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Taming the 'trolls': Major public projects in the making

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Abstract

Major projects are not yet sufficiently understood, and practices in project governance and project management do not yet reflect the current state of knowledge of large, complex projects. In an attempt to understand the reasons, the authors therefore investigated the latest relevant findings documented in three countries: the UK, Norway, and the Netherlands. Their examination of the effect of implementing governance frameworks for public projects in these countries indicates that efforts to improve major projects are giving rewards: Even if complex public projects, the 'trolls', become more challenging, efforts to 'tame' them are improving. The results of the study show that project planning has improved and cost overruns are reduced. However, recent observations indicate that the effect may wear off remarkably quickly. Hence, the need for continuous improvement and change is prominent. There are fundamental limitations in the use of formal systems as they cannot detect all problems and there are limitations to humans' ability in terms of optimism bias that cannot be eliminated.

Keywords: Project governance; Governance frameworks; Project success; Complexity

1. Introduction

In this paper we examine the development of the governance of major public projects in three European countries in recent years: UK, Norway, and the Netherlands. Governance of public projects includes the practices and systems implemented to oversee initiatives organized as projects on behalf of society. The term governance used in this paper comes from political science and in the project context it is about the relationship of the project owner and its temporary project organization (Winch, 2014). Particularly as a result of the work of Peter Morris (1997, 2013a), a greater understanding of the behavior of complex public and public–private projects and thus how they can be better set up and governed has led to developments within governmental frameworks. We trace those developments and consider the extent to which projects can be shown to be set up and/or governed better. In particular, we concentrate on the front–end, the stage considered most important in establishing the success or otherwise of a major project (Morris, 1997). In their consideration of several international megaprojects, Flyvbjerg et al. (2003) state that governance is relative and country-dependent. Accordingly, we examine the United Kingdom, Norway, and the Netherlands as examples, as these countries have been particularly active in looking for improvements in this respect and empirical evidence from them is readily available.

Our study focuses on the governance of projects in the public sector, which has a key position in developing critical infrastructure for society. Due to its role as keeper of our common economy, the public sector differs in its nature from financially interested owners or investors in the private sector. The governance of projects covers the complex process of steering multiple coupled agencies and firms. Traditionally, governance has operated in accordance with regulations, economic means, and information (Bemelmans-Videc et al.,

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1998). The governance of national public investment projects has two parallel subsystems: the political (not discussed in this paper) and the administrative. New public management (NPM) has taken over the latter in recent years (Christensen and Lægreid, 2010), and has introduced private-sector ways of thinking and designing systems in the public sector in Europe (Pollitt and Bouckaert, 2000), including Scandinavia (Bush et al., 2005). Some (e.g. Christensen and Lægreid, 2001) consider that NPM does not fully take the public sector context into consideration. Several post-NPM reforms have therefore been introduced to reinstate more central political and administrative control (Christensen, 2009), and it is within this context that we consider the governance frameworks examined in this paper.

Public projects have become increasingly complex and difficult to manage, long in duration and conducted by multiple organizations; since we are examining particularly the situation in Norway, the analogy to trolls, which are difficult to tame and control, is appropriate. In Scandinavian folklore, trolls are known to be frightening and vicious creatures that are big and wild. Trolls need firm management to ensure they behave as we want them to, but as they are foul creatures the question still remains as whether they can be tamed.

There appears to be significant evidence that all is not yet well in this area in the three case countries. In Norway, the account of a torpedo battery that was finished on time and on cost but that closed immediately after completion and was never used, is well known (Whist and Christensen, 2011), and illustrates the flaws in the decision-making processes and the lack of a cost–benefit analysis or any systematic establishment of the real needs or future benefits. Whist and Christensen summarize 18 Norwegian public projects and find similar flaws in the majority of them. Recent papers from the three case countries (the UK, Norway, and the Netherlands) report similar results (Primeus and van Wee, 2013; Williams and Samset, 2012).

In this paper we follow the findings of Merrow (2011) relating to megaprojects in general, Flyvbjerg et al.'s (2003) understanding of the need for an outside view and the risks of optimism bias and strategic misrepresentation in public projects, the IMEC study of large engineering projects that shows the need for flexible governance structures (Miller and Lessard, 2000), and the emphasis that all of these authors and Morris (2009) give to the front–end analysis of projects. Thereafter, we examine the evidence and discuss to what extent it can be argued that the challenges of major public projects have been resolved. We address the following questions: Will our structures secure successful public projects in the future? What are the limitations? Does success lead to complacency? Do we understand the multiple agencies and the mix of 'hard' and 'soft' signals in a project? How successful has this attempt to improve major public projects been?

2. The development in project management perspectives and success in public megaprojects

Peter Morris (2013a, 2013b) published a general overview of the developments in project management as a profession and a discipline. Here, we focus the development of knowledge about a specific class of projects: public megaprojects. Significant contributions from megaproject literature, based on empirical data from a large number of real-life projects, are listed in Table 1. We selected the publications from a large number of contributions, and although the list is not complete and does not include all of the most important ones, the selected publications are among the most notable.

The start of the development in project management coincided with a ground-breaking study by Morris and Hough (1987), which led to the general understanding that lack of political support, unclear success criteria, changing sponsor strategy, poor project definition and control, and weak quality assurance are among the main causes of megaproject failure. Many of these issues were defined as outside the scope of project management at the time. Clearly, the cited contributions shared some common traits. In particular, the identified fundamental challenges have remained the same from the early 1980s up to the present, and interestingly Morris and Hough's (1987) diagnoses are still relevant today. However, the precision with which causes and effects are identified has improved, and the understanding of the consequences has shown a similar development. Publications listed in Table 1 led to a successively more detailed and robust picture of the challenges that projects face.

The contributions listed in Table 1 represent different perspectives on megaprojects, studies varying from those with an empirical base of several thousand statistics from a variety of projects, to studies focused on a limited number of similar projects, and to in-depth studies of a few selected case-projects. Projects represented public and private sector projects of megascale and a high degree of complexity. Much attention in these books is directed towards the public sector, but Merrow (2011) documents in great detail how problems of megaprojects are also significant in the private sector, even if some might argue that the complexity of the stakeholder and political environment makes the public sector more challenging. The most recent publication in Table 1, by Peter Morris (2013a), summarizes the knowledge accumulated to date in terms of defining the management of projects and of project management as a discipline. Today, our knowledge of the causes and effects are more detailed and precise, which means that we should be better able to find the necessary means to manage and control public megaprojects.

In the following sections, we discuss how the case countries are meeting the challenges of public megaprojects in light of the new knowledge, and have done for more than a decade.

