example of lessons learnt from practice is the publication of King / Dienst Metro on the lessons learnt from the North/Southline project in Amsterdam so far (Raats, 2013). This publication very well illustrates how the implementation of lessons learnt during the project execution actually contributed to improving its performance. Whereas at some point, the public opinion was very negative about the project and its problems, at current stage the public opinion is rather positive. Further implementation of these lessons learnt in subsequent projects, from early project phases onwards, offers opportunities to improve project performance.

7.6 | New focus areas

This chapter on front-end development concludes with some trends related to the early project phases. First the topic of safety is discussed, which deserves attention throughout the project lifecycle and hence also in the front-end phase. With foreseen scarcity of (energy) resources in future, the theme of sustainability becomes increasingly important. Therefore sustainability is discussed subsequently. This chapter ends with a plea for a lifecycle approach, in which an integral view is applied to project management, including asset management.

7.6.1. Safety

Only disasters trigger industry and government to actually, and in some cases finally, take action. From aviation industry to infrastructure, from oil and gas industry to construction: all industries do have their disasters in the field of safety. Think of the Challenger disaster in 1986 that triggered NASA to change the organisation structure and professionalise project management. Think of the Deepwater Horizon oil spill in the Gulf of Mexico in 2012, where organisations were blamed for their poor safety systems. Think of the Texas refinery disaster in 2005. Or the fire in the Mont Blanc Tunnel in 1999, where a lack of coordination was said to hamper the tunnel safety and measures were taken to improve the situation.

Throughout project phases, safety needs serious attention. It is about the safety of all employees involved, on the project site as well as in the project offices. It is about the safety of the future operations but also about safety during project construction or implementation.

A recent PhD study deeply investigated structural safety in the construction industry (Terwel, 2014). Critical factors appearing most important to assure structural safety were found to be: communication and collaboration, risk management, control, allocation of responsibilities, safety culture and knowledge infrastructure. More details on the findings of this study are provided below.

Structural Safety – Study into critical factors in the design and construction process *(Terwel, 2014)*

'The main aim of this study was to determine factors in the design and construction processes within current Dutch building industry that need improvement with respect to structural safety. The current Dutch building industry is complex with a variety of actors, like clients, advisors, contractors, subcontractors and suppliers, who work on projects in various forms of collaboration. In addition, projects tend to become increasingly complex, due to clients' wishes and opportunities of computational design.

Based on a national survey, six critical factors for structural safety were identified: communication and collaboration, risk management, control, allocation of responsibilities, safety culture and knowledge infrastructure. Measures were suggested that can lead to improvement of each factor. It was concluded that for many of these factors measures have been suggested before in Dutch publications, without proper implementation.

It appeared that especially for structural risk management of product and process in current building practice more guidance is needed. For allocation of responsibilities and control mechanisms, implementing already suggested measures needs attention. Furthermore, increased liability of advisors might lead to improvements in the way tasks are performed and covered.

For safety culture it is believed that process industry and aviation provide useful examples of a developed safety culture, with mandatory failure reporting and a high level of safety awareness. Adequate application of BIM, and increase of chain integration and integrated contracts can improve communication and collaboration in the current building industry. Best practices of knowledge management need to be shared and implemented to improve knowledge infrastructure.

It is expected that extra attention to the critical factors and usual attention to the other influencing factors will ensure improved structural safety in projects and in the Dutch building sector.'

7.6.2. Sustainability

Next to the traditional project drivers of cost, time, quality and scope (see also Chapter 1 and Chapter 6), sustainability is mentioned as an important future project driver (Oehlmann, 2010) that needs attention also in the front-end project phase.

The business principle behind sustainable development is often expressed as 'People', 'Planet', 'Profit', or as the triple bottom line (Redclift, 1987; Mulder, 2006). The project manager should find a good balance between these three aspects but the focus so far tends to be placed on the 'Profit' value (Dijkstra-Hellinga, 2009) rather than on the environment value (Planet) or social value (People). In projects, trade-offs do not only have to be made between the high level notions of 'People', 'Planet' and 'Profit', but also a choice needs to be made between the project management constraints of scope, time, quality and budget (Meredith & Mantel, 2006; Turner, 2014). Where does sustainability fit in these lists?

In other words: how to include sustainability aspects in projects in general and in the front-end development phase in particular? The Sustainable Footprint Methodology is presented in Figure 7.3 (Oehlmann, 2010). The methodology distinguishes three rough project phases to take into account: project pre-phase (in fact front-end development), project execution and operation of the asset. The Triple Bottom Line (People, Planet, Profit) forms the other dimension of the matrix. All cells in the matrix provide attention points to include sustainability considerations in project management. This matrix could be seen as an extensive checklist, with the danger of being considered as just another tick-the-box exercise to be completed in a project.

