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The Front-End of Projects: A Systematic Literature Review and Structuring

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The Front-End of Projects: A Systematic Literature Review and Structuring

This paper summarises the results of a comprehensive systematic literature survey on the front-end of a project, commissioned by the Project Management Institute. The dedicated literature on the front-end is sparse: although the front-end has been shown to be critical to the strategic success of the project, this phase of the lifecycle is not well understood. This paper presents the literature on the concept of the front-end, and defines a temporarily ordered structure of generic processes that form the 'front-end' and how these fit together as a coherent whole. These start from the preliminaries to the initiative, then the project purpose (for various stakeholders), the initial analysis and scenario analysis; the analysis of alternatives and choice of project concept; assessment of the project, finishing with setting up project execution. It summarises the recent literature at each of these elements in turn, specifically as they relate to the front-end.

Keywords: project front-end; project management; project concept

1. Introduction: the Literature Survey

This report summarises the results of a literature survey on the front-end of a project (Williams et al. 2018), commissioned by the Project Management Institute (PMI). Morris (2011, 6) explains how 'most of the factors which seriously affect […] project outcome, for good or ill, will have been built-in to the front-end definitional decisions', but continues 'the problem is, we don't generically know what managing the front-end really entails.' Edkins et al. (2013, 71) make the same points 'that many of the things that cause projects not to succeed have their origins in decisions made in the project's front-end and that the front-end is the part of the project that has the greatest opportunity for creating value' but our knowledge of the front-end is inadequate. Apart from these key references on the front-end of projects (and, e.g., Samset and Volden [2016]; Williams and Samset [2010 and 2012]; Williams, Samset, and Sunnevåg [2009]), there is not a clear definition of 'front-end' nor a clear understanding, nor a firm foundation.

This study reports on the findings of a systematic review of publications published mostly during Jan 2006 and Sep 2017 on the area, aiming to investigate what defines the 'front-end' of a project, examine what generic processes comprise the 'front-end' and how these fit together as a coherent whole. We also reference a project-management lens and discuss the implications of this work for managerial practice. This research seeks to address five main research questions (RQs)

which helped guide this literature review. We have three preliminary questions: RQ1: What is the front-end?; RQ2: Why is the front-end important?; and RQ3: What are the roles and responsibilities in the front-end? Then the main thrust of the paper is exploring two further research questions - RQ4: What happens in the front-end? and RQ5 What should a structure for the front-end comprise?

To the best of our knowledge, no previous research has been carried out specifically with this purpose. Hence, this study provides a significant opportunity to advance the understanding of this growing area of research. For reasons discussed below, the main survey conducted is of literature since 2006.

The paper is structured as follows. Following this introduction, Section 2 gives the methodology for conducting the literature review. Sections 3-4 reports the results obtained, that is, the nature of the front-end, why it is important, what the roles involve, what constitutes it, and the elements of the front-end in turn with a diagrammatic temporal representation. Section 5 discusses limitations of the work and Section 6 offers some concluding and theoretical remarks.

2. Methodology

The systematic literature search proceeded through three steps. A comprehensive list of keyword combinations was first developed through reference to key literature and two major databases in the EBSCOhost research platform, 'Academic Search Premier' and 'Business Source Premier' employed. The search was planned in 2016 and initiated in 2017. Appendix 1 shows the specific search strings employed and the results.

For the three keywords which are fundamental to this study - 'front-end', 'project concept', and 'conceptual appraisal/phase' - we searched for publications with no time limit (see below). However, we found that of the relevant papers, 82% were published after 2005. In order to limit the size of the task for other keywords, we therefore only searched articles in the previous decade (i.e. from Jan 2006 onwards). In doing so, it is acknowledged that some of the fundamental classic authors may not be cited, e.g. work such as Shenhar's (2001 and other publications) or Pinto & Slevin (1988 and other publications). However, where this is the case we have ensured that the foundational work is encompassed within – and appropriately cited by – the references below (in the examples we just quoted, Ika (2009)'s literature survey discusses this work). Therefore, while it may be that some authors are not cited, the content presented below covers these authors' important work.

In Stage 1, we searched using a primary group of 15 term combinations included the central term ‘front-end’ and similar words. Two iterations were conducted. In the first, the papers were collected. For two specific quite general keywords, there were a considerable number of papers, so we reduced the set by using a list of journals. [We employed the UK Association of Business Schools (ABS)' Academic Journal Quality Guide (2015), focusing on (i) mainstream journals such as those in subject areas of Accounting; General Management, Ethics, & Social Responsibility; Operations and Technology Management; Operations Research & Management Science; Public Sector & Health Care; Regional Studies, Planning & Environment; Strategy; (ii) journals that explicitly welcome project management; and (iii) journals in specific sectors such as regional studies and transportation. We only selected journals given a rating of at least 3, except specific project-management journals. Also, a selection of 20 journals in related areas (but not on the ABS list) was added, giving a list of 118 targeted journals in total]. 2,446 articles resulted from the first search iteration. In the second iteration, we then checked each of these articles for relevance to the objective of this study by carefully reviewing the title and abstract of each article. We excluded all the publications that did not have ‘project front-end’ as their main research focus. Eventually, 199 of the most relevant papers were selected for detailed analysis and inclusion in this study.

In Stage 2, we searched for an exploratory group of 23 term combinations (see Appendix 1) which related to ‘front-end’ to a certain extent, and for 14 of these terms, we again restricted the output using the journal list. At this stage, 2,090 articles were chosen in the first iteration and, following the same principles as outlined above, 168 papers in the second.

In this way, the 43,000 original papers were reduced to 4,500 and then to 367 papers. As we studied these papers, in Stage 3 we identified key papers and used citation indices to search systematically for good papers that cited them, and looked for any particular key references used, resulting in a final set considered for this study comprising 524 papers. This formed the basis of the full survey report delivered to PMI, which is over 50,000 words long. This paper forms a structured summary of that survey, but for the purposes of space does not have every paper referenced here. During this process of refinement and review further key references have been added.

3. Findings and Discussion – RQ 1-4

This section is divided into four main sub-sections, each of which presents the results relating to one

of the research questions; the fifth question will be dealt with in Section 4.

3.1. RQ1 - What is the Front-End?

The definition of the "front-end" of the project is bound up with the definition of what a "project" is. Morris (2016) distinguishes between those that see the front-end as the vital 'shaping' part of a potential project, and those that see the project only starting once the 'front-end' is completed. Edkins and Smith (2012, 138) note that there is not agreement on the definition, but conclude that there is agreement (and evidence) that 'the early stages of a project are one of the primary points where strategic success or failure for the project is set.' Certain developments need to occur before the project proper starts, as shown in Table 2 below, and these all need to occur in the "front-end".

A project results when an organisation or party has a desire to achieve a particular change or outcome. When this desire is sufficiently specified and formalised, a person or organisation is nominated and/or delegated to undertake a defined project, whose output is deemed appropriate to achieving or contributing to that change or outcome. The organisation which initiates the project and desires the project outcome has been called the 'permanent organisation' although we will see below that the terminology varies. This is in contrast to the extensive literature around the phrase the 'temporary organisation' for the entity that undertakes the project. Often the project is undertaken by an entirely separate organisation ('the contractor's job is to deliver a project as specified, on time and budget; the owner's job is to specify the right project' [Merrow 2011, 126]). However, a 'project' does not necessarily imply the existence of a separate organisation or indeed the existence of an organisational structure (although it is difficult to imagine executing a project of any size without some sort of organising). Indeed, early work on matrix organisation assumed team structures superimposed upon the permanent organization structure. Bakker's (2010) review of organising talks about 'temporary organizational forms' rather than temporary organisations. The important element here is the permanent organisation and its definition of its needs. The nature of the organisation or structure undertaking the project is actually a decision to be made in the front-end of the project. But the undertaking or project is temporary – or more properly 'determinate' (i.e., it has a foreseeable and pre-agreed delivery objective and end-time) as defined by Winch (2014).

The review of the 'front-end' of the project will thus engage with the period up until the permanent organisation tasks the person or organisation who is to be responsible for delivering the

project (see Figure 1), although it should be noted here that that person/organisation might have already been included in the front-end to give advice on the process or carry out other front-end activities (see below). It makes no assumption of the nature of that person/organisation – and indeed, one of the tasks of the 'front-end' will be to start to explore that nature.

This is of course somewhat simplistic. In particular, there will often be a pre-contract or mobilisation phase between a contract being granted and the start of that contract; we deem this to be outside of the 'front-end' since a contract is defined and placed at this point (and besides, there appears little literature in this area). Furthermore, the single 'front-end' within the permanent organisation might well consist of subgroups who shape and define the project – but this is all within the permanent organisation, and therefore within our definition of the front-end.

Figure 1 is here

The strategic role of the 'front-end' is in defining what the project is to achieve, establishing its feasibility, and shaping project 'success' (defined in terms of strategic performance rather than deliverables – see below). This brings in the need for recognising the 'drivers' for what may become the project: opportunities (achieving something desirous) and problems (resolve something that is harming or troubling). The two key words here are 'strategy' and 'context'. It is important to understand that the project 'emerges' from some form of consideration. This can be actively encouraged or unexpectedly apparent. Whether active or passive, all projects are the result of some form of consideration and sanction.

This then brings in the two important components of the front-end: the principal players and the primary process, 'ideation' being at the heart of the latter (Kock, Heising, and Gemünden 2015, 2016). The key players can be considered as the 'who' and in asking 'who is driving the project?' one has to then ask 'and why?'. The 'who' drives the front-end: it is from the organisation that has a desire to achieve a particular change or outcome. That organisation will have to put in place project governance (Samset and Volden 2016) to oversee the project - distinct from project management. The 'who' is thus most typically from outside the project management function. While much of the understanding of what goes on in the front-end is still unclear and poorly understood, what is clear is that it is project management's role to deliver the (initially undefined) project.

Generally, the point at which the front-end finishes is considered to be the point at which final sanction is given to authorise the project. This can though sometimes be both not clear and/or not well-defined. We consider the front-end as being concluded when the point at which responsibility is

handed over to the individuals with ideally accountability and responsibility for delivering the defined and approved project. What is striking in this discussion is the variety of ways that the front-end can be considered and understood – although it could be suggested that the greater the maturity of the permanent organisation in dealing with projects, the more structured and well-defined the management of the front-end is likely to be.

This discussion also points to what is perhaps a gap in knowledge in our field. There has been much work on what organisations need to do and why (well-grounded but treating projects as entities that realise strategy) and internal study within well-defined projects (sometimes theory-light normative studies although less so more recently – eg Maylor et al 2018 and Geraldi and Söderlund 2018). The front-end is where these two come together: the project does not sit alone, but within an environment and context which defines the need and context for the project. The move recently into 'Project Studies' (e.g., Geraldi and Söderlund 2018) recognises the need to study both together and the complex interfaces between them. The "front-end" is what defines the joining together of these, and sets the scene up to passing the project over to "project management".

3.2. RQ2 – Why is the Front-End Important?

Part of the object of the front-end in some systems is to prepare a project for funding approval or sanction and some version of a stage-gate (e.g., Klakegg et al. [2008] in the public sector; Shiferaw, Klakegg, and Haavaldsen [2012] in construction; Roobaert [2011] and Jambhekar and Weeks [2008] in Front End Engineering Design (FEED), Strang [2011] in portfolio selection and evaluation). One of the paradoxes identified in practice by Samset and Volden (2016, 5) is that 'less resources are used up front to identify the best conceptual solution (project governance) than to improve tactical performance during implementation'. But it might be that this sort of stage-gate mechanism is becoming more frequent: Construction Europe (2015) shows pre-project due diligence reviews increasing.

The importance of the front-end decision-making phase in securing projects' long-term success is increasingly recognized (Samset and Volden 2016). The interest in the front-end as a discrete part of the management of the project (noting that we technically are managing a phase that is before the project formally exists) is justified from the downstream results. The literature seems to be clear that an emphasis on a careful and thorough front-end is related to project and portfolio success,

as discussed in Morris (2016), Flyvbjerg (2013), Shiferaw, Klakegg, and Haavaldsen (2012), Kock, Heising, and Gemünden (2015, 2016), Hwang and Ho (2011), and Cravens (2017).

The particular importance of the front-end is because critical decisions are made during this phase (Kock, Heising, and Gemünden 2015; Jankovic, Cardinal, and Bocquet 2009). Heising (2012) discusses how at the front-end, opportunities are discovered, ideas are created, and the foundation for the later project, portfolio, and, eventually, corporate success is laid. A key advantage of this phase is the clarity with which the fundamental reasons for the project can be addressed, before the confusion between achieving 'project delivery' success and 'project outcome' success. Because the Business Case (BC) focuses on the benefits the customer or user hopes to receive, this can form the basis of the planning documents (Kloppenborg, Tesch, and Manolis 2014). Kwak et al. (2014) show an example of the clarity arising from this phase in the case of the Hoover Dam.

