Pergamon

International Journal of Project Management, Vol. 32, No. 12, pp. 286-297, 2014

Printed in Great Britain
0283-5862/99 $20.00 + 0.00

PII:S02567-7596(52)52459-6

Front-end development: one of project management's most influential areas is also it's most underexposed

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This paper suggests a novel perspective on project management and it's value. Project management is widely accepted as a relevant perspecti've on the development of large engineering projects. Over time it proved its value and through incremental improvement has developed further. Although often applied for the development of projects project management's main value is controlling and measuring the performance of a project and not as is often assumed aiding in the development. The paper suggests that this mainly has to do with its focus in time. Decision that are made early in the development often have a lasting effect during the project development and the project lifespan. The effect of these choices is substantial, while most research on project and project management success is aimed at the later stages of the development process. The paper presents a new framework focused on the early phases of project development. It provides support for the development of future projects.

Keywords*:* Front-end development, project management, success criteria, pre-project planning, renewable energy.

Project management research is predominantly aimed at controlling and measuring project management performance and lacks insight on what criteria really influence project success. This has been the topic of many studies, like Atkinson, who rightly so questions the relevance of the classic project management criteria: cost, time and quality. Despite their general acceptance and common application aren't they just criteria for measuring short-term project management success? What do they tell us about the eventual success of a project? Although project management developed beyond the iron triangle its focus is still spread over the planning and execution phases of a project with a strong focus on execution and controlling.

When willing to increase the value of a project and not just control its development might it be that we have to focus earlier in time, earlier in the process, to really add value? Decisions that influence the entire project lifecycle are made at its very start while these particular early phases in fact are perceived as underexposed (Gibson & Dumont, 1996). To be more precise Gibson (2006) observes, during several research projects, that the early development stages of a project have a more significant influence on the project outcome than the later stages.

During the front-end development phases a wide variety of options is still open and the costs to adjust part of a project are relatively low. While during this phase the potential to add value by including certain possibilities and applying to certain trends for instance is relatively high. This ratio between the *cost to change* and the *potential to add value* changes over the course of the project. It becomes increasingly difficult to make changes to the project when a project proceeds. Consequently the costs to change rise and the potential to add value diminish. The relevance of the front-end development phases is clearly visualised in figure 1. It shows the development of the ratio between *cost to change* and *potential to add value* over the course of a project. This paper reviews the current status of project management, both in terms of focus over time as in terms of selection and suggests front-end development as a new perspective on project development aimed specifically at the early development phases.

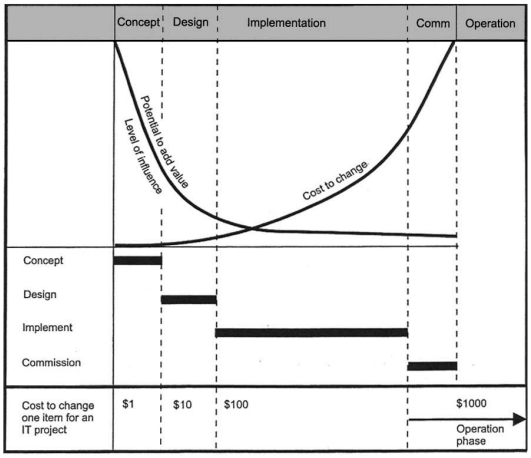

Figure 1 Development potential to change over time

Project management of large engineering projects, like renewable energy and biomass projects, is typically characterised by high project complexity, both on a technical and a social level. The multi-disciplinary nature of front-end development makes it both interesting and challenging at the same time. The paper presents a front-end framework by means of the renewable energy project development practise. The renewable energy sector is a developing sector with a high investment need due to the European targets for renewable energy production in 2020. The shift from conventional energy toward renewable energy generation further results in a shift from centralised energy production toward decentralised energy production. This shift is characterised by an increase in smaller energy projects and a consecutive lowering of the market barriers. The lowering of market barriers led to a group of new and/ or inexperienced project developers/ owners entering the electricity generation market. In the developing market a lack of common learning is identified. For this reason mistakes are often repeated and lead to a loss of producer surplus. An increased insight in the development of projects would improve and accelerate the development and profit the entire sector. With the expected growth in new renewable energy projects and the varying project development performance the need for a new perspective is apparent in this sector.

