RISK MANAGEMENT AND UNCERTAINTY IN INFRASTRUCTURE PROJECTS – WHAT ROLE(S) FOR KNOWLEDGE AND CONSTRUCTION MANAGEMENT?

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The assumption that large complex projects should be managed in order to reduce uncertainty and increase predictability is not new. What is relatively new, however, is that uncertainty reduction can and should be obtained through formal risk management approaches. We question both assumptions by addressing a more fundamental question about the role of knowledge in current risk management practices. Inquiries into the predominant approaches to risk management in large infrastructure and construction projects reveal their assumptions about knowledge and we discuss the ramifications these have for project and construction management. Our argument and claim is that predominant risk management approaches tends to reinforce conventional ideas of project control whilst undermining other notions of value and relevance of built assets and project management process. These approaches fail to consider the role and potential value of knowledge production during the project process, instead seeing knowledge as an input into upfront planning and specification. We examine ways in which actual project practices approach the question of risk management for the case of large public hospital building and infrastructure projects in Denmark. These projects are characterized by long durations involving substantial materiality, high uncertainty, ambiguity, and complexity. Yet, they are also subjected to risk management that operates according to a standardized 'best practice' control approach – as if these hospital and infrastructure projects are quite simple, predictive and similar in nature. The cases reveal the emerging uncertainties that challenge the project plan and the risk management approach as new knowledge about the conditions are produced during the project processes. The paper concludes by proposing a more dynamic understanding of the role of knowledge, considering the practical implications of uncertain knowledge conditions as a prevailing condition for construction management rather than something to be known in advanced and reduced by risk management.

Keywords: risk, uncertainty, knowledge, infrastructure.

INTRODUCTION

"The [ideal knowledge] conditions required for it to be relevant to talk of risk are not met. We know that we do not know, but that is almost all we know: there is no better definition of uncertainty" (Callon *et al*. 2009, p. 21).

During the last two decades scholars within management and organization studies, sociology and economics have developed a renewed interest in the concept of risk,

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dealing with classical topics such as gambling, occupational and operational risks as well as more recent and encompassing topics and notions such as 'risk society', 'world risk society' (Beck 2009) 'enterprise risk management' and 'the risk management of everything' (Power 2004). According to Power (2004) ideals about more and better control are underpinning the recent expansion of risk management practices across organizations and societies. Best practice approaches to project management have long since promoted control with a corresponding role for project management: a key role and responsibility of project management is about ensuring ongoing monitoring and control so that the project can be executed efficiently and accurately and delivered according to predictions. That is, according to a set goal and plan (Turner *et al*., 2010, Flyvbjerg 2006). The reduction of uncertainty to ensure execution according to a set goal and plan is integral to the control ideal in 'best practice' project management.

During the last two decades an increasing numbers of scholars in project research have addressed a number of critical issues and limitations associated with uncertainty reduction and control such as; the project's lack of effectiveness and loss of relevance in the wider stakeholder environment (Christensen and Kreiner (1991), Kreiner (1995), the lack of a broader value-orientation (Morris, 2010), the reduction of robustness and reliability in organizational performance due a false sense of control and certainty (Weick and Sutcliffe 2001, Coutu 2003). A key argument across several contributions concerns the conditions of knowledge in temporary project settings. Knowledge about the project and task is always uncertain, especially in the beginning of the temporary project when few actions have been taken and relatively little is known. Christensen and Kreiner (1991), Kreiner (1995), Lundin and Söderholm (1995), Engwall (2002), Jönsson (2004), Atkinson *et al*. (2006) and Lindkvist (2011) have all emphasized the contextual complexity, uncertainty and ambiguity of temporary project settings. Alongside these conditions, Van Marrewijk (2007) noted the prevalence of rituals and cultural values governing mega-infrastructure projects and Winch (2002) noted the existence of wicked problems in construction projects. These are problems that are uncertain in the sense of being ill-defined and without an optimal solution. In brief then, the conventional control approach to projects and project management has been questioned for being reductionist when dealing with uncertainty, biased in favour of predictability and efficiency in execution while disregarding the project context and longer term perspective after the project is handed over and its results are put to use.