3. The development in public sector projects in the UK, Norway, and the Netherlands

Countries strive to make the most out of their public finances; public change programs and investment projects are vital to create value from these limited funds. Our three study countries (UK, Norway, and the Netherlands) have been particularly keen on challenging major public projects and have all introduced governance frameworks (Table 2). In this

Table 1
Important publications on megaprojects and the main problem areas identified (based on and expanded from Table 1 in Klakegg, 2009).

Author	Focus	Most important problem areas identified
Peter Hall (1981)	Decision-making models Roles/actors	- Forecasting the future - Trade-offs between groups
Morris and Hough (1987)	Different perspectives on project success	- Human errors - Project objectives and their validity - Influence of politics - Government as sponsor, champion, and owner - Financial matters - Implementation of results
David Collingridge (1992)	Decision-making processes in big organizations Trial-and-error learning	- Limitations in human capacity to control and understand complexity - Problem changes over time - Inflexibility in technologies (projects) - Changes are costly and painful—inhibit critical scrutiny
Miller and Lessard (2000)	Institutional frameworks, decision-making, and project sponsoring	- Handling turbulence in project environments - Opportunism and omission - Decision-making is not fully rational - Coordination and cooperation - Design of institutional frameworks
Flyvbjerg et al. (2003)	Better and more rational decision-making and communication Institutional arrangements, accountability, and handling risk	- Applying the wrong method is a minor reason for forecasting failures - Poor data are a more important for predicting failures than methodology - Discontinuous behavior and the influence of complementary factors not included in predictions - Unexpected changes of exogenous factors - Unexpected political activities or missing realization of complementary policies - Appraisal bias of the consultant and the project promoter
Altschuler and Luberoff (2003)	Theoretical analysis National patterns over time Intergovernmental aspects	- Lack of competence and experience transfer - Handling complex networks of practices and roles - The public sector leadership role - Handling harmful side-effects - Conflict between local support and central financing - Project financing models - Cost escalation and underestimation
Merrow (2011)	Understanding projects Business decisions before starting projects Making project decisions	- Unbalanced allocation of value—greed - Schedule pressure—cutting corners, opportunism - Developing a detailed business deal early - Weak planning upfront - Cost reductions without respecting the scope definition - Trying to transfer megaproject risks to contractors - Firing project managers for cost overruns—lack of continuity
Morris (2013a)	History of project management Management of projects Aligned supply: focusing on value	- Realization of business outcomes - Relevance of project management in light of global changes and challenges - Shaping the context to allow project success - Alignment of suppliers and sponsors

section we look at the key governance instruments used in these established governance frameworks. We present a brief overview to identify which means have been introduced in the countries (see Klakegg et al., 2009; Shiferaw, 2013a, 2013b; Williams et al., 2010 for more detailed comparisons).

The frameworks are to secure successful projects so their purpose reflects the respective countries' perception of success. The purpose of the Norwegian framework is explicitly stated as maximizing value for society, understood as society as a whole, including users and executing parties (private sector) in order to

Table 2
Stated purpose of three public project governance frameworks.

Country	Framework name	Stated purpose
UK	OGC Gateway™ Process	Achieve financial targets, improve delivery of public projects (Klakegg et al., 2009)
Norway	Norwegian State Project Model (formerly the QA regime)	Cost savings, improve cost control, maximize value of public investment projects for society (Klakegg et al., 2009).
Netherlands	'Faster and Better' & the MIRT program	Shorten project realization time, improve decision-making efficiency in the development of infrastructure projects (Arts, 2010)

maintain balance. Explicitly for the state, the purpose is to reduce costs and increase cost control. In the UK the stated purpose of the governance framework is similar but more neutral (and thus easier to interpret as balanced), and more business-like (i.e. it relates to financial targets). By contrast, the Netherlands' framework mainly focuses the means (i.e. faster, better, and with coherence between different policy fields), but the underlying intentions are clearly similar to those in Norway and the UK.

3.1. United Kingdom

In the late 1990s, Peter Gershon, then at GEC Marconi in the private sector, was commissioned to examine the status of public procurement in government. The findings are published in his influential report *Review of civil procurement in central government* (Gershon, 1999). Gershon was subsequently asked to set up the Office of Government Commerce (OGC), which he did in April 2000 by integrating several previous government agencies and resources. The methods developed in the Gershon report cover the general procurement of commodities and project procurement. The OGC Gateway™ Process, the Buying Solutions, Prince2®, and other best practice elements set up by the OGC reflect private sector practices.

The OGC Gateway™ Process is composed of a formal structure with six gateways to check that projects are sufficiently mature and well planned before they move to the next phase. When the process was first implemented, the review team gave their recommendations and shared experience without being formally authorized to give instructions to the project or its Senior Responsible Officer (SRO). Initially, reviewers were mainly approved by experienced senior consultants from the private sector (Klakegg et al., 2009). Since then, there has been a tendency for increased numbers of public sector reviewers, up to 86% of the total in 2012 (Cabinet Office, 2013, p. 26). The reviews were carried out in accordance with strict codes, including avoiding blame and practising strict confidentiality. The OGC looked for systemic trends that were indicative of weak project governance and then added a number of mechanisms to provide anchoring, particularly political anchoring (Klakegg et al., 2009).

Risk management was introduced in HM Treasury guidance as an instrument to avoid cost overruns and was used extensively in public projects. Based on a detailed study of 50 major projects (Mott MacDonald, 2002), HM Treasury advised in its revised Green Book published in 2002 that projects should be subject to external view on an empirical basis to avoid optimism bias. In the absence of a relevant empirical basis, a standard additional contingency for the relevant type of project was later added to the budget (Department for Transport, 2004; HM Treasury, 2004; HM Treasury, 2011, p. 85). In practical terms this is done by adding a proportional factor to the calculated cost estimate to cover for expected influence of optimism bias. The factor depends on the duration and size of capital expenditure, and the degree to which the effect of optimism bias has already been mitigated in the project proposal.

The role of the OGC has developed over time and its organizational position in the Government changed several times until it was reorganized and integrated into the Cabinet Office in 2010. Gateway processes have become more powerful and mandated. Cabinet Office (2013, p. 14) states:

> The Government launched the Major Projects Authority (MPA), within the Cabinet Office's Efficiency and Reform Group (ERG), in March 2011. It operates as a partnership between the Cabinet Office and HM Treasury, reporting jointly to the Minister for the Cabinet Office and the Chief Secretary to the Treasury. It is supported by a strong Prime Ministerial mandate … [and has the authority to] develop the Government's Major Projects Portfolio and work with departments to provide verified, timely data on projects, regularly reporting to Ministers.

The MPA's role is described as reviewing, challenging, and advising (Cabinet Office, 2014). New concepts such as the Starting Gate and Assurance Reviews are added, but still the OGC Gateway™ Process remains the basis for the reviews. This development established project assurance as a new buzzword in the project management community.