The paper has five sections. The first sections describes what project management is, how it developed and discusses what it is project management actually measures. The second discusses the need for an alternative. The third sections presents the general idea of front-end development and its relevance, while the fourth elaborates on the consequence of the focus on front-end development for the selection of criteria. The thesis is ended with the conclusions and some recommendations.

What is project management and what is it actually measuring?

To best comprehend the focus of project management the paper briefly reflects on its origin before proceeding to the current project management perspectives. Project management originates from construction projects and the construction industry mainly (Locke, 1984). The development of large construction projects requires a definite amount of control in regard to its performance. The field was and still is aimed at controlling (and measuring) the performance of a project so that its delivery is within cost and time and of a

certain quality. Atkinson firmly states that these criteria are no more than "two best guesses and a phenomenon" (1999).

Three main perspectives in recent project management theory are identified: the classic perspective as per Olsen (1971); the new perspective as per Morris & Hough (1987); an extended version of the classic perspective which is defined here as the hybrid perspective (Atkinson, 1999; Pinto & Slevin, 1987). Generally speaking the development of project management as a research field over time can be labelled as incremental.

Olsen (1971) laid the base for the classic project management perspective and first suggested cost, time and quality as the main project management criteria. These criteria are widely accepted and are more commonly known as the iron triangle of project management. For years they formed the base of project management literature. However while these criteria are broadly accepted and applied projects keep failing suggesting that the original criteria might have been in error (Atkinson, 1999; Pinto & Slevin, 1987). The question is raised whether the iron triangle positively influences the project management process or mainly measures the project outcome, as time, cost and quality are all criteria measuring project management efficiency.

New perspectives are developed that focus on the difference between project and project management success (de Wit, 1988). The classic perspective mainly measures project management success. As the project result post-delivery and not just the planning and execution are relevant for a project's overall success rate the classic perspective is unable to provide sufficient information on how to influence overall project success. One of the possible motivations for maintaining cost and time as the main project management criteria is the simple fact that it's much easier to measure the short-term performance (e.g. project management performance) of a project than the long term (project performance) (Pinto & Slevin, 1987). The short-term effect being measured directly after delivery, while the long term effect can't be truly measured before shut down. This makes it substantially harder to measure the long-term success of a project then the short-term success. In addition to this cost and quantity as criteria are easy to quantify in contrast to criteria like quality and scope, who are much more difficult to measure (Luu, Kim, & Huynh, 2008).

Before focussing further on project management literature first the difference between a project and project management needs to be made. A project is often defined as completing an objective within a specific frame of time and budget. An example of a project would for instance be the construction of a renewable energy generation facility in order to produce a certain amount of electricity per timeframe, within a given period of time and budget. In their work *The role of project management in achieving project success* Munns & Bjeirmi give the following definition of what a project is:

> A project can be considered to be the achievement of a specific objective, which involves a series of activities and tasks, which consume resources. It has to be completed within a set specification, having definite start and end dates (Munns & Bjeirmi, 1996).

This definition provides us with some basic information on what is important for a project. The most interesting here is the distinction between the completing of certain tasks and activities and the use of resources. Atkinson provides another definition:

> The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance (Atkinson, 1999).

As projects kept failing while the iron triangle is well known new perspectives on project management are developed. This new perspective acknowledges the difference between project and project management success and consequently that the factors affecting project success aren't the same as factors

influencing project management success. Pinto & Slevin (1987) state that the iron triangle merely measures project management efficiency and is by no means a path to project success. The new perspective correctly identifies the difference between project and project management success (de Wit, 1988; Morris & Hough, 1987) and provides a broader set of criteria with a focus on post-delivery project success. It fulfils a supplementary function relative to the classic perspective. These criteria offer specific insights in project success, but (often) lack in insight in project management success. The weakness of the new perspective is therefore the lack of process criteria and it's very ex post nature.