Meier (2008) shows that early pre-acquisition activities can significantly reduce cost and schedule growth. Collins, Parrish, and Gibson Jr (2017) show that projects with better scope definition had improved cost and schedule performance. Thomas and Ellis (2007) indicate that better pre-bid plans reduce costs, shorten schedules, and improve labour productivity.

On the negative side of the argument, Williams et al. (2012, 41)'s work on 'early warning signs of problems' suggests that 'Roots of problems in later project phases are found in processes and decisions at the front-end of projects.' The types of "problem" found in later phases can be many and varied, including problems with delivery (cost overrun, schedule delay), quality (unsatisfactory quality, error rates), benefits shortfall, and so on. Guarding against these problems, and the necessary work to be done in the front-end, is discussed in the various sections below. However, it is worth noting that a body of 'systems' work has tried to trace these cause/effect structures in post-hoc analyiss (see a summary of this literature up to 2005 in Williams (2005) and a more recent paper in this journal (Love et al 2018). McClory, Read, and Labib (2017) give the top reason for project failure as poor pre-project-planning (including 'lack of ability to manage the front-end very well'). Eun Ho et al. (2016) show that inadequate construction input during the front-end results in the fragility of plans regarding constructability. Even where the 'front-end' is not mentioned as such, Stretton (2014) found 42 different causes for project failure, many of which can be grouped as project initiation (e.g. unclear success criteria, changing sponsor strategy, poor project definition, unrealistic project baselines, incomplete requirements, inadequate estimating, unrealistic expectations, commitment escalation). Where the front-end is not given sufficient resource (including money, time and degree of intellectual

focus) and it is rushed, there is a danger that it is simply put onto a register or into a portfolio, providing the opportunity to place pressure on the permanent organisation for both continuing existence and resource attention. The literature appears clear that this acceleration through the front-end to the point of sanction legitimisation is recognised as a cause of downstream failure (Wearne 2014). In certain sectors (such as industrial, oil and gas and extractive sectors) the emphasis is explicitly on the front-end (Front End Loading (FEL) – as part of the FEED approach) and is there to force the minimisation of the chances of later problems.

Front-end maturity – knowledge transfer: Early estimates of a project's efficiency, effectiveness, and impacts are undoubtedly challenging, and therefore it is important to acquire experiential knowledge by studying similar projects (Samset 2013). While projects are by definition new, a more mature organisation will be able to transfer knowledge about projects and how to develop a front-end (see, e.g., Lê and Bronn [2007]). Chronéer and Backlund (2015) aim to help this process by developing an 'organizational-wide project learning process' to improve learning in project-based organizations. Williams (2016) similarly encourages the move from learning from individual projects to learning about organizational, cultural, and environmental factors that can lead to project success. This is discussed further below.

3.3. RQ3 - What are the Roles and Responsibilities in the Front-End?

There are a number of different roles in the frontend, but there are no agreed definitions.. However, Zwikael and Meredith (2018) have undertaken a significant attempt to bring common definitions for key roles found in the front-end. Clarity is needed in distinguishing between the front-end, as embedded in the permanent organisation interested in the strategic benefits which are outcomes from the project, and the project environment being set up in the front-end with a project delivery team tasked with producing the project deliverables; Elbarkouky and Fayek (2011) look at this distinction linguistically. There are quite different roles in these two different project phases (Sewchurran and Barron 2008). The front-end of the project is the start of such dialectic relationships between all the different roles and moving into the project phase (see also Matinheikki et al. (2016) who discuss governance within inter-organizational networks). While Zwikael and Meredith found ten project roles, we use a coarser classification and find in the literature five types of role (see Table 1).

Table 1 is here

3.4. RQ4 - What Happens in the Front-End?

It is clear from the literature that some activities or events occur during the front-end (Table 2), and this has helped to inform the structure for this paper: each of the following is discussed below.

Table 2 is here

This list of issues and factors not only informs the structure for this paper which will be discussed in detail in the later section, it illustrates the process and logic through which a project front-end proceeds (as presented below in Figure 2), although noting the comment in (x) (Table 2) that there can be feedback and nonlinearity in the process. Figure 2 was designed to illustrate the front-end process rather than the roles in the front-end phase, which are considered separately further below.

Figure 2 is here

4. Findings and Discussion – RQ5: *What Should a Structure for the Front-End Comprise?*

In this section, which forms the bulk of the paper, each component of Figure 2 is discussed in detail in a structured flow from the genesis of an idea through to setting up the project for execution. Section 4.1 below looks at the environment and describes some preliminaries. Then Sections 4.2-4.5 and their subsections look at each box and sub-element of Figure 2 in turn.

4.1. Project Initiative: the Preliminaries

4.1.1. Environment

As we consider the genesis of a project, we need to look at the context where it emerges. A project does not exist in isolation but is dependent on various factors (both internal and external) which are complex and uncertain. Analysis of the project environment can facilitate the project to position itself carefully to its environment and align its objectives and management (Artto et al. 2008). Within the public domain, Christensen (2012) describes major public projects as a political decision-making process in which politicians utilise a neutral administrative mechanism to execute the policies adopted by the elected legislative bodies. The political environment thus impacts the project indirectly through the strategic context of the organisation created by the decisions made by the top management level (Narayanan and DeFillippi 2012). There is growing interest in the political aspect of projects; Söderlund's (2011) categorisation of articles on project management into seven schools of thoughts

include the Decision School characterised by its primary interest in explaining the complexity of the political and decision-making processes inherent in public projects during their early phases.

Studies on the front-end (e.g., Williams and Samset [2010, 46]) point out that the formation of project strategy and significant decisions during the front-end of major public projects are usually not made solely by individuals but in consideration of 'social geography and politics' of decision-making groups, and also show the negative impacts of political biases, preferences, and pressures on the estimation of project costs and benefits. These findings are reinforced by Samset and Volden (2016, 7) who state that 'decisions are made at the intersection between the professional and political' during the front-end and that legislative priorities might have a more significant impact than rational judgment on the decision making. Gil and Pinto (2018) examine the effect of polycentric organizing for project environments. They show politics and its structure as front-end decisions can heavily impact the results of the project. On the other hand, Christensen's (2012) study of the major public projects in Norway shows no sound impression of robust control of political executives; he also indicates that projects at the regional level have a smoother collaboration between politicians and expert authorities than those at the central government level and central government has a stronger influence on the national projects than on regional projects.

4.1.2. Business Case (BC)/project proposal.

The importance of a well-written BC early in the project lifecycle is well-recognised (e.g., Dalcher 2011; Hoppszallern 2010). Some governmental bodies e.g. the UK Treasury (Flanagan and Nicholls 2007) and professional bodies (e.g. PMI [2017b]) consider the BC as essential for any project or programme, although many organisations are reluctant to assert that they follow this. (Note that we are accepting here that, particularly in major government projects, the words 'project' and 'programme' (Rijke et al. 2014) are concepts that can be muddled together, and the work we describe here applies to both self-standing projects and programmes).

There are a variety of definitions of the term BC (e.g. Association for Project Management [2012]; AXELOS [2009]; HM Treasury [2013]; Kopmann et al. [2015]; PMI [2017a, 2017b]). However, key aspects are that (i) it captures the quantitative and qualitative justification for the initiation of a project/programme; (ii) it is prepared during the early stages of a prospective project as a basis for the decision on the feasibility of the project; (iii) it can range from voluminous,

comprehensive and well-structured to brief and informal; (iv) it assesses the cost, benefits, timescales, and risk of alternative options or the option of doing nothing and provides a rationale for the preferred solution; (v) it establishes baselines against which the project progresses and success can be measured; (vi) it is a living document to reflect the change of the project environment; and (vii) it is initiated by the executive or manager above the project level (maybe with the assistance of the project manager), re-evaluated at the end of each project phase gate or critical decision point, and maintained throughout the project lifecycle by the project manager.

In the UK, the 'Five Case Model' is recommended by the HM Treasury as a standard for the development of BCs and is extensively used within central government departments and their agencies (HM Treasury 2013). The model looks to establish a case for investment by preparing five key cases: strategic, economic, commercial, financial, and management (HM Treasury 2013, 7& 11).

Few scholars have addressed the use of BC at a project portfolio level; the study led by Kopmann et al. (2015) demonstrated a positive relationship between 'BC control' and the success of project portfolio, and suggested relating responsibility for the realisation of the BC and incentive schemes. The authors identify three main elements constituting BC control: the evaluation and prioritisation of project proposals using the BC, the on-going monitoring of the feasibility of evolving projects, and tracking of the BC regarding benefits realisation following the project closure.

4.1.3. Project selection & go/no-go decisions.

The selection process for projects, in reality, is 'complex, less structured, and affected by chance,' and is often influenced by biased or insufficient analysis as well as political priorities (Williams and Samset 2010). Various methods for project selection have been offered in the literature; a systematic literature review conducted by Dutra, Ribeiro, and de Carvalho (2014, 1042) results in 35 different criteria used in project selection methods, which are classified into four groups: strategic benefits, business benefits, technical difficulty, and financial costs; they propose a selection model in which the use of 'economic and probabilistic approaches' are integrated in order to quantify the investments and their potential uncertainties to decision makers.

The approach taken to project selection depends upon the sector. Oil companies sometimes employ a three-stage process for project initiation: 'appraise', 'select', and 'define' (Jambhekar and Weeks 2008), where the 'select' stage evaluates options and picks the best, then focuses on the

conceptual design for the chosen option; the recommended concept will be subjected to further analysis to make sure it still aligns with the organisation's strategic objectives. For information system projects, Hsu et al. (2011) find that project performance can be improved by considering the user perspective in the screening criteria of the project selection process. For projects in transportation, manufacturing and service industries, where consideration of equity issues in resources distribution is necessary, Joshi and Lambert (2007, 539) use 'network-level equity metrics.' For construction projects, Han, Kim, and Hyoungkwan (2007, 354) propose a profit prediction model for the selection of international projects, including 'defining, analyzing, and evaluating various profit-influencing risk variables'. In the public sector, Puthamont and Charoenngam (2007) propose the use of three phases (conceptual, design and final approval) for selecting projects.

The literature generally assumes that a project has come out of planned consideration within an organisation. There are different circumstances where a project is driven by extreme contexts such as emergency contexts, risky contexts, and disrupted contexts (Hällgren, Rouleau, and De Rond 2018). Whilst there is relatively scant literature on this area through the project lens (Chang et al. 2012), there is more diverse literature on disasters and disaster recovery when considered as more generically (Phillips 2015) or when considered as a process. As the specific variations in such urgent and important projects cannot be completely predicted, the focus is on the planning and preparedness of those responding. It is therefore not surprising that the focus is on the topics of learning from emergency contexts (Hällgren, Rouleau, and De Rond 2018), availability and management of resources (Chang et al. 2012) and capability (Sheth, McHugh, and Jones 2008).

Decision biases are also very important here. Miller and Hobbs (2009) question the underlying assumptions of the rational decision-making mechanisms of projects and explain a number of issues often clouding judgment and leading to choices not aligning with strategic objectives. Various cognitive biases are natural to humans and particularly affect project decision making such as: selection bias - a phenomenon in which only winning projects will be built and observed, and where losing projects are never created or never appear in the system, which might cause overestimation (Xu et al. 2015); decision biases in probability estimation (Moret and Einstein 2012a); optimism bias (unintentional underestimating of costs and overestimating of benefits) and political-economic bias (explanations of the deliberative claim of an optimistic view of the future) (Flyvbjerg 2009); and the effect of remuneration systems (Koller, Lovallo, and Williams 2012) which can lead to what could be called 'pessimism bias' – unintentional overestimating of the probabilities of negative future events

that leads to not choosing a project even when there is clear evidence that the potential losses of the project are much less than its potential earnings. Both Kirkebøen (2009) and Liedtka (2015) have given lists of cognitive biases, grouped, and attempt to explain their causes. Although there has been an enormous literature on this topic, space constraints mean that there is not scope to explore this area more fully in this paper.