3.2. Norway

In Norway a similar development started in the late 1990s. Public projects were notorious for overspending and finishing late. Deputy Secretary General of the Ministry of Finance, Peder Berg, led a government committee to identify the reasons behind the problems and to suggest means for improvement. The Berg report (Ministry of Finance, 1999) turned out to be very influential. Based on this initiative the Ministry of Finance set up a new Quality Assurance (QA) Scheme in 2000, which was further expanded in 2005 (Samset et al., 2006). This scheme has since been developed further and is currently referred to as the Norwegian State Project Model (Samset and Volden, 2013). The Ministry of Finance established the Concept research program in 2002 to follow up, support, and report on the development of public projects; substantial documentation is thus available to researchers, and valuable knowledge about the achieved effect published.

In 2000 the Norwegian Ministry of Finance introduced a strong mandatory control regime for all major public projects financed by the state (viz. projects expected cost more than NOK 750 million (GBP 73 M)) (Samset et al., 2006). The control regime includes having an external expert team from the private sector study all relevant documentation, evaluate data and methods, analyze, and recommend. All major projects have to pass to be presented for decision by the Government or Parliament.

The purpose of the first-generation QA regime (from 2000) was to implement better control of project cost and thus public spending on projects. The second generation (from 2005) was to ensure that political and administrative roles are thoroughly divided, critical decisions are made at the right level, and that the right projects are chosen and executed well. The Norwegian method of monitoring public projects has also become very

influential in the private sector, due to private sector actors positioning for delivery into public projects.

The Norwegian project governance framework model is very basic, with only these two gateways. The framework is characterized by its external, critical gateway reviews. All QA reports are published openly to secure full transparency. This transparency is powerful as it exposes those that do not perform well to their peers. The strategy puts much pressure on professionals to keep up with standards (Klakegg et al., 2009). The external QA reviews are mandatory for all major investment projects financed by the state, and recommendations made in the QA reports have proven influential in decision-making, as shown empirically by Magnussen (2010) and theoretically by Christensen (2009). The framework and reviews directly influence individual projects and as such represent a significant strengthening of project governance.

In common with the UK, the management of uncertainty was a major issue in project governance introduced by the Norwegian Ministry of Finance. Independent analysis of cost under uncertainty is a key element in all QA reviews. However, in Norway there is no standardized contingency attached to projects. Every project needs to be analyzed individually by external consultants and the budget, including contingency, is based on such analyses according to Ministry of Finance guidelines. The outside view is increased by a 'reference check', whereby a project or cost elements in the estimate are compared to relevant similar projects.

3.3. Netherlands

In the Netherlands each ministry has its own planning, prioritization, and decision-making processes. The project preparation and execution systems had problems and several decision-making pitfalls (Priemus, 2007). There was strong focus on project study phase, often without careful problem definition and thorough consideration of other front–end requirements (Tillema and Arts, 2009). To improve this, the Dutch project governance system has been subject to continuous scrutiny and a series of reforms have been introduced (Shiferaw, 2013b). In 2007 the Ministry of Infrastructure and the Environment (I&M), which has by far the biggest investment volume of all ministries, introduced the programming and budgeting system MIRT (Multi-year Plan for Infrastructure, Spatial Planning and Transport). To facilitate the implementation of MIRT, particularly speeding up the planning procedures and making better decisions, I&M started a program called 'Faster and Better'.

Parliament and the Cabinet respectively appointed in 2004 and 2007 two different committees to come up with proposals to avoid cost overruns and schedule slips in infrastructure projects. In 2004 the Parliamentary Commission for Infrastructure Projects (TCI), chaired by Adri Duivesteijn MP (Member of Parliament), conducted an investigation into the decision-making and implementation control of two major infrastructure projects (TCI, 2004) and identified major problems associated with the projects. Based on its findings the committee put forward a new project assessment and decision-making framework. However, although the proposal was accepted in principle by the Parliament, it was not implemented. In 2007 another external committee, led by well-known businessman Peter Elverding, was appointed by the Cabinet to prepare a proposal that would help to speed up the process of infrastructure projects' realization. The committee's proposal was accepted by the government (Marshall, 2013). Although the Elverding committee's focus was on time and the TCI's focus was on cost, their recommendations showed similarities (Shiferaw, 2013a).

The Elverding Committee made several recommendations concerning procedural, process, and content-related improvements to make project realization faster (Elverding, 2008), including a call for a more balanced approach in terms of attention and effort in the different planning phases (Arts, 2010). In particular, the committee recommended more attention and effort towards the front end of the project development process, to ensure a more robust, open, and broad foundation. Accordingly, broad participation by stakeholders, including market parties, broad scope of alternatives, clear financial scope, program budgeting and prioritization, robust political commitment, and a clear choice of alternatives were recommended as front–end requirements (Arts, 2010).

To realize Elverding committee's recommendations, I&M developed the 'Faster and Better' program to shorten planning periods of infrastructure projects by 50% and make better decisions through improved public participation, adjusted legislation, and better procedures for evaluation and prioritization of project initiatives (Arts, 2010; Marshall, 2013). The 'faster' element focuses on reducing unnecessary information load and focusing on relevant issues, whereas the 'better' element involves the application of an integrated approach and early participation of public, market parties and government agencies.

MIRT is an integrated investment program that has been developed to ensure coherence and synergy between different policy fields. It provides an overview of current infrastructure projects' development and decision-making. It is composed of three phases (feasibility, planning, and realization) and four gateway reviews and decisions (initial, preference, planning, and realization). Its rules specify the main process steps to direct how project initiatives in need of state funding should be developed. MIRT rules and procedures are mandatory and in order to be included in the MIRT program or to qualify for state funding, a project initiative is required to run through each of the MIRT review processes (I&M, 2010; Shiferaw, 2013b).

3.4. Key governance instruments

In the United Kingdom (UK), Norway (NO), and the Netherlands (NL), efforts to improve public investment projects include the following key governance instruments:

- gateways with requirements for documentation and comprehensive reviews (UK, NL, NO), specifically very early consultations—the starting gate (UK, NL), and use of external private sector consultants as third-party reviewers (NO, UK);