Several authors agree on the importance of cost, time and quality, while also acknowledging that other criteria should also be taken in account (de Wit, 1988; Grant & Pennypacker, 2006; Pinto & Slevin, 1987). Atkinson suggests that temporary criteria can be made available during some stages of the project. This offers the possibility to build upon classic project management theory, but include criteria that are relevant for the front-end development specifically. This perspective is defined as the hybrid perspective. The temporary criteria would be able to measure the progress made and therefore act as a control method (Atkinson, 1999). Atkinson (1999) and Grant & Pennypacker (2006) build on the classic perspective, while adding criteria aimed at including post-delivery performance measurement. This results in highly complete, yet compact set of criteria.

The fact that project management is mainly aimed at executing and controlling a project is party can be related to its origin and common application in the construction industry (Locke, 1984). Project management isn't applied there to aid the project developer/ owner in the development a project plan, but at helping them monitor and control the construction of a project. Despite this difference it is often applied to a wide variety of projects for the first reason. The difference clarifies that project management is something different then project development, which starts with the most elemental decisions at the base of any project and grows into a full-blown project plan.

Table 1 presents a global overview of selection of well-known project management literature and their selection of project management performance criteria. Certain authors like Atkison (1999) and Munns & Bjeirmi (1996) are excluded from the overview as their selection differs too significantly from the presented selection in terms of focus and/or definitions that combining them in a single table was not possible.

	Cost	Quality	Time	Schedule	Stakeholders	Control	HR	Scope
Cleland & King (1983)	x	x	x		x			x
De Wit (1988)			x		x		x	x
Grant & Pennypacker (2006)	x	x	x		x		x	x
Hayfield (1979)						x	x	x
Locke (1985)	x	x	x		x	x		x
Meredith & Mantel (2011)	x		x		x	x	x	x
Morris & Hough (1987)	x	x	x					
Hamilton & Gibson (1996)	x			x		x		x
Pinto & Slevin (1987)	x	x	x	x	x	x	x	x
PMBOK (2004)	x	x	x		x		x	x

	Management support	Risk	Finance	Information	Planning effort	Contracting	Integration	Technical
Cleland & King (1983)	x		x					
De Wit (1988)			x		x	x		
Grant & Pennypacker (2006)		x					x	
Hayfield (1979)				x				
Locke (1985)	x							
Meredith & Mantel (2011)	x	x						
Morris & Hough (1987)								
Hamilton & Gibson (1996)								x
Pinto & Slevin (1987)	x							x
PMBOK (2004)		x					x	

Table 1 Overview pm literature

Do we need an alternative approach?

Why is it that despite the extensive research on project management we are still not satisfied with the result? Might it be that project management isn't the ideal theory for the part of fields it is applied in? While the value of project management is clear and is mainly found in the late development, execution and control of a project it is often applied as a blueprint for developing a new project. A similar conclusion is drawn by Gibson in the nineties. In this period he was at the base of the pre-project planning field. A field that specifically addresses the early phases of project management and came up with remarkable results. A very simple definition of project management is made by Vrancken. He defines project development as a three-phase plan, which involves making a plan for a project (document), executing the plan (process) and controlling the project (system) (Vrancken, 2012). The current project management research seems mostly focused on the final two stages. Pre-project planning as a deviation from classic project management focuses more on pre-execution phases of project.

> Pre-project planning is defined as the process encompassing all the tasks between project initiation and the beginning of detailed design.

The effect of a strong focus on pre-project planning results in increased performance on time, costs and other operation characteristics (Gibson & Hamilton, 1996). The PDRI research stipulates the relevance of the early development phases in project management. An area that is often underexposed and rightfully deserves more attention as demonstrated in the PDRI research. Although this research addresses a very correct issue in project management it hasn't been widely

accepted or implemented and its influence stays limited.