4.2. Project Purpose

4.2.1. Strategic alignment.

Any project/programme conducted within an organisation should have its goals line up with its strategy, to 'achiev[e] objectives within an organization's strategic plan' (PMI 2017a, 9). Morgan, Malek, and Levitt (2008) describe executing the strategic process by projects in a six-step process: after establishing the organisation's purpose/long-term intentions, aligning the strategy with the company's culture, and goal-definition, the fourth step is doing the right projects to carry out the strategy (portfolio management), then executing the projects in the proper way and finally transitioning the results of the projects into the organisation's operations.

Although projects are means of implementing organisational strategy, few studies seem to have investigated the linkage between the shaping and executing of projects and the implementation of the organisational strategy (Morris 2009). Samset and Volden (2016) define the alignment of objectives as an essential activity that needs to be carried out before commencing any significant work on a project. However, this is not always appropriately done (Cooke-Davies 2009) due to the complexity and ambiguity of projects (Linehan and Kavanagh 2006) who dismiss the idea of a sole and explicit project goal. Too often inadequate time is spent in the early project phases to establish a robust project definition (Morris 2009, 44). There is 'a need for a more concise formulation of objectives' and statement of scope in the front-end to form a common understanding of the project's direction and when a target is achieved (Samset and Volden 2016, 305).

Cooke-Davies, Crawford, and Lechler (2009) show that the 'fit' between an organisation's strategic drivers of value and the configuration of its project management system helps determine the value it obtains from project management (see similarly Thomas and Mullaly 2008). Strategic fit is an important aspect of organizational structuring driving the front-end phase that can result in better project performance (Rauniar and Rawski 2012).

Patanakul and Shenhar (2012) report a growing trend of 'strategic project management' in the literature, in which the general idea is that the project team focuses on not only achieving the traditional 'iron triangle' (i.e., time, cost, and scope) (Atkinson 1999) but also supporting the strategy and sustainability of their company. They highlight the importance of the concept of 'project strategy,' which they define as 'the project perspective, position, and guidelines for what to do and how to do it, to achieve the highest competitive advantage and the best value from the project' (Patanakul and Shenhar 2012, 7). But this does not mean projects must follow the strategy of their permanent organisation. For a project to stay aligned with organisation's strategy, Samset and Volden (2012) indicate a need to identify the project's environmental turbulence and enhance the capability to deal with this confusion during the front-end. Similarly, Artto et al. (2008) suggest the opportunity for projects to play a more pro-active role in the formulation and implementation of the corporate strategy, and Vuori, Artto, and Sallinen (2012) show how the relationship between the parent organisation and the project affect the development of a project's strategy.

Project Portfolio Management (PPM) serves as a bridge between organisational strategy and project management (Tharp 2007), selecting and prioritising the most suitable projects (Too and Weaver 2014). Narayanan and DeFillippi (2012) describe the project portfolio of an organisation as a reflection of its underlying corporate strategy. Front-end success is an essential determinant for the success of the project portfolio, with real benefits relying on a large number of 'potential contingency factors' (Kock, Heising, and Gemünden 2016, 118). There is considerable literature on the PPM, including the need for the organisational structure to align (Kaiser, El Arbi, and Ahlemann 2015), 'Mission Breakdown Structure' (Andersen 2014), the importance of considering stakeholders in an integrated fashion across the portfolio (Voss 2012; Voss and Kock 2013), the effect of uncertainty on portfolios managed in dynamic environment (Petit and Hobbs 2010), the movement of technology and where decisions have irreversible implications (Focacci 2017) and particularly on the selection of what to fund (e.g., Tharp 2007; Wibowo and Kochendoerfer 2011), and the need for new PPM frameworks besides rational decision making processes, such as viewing PPM as negotiation and bargaining and as structural reconfiguration (Martinsuo 2013). PPM practices have a solid base in the management of innovation projects (Killen, Hunt, and Kleinschmidt 2008); there is, however, a general lack of research in the concept of an innovation portfolio and its link to the organisational strategy (Mathews 2010).

4.2.2. Success criteria.

Central to the definition of a project is what we mean by project 'success'. This is suggested by Ika (2009, 7), after reviewing articles on project success published between 1986 and 2004 in the Project Management Journal and the International Journal of Project Management, as an 'ambiguous, inclusive, and multidimensional concept'. There is no definition that applies to all projects in all environments (Albert, Balve, and Spang 2017; van Niekerk and Steyn 2011). The definition is dependent on perception and personal objectives (Agarwal and Rathod 2006; Koops et al. 2016; Müller and Turner 2007; Samset and Volden 2012; Turner and Zolin 2012) and varies by project types (Cserháti and Szabó 2014; Müller and Turner 2007), stages of the project life cycle (Do Ba and Tun Lin 2008; Turner and Zolin 2012), and nationalities (Müller and Turner 2007). And public and private parties do not share a common perception of project success (Węgrzyn 2016).

Müller and Turner (2007) consider 'project success criteria' as the measures by which the successful outcome of a project will be judged. Due to the multifaceted nature of project success, of which only some criteria are clearly quantifiable (Williams 2016), it is typically not straightforward to measure success in projects (Samset and Volden 2012). Traditionally, project management has focused on delivering the planned outputs based on the 'iron triangle' of schedule, budget, and quality, in which quality is defined as 'the consistent conformance to customer expectations' (Basu 2014, 181). However, Albert, Balve, and Spang (2017) illustrate clearly that this triumvirate of objectives is increasingly not the only elements for the determination of project success.

The critical point here appreciates that we are in the process of project definition – ahead of formal sanction. Initially, we have needs that we (and other stakeholders) require to have satisfied. Success is therefore defined as the satisfaction of those needs. This can be described as project outcome success or project benefit success. Once a project is defined, then it will have particular targets, including schedule and cost: satisfying these will give delivery or operational or efficiency success: this is where the 'iron triangle' fits. There is often confusion between these two types of 'project success,' and we need to establish longer-term values that a project can contribute to the fulfilment of corporate objectives (Greenhalgh et al. 2012; Williams and Samset 2010).

Thus, success criteria have been divided by Samset and Volden (2012) into tactical and strategic performance: Success in tactical terms typically means the criteria of iron triangle, which are short-term targets; they are measures of the project's efficiency and are fundamentally the project

management issues. Strategic success, on the other hand, focuses more on the economic, societal and environmental matters, which embraces the broader and longer-term perspective of whether the project would have a sustainable influence and remain fit and compelling over its lifespan. Koops et al (2016) illustrate the role of the 'iron triangle' is the perceptions of public project managers.

Perhaps the most influential framework classifying strategic success criteria was developed through work with the US Agency for International Development, then the UN and OECD (Samset 2010). This characterises a project's success by five criteria, the first of which (only) reflects the operational 'iron triangle' element: firstly efficiency (could the outputs have been produced in a better way? was the project well managed?), then effectiveness (were the goals achieved? did the output meet the goals?), relevance (how useful was the project to the organisation in context? was the goal aligned with the needs of the organisation?), impact (was the goal appropriate to the purpose of the organisation? What was the sum of the anticipated/unintended effects of the project?), and sustainability (will the positive impacts of the project continue longer-term?).

Project success includes different criteria which are independent but come together in complex causal interactions (Williams 2016). Key to these are the higher level success criteria set up before the project is defined and is therefore relevant to the front-end, then the efficiency measures ('iron triangle') to deliver the subsequently-defined project. Literature in this area has seen the suggestion of many criteria other than simply meeting objectives, including: customer satisfaction and other stakeholder satisfaction (Blaskovics 2016; Müller and Turner 2007; Williams et al. 2015); the triple bottom line (economic, social and environmental criteria) (Ghanbaripour, Langston, and Yousefi 2017); flexibility - the project's ability to deal with changes in the project definition or scope with minimal impacts on schedule, budget, and quality (Shahu, Pundir, and Ganapathy 2012); the performance of project manager as a team leader ('Many Shades of Success' 2015); and the controllability of the procedure between the front-end stage up to project delivery and handover (Koops et al. 2016). For public private partnership projects, some of the suggested success criteria include "profitability", "reduced public and political protests", "reduced litigation and disputes", "local economic development", "effective technology transfer and innovation", "effective risk management", "reduced public sector administrative cost", "reduced project life cycle cost", and "satisfying the need for public facility and/or service" (Osei-Kyei and Chan 2017, 85-87). Turner and Zolin (2012) have developed a list of performance indicators on how stakeholders will perceive the success of the project; their study brings together a number of success criteria at different timescales

for different criteria and different stakeholders.

These ideas should be distinguished from success factors, which are seen as the enablers of success. There is a considerable literature on success factors, including design and monitoring (Ika, Diallo, and Thuillier 201]), buy-in from senior management, explicit and realistic goals, and efficient plan (Fortune and White 2006); Blaskovics (2016) suggests nine groups of success factors, of which some are activities occurring during the front-end of a project, such as the clarity of the underlying the project strategic objectives, the scope definition of the project, and organisational and environmental characteristics; Menches and Hanna (2006) identify eight common success factors; Cserháti and Szabó (2014) separate factors in the front-end and execution phase.

4.2.3. Stakeholder management.

Up-front stakeholder management plays a key role in delivering successful project outcomes, both in terms of satisfying stakeholders' expectations, and avoiding stakeholder problems. Samset (2013) claimed that the designs of megaprojects are often undertaken without sufficiently analysing interests and needs of key stakeholders; Achterkamp and Vos's (2008) literature survey on project stakeholders confirms the need for stakeholders' interests toward a project to be dealt with during the early stages of the project (see also Assudani and Kloppenborg 2010). But evidence shows that the identification of a project's stakeholders in the front-end is still a considerably challenging task. The reason for this is clear: a complex project usually draws interest from multiple stakeholders, who express various requirements and expectations which are often in conflict with each other (Olander 2007).

Several attempts have been made to develop a classification framework to help formalise a front-end stakeholder management process. Olander (2007) develops a 'stakeholder impact analysis,' Achterkamp and Vos (2008, 754) advocate the use of a structured 'role-based stakeholder classification model' based on 'the stakeholder literature and the project roles in the project management literature.' Aaltonen et al. (2015) suggest the use of a 'stakeholder-salience-position matrix.' Revellino and Mouritsen (2017) offer an unusual stakeholder analysis to concentrate on the objects that matter to those stakeholders, using Latour's philosophy. For infrastructure projects, Mostafa and El-Gohary (2015) propose a stakeholder management scheme considering both the benefits and needs of project stakeholders and trying to achieve the highest social welfare. Social Network Analysis is often used to identify and prioritise stakeholders (Assudani and Kloppenborg

2010; Mok, Shen, and Yang 2015; Williams, Ferdinand, and Pasian 2015).

It is important to build good relationships with key stakeholders and to secure their commitment during the front-end of a project. Effective stakeholder communication practices help ensure fruitful engagement with stakeholders and consequently lead to a higher chance of achieving a comprehensive set of stakeholders' needs and requirements. The front-end is a very specific part of the project: different communication approaches are useful for different stakeholders at different stages of the project (Turkulainen, Aaltonen, and Lohikoski 2015) due to the varying degrees of stakeholder salience (Assudani and Kloppenborg 2010). Facilitated and structured workshops form a key part of the stakeholder assessment during the early briefing phase of a project, and Thyssen et al. (2010) have demonstrated how these are used to identify stakeholders' ideas of 'value.'

A better understanding of the possible conflict of stakeholder objectives could contribute to better front-end stakeholder management (see Aaltonen and Kujala (2010); Boudet, Jayasundera, and Davis (2011); and Metcalfe and Sastrowardoyo's (2013) argument mapping technique which enables the project team to visualise an argument in an easy-to-be-amended/discussed structure). Often objectives are unclear, and different constituencies have conflicting aims; Winter (2006) suggests a role for problem structuring methods to help define preferences and incentives. Different groups of stakeholders have different understandings of project sustainability (Hongping 2017). These issues are particularly acute in megaprojects, which are often highly contested and approached by a wide variety of stakeholders (see Van Marrewijk (2015)'s view of projects as cultural phenomena).

4.2.4. Benefits/needs analysis

Projects are a means to create value and deliver benefits (Morris 2009). A chain of benefits flows from organisation strategy and business objectives (Serra and Kunc 2015). The hierarchical chain starts with the organisation's strategic goals at the highest level, followed by end benefits, intermediary benefits, and desired outcomes. It is evident that organisations can gain more benefits from projects when benefits are unambiguously articulated in the early front-end planning stage (Marnewick, 2016; Terlizzi et al., 2017), even though all potential benefits cannot necessarily be known at this stage (Doherty et al., 2012). The identification of desired benefits during the preparation of a project's BC is a crucial step supporting the clarification of the fundamental motivation behind the investment decision (PMI 2016b). However, this activity can take place with inadequate attention

from senior management (Badewi 2016; Breese et al. 2015), leading to additional time, cost, and performance issues at later phases (Edkins and Smith 2012). The PMI's (2016a) study shows that less than half of organisations identify desired outcomes before the project initiation. It is also important that benefits are not overstated at this early stage of the project (Shiferaw and Klakegg 2012).