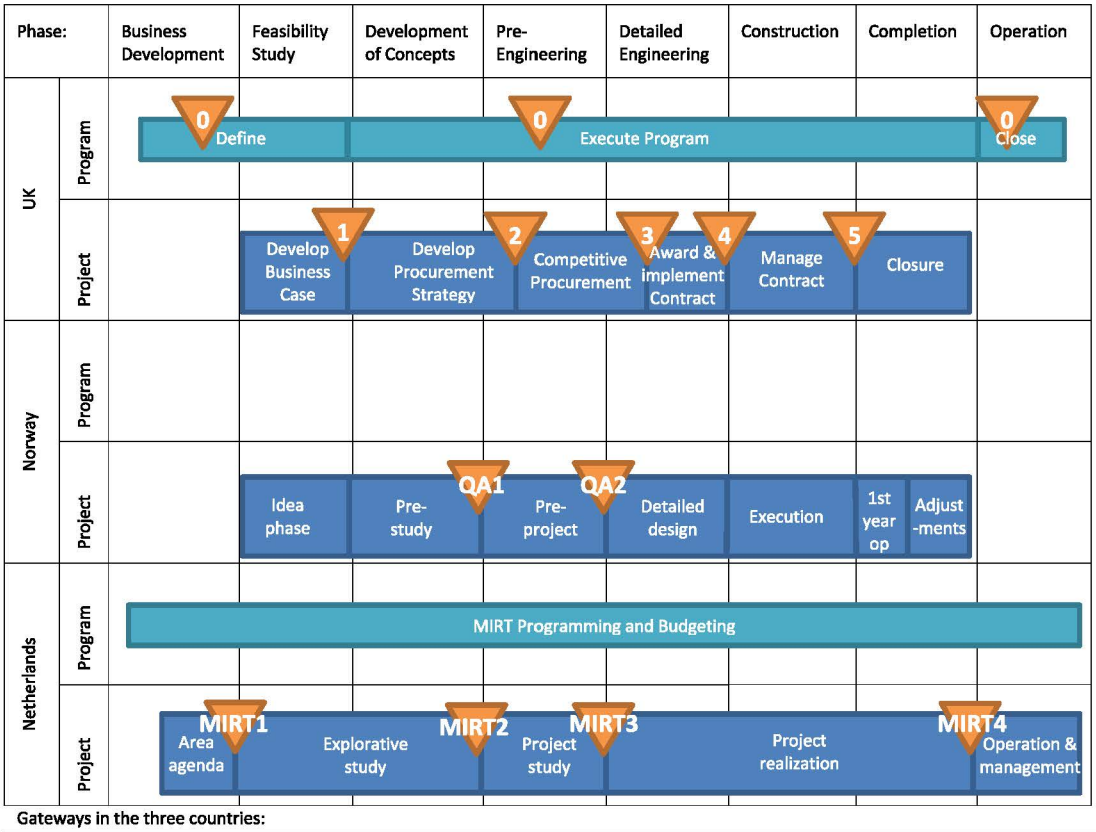
- placing key decisions at a high political level (NO);
- strong project governance by mandatory intervention in individual projects (NO, NL, later UK);
- increased transparency by publishing review results on an individual project basis (NO) and on an aggregated level (UK, NO, NL);
- focus on needs and a more robust, clear, and broad foundation in front–end planning (UK, NL, NO);
- integrated planning—horizontally (spatial planning, economy, mobility, and liveability) and vertically (national government, provinces, and municipalities) (NL);
- extensive use of early involvement of stakeholders (NL);
- active risk management, independent cost estimation review, and the use of contingency reserves in budgets to hedge against uncertainty and avoid cost overrun (UK, NO);
- professionalization of public project organizations, including agencies and private sector suppliers, by strengthening requirements, systems, training, and issuing guidelines (UK, NO, NL);
- focus on alignment with public policies (UK, NL, NO).

The above-listed instruments are fundamentally consistent with the recommendations in the literature cited in Table 1. Fig. 1 illustrates some characteristic differences and similarities between the formal structures of the three countries. More details can be found in Klakegg et al. (2009, 2010a), Heeres et al. (forthcoming), and Shiferaw (2013a,b).

4. Governance frameworks documented effect on public investment projects

This section focuses on the aggregate level and major projects to investigate the documented effects of improved performance in public projects in the UK, Norway, and the Netherlands. We analyze the portfolio of state-financed projects within the three governance frameworks (see Table 3 for a summary of some relevant facts about the frameworks and the major projects' portfolios).

In the following we look at the effects documented following the implementation of new governance frameworks and the challenges identified as still remaining.



Gateways in the three countries:

UK	Norway	Netherlands
0 = Business Need	**QA1** = Quality Assurance of choice of Concept	**MIRT1** = Intake Decision
1 = Business Case Review	**QA2** = Quality Assurance of Budget Proposal	**MIRT2** = Decision on preferential alternative
2 = Procurement Strategy		**MIRT3** = Project Realization Decision
3 = Investment Strategy		**MIRT4** = Approval Decision
4 = Readiness for Service		
5 = Benefits Realization		

Fig. 1. The structure of the governance frameworks in the three countries compared on program and project level. Reference phase model adapted from (Klakegg et al., 2010a).

Table 3
Some significant similarities and differences between the governance frameworks and project portfolios in the UK, Norway, and the Netherlands in 2014.

Theme	UK	Norway	Netherlands
Framework mandate	Mandatory	Mandatory	Mandatory
Authority	Cabinet Office	Prime Minister's Office	Ministry of Infrastructure and the Environment (I&M)
Decision-makers	Ministry & Cabinet	Cabinet & Parliament	I&M
Driving factor	Value for money	Cost overruns	Project delays
Special features	Review teams to assess programs and projects, challenge, and give advice Focus on critical projects	Independent, external consultants to review project documents and give recommendations	Co-operation with other authorities & improved public participation. Involvement of stakeholders in the early stage
Project management level	Portfolio, program	Single projects	Program, single projects
Project development stage	Life cycle	Front–end phase	Explorative stage and continuous follow up through life cycle
Project type	Mix of projects belonging to 20 ministries. Transformation programs	Road, rail, building, defense, and ICT projects	Physical infrastructure projects (railroads, roads and waterways)
Project size	GBP 33–580 million Average GBP 372 million	GBP 50–300 million	All physical infrastructure projects needing state funding (no cost limit). Average GBP 560 million
Average project realization time	Majority less than 5 years and some more than 15 years	5–10 years planning + 5–10 years execution	On average 14 years, including 5 years to reach a preferential decision

4.1. United Kingdom

The OGC's role in supporting procurement and acquisition processes of public sector organizations in the UK covered both project and non-project acquisition. Specific financial targets were set up and reported against. A Government report on the performance of the OGC states:

> [T]he OGC has achieved some notable successes since it was set up in 2000 … The OGC has also established Gateway reviews as a means to help departments improve their record in project delivery. Over 1,500 Gateway reviews have been completed since their introduction in 2001 on more than 700 separate projects and programmes in central government, resulting in over £2.5 billion value for money savings (HM Treasury, 2007, quoted in Williams, 2009, p. 5).

The OGC is probably one of the most influential units in public project management. Today, its results and methods are used commercially and implemented internationally, not least in the private sector. The assurance role of OGC was absorbed into the Cabinet Office, while the methodologies side of their work was spun off into a public-private partnership called Axelos (www.axelos.com).

The overall analysis of performance in UK major projects has been reported annually by the Major Projects Authority (MPA). The executive summary of the MPA's annual report for 2012–2013 states: 'This report shows that we are on the right track. By intervening in failing projects the MPA has already saved taxpayers £1.7 billion. Better assurance and leadership means that we are set to double the success rate of major projects from less than a third before 2010 to well over two-thirds' (Cabinet Office, 2013, p. 7).