Let us shorty reflect on the development of pre-project planning and its value. Pre-project planning as a research field is deviated from project management science. It is conceived as a separate project management discipline at Texas University in the 1990's. As a research field pre-project planning literature relates quite closely to the theme of the paper in terms of delineation over time. In a relative short period of time several different studies (Cho & Gibson, 2002; Gibson & Dumont, 1996; Griffith & Gibson, 2001; Hamilton & Gibson, 1996) into pre-project planning took place. Besides the University of Texas G.E. Gibson is the common factor and is involved in all of the different publications. The research results show that pre-project planning leads to improved performance in terms of costs, schedule and other operational characteristics (Gibson, Wang, Cho, & Pappas, 2006). The main framework developed in this period is the Project Definition Rating Index (PDRI). PDRI is developed as tool to measure a project's scope definition and is widely applied as a project planning tool. A differentiation in criteria between project, business and operational objectives is observed, showing a broader focus than most project management perspectives. However when analysing the PDRI framework the focus is mainly on the planning execution and technical aspects of the project. The research is well founded in practise with extensive empirical surveys.

One specific application of PDRI to the renewable energy sector is found. The work of the U.S. Department of Energy (2010) describes the PDRI protocol for the development of nuclear energy facilities in the U.S. It provides a very extensive and thorough analysis of the construction of a nuclear energy facility and includes some other aspects, like safety, as well. A slight difference in focus relative to the focus of the paper is observed. Where the paper focuses on the full range of development aspects the PRDI framework stems from the construction sector originally and this focus remains leading in the framework. It further provides detailed criteria definitions both useful for delineating the criteria as well as quantifying them. On contrast the overall level of detail puts significant data requirements on the application of the framework. This might be feasible for the development of a nuclear facility however it isn't necessarily feasible when willing to apply the framework to smaller energy projects. One of the interesting aspects of pre-project planning is that is brings in a business need and doesn't just focus on the execution of a project. In a way this is a direct consequence of moving the focus forward in time. It is expected that the business case of a project isn't properly addressed at the initiation of a project, but has been at the time of a project's execution for instance.

Table 2 presents a compact comparison of relevant performance criteria of the classic perspective as per Olsen (1971), the new perspective as per Morris & Hough (1987), the hybrid perspective as per Grant & Pennypacker (2006) and PDRI as per Hamilton & Gibson (1996). Olsen and Grant & Pennypacker are accepted by a variety of authors as having selected the base of criteria of their perspective. As the new perspective is more diversified Morris & Hough as the widely recognised contributors are selected as the most appropriate example. Gibson can be acknowledged as the founder and leading author of pre-project planning and consequently PDRI.

Classic	New	Hybrid	PDRI
Cost	Project summary	Integration	Cost
Time	Operation concept	Scope	Schedule
Quality	Financial support	Time	Scope/ technical
(Scope)	Logistical requirements	Cost	Management, planning and control
	Facility support	Quality	Safety
	Project schedule	Human resources	
	Training of personnel	Communications	
	Manpower and organisation	Risk	
	Information and communication channels	Procurement	
	Project review		

Table 2 Overview different pm perspectives

The overview shows the development from iron triangle to a broader perspective including more social aspects. The hybrid perspective offers a rather complete overview including both project and project management success criteria. In reflection the overview shows that PDRI is mainly based on the classic perspective with the addition of the extra control related criteria. PDRI therefore neglects part of the knowledge from the hybrid perspective. So although an interesting focus in time is taken it is based on a perspective that has lost most of its relevance due to the development of more complete perspectives.

PDRI also misses one other interesting notion, despite their focus on the early development phases, which concerns the relation between time and decision space. The decision room is largest at the start of a project and diminishes during the course of its development. To optimise the added value of a project the full decision space at the starts needs to be evaluated.

Front-end development

The past paragraphs discussed the value, but also the shortcomings of both project management and pre-project planning literature. Pre-project planning addresses an interesting area that is underexposed in the current project management literature. While it correctly demonstrates the value of the early development phases it is mainly based on a project management perspective that has lost part of its relevance. The paper suggests front-end development as alternative perspective on the early development of large engineering projects. It's the result of an exploratory analysis based on a combination of literature research, expert interviews and empirical research. Front-end development is defined as follows:

> The front-end development phases are the planning phases of the project. The output of the development phases is the blueprint that serves as the input for the execution phases of the project. Both phases are separated by a standardised milestone: the final investment decision.