The distinction between uncertainty and risk is integral to the above discussion. As noted by Chapman and Ward (2011) uncertainty management can be better than risk management insofar as the former implies further consideration of potential favourable opportunities, benefits and outcomes, in contrast to the more limited notion of risk management which tends to deal with the unfavourable costs and outcomes. However, as also noted by Power (2004) there seems to be more to this distinction. When the economist Frank Knight (1921) introduced the distinction between uncertainty and risk it was, according to Langlois and Cosgel (1993), to address a more fundamental uncertainty that goes beyond assigning probabilities to more or less favourable outcomes. The latter presuppose that we at least have knowledge of concepts to classify outcomes, although we might not know their probability distribution. Knight reserved the notion of risk for such situations and states that are sufficiently known to be measured and calculated. *"By contrast, uncertainty as Knight understood it arises from the impossibility of exhaustive classification of states"*, that

is, when the knowledge and conceptual categories are themselves unknown. (Langlois and Cosgel, 1993, p. 459 – 460). Thus, according to a Knightian distinction, the concept of uncertainty is broader in scope and implication than the concept of risk – while the latter can be subjected to quantifications and calculations, the former cannot. Instead, when actors are confronted with uncertainty, they must rely on judgment and intuition. As noted by Winch and Maytorena (2009) the distinction between uncertainty and risk was carried into management and organization research through the work of March and Simon (1958). Simon (1983) in turn questioned the contemplative 'cold' cognitive bias of much previous work on decision-making in organizations, especially associated with rational choice and the so called subjective expected utility theory. Instead, Simon proposed a model based on intuition and emotion, drawing attention to 'hot cognitions'. Hot cognitions are related to surprise and sudden discovery as well as the excitement these provoke. This notion carries further associations to March (1971) work on 'technology of foolishness' and the distinction between exploration (of yet unknown and hence uncertain worlds) and exploitation (within a relatively well known universe).

Some more recent contributions have also addressed possible complementary perspectives on uncertainty and risk management. Corvellec (2009) draws attention to the usefulness of silent, non-explicit non-formalized risk management practices. While Flyvbjerg (2006) points to the usefulness and importance of accuracy and the reference class forecasting method as a way to facilitate better control and predictability of large complex infrastructure projects and outcomes, Millo and MacKenzie (2009) point to the usefulness of inaccurate models and methods. According to them, the success of a forecasting method can depend on its usefulness in practice and thus be independent of the method's more or less predictive powers and expert knowledge. For example, organizational actors might adopt a particular forecasting method because it helps them to make fast and efficient calculations and decisions, and in turn, justify those calculations and decisions, and to communicate with others about issues of mutual interest. This is a rather different utility that the classic argument about making reality and the project more certain. Millo and Mackenzie's (2008) idea of inaccuracy, Callon and Law (2005) on qualculation as a continuum between judgment and calculation, Callon *et al*.'s (2009) emphasis on action in an uncertain world as opposed decision, choice and risk, and Latour (2002) on technical action, all point towards the active and performative role of technical devices in enacting and shaping the world they help to describe. Beck (1999) seems to allude to something similar when he comments on what an emphasis on the notion of risk and risk society implies:

"So risk is man-made hybrids […the notion of risk…] is the way the 'hybrid society' watches, describes, values, criticizes its own hybridity" (Beck 1999, p. 146).

In our reading, the emphasis on risk can be for better or worse and should be examined empirically alongside a less instrumental notion of acting and preforming within uncertain knowledge conditions. Below, we present empirical material from studies of two large infrastructure projects in Denmark; the current Danish hospital building programme which represents the largest ever public infrastructure investment in the country at some 42 billion DKK (£46 billion), and the 13 year, 3.2 billion Euro Danish rail signalling infrastructure redevelopment programme. Both cases demonstrate the complex interplay of risk and uncertainty in large projects, as well as the tension between risk management producing knowledge about project conditions 'out there' and risk management performing and reifying those conditions. In the

context of our work we focus on risk management practices in projects, but complement this with a particular focus on the possible complex dynamics and exchanges between a more or less uncertain project condition and the risk management practices that are used to manage those uncertain conditions. More specifically we ask how risk management practices shape project conditions for large construction and infrastructure projects and with what ramifications for knowledge and project- and construction management roles.