Facilitated/structured workshops are important practices that can be used before the project is formally launched to assess stakeholders' opinions on the project value (Thyssen et al., 2010). For enterprise resource planning projects, a holistic organisation-wide consideration of needs and understanding of what existing solutions and technologies can do are essential (Millet, 2013).

Before decisions on the choice of a concept solution are made, a thorough understanding of stakeholders' needs and requirements is crucial to shaping the desired benefits (Edkins and Smith 2012). But stakeholders have different perceptions of project success (McLeod, Doolin, and MacDonell 2012), and some will advantage while others suffer disadvantages or losses (Edkins and Smith 2012). Turner and Zolin (2012)'s index of stakeholders success perceptions described above is relevant here. Keeys and Huemann (2017) consider benefits co-creation as a strategy for creating benefits for a large group of stakeholders.

The distinction between 'wants' and 'needs' is vital in large public projects but complex and ambiguous (Næss 2009), so, it may be challenging to explicitly declare to what extent there is a need for a project. Næss (2009) provides guidelines on assessment of needs (see also Nina and Sven [2007], who describe a process beginning with the identification of client's requirements, followed by their translation into a strategic brief, and eventually transformed into a project brief). Sometimes - perhaps, often - the project concept might be determined in advance without considering alternatives – may be chosen based on the interest of one individual or group, or the result of political preferences or pressures (Williams and Samset 2010). It is not a rare case that project promoters integrate their own preferences into the project selection process, leading to the adoption of more favourable options (Næss 2009). This is discussed further below.

As part of the stakeholders' needs assessment, it is essential to ensure that no "perverse incentives" are set up. Public investments, especially those with no financial commitments for the project promoters, may cause perverse incentive that leads to the misallocation of public funds, waste of taxpayers' money, and negative impacts such as corruption (Samset and Volden 2016, 12). This is not explored a great deal in the literature. To prevent or mitigate the adverse side effects caused by

perverse incentives, Samset and Volden (2016, 309) suggest a twofold solution which is similar to the Norwegian quality assurance regime: first, aligning the objectives of project promoters with governmental goals through, for example, 'co-financing and local risk-taking' requirements; and second, lessening 'information asymmetry' problem by implementing, for instance, 'information control, external review, and public hearings'. The principal theoretical basis used to understand this phenomenon is Principal-Agent Theory.

4.2.5. Logframe.

It is worth making an aside here in the structure of this paper to note one particular project management approach that should be highlighted: 'Logframe,' or the 'Logical Framework Approach to Project Cycle Management' or LFA. This system was created in 1969 for the US Agency for International Development. LFA explicitly links highest level goals (i.e. organisational strategy: strategic goals), intermediate outcomes (i.e. project target benefits: tactical goals), outputs (i.e. iron triangle: operational goals) and inputs of a project. In this way, it embodies the view that projects should be driven by the outcomes and justified by the strategic goals. Part of the rationale of the framework is that projects are considered as a structured form of discovery, i.e., they are operating under uncertain and unknown conditions, and must be open for change. The power of Logframe comes in the front-end of the project, where it is used to create clear objectives and build commitment and ownership among the various stakeholders. It is a qualitative analysis of causalities and judgmental probabilities that does not necessarily require quantitative information, so is particularly useful at a very early stage when little information exists. Couillard, Garon, and Riznic (2009) and Ssegawa and Muzinda (2016)'s Results-Based Management are updated versions of Logframe.

4.3. Concept Analysis and alternatives analysis

Now that the initial idea for a project is defined, an initial analysis can be carried out. However, this is usually within an environment of uncertainty and complexity, and we consider these aspects here. Initially we need to remember that we are looking at the environment of the suggested initiative, and are not yet looking at the risk of a particular solution, but the aim of this stage of the analysis should be to identify a concept to form the basis of the project.

4.3.1. Uncertainty analysis

Uncertainty can be negative (risks) or positive (opportunities) (Perminova, Gustafsson, and Wikström 2008). Uncertainty is most elevated at the earliest stage of a project and then tends to decrease as information accumulates over time (Samset and Volden 2016; Winch 2010), so the project front-end is when the potential to mitigate risk (and exploit opportunity) is most significant. There has been a tendency to use uncertainty and risk synonymously, which in effect implies that uncertainty is either treated similarly as risk or overlooked (Sanderson 2012). This tendency is dangerous since it might encourage the emphasis on operational planning and risk control and leave the opportunities unexploited (Johansen et al. 2016; Sanderson 2012). It is important to consider both threats and opportunities: both have the potential for disrupting the project say Edkins and Smith (2012), who recommend the use of Performance Uncertainty Management Processes (PUMP) developed by Ward and Chapman (2011) for its balanced view between the challenges to be overcome and the opportunities to be grasped.

The project is not yet defined so the considerable literature on pre-project risk management will be dealt with in Section 4.4.2.

Scenario analysis and planning is an important tool, the most popular method of corporate foresight (Pinter and Leitner 2014), and a vital technique to enhance the quality and effectiveness of strategic planning in the front-end of new product development (Postma, Broekhuizen, and van den Bosch 2012), especially in dealing with future uncertainties (Hanafizadeh, Kazazi, and Jalili Bolhasani 2011) and transferring new ideas to the innovation process (Brem and Voigt 2009). A key writer on the topic, Heijden (2009) emphasises the vital role of scenario planning in making judgement at the project front-end, under conditions of uncertainty and scant information, when the project's purpose and scope are still underdeveloped. Heijden describes scenario planning as an exploratory process for analysing a project's business environment based on integrating global knowledge to reduce uncertainty. According to Heijden, scenario planning is an iterative 'outside in' process (69) including four stages (79): (i) 'context setting and boundary definition', (ii) 'knowledge elicitation and systems analysis', (iii) 'driving force categorisation, framework definition, and scenario building', and (iv) 'implications study'. (See also Bañuls et al.'s (2017) techniques).

There is also literature showing the importance of stakeholders as a significant source of uncertainty (Ward and Chapman 2008); contingency estimation using uncertainties in construction

projects (Chung-Li, Tong and Fu 2009), project novelty (Brockhoff 2006), equivocality (Frishammar, Florén, and Wincent 2011) and continual engagement in learning and sensemaking as facilitators of flexible and rapid decision making (Perminova, Gustafsson, and Wikström 2008).

Real option analysis is also important in valuing investment under uncertainty. Many scholars have investigated the use of real options analysis for projects (e.g., Chang 2013; Hawes and Duffey 2008; Kodukula and Papudesu 2006; Wang and Yang 2012). Chang (2013, 1057) combines the idea with that of 'risk-bearing capacity.'

Although most of the important choices are made during the project front-end, it is when uncertainty is at its highest and availability of information is at its most limited (Samset and Volden 2016; Williams and Samset 2010; Winch 2010; Yim et al. 2015). While it might be thought that the lack of information leads to poor project decisions, Williams and Samset (2010) and Samset and Volden (2016) support the view that the lack of detailed information during the project front-end can, in fact, be a benefit rather than an obstacle, in providing decision-makers with the need for both concentration and pliability. According to these authors, a crucial issue during the front-end is not the quantity but what type of information is required. Limited, but carefully selected information may help avoid 'analysis paralysis,' and also avoid locking decisions into an initially favoured concept (Samset and Volden 2016, 302). It is, therefore, critical that one thinks carefully about what information to use during the front-end (Kutsch and Hall 2010). The availability of information in the earliest stage of the project depends considerably on the novelty of the project concept (Grau and Back 2015). Samset and Volden (2012) recommend that 'creativity, imagination and intuition' can be more valuable at this phase than the expansive quantity of information.

4.3.2. Complexity.

Extensive research has been carried out on project complexity due to its contribution towards project failures regarding time delays and cost overruns (Bosch-Rekveldt et al. 2011; Mirza and Ehsan 2017; Qazi et al. 2016). There is no common definition of project complexity, although many authors have given heavily overlapping contributions generally concerning multiple interacting parts, uncertainty and social/human interactions (e.g., Priemus, Bosch-Rekveldt, and Giezen 2013; Vidal and Marle 2008). Torp and Klakegg (2016) and Brady and Davies (2014) give various dimensions of project complexity. Geraldi, Maylor, and Williams (2011), try to capture the various aspects of the

complexity of projects by characterizing these aspects using five dimensions: 'structural, uncertainty, dynamics, pace, and socio-political.' In public projects in particular, the stakeholder and political environment increase the complexity associated with the last of these dimensions (Klakegg, Williams, and Shiferaw 2016).

Complexity is considered as a core characteristic of the decision-making process in megaprojects (Priemus, Bosch-Rekveldt, and Giezen 2013). These are qualitatively more complex and uncertain, so have a more extended and complex 'front-end'. As complexity of megaprojects is enlarged by market dynamic and political discontinuity in evolving environment, adaptive capacity is the key to dealing with complexity (Priemus, Bosch-Rekveldt, and Giezen 2013).

This stage needs to identify and measure complexity. Methods published (some of which cannot be used until the project is defined but given here for completeness) include Bosch-Rekveldt et al.'s (2011) 50 elements contributing to project complexity; He et al.'s (2015) fuzzy analysis network process; Chapman's (2016) framework distinguishing between complexity originating from within the project itself that stemming from a project's context; Qazi et al.'s (2016) model on the interface of project complexity and Interdependency Modelling of Project Risks; and Mirza and Ehsan's (2017) Project Execution Complexity Index (PECI) tool based on the 'iron triangle'.

4.3.3. The project appraisal /evaluation process.

At this point, the project needs to be evaluated or assessed: "project appraisal", or "feasibility study" (Alkass, Al-Jibouri, and Techakosol 2006), or "ex-ante evaluation" (Bulathsinhala 2015; Irani 2010), done to decide whether or not to invest in the project and go ahead with it. Due to the lack of a strong culture of identifying genuine alternative concepts as the foundation for project design, a significant challenge which decision-makers face in the front-end stage is to recognise and evaluate feasible concepts (Williams and Samset 2010). An international study of 60 large infrastructure programmes (by IMEC, discussed in Samset and Volden 2012) reveals that less successful projects were typical results of authoritative choices made by influential interest groups and were often initiated under time pressure, with little resources assigned to the evaluation or appraisal of concepts. Formal appraisal of exploratory projects is perhaps more difficult since they do not always ex-ante provide sufficient arguments to guarantee direct profitability or benefit production; Maniak et al. (2014) suggests ways of viewing potential value using a real-options approach; Bulathsinhala (2015) and Feller (2007)

recommend some policy considerations that should be taken into account here.

Appropriate methods for ex-ante evaluation can improve the selection of the suitable concepts (Raschke and Sen 2013). Alkass, Al-Jibouri, and Techakosol (2006) indicate the main criteria (financial, technical, and economic feasibility) but also, e.g., reputation, public and customer relations, project portfolio's diversification, and risk. Vidueira, Díaz-Puente, and Rivera (2014) study the ex-ante evaluation of rural development programs in the EU, indicates a variety of pointers, including the use of dynamic behavioural techniques and nonparametric estimations to get control of the complexity of impacts produced by programs. Indeed, several attempts have been made to explore ex-ante evaluation methodologies including the use of scenario analysis with sensitivity analysis (Alkass, Al-Jibouri, and Techakosol 2006); a Build Operate Transfer credit risk model (Kong et al. 2008); Cost-Benefit Analysis (CBA) (Annema 2013; van Wee and Rietveld 2013); incorporating ethics in the ex-ante evaluation of megaprojects to overcome several limitations of CBA (van Wee 2013); 'multi-actor and multi-criteria analysis' for megaprojects (Macharis and Nijkamp 2013); risk analysis concerning socio-economic feasibility (Salling and Leleur 2015); and using activity-based management (Vereen, Sinacori, and Back 2016).