During the early phases of development the cost to change are low, while the potential to add value is still high. Figure 2 presents a graphical representation of this. Currently no appropriate perspective is available for maximising the potential to add value early in the development. The paper suggests front-end development as a possible perspective for this.

One of the key observations at the base of front-end development is that fact that when the focus moves back in time a wider set of criteria becomes relevant. This notion seems to be missing or at least isn't taken in account in the selection of criteria in PDRI, the only identified research focused specifically on the development phases. At the initiation of a project the amount of choices that need to

be addressed is substantial. Properly addressing these criteria at that point offers the possibility to maximize the added value. This relates directly to the observation that the possibility to change parts of the project changes over the course of its development. By moving back in time in the development to the earlier phases the possibilities to influence the rest of the project and its development increase. Consequently the decision room diminishes during the course of a project. Figure 1 presents a visual representation of this process.

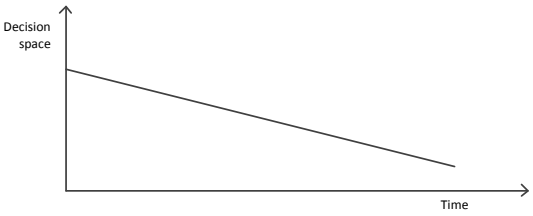

Figure 2 Development of decision room over time

Shifting the focus back in time leads to inclusion of factors like business case and permitting that are addressed before the execution of the project. The shift also influences how and when the performance is measured. Instead of measuring performance ex post the performance is now mainly measured ex ante. This assumes that measuring the planning effort provides an correct estimation of the final outcome. The framework provides a methodology for measuring the project performance from initiation to the final investment decision. The deliverable of the project is at that moment the blueprint for the further development.

The selection of the right set of KPI's and sub-indicators for measuring front-end development performance is a crucial phase in the development of the framework as vulnerability to the selection of criteria is among the common pitfalls during the development of an assessment methodology. An overview of criteria following from the main project management literature is presented in table 1. Table 3 presents an overview of the most relevant recurring criteria.

Criterion	Source
Control	(de Wit, 1988; Locke, 1984; Pinto & Slevin, 1987)
Cost	(Atkinson, 1999; Locke, 1984; Meredith & Mantel, 2010)
Human Resources	(de Wit, 1988; Kerzner, 2013; Munns & Bjeirmi, 1996; Pinto & Slevin, 1987)
Integration	(Grant & Pennypacker, 2006; Project Management Institute, 2004)
Procurement	(Grant & Pennypacker, 2006; Project Management Institute, 2004)
Quality	(Atkinson, 1999; de Wit, 1988)
Safety	(Hamilton & Gibson, 1996; U.S. Department of Energy, 2010)
Scope	(Cooke-Davies, 2002; de Wit, 1988; Munns & Bjeirmi, 1996; Pinto & Slevin, 1987)
Stakeholders	(Atkinson, 1999; Meredith & Mantel, 2010; Pinto & Slevin, 1987)
Time	(Atkinson, 1999; Locke, 1984; Meredith & Mantel, 2010)

Table 3 Overview pm criteria

Control is a crucial part of the management of large engineering projects. The monitoring and control of the project progress are among the key elements in classic project management works (Cleland & King, 1975; Grant & Pennypacker, 2006; Locke, 1984). Control is mainly operational during the execution phases of a project and is sometimes even considerate a separate section (Vrancken, 2012).

A division in *cost* is identified between *Opex* and *Capex*. As projects van differ significantly on both aspects the different aspects can best be included in the analysis separately. In addition a *cost risk analysis* provides insight in the possible risk on costs overruns during the development and operation of the project.

Human resources are a crucial part of project development. The influence of the project team and team leader on the development outcome is substantial (Locke, 1984; Meredith & Mantel, 2010). In addition the multi-disciplinary nature of the development requires the project team's capabilities to reflect the major areas of expertise needed for the planning and execution of the project (U.S. Department of Energy, 2010).