	The Triple Bottom Line		
	1. People	2. Planet	3. Profit
Level 1 Project Pre-Phase	1.1.1 Stakeholders	1.2.1 Design Options	1.3.1 Expected Economic Performance
	1.1.2 Customers	1.2.2 Land and Biodiversity	1.3.2 Expected Financial Health and Stability
	1.1.3 Politics and Legislation	1.2.3 Environmental Plan	1.3.3 Expected Shareholder Involvement
	1.1.4 Team Participants	1.2.4 Product	
	1.1.5 Health and Safety Plan		
Level 2 Project Execution	2.1.1 Stakeholders	2.2.1 Transport	2.3.1 Market Presence
	2.1.2 Society	2.2.2 Emissions and Waste	2.3.2 Macro Economic Effect
	2.1.3 Suppliers	2.2.3 Materials	2.3.3 Commercial Performance
	2.1.4 Communication	2.2.4 Water	2.3.4 Capability Management
	2.1.5 Human Resources	2.2.5 Energy	2.3.5 Environmental Expenditures
	2.1.6 Health and Safety	2.2.6 Noise and Vibrations	
Level 3 Operation of the Asset	3.1.1 Stakeholders	3.2.1 Transport	3.3.1 Market Presence
	3.1.2 Society	3.2.2 Emissions and Waste	3.3.2 Macro Economic Effect
	3.1.3 Suppliers	3.2.3 Materials	3.3.3 Efficiency of Asset
	3.1.4 Community Capital	3.2.4 Water	3.3.4 Environmental Expenditures
	3.1.5 Human Resources	3.2.5 Energy	3.3.5 Long-Term Planning
	3.1.6 Occupational Health and Safety	3.2.6 Maintenance of the Asset	3.3.6 Realised Economic Performance
		3.2.7 Decomposing of the Asset	

Figure 7.3: The Sustainable Footprint Methodology (Oehlmann, 2010)

Perhaps the most important conclusion of Oehlmann's study is the need for an integrated approach in which the dominant paradigm of profit, profit, profit is replaced by a true triple P of people, planet, profit.

7.6.3. A lifecycle approach

In the front-end development phase, the fundaments of the project are created as was shown throughout this chapter. In the front-end phase, more and more attention is paid towards a life-cycle approach of projects. By including maintenance considerations in the design phase, one can for example avoid the problem of non-accessible windows for a window cleaner by changing the design upfront, rather than having to install additional equipment to facilitate the window cleaner. By including the operations' staff in the design phase, one can for example optimise the design to best answer the needs of the future operator upfront, rather than to redesign after the investment decision with all related cost consequences. This 'integrated thinking' requires an integral view on what needs to be done. In a way, it is front-end development 2.0: not only preparing the project execution but also the future use of the project's output and outcome.

In infrastructure projects, the recent Design-Build-Finance-Maintenance (DBFM) contracts can be seen as examples of a lifecycle approach. Such contracts span the design, construction, financing and maintenance for a period of up to 30 years. The idea is to optimally exploit the knowledge available at contractors, but the long-term contracts also imply that contractors have to commit to long-term debts (Herrala & Pakkala, 2011) potentially resulting in higher overall costs because of risks involved – (contractors want to be paid for bearing the increased financial risks).

Lifecycle costing (LCC) could help in making long-term impact decisions but currently, decisions in various industries are based on short-term budgets (Perrons & Richards, 2013), which also can have an adverse effect on the total lifecycle cost. Note that some value of a project is hard to express in simple money anyway (see also Chapter 2 of this book). Maybe this is why the implementation of LCC across various industries is slow (Woodward, 1997); (Korpi & Ala-Risku, 2008), although the concept of LCC already was developed in the seventies.

Throughout this chapter, it was shown that integration and involvement are key. Integration of people from different companies in truly integrated teams, integration of key players in the different project phases and integration of maintenance consideration in the design phase(s).
It is about the true involvement of the people within the team. To achieve quality of the front-end development phase, structure is a necessary, but insufficient precondition. On top of the structure, the people can make the difference.
And last but not least the need for integration of the triple P (people, planet and profit) in a project context was stressed.

7.7 | The Wind Farm

In order to decide which activities need (additional) efforts in the front-end phases, performing a complexity assessment on this project might be helpful. Because of the inherent subjective character of project complexity, it is important to involve several relevant parties in the assessment. At least representatives of Allwind Energy, the project team and the Participants Windenergy Vento are invited to participate in the complexity assessment.

This project appears particularly complex due to external complexities like a high *variety of external stakeholders' perspectives* (perhaps not all parties are equally enthusiastic about having wind turbines near-shore and onshore), *political influence* (political atmosphere might influence the process of obtaining the necessary permits) and *remoteness of location* (approaching the 80 wind turbine locations might be difficult). Organisational complexities might also play a role such as *organisational risks* (because of these different locations) or *lack of experience with the parties involved* (in case Allwind has not worked with the contractors before). In terms of technical complexities, the *newness of technology* might play an important role because non-proven technology will be included.

After an inventory of potential complexities and discussion between different parties about their complexity perceptions, measures will be taken to deal with the identified complexities. For example, by paying more attention towards stakeholder management to make sure that perspectives are aligned as much as possible (or at least be aware of distinct differences). The application of VIPs will also be tailored to the particularities of this project.