The National Audit Office (NAO) comments on the MPA's first annual report as follows:

> The Authority published its first annual report in May 2013. Although this was significantly later than planned, it was an important step in improving the transparency with which progress on the Portfolio is reported. Comprehensive information on the Portfolio had not been published together before. The report provides an overview of the Authority's remit and priorities, and of the overall progress on delivering the 191 major projects by the end of September 2012. It was accompanied by departmental narratives on the deliverability, cost and timing of the projects. (NAO, 2014a, p. 5)

The reports from Cabinet Office and NAO clearly state that the establishment and strengthened authority of the MPA have worked positively and quickly. The reports give strong indications that the increased transparency helps improve the performance of major public projects. These observations were based on all critical projects at the time of reporting.

The NAO (2014a, p. 6) summarizes the key findings in the MPA annual report for 2012–2013 as follows:

- Forty-three percent of projects were categorized as highly likely or probably likely to be completed successfully, but there were significant doubts about the deliverability of 16% of the projects, with ratings reported as varying significantly between departments.
- Eight projects were rated as red, which indicated the highest risk to successful delivery. Problems occurred because departments initially underestimated the projects' complexity.

Furthermore, the following specific critical observation is made by the NAO (2014a, p. 6):

> The majority of projects are also due to complete soon. Over half of current major projects (97 out of 191 projects) are scheduled to complete between 2012-13 and 2014–15. We are particularly concerned that, of these projects nearing completion, the Authority has rated successful delivery as probable for less than half. Departments will have to make rapid improvements to complete these projects on time and on budget.

With regard to transparency, the NAO points out that there is a 6-month delay to publishing project data to allow time for the relevant department to respond to the findings. Furthermore, they found that published data were incomplete due to the right to not disclose data due to commercial sensitivity and national security. Data were inaccurate and lacked detail in important areas. The reported development is positive, but serious challenges remain. Nevertheless, less than half of the projects in MPAs portfolio are expected to be completed successfully. Furthermore, some of the known challenges from earlier reports still remain, thereby disturbing ongoing projects.

The main finding is that major projects in the UK are performing significantly better than prior to 2010. The reports from MPA and NAO focus mainly the traditional project success criteria: cost, time, and quality and saving taxpayers money seems to be priority. The MPA wants to include in the criteria also the operating environment and the need to improve the links between policy and delivery (Cabinet Office, 2013, p. 15). The systems and methodologies developed by the OGC over more than a decade include a strong focus on value and benefits in the business case, but currently receive little attention in the MPA's annual reports.

The NAO discussed the following development published in the MPA's annual report for 2013–2014:

> The Portfolio data from September 2013 shows an overall deterioration in the delivery confidence ratings of government major projects. There has been a marked increase in the number and value of amber-red rated projects ['19 per cent of Portfolio projects in 2013–14 compared to 12 per cent in 2012–13'], while the corresponding figures for green rated projects have fallen ['9 per cent in 2013–14 compared to 17 per cent in 2012–13']. In part this is due to 39 mature projects leaving the Portfolio while 47 new projects have joined. More mature projects tend to have higher delivery confidence ratings while projects at an early stage tend to be rated as higher risk, so this has impacted on the overall deliverability of the Portfolio. However, the rating of ongoing projects declined slightly as well, with 27 projects receiving an improved delivery confidence rating and 32 receiving a lower confidence rating. This highlights the severity of the challenges facing the Authority and the government in improving the delivery record of government major projects. (NAO, 2014b, p. 5)

In the report for 2012–2013 (NAO, 2014a) the NAO concluded a positive status to the capability and influence on government major projects, while warning that the MPA still faced significant challenges in achieving their desired results. This situation is confirmed by the 2013–2014 report above. The NAO has therefore defined the following key focus areas for further development:

- training and developing high-quality project leaders through the Major Projects Leadership Academy;
- empowering project leaders and ensuring there are clear lines of responsibility and accountability;
- ensuring that more detailed planning and investigation of options are conducted at an early stage;
- creating a culture of openness and honesty, to identify and address challenges facing major projects.

4.2. Norway

The Concept research program monitors the QA regime, develops new knowledge about major projects, and gives advice to the Ministry. Concept has conducted research continuously since 2002, Concept report no. 36, *Investing for impact* (Samset and Volden, 2013), summarizing the findings and concluding that the introduction of the regime has been a great success. The report collected a significant amount of data relating to completed projects that had been subject to QA2 (quality assurance of cost estimation and cost control) and documented the performance of 40 recent projects, including all major projects finished after going through QA2 since the regime was introduced in 2000. Results (Samset and Volden, 2013, pp. 9–10) show that:

- 32 of 40 projects (80%) were completed within their cost frame approved by Parliament, which is on target according the Ministry of Finance's requirements;
- 19 of 40 projects (50%) were completed within the agreed steering frame (generally agreed on the basis of expected cost or the P50 value (i.e. the expected value of the cost estimation including contingency reserves, but no management reserves)), which is very close to target;
- the combined actual cost of all 40 projects was very close to (slightly below) the expected cost of the whole portfolio.

QA2 seems to have established practices that secure reliable cost estimates and the merciless transparency motivated everyone involved to strive to be more professional and implement good practices.

For QA1, the report concludes that the documentation and basis for decisions about choice of concept was significantly improved. None of the projects that had gone through QA1 had been completed at the time when the research was carried out and therefore the overall effect of QA1 has yet to be established.

The governance framework's cost estimation and control efforts have given significant improvements since 2000 (Samset and Volden, 2013). The key to this improvement has been the mandatory implementation of uncertainty analyses and contingencies in the budgets to handle uncertainties during project execution. The cost frame normally refers to P85 (the value implying an 85% chance of not exceeding budget) and includes management reserves. For the 32 projects that completed within their cost frame approved by Parliament the savings were approximately GBP 0.5 billion, whereas the remaining eight projects (20%) exceeded their cost frame by c. 0.2 billion GBP, half of which was due to one railway project alone. The net savings of the portfolio as a whole was c. 7% of the total investment. When compared to the agencies' steering frame, which refers to the P50 value, the same dataset showed

that approximately half of the projects exceeded the steering frame. For the portfolio as a whole, the combined cost was very close to the expected value. Overall, cost deviations are acceptable. These results are extremely good compared to the results before the introduction of the QA regime in 2000. The improvement has not only been due to the introduction of the regime, but there is evidence that project management and cost management have been professionalized in the agencies. These findings are very encouraging and certainly an improvement on the past in Norway and the reported results on the performance of public projects internationally.