Project evaluation is well established in the public sector. Different countries have different tools and procedures used in evaluating major public projects. The 'Five Case Model' approach is used in the UK (HM Treasury 2011, 2013); In Australia, the Department of Infrastructure and Regional Development (Australian Transport Assessment and Planning (ATAP) Steering Committee 2016a, 2016b) employs the 'Transport System Management Framework' and the Commonwealth of Australia - Department of Finance (2014) uses a 'Two Stage Capital Works Approval Process'; Canada uses a structured set of assessments (Treasury Board of Canada Secretariat n.d.); for projects funded by the European Union, European Commission (2015) gives the regulatory requirements for the project appraisal process; European Investment Bank (2013) presents their economic appraisal methods; Samset & Volden (2013) describe the Norwegian Quality Assurance gateway system; and in the US, the 'Analysis of Alternatives' (AoA) issued by the U.S. Department of Energy (2018) is an analytical comparison of the operational effectiveness, suitability, risk, and life cycle cost (or total ownership cost, if applicable) of alternatives, although Rosacker and Olson (2008) describe some simple methods for US government IT projects. Lepori et al. (2007) discuss how to analysis, and see the shortcomings, of public systems in European nations.

4.3.4. Project Concept.

Having established the needs or problems that need to be resolved, the various project concepts that could answer those needs have to be identified, and one chosen and understood (Samset and Volden 2012) - even if the attempt to define project goals is difficult. A number of concepts might be identified, then one chosen, and it is this which forms the basis of the investment case and ultimately the project. The definition and clarification of the initial project concept is the cornerstone of the project (Stamatiadis et al. 2010). It is important to start with the problem, and related needs and objectives to consider the concept, rather than is often the case, choosing a concept and just staying with that (Samset and Volden [2012, 62] discussing the work of Minken; see also Patanakul and Shenhar [2012]). This idea of the 'project concept' is important for small as much as for large projects (Collins, Parrish, and Gibson Jr 2017).

However, Samset (2010, 100) states that 'there are no commonly agreed guidelines for … systematic identification and selection of unique and different solution to a problem. Also, there are not a great many studies that offer a systematic inquiry into how this is done in practice, the range of alternative concepts that are identified, and which ones are chosen.' Samset and Christensen (2017) look at various logical ways of thinking about these situated, complex projects (instrumental, institutional, environmental and contingency logic) which helps to clarify some of the issues around this analysis. In looking at a range of projects, they identify that only around a quarter had clear well-thought-through analyses at the start.

Samset, Andersen, and Austeng (2014) provide an analysis of some concept analysis studies and reports empirical evidence that the search for alternative concepts is often in practice very restricted. This they put down to political pre-determination, but also path dependency (alternatives represent a continuation or variant of the current solution), the level of detail in analyses (which were often very detailed and more project-specific rather than facilitating conceptual discussion), and a sectorial focus being too strong. What seemed to be common across the cases was a conceptual analysis that occurred too late in the process: 'Ex ante evaluation is a broad initial assessment aimed at identifying which alternative will yield the greatest benefit. More commonly, considerable resources are used on detailed planning of a single, specific solution, whereas alternatives are not (or are inadequately) assessed early on. Consequently, there is no adequate basis for concluding that the preferred alternative is the best choice' (Samset and Christensen 2017, 2).

The evaluation of a concept and its impact needs to take a broad view of its effects. 'The benefit of an ex-ante evaluation is principally related to whether one is able to identify the best solution … this will be based on estimates of the project's effects' (Samset and Christensen 2017, 2). The 'zero option', or the 'reference concept', is also an important idea in many governmental CBA (see below and also Samset [2010]).

When chosen, the selected concept needs to be appraised in depth, and aspects that need to be studied in more detail once a project concept is selected and the project defined, are discussed in the following 'project assessment' section.

4.4. Assessment

A main part of the front-end is assessing the project concept that has now been settled upon. This Section will list the various aspects of this: particularly the various issues involved in estimating, preceded by the scope of the project and its link with strategy, followed by learning lessons from previous projects, technology and environmental/sustainability assessment, and consideration of the various project delivery systems available. Only brief descriptions will be given.

4.4.1. Defining and estimating the project.

The main element of the project assessment is estimating the project as far as it has been defined. Estimating is a combination of bottom-up estimation and parametric methods (e.g., Brunsman, Robson, and Gransberg [2008]). Both methods need to learn project-to-project (MiŁOsz and Borys 2011). Indeed, taking advantage of lessons learned from previous projects should play an important part in developing future projects. But while there has been considerable literature on the collection of 'lessons learned' (e.g., Duffield and Whitty [2015], Hartmann and Dorée [2015]), these do not appear in a literature search on 'front-end', perhaps because it is assumed that such lessons would be applied then. One paper that does appear is that of McClory, Read, and Labib (2017), who conceptualise the lessons-learned process and explain how learning goals defined at all organisational levels should form part of the BC, project benefits, and risk management processes.

Eight elements are discussed here: scope, cost, benefits, schedule, through-life costs, then we look at some of three issues that affect all of these: optimism bias, strategic underestimation, and the

idea of Reference Class Forecasting. This section represents both of the top two elements in the "Assessment" box of Figure 2. These elements will be brought together in a following sub-section on risk analysis.

Firstly, defining the scope of a project is clearly key to defining what that project is to consist of. Here the key link is to the strategy of the organisation and the purpose of doing the project. The scope may not be fully defined at this point in the lifecycle, so parametric methods might be useful (Holmlin 2016). But Fageha and Aibinu (2014) discuss the importance of project scope definition as complete as possible during the front-end. Failing to do so can be an important cause of later problems (e.g., Jergeas's [2008] analysis of Alberta oil sands projects). The definition of the scope develops during the course of the front-end, as the project is defined or due to exogenous shocks in the wider environment (e.g., the London 2012 Olympics [Jennings 2012]).

Cost estimation is second. Samset and Volden (2012) describe how estimates (particularly cost) are developed during the front-end, pointing out that the final level of cost overrun is 'often only the tip of the iceberg. In innumerable cases, the budget increase in the front-end phase, from the first cost estimate to the adopted budget, is much greater in relative terms.' An unrealistically low initial cost estimate may increase the chance of the project idea being considered/adopted and subsequently influence strategic success (see also Welde and Odeck [2017]).

Liu and Zhu (2007) show how, as cost estimating progresses through the project, programmability and measurability increase. Legaca, Radujković, and Šimac (2014) point to some reasons why costs, benefits, and time forecasts particularly for complex projects are systematically over-optimistic in the front-end than less-complex projects. Initially low estimates, increased significantly during the front-end, are so common that this is termed 'normalization of deviation' (Pinto and Slevin 2006). This variation during the front-end is important for the concept of 'lock-in': costs are considered at the formal decision to execute a project – but often the actual decision to execute precedes this (Cantarelli et al. 2010), so decisions are made on earlier, lower, cost estimates. This 'escalating commitment of decision-makers' (Cantarelli et al. 2010) can occur both at the decision-making level (before the decision) and during project execution. Public projects are prone to wider influences such as political and legislative factors in the project front-end (Doloi 2011).

Historical information is important on which to base estimates (Merrow 2011). Constructing databases needs contextual information (Kiziltas and Akinci 2009). The development of Building Information Modelling may help (Lu, Won, and Cheng 2016). However, Aibinu and Pasco (2008)

point out that historical benchmarking needs careful analysis and databases updating, suggesting that estimates at the end of the front-end tend to be generous, particularly for smaller projects (although Jørgensen, Halkjelsvik, and Kitchenham [2012] question the relationship between size and cost-estimation-error). Parametric methods for construction are discussed in Sae-Hyun, Moonseo, and Hyun-Soo (2010), Wang et al. (2017), and Dursun and Stoy (2016). In developing bottom-up estimates, estimation needs to remember not only the overall cost but also cash-flow (González Jiménez and Blanco Pascual 2008; Qingbin, Hastak, and Halpin 2010). The indirect costs need to be included (Littau, Jujagiri, and Adlbrecht 2010), and correlations between cost items (Firouzi, Wei, and Chun-Qing 2016; Moret and Einstein 2012b). It is clear that under-estimation of costs is very frequent (Andersen, Samset, and Welde 2016), and further below we suggest some reasons.

Third comes benefits estimation. We discussed above the purpose of the project, to achieve some ends or benefit, and the choice of concept to satisfy that purpose. Project 'success' was defined (simplistically) as the extent to which those ends or benefits were achieved. For this, we need to quantify benefits. Zwikael and Smyrk (2012) give definitions for concepts such as benefits, target outcome, and outputs as well as explain the relationship between them. Chih and Zwikael (2015) develop a framework of project target benefit formulation for the public sector, where benefits are often dynamic and have different meanings for various stakeholders, using SMART ideas.

In practice, many benefits can only be quantified with difficulty, and guidance on how to identify and quantify them seems not be consistent (Atkins, Davies, and Kidney Bishop 2017). Estimating both costs and benefits are necessary to carry out a CBA. Mouter (2017) discusses the use of CBA in political decision-making, highlighting its obvious benefits – providing a structure for evaluating effects, and putting all monetisable costs and benefits into one indicator – but showing how it can be seen to 'kill' political debate, and encouraging its use as part of political discourse. (See also Dimitriou, Ward, and Wright [2013], Salling and Pryn [2015]). Benefit estimation, as cost estimation, is subject to biases, and some are discussed further below.

Fourth is schedule estimation, whose principles are similar to those of cost estimating methods, except for activity predecessor/successor relationships. Again, past data maybe useful (Baqerin, Shafahi, and Kashani 2016). Parametric estimation can be used. 'Learning' or 'reasoning' tools to estimate are becoming more common (e.g., RunZhi et al. [2016]). Vandevoorde and Vanhoucke (2006), Kim, Kang, and Hwang (2012), and Balouka, Cohen, and Shtub (2016) look at time and costs together, considering the triple-constraint trade-off (see also Cho and Hastak 2013;

Sousa, Almeida, and Dias 2014). Maravas and Pantouvakis (2012) and Moussa, Ruwanpura, and Jergeas (2009) also take cash-flow into account.

Fifth is estimation of through-life cost of the asset after the project is complete, including operations and maintenance: here, 'decisions made during the formative stages of a project carry far-reaching economic consequences and can seal its financial fate' (Ahiaga-Dagbui, Love, Smith et al. 2017, 89). While whole-life cost appraisal is important, it is perhaps Whole Life Performance that needs to be considered (Sung Ho 2009). Schneiderova Heralova (2014) summarises major issues of life cycle costing, and presents the most frequently used public-sector methods.

We now consider sixthly optimism bias. Many projects, over-run their budget, and reasons include behavioural issues during the front-end (Legaca, Radujković, and Šimac 2014). It is known that a prime cause of mis-estimation is the human tendency to be over-optimistic, famously discussed (in generality) in Kahneman (2011) and applied to projects particularly by Flyvbjerg (2006). Optimism bias has been shown to be a factor both in under-estimating costs, and also in over-estimating likely benefits of major projects. Indeed, this was what prompted the World Bank to initiate Hirschmann's work in the 1960's which Ika (2017) develops. Mention of optimism bias is frequent both in analyses of cost-overruns (e.g., Jergeas 2008) and in advice on how to view estimates in project governance (e.g., HM Treasury 2013; State of New South Wales - Department of Finance Services and Innovation 2015). Similar discussions of optimism bias and its relationship with other biases are given by Kutsch et al. (2011) and Son and Rojas (2011). While these papers describe optimism bias as unconscious, Bertisen and Davis (2008) show that the situation is not improving (so learning is not happening), and argue that the persistence of bias is instead intentional and rational, including the next discussion.

Seventh, a related cause of cost under-estimation and benefits over-estimation is 'strategic misrepresentation' (Flyvbjerg 2006) – the deliberate under-estimation of costs to get the project approved (Dalcher 2016). This is not uncontested (Osland and Strand 2010), and conclusive evidence is difficult to find (Andersen, Samset, and Welde 2016). An external view and increased oversight might reduce the phenomenon if it does exist (Klakegg, Williams, and Shiferaw 2016, 293) but will not understand some of the intricacies and context of the project. Atkins, Davies, and Kidney Bishop's (2017) analysis point to strategic misrepresentation and optimism bias, but adds a third phenomenon 'anchoring and adjustment' (Kahneman 2011), difficulty in adjusting away from an initial estimate (remembering that costs tend to be underestimated at the start of the front-end).

Finally comes a response to the previous two points: 'reference class forecasting' (RCF) which claims to base forecasts on actual performance in a reference class of comparable projects (Flyvbjerg [2006] and Flyvbjerg, Chi-keung, and Wing Huen [2016] take the ideas further). In this method, a reference class of projects is analysed, so that a standard multiplier can be placed on initial estimates (Prieto 2013). A recent literature survey of this is given by Prater, Kirytopoulos, and Ma (2017, 370) who conclude that, while optimism bias is widely accepted, and Flyvbjerg's RCF is recommended, 'there has been no experimental and statistically validated research into the effectiveness of this method'. They recommend an outside view which, 'unlike reference class forecasting…does not apply a standard multiplier …but recommends that the project team review similar classes of project to use as the basis to commence their estimation upon.' (380). Koch (2012) similarly suggests that the 'outside' view of reference class forecast should be combined with 'inside' approaches appreciating the socio-technical content. Batselier and Vanhoucke (2016) compare the use of RCF with other methods but find it only superior if the project is highly similar to the projects in the reference class. RCF is applied as standard in the UK Government (HM Treasury 2013).