CASES AND METHOD

Both cases are on-going in terms of data collection. The *"Kvalitetsfonden"* hospital building programme data to date consists of a combination of interviews with actors from the Danish Regions state client organisation and built environment organisations involved in the design and construction of several of the individual hospitals that constitute the programme, along with attendance at public and closed project meetings, and documentary data. The documentary data is significant given the extent of public domain reports and media coverage. The signalling programme data consists primary of long-term participant observation within the projects from the end of 2009 when the programme received the go-ahead, combined with interviews and documentary data conducted and collected during this period also.

RISK MANAGEMENT IN THE DANISH HOSPITAL BUILDING PROGRAM

"Kvalitetsfonden", the current building and renovation program for the Danish hospitals is the largest public investment in physical infrastructure ever seen in Denmark. With a total budget of 42 billion Danish crowns (DKK), the *"Kvalitetsfonden"* involves 16 hospital construction projects ranging from significant rebuild and renovations of existing hospitals, through green field projects, university hospitals to so called 'super hospitals' with individual project budgets between 4 and -6.5 billion DKK. During the start-up of the program in early 2008 the client and umbrella organization for public hospital care, Danish Regions, requested help from the well-known consultancy firm KPMG to advice on how to manage the risks in such a complex building program. KPMG was at that time about to deliver their final report to the Danish state concerning a public inquiry into the new building for Danish Radio. The project became infamous for being late and for going over budget by 1.7 billion DKK. According to KPMG and Grant Thorton (2008), the deviations from the time schedule and budget were due to a lack of overall control and inadequate calibration and use of the risk management tools. The tool in use, *"successive calculation"* should have been calibrated differently in order to assess and communicating the actual risks.

With this track-record KPMG seemed well prepared to advise the Danish Regions on risk matters in large public constructions projects. The report (KPMG 2008) introduced the potential benefits of *"successive calculation"* supplemented with case scenarios such as worst, best and most likely along with the suggestion to identify the *"top-ten"* risk and uncertainty factors for the construction project (appendix, p.34). The National Audit Office (NAO) assumed a particular task and responsibility of monitoring the ways in which the different constituencies managed the execution of each of the projects as well as the overall programme. The NAO (Rigsrevisionen, 2010) urged the regions to increase the focus on risk management in each project, citing the KPMG (2008) report. In NAO (Rigsrevisionen, 2011) the focus on project risk was reinforced and extended to the Ministry of Health:

"Rigsrevisionen [NAO] notes that construction projects of such scale and complexity involve risks. It is therefore essential that the Ministry of Health specifies and meets its responsibilities as manager of the grants and supervisor to ensure that the construction projects are implemented within the total budget framework".

The regions, as client are, however, still in NAO's focus:

"The regions should throughout the construction process be focused on risk management and ensuring robust and competent building organizations in order to achieve the objectives set for the construction projects within the budget framework." (p. 3. English in original).

What prompted NAO to reinforce the focus on risk management and budget control among the constituencies was the disturbing news, that one of the largest projects in the program was reported to have a significant risk of going more than 1.2 billion DKK over budget.

The Ministry of Health (Ministeriet for Sundhed og Forebyggelse, 2012) took swift action, used the KPMG (2008) model for project reporting and elaborated upon it to include a traffic light model for how each of the project risks concerning budget, time and quality could be assessed and then stipulated that each project organization should use this standard format and report accordingly on a quarterly basis. During this period, there were also emerging concerns within the project organizations about how to best estimate the risks. A risk manager in one of the projects considered it to be an extraordinarily difficult and uncertain task to estimate risks on a large and complex hospital construction project with a completion time 10 years in the future.

"Frankly speaking, nobody knows if we will be on, below or even twice beyond the budget or more [!]"

Another, and perhaps more damning concern, was the certainty and the rigidity of the authorized budget frame – as if it was being *"made of stone"*. This rigidity was considered to be potentially detrimental for the resulting hospital. Given the uncertainty and complexity of the task and project it would be better to have more flexibility so that the project plan and design could adapt to new and still unknown technological solutions, and social and health trends. This would benefit the new hospital when in operation. But within the budgetary constraints, even if long term operational advantages using alternative technological solutions could be demonstrated using an impeccable investment calculus as support, it would not be possible to negotiate for the extra money. Everything had to be accounted for within the existing project budget, the risk manager explained, while adding that the current risk management set-up appeared to be more about bureaucratic control within the confined space of the project budget and less about the longer term quality, benefits and value for the hospital in use.