A Concept working report (Welde, 2014) includes updated documentation on a further 11 projects that were finished recently. The total portfolio is thus now 51 projects. Welde's analysis shows that 75% of the projects were below the cost frame and 55% exceeded the steering frame. The total cost of this portfolio was GBP 0.3 billion or 3.6% below the accumulated cost frame. The accumulated cost over the steering frame was GBP 0.6 billion or 8.3% of the expected cost. This is still a good result compared to most other published similar results, but the trend is significantly negative compared to Samset and Volden (2013) and needs to be analyzed.

Concept has indicated the following key areas for further development (Samset and Volden, 2013):

- keep following up on the operational performance of projects to monitor the trend and suggest improvements to the State Project Model/QA regime;
- research how project content, scope, and cost estimate evolve in the front–end, before project approval;
- evaluations of projects, focusing their tactical and strategic performance.

4.3. The Netherlands

The I&M has developed ample legal means to implement the MIRT and Faster and Better frameworks, particularly to involve stakeholders upfront and account for their interests. All implementation activities of the I&M are required to meet the conditions set by MIRT rules. In these, discussions and negotiations between stakeholders are pulled towards the front end of the planning process. There is also a need to ease the planning process, speed up decision-making, and conjugate the needs in an informed and coherent way, to shorten the project realization time. It might be too early to discuss the impacts of 'Faster and Better' because some time is needed before measures to improve planning and decision-making will impact on practice. However, according to the I&M (2010), projects in the MIRT program are expected to progress according to the rules and to succeed.

Recently, I&M evaluated the Faster and Better initiative for 21 national road and waterway projects. The objective was to identify whether those projects had been implemented according to the rules and the framework of the initiative, and whether the initiative's principles had been implemented. According to De Vries et al. (2013), the results indicated both success and difficulties in achieving the desired improvement. The Faster and Better initiative has led to a clearly defined explorative stage, and the preferential decision (MIRT 2) has been made comparatively faster. Prior to the implementation, an average of 5 years was needed to make the preferential decision, but after implementation the time was reduced to 2–4 years. The results of the evaluation also indicated that some large and complex projects needed more detailed studies and longer time than initially expected and the reform seems oversized for small projects. This reality check indicated that more effort and commitment are required in relation to public involvement and cooperation with authorities. Another finding was that for some projects the explorative stage ended too soon due to the pressure from politicians. De Vries et al. (2013) claim that the process of planning infrastructure projects in the Netherlands has been improved since the implementation of the Faster and Better initiative but recommend the need for further studies. Similarly, feedback from I&M indicates that the overall performance of the reform is good, that the I&M is no longer in a state of crisis in relation to projects' realization time, and that the focus has shifted to project costs (De Vries et al., 2013).

To sustain positive effects and for further improvement, De Vries et al. (2013) call for changes in the Dutch political culture in relation to projects. They support Dais et al. (2011), who argue that the political culture of governance is a potential threat to the success of the reform. We interpret this as indicating that even though there are several encouraging developments in the Netherlands' project governance system, the reform may not be a complete success if the political culture is not changed. The question of how to improve the political culture remains.

Based on the work of Dais et al. (2011) and De Vries et al. (2013), we summarize the observed challenges in the Netherlands as follows:

- the need for changes in political culture to avoid cutting corners and to stick with previous choices;
- appropriate public participation and cooperation between authorities;
- adaptation of the framework to smaller projects and the largest, most complex projects;
- avoid ending the exploratory stage too soon; take the necessary time for decisions on complex projects;
- the need for better co-ordination of decision-making and aligning of SEA (Strategic Environmental Assessment) and EIA (Environmental Impact Assessment);
- continuing research to document the performance of projects and the governance framework.

5. Discussion of current status and development

All countries have their own 'trolls' challenging public projects that in some dimensions seem to become increasingly more challenging as they grow bigger and become more complex. Table 4 indicates some characteristics, documented effects, and remaining challenges in the three case countries' efforts to tame their 'trolls'.

Table 4
Comparison of governance frameworks, effects, and challenges in the UK, Norway, and the Netherlands.

Country	Key framework characteristic	Documented effect	Remaining challenges
UK	Guided gateways and a complete system	Cost savings, improved delivery confidence	Low quality of data Culture of mandatory interventions and open reporting to increase transparency
Norway	Gateways and critical control	Cost savings, improved cost control	Methodological challenges in cost/benefit analyses and front–end planning
Netherlands	Participation and Gateway reviews	Faster preferential decisions	May be complex for smaller projects, and may not fit complex projects Political culture of governance

UK, Norway, and the Netherlands are all Western democracies and rich countries with well-developed economies and administration, so direct comparison is justified. Furthermore, they can also rely on competent private sector suppliers and a professional project management community. Moreover, their governance frameworks have a similar purpose: to ensure society receives more value for money in the public sector. However, their approaches are very different in terms of their frameworks' design. Development history and national culture, as well as political and judicial systems are important factors in deciding what sort of interventions will be most effective (Klakegg et al., 2009). These issues reveal differences in detail, and also give different dynamic interplays between the system level (governance level) and actor level (institutional level), as pointed out by Winch (2002). However, we do not address the effects here.

Are the effects above due to improvements in the quality of measurement and reporting? The frameworks implemented in the UK and Norway throughout the period 2000–2014 showed significantly strengthened reporting. Aspects that would have gone unnoticed prior to 2000 are now documented. This raises questions about the direct comparison of project success pre- and post-2000. However, the effects in focus in this particular analysis are based on measurements reported for short time intervals (one year) in the UK and Norway, and there was no significant change in reporting during that time span.

For a cross-country analysis, comparison of the UK and Norway is more natural as they both focus on cost and have a longer period of implementation. Results in the UK and Norway are very similar, although perhaps stronger in Norway than in the UK. The development in the Netherlands is premature in terms of giving strong indications, as implementation challenges still dominate. Some significant similarities and differences between the development in Norway, the Netherlands, and the UK can be identified (see Table 3 for more details):