Integration is only included the selection of Grant & Pennypacker (2006) and the PMBOK (2004). Despite the fact that it isn't mentioned often it addresses a highly relevant issue: are all the project aspects aligned with each? Is the permitting and regulation strategy for instance aligned with the project schedule and critical path? The integration of the different project aspects seems to be highly relevant for the development of a project.

Procurement is specifically included in the different PDRI frameworks (Hamilton & Gibson, 1996; U.S. Department of Energy, 2010). They're particularly focused on the technical aspects and material management of the development. Procurement can possibly be included as a separate criterion or as a part of contracting.

As a part of the iron triangle (Atkinson, 1999) *quality* includes different aspects that are identified in the thesis as relevant, like human resources and stakeholders. For this reason it is questioned whether *quality* should be included in the framework as a separate criterion. *Quality* might operate at a higher abstraction level then those identified criteria making it less feasible or even impossible to compare their performances.

Although mainly brought forward as a criterion by the PDRI framework *safety* as a criterion must be noted (U.S. Department of Energy, 2010). In any project safety must remain the top priority.

A well-defined and well-fitted project *scope* is developed, both internally as in collaboration with other stakeholders. The scope definition includes the goal and clear objectives of the project as well as all the aspects of the project schedule. The goals and objectives are accessible to all interested parties.

The socio-technical nature of the front-end development of biomass projects places the development in a complex stakeholder environment with *stakeholders* ranging from suppliers and local residents to different levels of governmental agencies. A stakeholder analysis and management program could increase stakeholder engagement and diminish chances on issues later in the process.

In regard the ex ante application of the framework possible issues with *time* as a criterion are expected. Time, as a criterion, is better suited for ex post performance measurement, as the eventual project time is unknown before the execution is finished. Schedule is suggested as a possible alternative to time (Cleland & King, 1975; Pinto & Slevin, 1987).

The paper applies front-end development to the case of renewable energy project development. The industry appropriate for demonstrating the value of the perspective due it's the level of development in the sector, the current high investment need due to European target for renewable energy production and the identified lack of common learning in the sector. The high project complexity and its situation in a socio-technical environment make it a suitable example for the application to large engineering projects. The initial analysis from project management and pre-project management literature is supplemented by literature research and expert interview related to the renewable energy sector. Table 4 presents the identified criteria.

Criteria	Literature	Interview
Business case	(Netherlands Enterprise Agency, 2013)	(Middelkamp, 2014; Nijboer, 2014; Oskam, 2014; Pulles, 2014)
Contracting	(Morris & Hough, 1987)	(Nijboer, 2014; Oskam, 2014; Pulles, 2014)
Financial support	(Netherlands Enterprise Agency, 2013)	(Middelkamp, 2014; Van Dongen, 2014)
Permitting and regulation	(Kahn, 2000)	(Emonds, 2014; Oskam, 2014; Pfeiffer, 2014; Pronk, 2014; Pulles, 2014)
Public Opinion	(Agentschap NL, 2011; Devine-wright, 2007)	
Regulation	(Agentschap NL, 2011)	(Emonds, 2014; Nijboer, 2014; Pronk, 2014; Pulles, 2014; Van Dongen, 2014)
Sourcing	(Faaij et al., 1998; Netherlands Enterprise Agency, 2013; Niemela, Roder, & Murray, 2010)	(Middelkamp, 2014; Nijboer, 2014; Oskam, 2014; Pfeiffer, 2014; Pulles, 2014; Van Dongen, 2014)
Technology		(Middelkamp, 2014)

Table 4 Overview RE criteria

In contract to *cost* as identified in paragraph 2.1.2 *business case* includes both the cost and the revenue side of a project. The possible revenue depends on the sales volume, the electricity and heat price and possible financial support. *Cost* is discussed in paragraph 2.1.2. In contrast to other renewables the marginal costs of biomass projects aren't equal to zero therefore creating a two-sided price risk.