4.4.2. Risk analysis.

While we considered environmental uncertainty above, a detailed risk assessment of the chosen option needs be carried out at this point, taking into account all the issues of Section 4.4.1. While some uncertainties can be understood from previous projects, unknowns about the future, new initiatives, new technology, and bounded human rationality means that there is significant epistemic uncertainty (Williams and Samset 2010), even in apparently repeat-type projects (e.g., Ahiaga-Dagbui et al. 2017). From these risks, contingencies are then calculated (Touran 2010; Thal, Cook, and White 2010).

'Risk' is one of the most well-researched areas in the front-end, including some recent useful literature surveys, including Thomé et al. (2016) looking at the relationship between complexity, uncertainty, risk, and resilience; Zhang (2011) looking at risk as 'an objective fact' and as 'a subjective construction'; Sanchez-Cazorla, Alfalla-Luque, and Isabel Irimia-Dieguez (2016) describe a systematic literature review of risk management in megaprojects, and give a comprehensive categorisation of risks (design risks, legal and/or political risks, contractual risks, construction risks, operation and maintenance risks, labour risks, customer/user/society risks, financial and/or economic

risks, and force majeure risks).. Torp and Klakegg (2016) also describe some current methods. This is a well-established part of the project front-end, although the evidence is not clear as to how useful it is and why, as discussed in Bakker (2010), de Bakker, Boonstra, and Wortmann (2011), and Kutsch and Hall (2009). A key element is distinguishing risks to project outputs from 'strategic' risks to the project purpose (Krane, Olsson, and Rolstadås 2012; Krane, Rolstadås, and Olsson 2010).

Risk analysis generally follows a clear (cyclic) process. The first step is identification, recent papers including Tiendung et al. (2009); Zeynalian, Trigunarsyah, and Ronagh (2013); Boateng, Chen, and Ogunlana (2015) on megaprojects; Goh, Abdul-Rahman, and Abdul Samad (2013) using workshops; and Xiang et al. (2012) using asymmetric information theory. Here, discourse and inter-relationships between stakeholders are key (Van Os et al. 2015), both in understanding the dynamics within the organisation (Thamhain 2013; Govan and Damnjanovic 2016) and more widely (Osipova and Eriksson 2011). In megaprojects and large international projects, risks can become much more ill-defined often in the socio-political space (Vereen, Sinacori, and Back 2016; Liu, Zhu et al. 2016). The second step is to quantify the risks, either using expert judgement or past data (e.g., Choi and Mahadevan 2008). Finally, the overall risk needs to be calculated, remembering that risks are not self-contained, but will often be inter-related or come in sets or systems (Qazi et al. 2016; Zhang 2016), indeed often producing an uncertainty system which is complex and emergent, particularly with human interaction within the project compounding the risk inter-dependencies (Williams 2017). The objectives of the project cannot be treated independently, and it is important to analyse schedule risk (Barraza 2011; Dikmen et al. 2012; Khamooshi and Cioffi 2013; Pawan and Lorterapong 2016; Schatteman et al. 2008) as well as cost risk, as these affect each other, and can sometimes be traded off (Sarigiannidis and Chatzoglou 2014; Zeynalian, Trigunarsyah, and Ronagh 2013). Imbeah and Guikema (2009) give a combined risk tool for cost, schedule, and quality risks together. Finally, Teller, Kock, and Gemünden (2014) note that the risks in all of a portfolio ought to be considered as a whole, considering the strategic risk of one project in the light of the risks coming from the entire portfolio. Analyses should also consider both upside and downside risks (Kirkland 2013), or model value and risk and opportunity altogether (Browning 2014).

4.4.3. Technology assessment.

Technology assessment looks firstly at the maturity of the technology (e.g., standardised 'Technology

Readiness Levels' [Towery, Machek, and Thomas 2017]). Cost, quality, and obsolescence are also important. Many projects require a mix of technologies at different levels of readiness, and Özmen (2014, 3) offers a useful set of questions used in Shell Global Solutions. Technology 'lock-in' becomes critical when a project uses third-party technology that has ongoing need for support. For example, many bespoke organisational software systems floundered when they were based on Microsoft's XP operating system, which Microsoft stopped supporting. This risk can become fatal for projects as was the case with the UK Ministry of Defence's Nimrod MRA4 aircraft (Anderson 2011). The effect on the economy and society also need to be assessed, bringing in the aspects of other stakeholders as considered below.

4.4.4. Environmental assessment and Sustainability.

A key criterion viewed as increasingly important is sustainability. Traditional project success criteria focus on short-term project outputs, only superficially treating stakeholders' issues; including stakeholder management within sustainable development would imply a 'paradigm shift in the underpinning values' (Eskerod and Huemann 2013, 36). Keeys and Huemann (2017) discuss Sustainable Development (SD), with projects managed to deliver benefits to a broad group of stakeholders. SD 'addresses holistically the integrated dimensions of economic growth, environmental safeguards and societal wellbeing of all development activities, commercial and non-commercial and which incorporates values of participation, transparency and equity' (Keeys and Huemann 2017, 1197). SD principles can transcend both short-term needs and long-term responsibility, which Herazo, Lizarralde, and Paquin (2012) claim helps align strategic and tactical plans. The literature on this area is considerable, covering both environmental (e.g., Aarseth et al. 2017; Kang et al. 2013; Laedre et al. 2015; Shen, Wu, and Zhang 2011; Hongping 2017; Hueskes, Verhoest, and Block 2017; Zhang et al. 2014) and social (e.g., Valdes-Vasquez and Klotz [2012], Christensen [2012], Rowan and Streather's [2011] Social Impact Assessment work, Kivilä et al.'s [2017] issues). Social responsibility is particularly an issue of megaprojects (Samset 2011; Zhou and Mi 2017; Dyer 2017).

4.4.5. Project Delivery system.

Selecting an appropriate Project Delivery System is a key decision in the front-end (Saad, Baba, and Amoudi 2015; Touran 2008). Mostafavi and Karamouz (2010) describe the basic structure of Design-

Build, or Engineer, Procure, Construct (EPC) etc. and ways of choosing between them. Palacios, Gonzalez, and Alarcón (2014) helpfully describe some generic types of systems used in construction, such as Partnering, Alliancing, Lean Project Delivery, and Relational Contracts in its various guises: traditional/transactional, partnering/transactional with agreements, and alliancing/relational. Special Purpose Entities or Vehicles are particularly used for megaprojects as a specific delivery mechanism (Sainati, Brookes, and Locatelli 2017). Choosing between such mechanisms involve a variety of criteria, such as: the amount of risk the owner is willing to carry, and the level of control required (Touran 2008; Tran and Molenaar 2015); the complexity of the system being procured (Roehrich and Lewis [2014] show that simplified contractual governance may be effective to counteract complexity, if this is carried out in combination with relational governance); Whole-Life Cost and Whole Life Performance (Sung Ho 2009) and life-span (Zhang et al. 2016); transaction costs involved (Li, Arditi, and Wang 2013); in 'alliance'-type delivery systems, appropriate partners (Maurer 2010; El Asmar, Hanna, and Chul-Ki 2009) and trust-building (Hellström et al. 2013); and sustainability (Mollaoglu-Korkmaz, Swarup, and Riley 2013; Lenferink, Tillema, and Arts 2013). Again, for Public Private Partnership (PPP) projects, there are different government support mechanisms that make the considerations more complicated (Mirzadeh and Birgisson 2016); Chou and Pramudawardhani (2015) give some advice on key drivers, critical success factors and risk allocation. But the evidence on which to base such decisions is often unclear: Qing et al. (2016) question the reputation of better cost and time performance using design-build; Kunhee et al. (2016) look at the evidence when using Accelerated Contract Provisions (ACPs); Park and Kwak (2017) do not find a clear empirical choice between Design-Bid-Build and Design-Build.

4.5. Setting up for Successful Project Execution

Before moving to full project execution, there are some additional steps to carry out as well as the preliminary planning activities. Bradshaw (2008), for example, emphasises the importance of establishing the project controls organization and functions early in the life cycle of a large complex project.

4.5.1. Project finance

Raising the finance for the project is an important but specialist area (see particularly Esty [2014] and

Gatti [2013]). Samset and Volden (2012) look into different financing mechanisms for public projects, one specific area of importance being the various types of PPP mechanism (Bovis 2012, 2015; Daube, Vollrath, and Alfen 2008).

4.5.2. Project governance

As discussed above, it is important to set up a governance structure to oversee the project before it starts. There is a significant amount of literature on setting up a project governance structure (see surveys by Biesenthal and Wilden [2014] and Joslin and Müller [2015]). Public project governance has its own literature (Klakegg et al. 2008; Klakegg, Williams, and Shiferaw 2016). Volden and Samset (2017) compare project governance schemes in six OECD countries.

Since Governance is where the permanent organisation has oversight of the 'project' organisation, the structure needs to be oriented to the organisation's strategic objectives (Hjelmbrekke, Klakegg, and Lohne 2017), to give the project team a more 'efficiency' and deliverable-focused business model. Indeed, the governance process needs to recognise the benefit of the project to the permanent organisation and how that is to be achieved rather than simply the deliverables (Zwikael, Smyrk, and Meredith 2016), and this is of particular importance in public projects with the more complex socio-political-economic environment.

Some empirical evidence is given by Joslin and Müller (2016) (suggesting 'control' is not the dominating factor, rather the stakeholder vs. shareholder orientation) and Cardenas, Voordijk, and Dewulf (2017) (finding the financial/economic setting and institutional setting are important moderating variables). Tiwana (2009) gives some models for IT projects, and Lappi and Aaltonen (2017) for agile projects. These questions can be more complex when looking at major multi-firm projects (Ruuska et al. 2011) in complex networked structures; for these, more sophisticated governance structures are required that can be flexible and deal with self-regulation and emergence.

4.5.3. Contract/Procurement

Before a project can be handed over to a different organisational entity from the permanent organisation for delivery, some sort of legal agreement needs to be made between the parties – a contract. There are various types of contract, a key difference being the degree of risk passed onto the contractor. Shuibo et al. (2016) claim that risk transfer negatively affects the contractor's cooperative

behaviour, with the contractor's fairness perception partially mediating the effect; in addition, the use of risk premiums does little to reduce uncooperative behaviour. Palacios, Gonzalez, and Alarcón (2014) show how simple types of contracts have not promoted project success, and indeed can be counter-effective, and identify three types of relationships that can be used to establish contractual relationships: traditional/transactional, partnering/transactional with agreements, and alliancing/ relational. Most long-term contracts for major projects have to be 'incomplete' since they cannot deal explicitly with every possible future occasion but rather leave many aspects to be decided upon later.

A key literature here has been the transaction cost approach, pointing to the cost saving of not having to write a complete contract. The logic suggests that parties involved in such complex and emergent projects will write incomplete contracts at the start, which will require renegotiation and completion as the project lifecycle progresses. Particularly important to this context is the idea of 'relational contracting' to avoid principal-agent issues (Bertelli and Smith 2009). Researching and implementing this requires a conceptualisation of relational quality, which Jelodar, Yiu, and Wilkinson (2016) start to do. The degree to with relational contracting works depends upon the relationship and degree of trust between the parties: an important determinant of success of a contract is whether each party acts in a 'perfunctory' or 'consummate' manner (Brown, Potoski, and Slyke 2015, 300). Following this line, Cheung, Yiu, and Chiu (2009) describe how construction contracting parties can take either a cooperative or aggressive stance in pursuing their goals and give taxonomies for aggressive and cooperative drivers. For their part, contractors are likely to be carrying out internal reviews of the contract to ensure the amount of risk taken on is appropriate (Derby and Zwikael 2012). Public–private partnerships require particular attention as they require long-lasting contracts, generally involving large sunk investments, often with significant uncertainty surrounding the project. Cruz and Marques (2013) describe how this requires contract flexibility, and describes various ways for incorporating contract flexibility into the development of a PPP contract.