- *The mandate of the authority responsible for administering the governance framework* is strong in all three countries and, particularly in the UK has been strengthened.
- *Types of projects* vary between the countries. In the UK the projects represent a mix of types but are dominated by transformation programs. In Norway the projects represent a mix of road, rail, building and construction, defense, and ICT projects. In the Netherlands the project portfolio comprises physical infrastructure (e.g. waterways, railways, and roads). The level of complexity is thus generally lower in Norway and the Netherlands than in the UK (more complex projects being more difficult to control) (Hertogh and Westerveld, 2010; Snowden and Boone, 2007).
- *Size of projects*: the average size (measured in cost) is significantly smaller in Norway than in the UK and the Netherlands. Size matters when evaluating project performance: on the one hand, large projects are harder to oversee and control, while on the other, they are richer in resources (knowledge and finances) and have more time to take corrective action. The size effect has been documented several times in Norway and results show that smaller projects have a relatively larger cost overrun (Odeck, 2004; Samset and Volden, 2013, p. 32). Also, the size of the economy matters: what are considered major projects differs in the UK, the Netherlands, and Norway, and this indicates that smaller projects are more relevant in Norway. In summary, it is difficult to be certain as to whether size influences total performance of a project, and whether differences in size are positive or negative.
- *Stage of project development*: There is a significant difference in uncertainty depending on a project's stage. In the UK a large part of the MPA portfolio was phased out between two reports and was exchanged for new ones in the latest portfolio report. This naturally increased the aggregated level of uncertainty and could explain why the number of projects with negative remarks increased. In Norway the projects in the portfolio continuously flow through the system. In the Netherlands there is a large focus on the early decisions and front–end, and securing a wide basis for the projects. We therefore assume that the majority of projects in the Faster and Better initiative are still in the very early stages and it is too early to say what the outcome will be.
- Duration of projects: Major public projects take a long time to develop, plan, and execute. Miller and Lessard (2000) show that it takes an average of 7 years between when an idea comes onto the agenda until Parliament approves the cost frame. Samset and Volden (2013) indicate 5–10 years in this phase, based on Norwegian data, and then the same amount of time to plan and execute. The UK MPA does not give the average duration in its annual reports. The NAO describes the majority of the portfolio as relatively short (less than 5 years), but that a significant minority are much longer (over 15 years) (NAO, 2014a, p. 6). In the Netherlands the reduction in time is regarded as a main issue and a key success criterion of the governance

framework. Elverding (2008) estimates an average duration of 14 years for motorway projects from start to deliverance. The average time for reaching a preferential decision used to be 5 years; the result of the Faster and Better initiative is a reduction to 2–4 years (De Vries et al., 2013). The pattern thus seems to be the same in all three countries, although the data do not refer to exactly the same milestones in each country.

Thus, there are more factors indicating similarities than differences between major public projects and the reporting in the case countries, and we therefore consider the comparison relevant.

5.1. Further development—deterioration or continuous improvement?

To consider the current development we need to look closer at UK and Norway: both governance frameworks were introduced in 2000 and have developed since, and both had good to excellent results before signs of deterioration appeared. What is happening?

In the case of the UK there seems to be a plausible explanation for the deterioration in the exchange of mature projects for new ones between the two MPA reports. However, there will always be a stream of new projects flowing through and old projects will become more mature in the meantime. This is also the situation in Norway. The unfortunate trend may be a statistical effect. The aggregated results may still be slightly exaggerated by the results in the initial period when the effect of the new regime was maximized. The current normal situation may be closer to the real truth about the performance.

We interpret the observed development as a sign of a general effect: everything that is established and used over time experiences wear and tear, and to remain effective there has to be change and continuous improvement. The need for additional measures has been observed by the National Audit Office (NAO) in the UK and by Concept in Norway, as indicated above. Even in a stable environment, a quality assurance instrument will not stay effective unless it changes to maintain awareness and a feeling of updated relevance. The Norwegian framework seems to have been the most stable one, although it has developed over time and the focus has changed from QA2 to QA1. The reporting in this analysis for Norway is based on QA2 which has been more or less unchanged since year 2000.

6. Limitations to current governance frameworks

Formal governance frameworks such as those reported here assume that getting the steps right along the way will help to alleviate the problems of overruns. We have provided evidence that the intended effect has been achieved, but have found recent signs that the effect may be deteriorating and have discussed some aspects of why this may be happening. Behavioral economics (e.g. Kahneman, 2011) finds that formal approaches are still predicated on the basis of optimism and/or self-serving biases. How do the governance frameworks fit with that finding? Will the practices prescribed in the frameworks and accompanying systems be adopted in practice? There are three issues that we need to look at:

- the relation between systems implementation and learning in practice;
- the relation between planning and decision-making;
- the relation between the systems approach and project characteristics.

The rationally based system implementation that is a key ingredient in all three initiatives is working, but has limitations. Despite their documented positive effect and informal reports from agencies that the initiatives have made a positive impact in terms of professionalization and implementation of good practices, there will always be situations and/or individuals that are not right. The suboptimization effect caused by humans chasing their own success, rather than that of society will always be present. Hence, there will always be forces that resist changes and are a source of friction to the intended development. Adoption of new practice is not automatic, even when mandated (Pellegrinelli et al., 2007). The world is continuously changing, and therefore systems need to change too, as has been demonstrated in the UK over the lifetime of the existing governance framework.

Cicmil et al. (2006) have challenged the research community to look critically beyond theoretical models and the normative positions of what should be done, to see what is actually done in praxis. In this respect, relevant literature includes a study of project assessments and reviews associated with governance frameworks (Klakegg et al., 2010a), which examines theory and practices in project assessments to see how they could help to identify early warning signs and thus help to improve success probability. Klakegg et al.'s report finds that there is no ultimate early warning sign that predicts project failure; rather, the reasons for failure are contextual. Warning signs will vary according to the type of project, the project environment, and over time. The report also confirms that many signals can be detected by performing formal assessments, such as those in the governance frameworks above; however, there are also signals that cannot be detected by formal assessments, and need to be detected by intuition or 'gut feeling' in situations involving dialogue. This leads Klakegg et al. (2010a) to conclude that the current trend for a high degree of dependence on formal assessments has a downside, leading to practices that conflict with current knowledge on complex projects. Project professionals apply more formal assessments, the more complex a project is; research shows that this practice is contrary to what is effective in such contexts: assessments based on dialogue and 'gut-feeling' are needed to look through the complexity (Klakegg et al., 2010a). A cybernetic control system that takes care of everything cannot be created.

The above finding illustrates one limitation that is highly relevant in the development and implementation of governance frameworks. The efforts to apply more formal mechanisms and rational logic to complex projects may backfire if

they are not supplemented with informal mechanisms and 'gut-feeling' approaches based on experience and intuition. 'Gut feeling' is not meant to take the place of formal mechanisms, but formal mechanisms cannot work without 'gut-feeling' elements, such as the critical judgment of a project manager or an experienced reviewer. 'Gut-feeling' and formal elements should go hand in hand and support and strengthen each other. Morris (2013b, p.17) seems to indicate a similar trend in project management: 'management could become less clunkily formal, more *instinctive*'.

The Netherlands have chosen a path of direct involvement of stakeholders in the planning process but have learned that the political culture needs to change for the reforms in the governance of projects to have full effect (Dais et al., 2011; De Vries et al., 2013). The balance between conceptual project planning and political decision-making is still unsolved. Morris (2013b) points out that project management both can and needs to shape the context in order to achieve more success. The political aspect may not be solved by project management at all, but the project management community needs to consider seriously how to play its role in the decision-making process. This has been much in focus in Norway (Samset et al., 2006), and the increased awareness has had positive impact (Samset and Volden, 2013). Similarly, in the UK, the NAO (2014a, p. 9) has commented on this insight and pointed out that advice from the MPA cannot be binding as that would limit the ability of elected ministers to make decisions. This limits the project management community's responsibility to making sure that the political community has a good basis for their decisions, which is an obvious responsibility, but one that is not always easy to fulfil.