Contracting is a key aspect of project development. Contractors are often used to outsource work due to cost considerations, lack of resources and/ or specific expertise or for transferring part of the project risk (Verbraeck, 2010). The selection of a contractor influences different other arrangements within the front-end development process. An example of this is project finance as it influences project risk. A contractor with a good track record, strong financial position and whom is able to give guaranties influence project financing possibilities positively and vice versa.

Renewable energy and biomass aren't on a competitive level with conventional energy regarding pricing and therefore additional *financial support* is needed. To stimulate renewable energy production different support schemes are available. These are discussed in paragraph 3.2.1.3.

Permitting and regulation is identified as one of areas where issues are common. Both due to an underestimation of permitting and regulatory needs as to the permitting time (Emonds, 2014). An analysis of the permitting and regulatory environment leading to the development of permitting and regulatory strategy and plan reduces the risk on these types of issues.

The *public opinion* regarding biomass differs from the public opinion regarding other renewables due to emissions from the combustion, the combustion chimney and the transport of the feedstock. Furthermore Devine-Wright (2007) identifies a relatively high ignorance regarding biomass. Public opinion indirectly affects regulation, permitting, financial support and stakeholders.

The *regulatory* environment of biomass projects is more complex than other renewables due to the use of external feedstock. The most common issues in regulation are related to the sustainability of feedstock, transport, emissions and feedstock storage.

As observed on several points in the research biomass *sourcing* increases the overall complexity of biomass in comparison to other renewables. The lack of biomass market creates uncertainty in biomass supply. Long-term contracts reduce this risk and are often demanded by investors.

Risk minimisation is a key element in investment decisions and project development. The risks in developing project with proven

technologies are substantially lower than with new and/ or unproven technologies. *Technological* flexibility in feedstock is identified as highly important for the projects feedstock sourcing and indirectly business case.

The identified criteria from project management and pre-project planning together with the identified criteria from the renewable energy practise form the base for the further selection of criteria.

Selection of Performance Criteria

The selection of criteria is a major step in the design of the front-end development framework. The selection forms the base of the assessment methodology. During the selection process a trade-off between the number of indicators and manageability of project needs to kept in mind. To prevent an information overload the selection must only include criteria that are a critical part of the development and contribute the overall development process. The risk of including too many criteria is apparent and must be taken in account constantly. A good selection allows for the position of the development to be checked, criteria to be prioritized, progress measured and the development status to be communicated.

On the selection of criteria Boussofiane states that all resources used must be included, as inputs and a wide range of performance and activity measures serves as outputs (Boussofiane, Dyson, & Thanassoulis, 1991). In contrast Luu states, in *Improving project management performance of large contractors using benchmarking approach* (2008), the selection of criteria to measure the project development can't be too extensive as this has severe implications for the manageability of the project.

> Too many KPI's will make a project very hard to manage and will therefore diminish the value of the framework in time (Luu et al., 2008).

The objective of the selection is thus to provide a complete as possible selection without having an information overload and losing the selection's manageability. Otherwise the practical purpose is reduced. The framework selection builds on the base of the hybrid project management perspective and the ideas behind the PDRI framework. It combines project and project management success criteria with a strong focus to the early development phases of a project. By building on the hybrid instead of classic perspective it addresses one of the major downfalls of PDRI.

The selection process is based on a literature study, expert interviews and empirical research. A total 17 experience renewable energy experts have been interviewed. All the experts have at least 3 years of experience in the renewable energy field. The experts include renewable energy developers, consultants and lawyers. The selection includes a total of 10 KPI's and 40 sub-indicators and is presented in table 5.