Part of the decision-making within the contract setting is the degree to which incentives are useful or helpful. The discussions on 'project success' above are important, distinguishing the beneficial gains desired by the permanent organisation and the delivery of the project outputs: incentivisation generally has targeted the latter. For a single contractor, Rose and Manley (2010) give a discussion, and Pryke and Pearson (2006) use Social Network Analysis for more complex consortia and multi-organisational structures. Although appearing relevant, there is little empirical data on the effectiveness of such schemes. Kunhee et al. (2016) and Choi et al. (2012) give some results, but

without clear implications. Suprapto et al. (2016) suggest that it is not the contract type or incentive type on it is own that is important, but the moderating effect of owner-contractor collaboration. Again, PPP projects have particular aspects (see, e.g., Liu, Gao et al. [2016] and Ashuri et al. [2012]) who use Real Options Theory and Hueskes, Verhoest, and Block [2017] looks at social sustainability criteria).

Having chosen the type of contract, often a contractor needs to be chosen from those tendering for the work, and there is a wide body of literature in this area. de Araújo, Alencar, and de Miranda Mota (2017) for example, produced a survey. Similarly, Watt, Kayis, and Willey (2009) look at the literature to identify a suite of representative (principal) tender evaluation and contractor selection criteria. Watt, Kayis, and Willey (2010) look at which criteria were preferred amongst Engineering Project Contract Management companies. El Asmar et al. (2010) advise on selection of design contractors in public (design-build) contracts. Finally, San Cristóbal (2012) illustrates the use of two multi-criteria decision-making methods (one TOPSIS), for selecting a contractor.

5. Limitations of the Study

While this paper covers all projects, there are three areas which we do not have space to explore.

One particular class of projects, megaprojects, have aspects that make the front-end both important and more difficult. They have very long initiation and delivery phases delivering assets that are used for decades or centuries (Brookes et al. 2017). They are large-scale and complex, delivered through partnerships between public and private organisations (van Marrewijk et al. 2008) with public investment, high ambitions, multifaceted product arising from complex decision-making processes, multiple actors, and multiple impacts (Priemus and van Wee 2013). They involve multiple temporalities in delivery, product life-cycle, stakeholder organizations, and special purpose vehicles, combining more and less temporary forms of organizing. Uncertainty is high. ‘Success’ generally includes significant social socio-cultural issues (Christensen 2011; Dyer 2017; Eling and Herstatt 2017; O'Leary 2012; Zhou and Mi 2017); public sentiment and engagement is important (Hanchen, Peng, and Maoshan 2016; Leung, Yu, and Chan 2014). The prolonged lifecycle and heterogeneous stakeholders pose significant challenges for governance (Ma et al. 2017; Samset 2011), which needs to be particularly flexible to deal with emergent complexity. Flyvbjerg (2014, 6) claims megaprojects are systematically subject to ‘survival of the unfit,’ although van Marrewijk et al. (2008) notes the problem but comes up with analyses of uncertainty, ambiguity, and risk to guide megaprojects.

Two further classes of projects that are not explored explicitly in this paper are New Product Development (Postma, Broekhuizen, and van den Bosch 2012) and Research and Development. They have their own specific literature and project structures which pose specific challenges for front-end management. To limit the size of this study, these two specific classes of project are not covered here.

The third topic, particularly in megaprojects, is innovation during the project - physical, process, organizational or financial. Davies et al. (2014) identify stages of opportunity for innovation in a megaproject, including the bridging stage when an innovative project process and governance structure is being formed, and the engaging stage, using tendering and contractual procedures to support innovation. Methods are provided by Tawiah and Russell [2008] to assess project innovation potential at the front-end and by van Binsbergen et al. (2013) to consider innovations and their quality and complexity. The extremely large Crossrail project specifically set out to foster innovation in an open and transparent way (Worsnop, Miraglia, and Davies 2016, see also Davies, Gann, and Douglas [2009] on Heathrow Terminal 5).

6. Consolidation and Further Work

From the extensive and systematic review of the literature conducted, we have described a foundation for the 'front-end' of a project. This has recognised the front-end's setting and place as the mechanism by which the permanent organisation commences the initiative. The various elements of the front-end process (Figure 2) have been presented in the form of a structured flow from the genesis of an idea to setting up the project for execution, then the literature for the various elements has been described in detail. This section offers a theoretical idea that informed the study, in case it is of use to future researchers. It then goes on to identify some areas where further research is needed, and to identify some practical implications for the practice of project management and delivery.

Firstly, we have not taken any specific theoretical stance, rather the study has been informed by the various theoretical lenses taken by the literature (Turner et al. 2010). But a useful approach is provided by Winter and Szxczepanek (2017), who provide seven theoretical 'images' (number 1 to 7 below) and the use of these images or lenses has indeed given three important motivations for our discussion.

(1) *The surrounding environment:* #1 'Projects as social processes': we have anchored the front-end in the surrounding environment, moving quickly to a consideration of the stakeholders

(and indeed, the wider world); and this looks at the reality of projects as a stream of activity, which influences the governance of the project. #2 'Projects as political processes' picks up the different agendas and strategic aims affecting projects adding the decision biases of stakeholders. The embedding of the project within the motivations of the permanent organisation and other stakeholders is an important theme of the paper. However, more research is clearly needed, for example, into:

- how a project derives from the relevant political environment;
- understanding of the multiple stakeholders: their incentives, their impact on decisions, clashes between differing goals, coalitions of stakeholders and their impact on decisions;
- how analysis supports the entire process: the analysis of root-cause as basis for alignment of needs and objectives, systematic analysis of the opportunity space as basis for alternatives analyses;
- the relationship with the executive level: clarity of decision-making roles, the effect of high-level anchoring and transparency; the role of board executives such as the CFO; and
- the effect of complexity, particularly in mega-projects.

(2) *The intended benefits:* This combines #3 'Projects as intervention processes', #4 'Projects as value creation processes' and #7 'Projects as change processes' and this keeps our attention on the intended outcomes and desired changes of the intervention rather than simply delivering the outputs of the defined project, and this emphasis is important throughout this paper. #5 'Projects as development processes' continues this theme but reminds us that projects are not one-off, determinate and separate. But more research is needed on:

- how to define success criteria of a project; how to understand the more entrepreneurial or creative or project with ill-defined goals; goal-definition where stakeholder objectives clash;
- systematic analysis of the opportunity space as basis for alternatives analyses; and
- how to maintain that attention and set up a project to deliver benefits rather than outputs, and how to write contracts.

(3) *Temporariness:* #6 'Projects as temporary organisations' has been one of the important trends in thinking about projects over the last two decades. An essential facet of a 'project' is that it is temporary or determinate. But more research is needed to understanding what the front-end is

conceptually, where it stops and starts, the relationship of the 'front-end' with the 'project,' the relationship between the permanent organisation and the temporary-project idea. Clarity of roles is needed during the front-end.

While we have strived to create some clarity and structure to the issues, we have also identified areas for further research. First amongst these is a need to bring a theoretically sound understanding to what the 'front-end' is. Our discussion above of the gap in knowledge between studies of projects-as-single-entities and studies-within-(well-defined)-projects is a pressing need to understand how to effect good project delivery, and the front-end is where these two areas come together. The definition of what the 'front-end' is being not well-established means that the idea of an organisation 'mature' in front-end preparation is unclear, and more research is needed on the effect of the front-end on the behaviour and outcome of the project, and what organisations need to do to become more proficient at the front-end. The part of the project where the front-end hands over to the "project" was seen as an area requiring more research, and little was found on (for example) project mobilisation. While the structure of Figure 2 of course needs validation and consideration by other authors, for every element of the Figure we found existing literature but still open questions, and in all of these areas we could see open research questions (e.g., on contract types, optimism bias, how to carry out risk analysis and so on). Finally, the current study did not find much on different front-end methods and approaches for different types of project (such as construction, service improvement, new product development, software development etc.), and further research on the different needs of sdifferent project types (with due acknowledgement of the foundational work of authors such as Shenhar (2001)) would be useful.

Looking at the more practical implications, our paramount objective is to ensure 'successful' investments (which might mean, for example, investments in time, effort and scarce resources that are: relevant, economically viable, timely, cost-efficient etc.). To do this, we need to have a conceptually sound front-end process, which understands needs and objectives (including the geographies of the environmental, social, economic and political landscape), and a process to find the right type of conceptual solution to address these (rather than, say, reverse engineering to find the needs that are going to be answered by a pre-ordained project with a pre-defined concept). Some of the practical aspects have been addressed in this paper, and these include:

- Formalising and standardising procedures for analysis and decisions during the front-end, e.g., by using decision gates, analytical tools, estimation procedures etc. Common analytic formats are needed in both ex-ante and ex-post evaluation of the front-end to improve decisions based on past experience.
- A procedure to explore and reveal the uncertainty space to get the right conceptual solution.
- Understand how to make decisions on scant information, focussing on major issues first, perhaps restricting the amount of information and the level of details.
- Understand biases and how to deal with them, including (but not restricted to) optimism bias.
- Concentrating on the strategic benefits to be delivered by the project rather than the immediate delivery objectives of the project.
- Defining clear roles for the governance of the project when executing.

It is hoped that definition of the front-end and the framework of processual elements will both provide a practical guide to practitioners to make their frontends better, and facilitate research to put the 'front-end' on a better conceptual and practical basis.

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Appendix 1 - Search strings and results (September 2017)

(Database: 'Academic Search Premier' and 'Business Source Premier' from the EBSCOhost research platform)

	Keyword	Field search	Paired Term 1	Field search	Paired Term 2	Field search	Total	1st Iteration[1]	2nd Iteration
1	'Front end'	Abstract	'Project' or 'Portfolio'	Subject-Terms (ST)	-	-	294	≡[2]	44
2	'Project concept'	Abstract					139	≡[2]	4
3	'Conceptual appraisal' OR 'Conceptual phase'	All-Text	3P[3]	ST			268	≡[2]	19
4	'Project Owner' OR 'Project sponsor' or 'SRO'	Abstract	'role'	Abstract	3P[3]	ST	94	≡[2]	8
5	'Project success criteria' OR 'Project success definition'	Abstract	3P[3]	ST			67	≡[2]	17
6	'Project lifecycle' or 'Project life cycle'	Abstract	3P[3]	ST			471	≡[2]	30
7	'Optimism bias'	All-Text	3P[3]	ST			124	≡[2]	23
8	'Project evaluation' OR 'Project appraisal'	Abstract	3P[3]	ST			899	67	16
9	'Quality at entry'	All-Text	3P[3]	ST			250	≡[2]	2
10	'Ex ante Evaluation' OR 'Ex ante appraisal'	All-Text	3P[3]	ST			68	≡[2]	7
11	'Project Finance'	Abstract	3P[3]	ST			1801	6	4
12	'Pre-study'	All-Text	3P[3]	ST			67	≡[2]	1
13	'Pre-project'	All-Text	3P[3]	ST			179	≡[2]	15
14	'Definition phase' or 'Entry phase'	All-Text	3P[3]	ST			240	≡[2]	3
15	'Scenario Analysis' OR 'Scenario planning'	Abstract	3P[3]	ST			112	≡[2]	6
	EBSCOhost search result for the secondary set of keywords								
1	'Business Case'	Abstract	3P[3]	ST			361	22	5
2	'Proposal'	Abstract	3P[3]	ST			2,828	8	5
3	'Investment case'	Abstract	3P[3]	ST			102	4	2
4	'Strategy'	Abstract	'Decision logic' OR 'rationale' OR 'logical framework' OR 'causality'	All-Text	3P[3]	ST	288	13	5
5	'Project governance'	Abstract	'Systems' OR 'schemes'	All-Text		ST	53	≡[2]	4
6	'Estimation' OR 'Stochastic estimation'	Abstract	'Strategic' OR 'Tactical'	All-Text	3P[3]	ST	102	17	2
7	'Effectiveness'	Abstract	'Cost and benefits'	All-Text	3P[3]	ST	16	≡[2]	-
8	'Contract'	Abstract	3P[3]	ST			3,274	155	18
9	'Feasibility' OR 'viability'	Abstract	3P[3]	ST			3,632	42	3
10	'Time perspective'	Abstract	3P[3]	ST			10	≡[2]	-
11	'Uncertainty' OR 'Risk'	ST	3P[3]	ST			7,035	320	35
12	'Decision bias'	Abstract	3P[3]	ST			14	≡[2]	1
13	'Real options'	Abstract	3P[3]	ST			75	13	4
14	'Reference class forecasting'	Abstract	3P[3]	ST			10	≡[2]	1
15	'Strategic alignment'	Abstract	3P[3]	ST			48	13	6
16	'Design to cost'	Abstract	3P[3]	ST			13	≡[2]	1
17	'Ideation'	Abstract	3P[3]	ST			68	≡[2]	2