Optimism bias is a fact of life, as documented by authors in psychology (Kahneman, 2011), medicine (Sharot et al., 2007), and project planning (Flyvbjerg et al., 2009). Since planning optimism is a part of human nature it will never go away, but it can be curbed in various ways. Awareness and increased knowledge probably helps, but are not enough, as experience shows. Strategic misrepresentation (Flyvbjerg et al. (2003, 2009)), is another phenomenon afflicting decision making on projects. Lying and deceiving in the budgeting process are reduced due to use of external control and increased transparency in Norway and the UK. In the Netherlands, extensive participation gives more transparency directly and potential for early identification of conflicts. Dias et al. (2011) and Elverding (2008) maintain that the involvement and broad perspective in the intake decision may lead to acceptance, and that the broad exploratory study results in information that serves a wide array of audiences.

Even scientifically based methods in project management are limited in their ability to reduce optimism bias and strategic misrepresentation. This, together with the anchoring effect, explains why the 'outside view' can be of significant help (Flyvbjerg, 2008; Kahneman, 2011). This may become an important future issue in project governance. Methods for reference class forecasting exist (Flyvbjerg, 2008), but are still rarely used. In Norway cost items are tested against other similar projects (reference checks) in cost estimation—a form of outside view without formal reference class method. Agencies in Norway have become more systematic in collecting data for future planning and learning. The Concept program has started systematic project evaluations to follow up on both the results (outputs) and effects (outcome) of Norwegian public projects to build relevant references for future learning. The efforts of the MPA and the NAO in the UK can be seen as similar elements, and it is reasonable to assume this is the situation in the Netherlands too. Certainly, these governance frameworks are important in a learning perspective. Strengthening the basis for informed decisions is a core aspect of them all, and performance measurements and research are clearly tools for this purpose. Gathering knowledge about previous projects is in itself a reason to invite planners to take the outside view.

A different side to the frameworks in the discussions of the outside view is the handling of contingencies to handle uncertainty. The 'inside view' approach includes dimensioning contingencies based on the actual project planned, whereas the outside view approach tends to dimension contingencies from a statistical representation of similar projects. Different countries have chosen different formalities. Norway has adopted the inside view approach whereas the UK uses the outside view approach. A combination of the two would probably provide the strongest approach to dimensioning contingency, but the problem of managing this contingency remains. The challenge is to avoid misuse of contingency to 'gold plate' or extend scope to secure the success of single actors at the sacrifice of the societal perspective (purpose). Any set of rules will be learned and used by those involved, because they are human. The key is a revealing transparency in handling contingency, such as intended in Norway and UK.

Another aspect of the frameworks is the 'trolls' themselves—the projects. The world is changing and so too are projects—they are becoming more complex, critical, and urgent. Hence, they are also becoming more difficult to control. Significant efforts have been made in project management research to understand project complexity (Cicmil et al., 2009; Hertogh and Westerveld, 2010). Two examples of training initiatives to handle such projects better in practice are the International Centre for Complex Project Management (ICCPM) and, the UK Government's leadership academy for civil servants responsible for major government projects (Saïd Business School, University of Oxford). Continued work in this direction will improve the probability for successful complex projects.

The issues discussed above highlight that formal governance frameworks are still not 'complete'. New elements are needed to compensate for weaknesses in systems and in human abilities. Adding new elements to the frameworks and systems makes them more complex, but system complexity is known to challenge the user (the human ability), which raises the question of whether it should be the way forward? In terms of complexity there is already a difference between the Norwegian approach and the UK approach (Klakegg et al., 2009). If this were to be set up as an even more complex model that examines a variety of projects and then opts for the appropriate governance methods based on a number of criteria, including complexity, would that lead to an improvement?

No single best method for management of public projects exists. The challenge with highly complex projects is that a framework specifically adapted to the situation (i.e. the project and its context) is needed (Miller and Hobbs, 2005). Direct transfer of a framework from one country or industry to another will not work (Klakegg et al., 2009). Furthermore, the situation includes ambiguity and turbulence (Williams and Samset, 2010). Consequently, there is a need for a wide range of framework elements and methods to cover all possible options and eventualities. This is illustrated by the differences between the frameworks in the UK, Norway, and the Netherlands described above.

If all the framework elements, system elements, and methods were to be collected in one toolbox covering all needs, that would be a fantastic source of knowledge and resource for practitioners and academics, but would also face severe challenges. The fundamental shortcomings of systems and humans would still exist, the political aspect would still be intact, and the added system complexity in itself would increase the problem for users with lack of oversight and misjudgement in their choice of what method to apply, creating a real dilemma in system development (Klakegg et al., 2010b) and in project governance.

7. Concluding remarks

This paper contributes new perspectives on the successful implementation of governance frameworks for public projects, based on an analysis of recent documentation from three countries. Our findings indicate that there is still a long way to go before major projects are sufficiently understood, and before practices in project governance and project management correspond to current knowledge relating to large, complex projects. However, as the cited studies indicate, efforts to improve governance of major projects are giving rewards. As the 'trolls' are becoming more challenging, we becoming better at taming them.

In the quest to improve the governance frameworks and project management practices, we need balance between the perspectives of owners and investors, users and beneficiaries, and the executing parties. As we show, formal governance framework such as those implemented in the UK, Norway, and the Netherlands need to be supplemented with 'gut-feeling'-based elements to see through complexity. The frameworks also need to be followed up using the 'outside view' in planning and cost estimation to help correct optimism bias and strategic misrepresentation. Finally, they need to be followed up with transparency and a strong focus on learning.

As the results and effects of introducing a governance framework have been documented we can now see the value of stringent and consistent project governance of major public projects. However, as recent results in the UK and Norway document, there are signs of an unfortunate trend. The means introduced to improve the cost estimation and cost control have worked as intended, but the effect has tended to wear off. Therefore, a future research question that will need to be addressed is: What needs to be done to preserve the effect?

Our three case countries have done much to tame their 'trolls' and have had some degree of success. Significant improvement has been documented, but the respective governance frameworks are still not perfect. Our findings show that there are limitations in the use of formal systems (they cannot detect everything) and limitations in our ability as humans (due to optimism bias, etc.). In addition, there is a limitation connected to the 'trolls' themselves: they are becoming increasingly challenging and hard to tame (due to increasing complexity, criticality, and urgency). We have yet to see the final answer to how trolls can be tamed. Still, our main conclusion is positive: some of the challenges pointed out by Peter Morris and his colleagues as early as the 1980s have become manageable.

Conflict of interest

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