KPI	Sub-indicator
Business case	Revenue estimate Construction cost estimate Operational cost estimate Scenario analysis Value improvement practices Finance
Contracting	Contracting analysis Contracting strategy Contracting operations Clear contracting scope
Feedstock	Market analysis Sourcing strategy Sourcing plan Sourcing operations
Human resources	Establishment of project team Upper management support of project team Team composition Team evaluation and improvement Clear objectives for project team
Permitting and regulation	Context analysis Integral strategy Integral plan Operations
Schedule	Project schedule Critical path management Change management program
Scope	Scope definition Change management program Clear objectives
Stakeholders	Stakeholder analysis Stakeholder management program Communication and mobilization
Financial support	Support possibility analysis Integral support strategy Integral support plan Operations
Technology	Technology fit Technology reliability Technology flexibility

Table 5 Overview KPI's and sub-indicators

The selection of KPI's and sub-indicators is based on balancing the completeness of the analysis with the practical considerations of applicability and manageability. The expert validation confirms that the selection of KPI's sufficiently covers the front-end development of biomass projects. The chosen delineation includes the full spectrum of front-end development instead of focusing on one specific aspect. This increases the overall applicability of the framework significantly.

Some criteria are not included in the selection for reasons related to the manageability of the selection. Examples of this are procurement, safety, control and integration. Although they are relevant to the front-end development, they are valued less important than the other criteria.

All of the KPI's are operationalized by the inclusion of different sub-indicators. For each sub-indicator a definition of it's ideal performance is developed. The definitions provide additional insight in each sub-indicator and aid in quantifying their performance. The definitions describe the different sub-indicators at their saturation point. At the saturation point performance is rated 5 on the scale of Likert, while a situation where the sub-indicator isn't addressed at all in a project is scored a 1 on the Likert-scale. The definitions are developed to increase the reproducibility of project results (Ceelen, 2014).

All the criteria presented in table 5 measures the performance of the front-end development, which is the outcome of the development process. *Development expenditure (*or *Devex)* is suggested as a possible input variable for the framework. Measuring the costs made for the front-end development, until final investment decision, *development expenditure* seems an adequate criterion for measuring the input. To allow for intra-project comparison without a specific point in time the ratio of *development expenditure spent* over *development expenditure* is used.

While the objective is originally delineated to the pre-execution phases of a project some its execution starts at the very initiation. In case of large engineering projects aspects like stakeholder management and permitting have to start at the initiation of a project and can't be postponed to the execution phases. This implies that a combination of ex ante and ex post performance measurement is necessary to correctly measure the development performance. This relates closely to the difference between project and project management success. Despite its focus on the early phases of project development both process and result measurements are included in the measurement.

Summary and recommendation

Project management as a research field is marked by an incremental development over time. Three main perspectives on project management are identified. The classic perspective purely measures the result of the project management and doesn't include any criteria measuring the performance of a project post-delivery. By focusing on project management success mainly the classic project management is aimed at measuring management efficiency rather that what criteria makes project management successful.

The new perspective in contrast is focused mainly on the post-delivery project results, but lacks project management criteria. It is observed that the criteria from both perspectives are highly unrelated. It is further questioned whether these perspective hold any current relevance since the development of the hybrid perspective. Atkinson suggests building on the classic base, but including temporary criteria for the different project stages. The hybrid perspective includes both project and project management success criteria. While this presents a more complete overview of relevant criteria the perspective remains focused at the execution phases of a project mainly. This suggests that project management isn't as much aimed at aiding the project developer/ owner develop a project plan, but at helping them monitor and control the execution of a project.

The potential to add value is observed highest in the early phases, while they in particular are underexposed. Pre-project planning addresses this with an interesting perspective, but for several reasons is unfit for wide application. Pre-project planning does show that projects that are well-developed during the early project phases yield better result later on with an accelerated development and less cost overruns. Pre-project planning shows the potential of increasing pre-execution effort, but neglects to fully benefit from the available knowledge. During the literature review it is observed that pre-project planning mostly builds on the classic project management perspective with its objectives more focused on management and control than development. It furthermore doesn't fully acknowledge (and as a result optimises) the fact that the design space is largest at the start of a project and diminishes over the course of its development. Project management and pre-project planning neglect (part of) the early development phases and therefore lose part of the value they are potentially able to add.

The papers suggest a novel front-end development framework as a possible appropriate methodology for addressing the early phases of project development. It combines a focus on the early phases, builds on the hybrid project management perspective and in this specific case characteristic of renewable energy development. Front-end development distinguishes itself from project management by aiming to add value, where project management mostly aims to maintain value.

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