18	'Sustainability'	Abstract	3P[3]	ST			1,779	100	11
19	'Cost'	Abstract	3P[3]	ST			14,694	654	24
20	'Relevance'	Abstract	'Rationale'	All-Text			53	≡[2]	2
21	'Objectives'	Abstract	'Parallel' OR 'linked' OR 'multiple' OR 'non-aligned'	All-Text	3P[3]	ST	1,222	26	2
22	'Needs' OR 'preferences' OR 'Incentives' OR 'policy'	Abstract	'Analysis' OR 'Stakeholders' OR 'perverse' OR 'objective'	All-Text	3P[3]	ST	2,204	256	22
23	'Megaprojects	Abstract	PPP[3]	ST			210	≡[2]	13
							43,164	**4,520**	**367**

[1]The search results were filtered using the set of target journals
[2]The number of articles is manageable, so there was no need to refine the result with the set of target journals
[3]'Project' OR 'Programme' OR 'Portfolio'

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Table 1. Roles in the front-end

#	Roles	Explanation
i	Owner	… is the (permanent) organisation or person who ultimately derives the strategic benefits from the project. It is at the heart of the initiation of the front-end of the project in actually having the need that is to be satisfied by the project, and is thus critical in assessing the 'success' of the project when looking at the project outcomes. Winch and Leiringer (2016) focus on the contribution of the 'strong owner' to project performance. Where the 'owner' is an organisation, there are clearly different roles within that organisation, particularly in the early stages. Edkins et al. (2013) shows the criticality of the Chief Financial Officer (CFO), who holds the purse, when the organisation is in that uncertain intellectual/organisational space where a problem or opportunity may (or may not) trigger the need for a sanctioned project. Then within the C-suite, disputes can arise between the Chief Executive Officer, carrying hierarchical and Board power, Chief Technology Officer, holding technological power, and the CFO, holding financial power.
ii	Sponsor	Still at the level of the permanent organisation, still looking at the strategic benefits of the project rather than the immediate project deliverables, it is considered best practice to have one individual responsible for the delivery of the strategic benefits; this individual we can call the 'sponsor' (Kloppenborg et al. 2006). Crawford et al. (2008) identifies the 'sponsor' as key in linking corporate and project governance, ensuring that governance requirements are met, and providing support to projects and programs. These two papers and Kloppenborg, Tesch, and Manolis (2011) consider helpful behaviours of sponsors. In the UK public sector, this is called the 'Senior Responsible Owner' (Stephens, Assirati, and Simcock 2009). The distinction between 'owner' and 'sponsor' is confused a little by Zwikael, Smyrk, and Meredith (2016), who propose the role of a 'project owner' responsible for attaining the strategic benefits sought by what they call the 'funder' (or the 'project client'), this is what we are calling 'project sponsor'.
iii	Project Manager	This is perhaps the clearest role, tasked with delivering the outputs of a project. In the front-end, the project itself is not yet defined or formally approved: a project manager is thus not needed, since the granting of responsibility to the project manager to deliver the project marks the end of the front-end. However, project managers can often play an advisory role in the front-end, using their expertise to help define a feasible, achievable project. This is often the case in construction Mosey (2009) and Cardenas, Voordijk, and Dewulf (2017) propose a project governance model for infrastructure projects including the involvement of the contractor in the front-end. Morris (2013, 9) claims in his Management of Projects model that the goal should be to include the project manager much more in the front-end activities, including, e.g., setting project objectives, carrying out stakeholder management, 'managing and shaping the emerging front-end' etc.
iv	Communities and the public (as stakeholders)	Edkins et al. (2013) considers how secondary stakeholders' behaviour changes during the project lifecycle and considers their potential to influence the project management's decision-making. Related to this area, Canning and Holmes (2006) looks at stakeholders in particularly public projects.
v	Users/ beneficiaries	… are those who will directly use or benefit from the project. This might be a subset of (iv) and can sometimes be subsumed into this set. However, direct users or direct beneficiaries will have specific inputs that can be valuable not only to the detailed design of a project but even to considering the project concept.

Table 2. What happens in the front-end?

	The front-end is where	Explanation
i.	The initial idea emerges.	Where does the idea for the project come from, what is it based on, whose interests would it serve, who would pay for it?
ii.	Complexity and underlying problems and needs are analysed (Australian Transport Assessment and Planning Steering Committee 2016b; Samset 2010) and	As the genesis of a project is considered, it is important to look at the context where it emerges, and the various complex and uncertain factors on which it depends.

contextualised (Stretton 2016).

iii. The first estimates of costs and benefits are made.	Early estimates are important to evaluate the project although these will become refined as project concept is identified (see ix)
iv. The stakeholders' preferences and incentives become visible.	These can be complex (Winter 2006), and stakeholders can be in complex structures (Aaltonen and Kujala 2010).
v. There is very little information	The front-end is characterised by scant information available about the prospective (as yet ill-defined) project (Williams, Samset & Sunnevåg 2009). The danger is that decisions are based on an overload of detailed (but uncertain) information up front rather than carefully selected facts and judgmental information relevant to the essential issues (Samset and Volden 2016).
vi. Uncertainty is at its highest.	Below we describe how this uncertainty can be navigated, and possible scenarios of the future considered. Before the project is defined, the use of highly-refined 'heavyweight' project risk management is not yet possible (Olsson and Magnussen 2007)
vii. The opportunity space is/should be explored.	Samset and Volden (2016) discuss the frequency which the choice of conceptual solution is made without systematically scrutinizing the opportunity space up front, which partly explains the well-noted 'rush to solution.'
viii. The conceptual alternatives are carved out.	Lessard and Miller (2013), when discussing the shaping of large engineering projects, note that the seeds of success or failure are planted early. A key to successful projects lies in the choice of concept (Samset and Volden 2016)
ix. First estimates are refined, as the concept is developed.	The focus is often on the final cost estimate (the budget), while early cost estimates are overlooked (Samset and Volden 2016); Kloppenborg, Tesch, and Manolis (2011) trend the cost estimate during the project front-end development. Consideration of optimism bias and strategic misrepresentation (e.g., Flyvbjerg, Chi-keung, and Wing Huen [2016])
x. Stakeholders are recognised.	The affected parties could/should have a chance to have some impact on decisions. This is a source of sometimes vital feedback, often forgotten, and illustrates the non-linearity of the process
xi. The project is situated within a wider strategy/project portfolio (Kock, Heising, and Gemünden 2016).	The selection and prioritisation of a new project requires consideration of the portfolio view.
xii. The foundation is laid, and the main decisions are made.	At this point, a Go/No-Go decision (i.e. the determination to proceed with or relinquish a project) can be reached.
xiii. 'Quality at entry' can be secured.	In other words, the project can be of high-quality of definition, and confidence can be placed in its success.

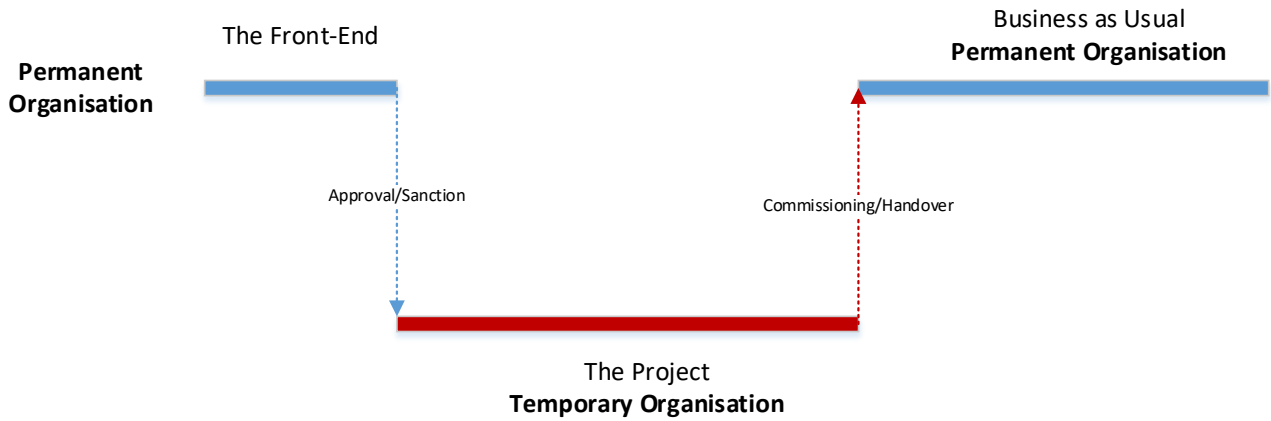

Figure 1. Project's front-end: The relationship between the permanent and temporary organisation

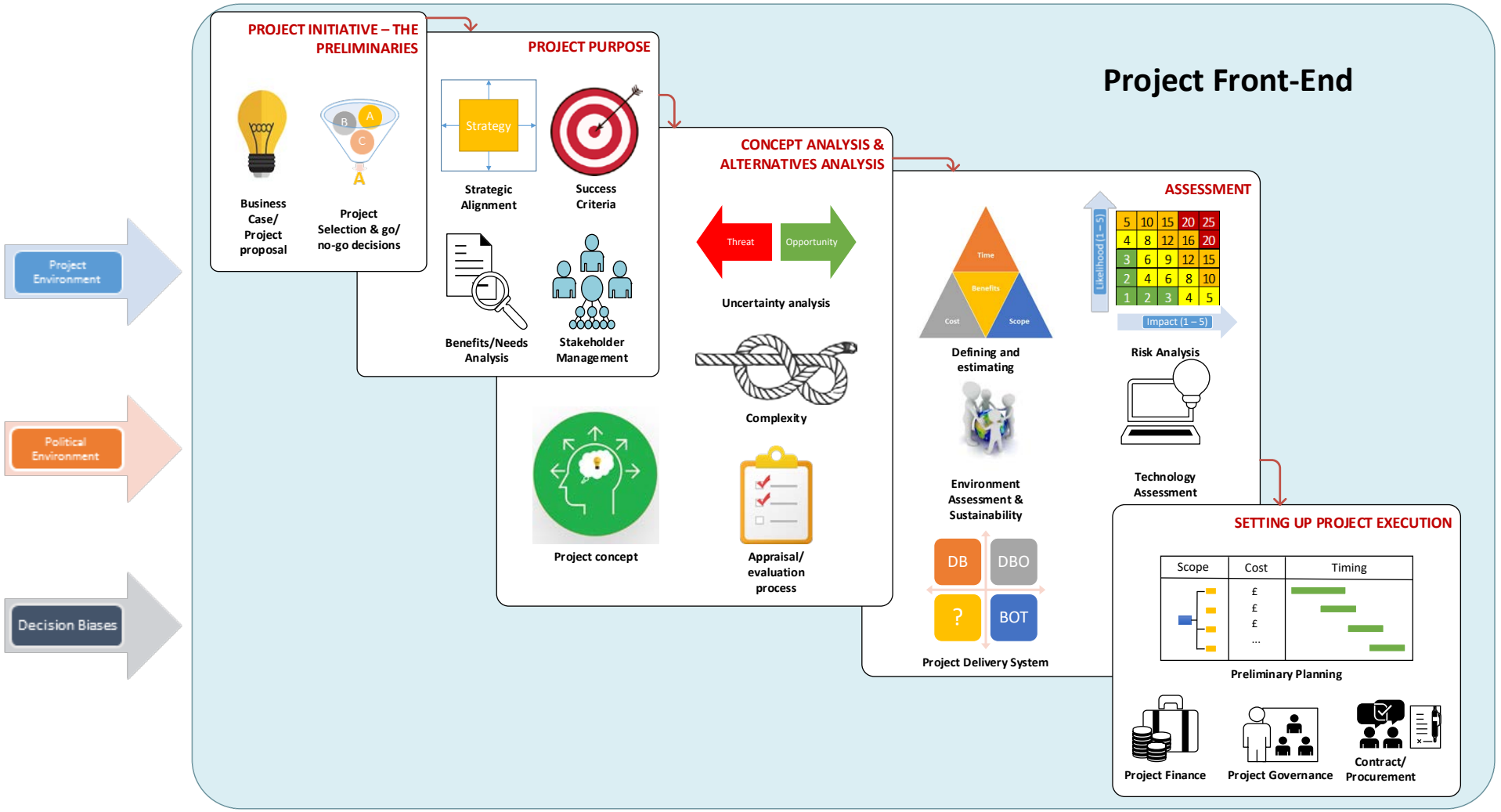

Figure 2. Summary of the Front-End
(Note. Adapted with permission from Samset's (2010, 161) overview of how techniques for concept appraisal fit together)