However, when the NAO (Rigsrevisionen, 2013) returned with a new status report for the hospitals under construction it was with a somewhat different focus. The focus was no longer primarily about the project economy and the risk of exceeding the construction budget, but rather about the longer term 'total economy' for the coming hospital in use. KPMG (2008) was again part of the argument, with the NAO (Rigsrevisionen, 2013) reminding the regions about total economy being an important criterion for public constructions since long before the hospital programme. Another reminder concerns the specific requirement for funding, that each project must demonstrate a certain level of increased efficiency and productivity in hospital

operations compared to a cost baseline defined at the point of project approval. NAO thus urged the regions and project owners to calculate the productivity gains and 'total economy'. But uncertainty is at least implicitly recognised:

"In connection with kvalitetsfondsbyggerierne the possibility of using a calculus of the total economy is limited due to the fixed [budget] frame for each construction, which cannot be exceeded. This means, that the regions can only implement solutions that are possible within the allocated [budget] frame" (p. 31Translated from Danish).

The NAO seem to express the concern that the longer term total economy of the hospitals 'in use' might have to pay for the rigidities associated with a 'fixed' construction budget at the commencement of the project. It further appears that the rigidities of the risk control set-up the risk manager at one of the projects warned against two years earlier, was about to return back to NAO as an emerging and quite complex issue about risks produced by the current risk management system itself. Although still framed in terms of the need for budget control and classic risk management, the issue of uncertainly and lack of flexibility over the long term has re-entered the discussion.

RISK MANAGEMENT IN THE DANISH EUR 3.2 BILLION RAILWAYS *"SIGNALLING PROGRAMME"*

In 2006 the Danish Ministry of Transport, encouraged by the Danish Ministry of Finance, implemented new formal requirements for dealing with uncertainty on large transportation infrastructure projects. As with the later hospital projects the Danish Ministry of Finance had grown tired of repeatedly having to deal with cost overruns on large infrastructure projects (Finansministeriet, 2010). In an attempt to avoid this, formal risk management was introduced to support management accounting control practices (Transportministeriet, 2006). In contrast to the hospital projects, however, successive calculation was banned as the Danish Ministry of Finance and the Danish Ministry of Transport blamed this principle for leading to inaccurate cost estimates (Finansministeriet, 2010). Instead, they emphasized that budgets had to be produced using known prices and quantities and a fixed contingency reserve of 30 percent had to be added on top of that. As this was only to be granted under strict requirements, however, formal risk management was introduced so make sure that uncertain events were dealt with so that project objectives could be achieved with greater certainty.

The Danish Ministry of Finance and the Danish Ministry of Transport, however, were unfamiliar with how to approach the construction of these new practices; they needed therefore to test this somehow. At that time, the need for a total replacement of the Danish railways signalling equipment was at hand. In the years leading up to 2006, the Danish railways signalling equipment had been decaying to the point that train operation was regularly being affected (Booz Allen Hamilton, 2006). Also, the National Audit Office had been criticizing the management accounting practices of the state-owned enterprise that manages the rail infrastructure, Rail Net Denmark, for being unsatisfactory (Rigsrevisionen, 2002, 2004, 2005). As parliament decided to approve of the total replacement of the signalling systems that same year - what was later to become the Signalling Programme - the Danish Ministry of Transport and the Danish Ministry of Finance saw this as a clear business case for implementing formal risk management for the first time.

The Signalling Programme runs from 2009 until 2020/21 and has been separated into three main subprojects; the regional lines west, the regional line east and the Copenhagen mass transit system. It has been approved with a EUR 3.2 billion total

capital cost budget and employs the first holistic practice of risk management to be attempted with large transportation infrastructure projects in Denmark. It employs on average more than 120 people whereof at least two-third of these are externally hired consultants. It uses the best practice approach to risk management as defined by the Project Management Institute, which has come to be the best-practice approach to be applied across the Ministry of Transport's domain (PMBOK). This means that it draws upon a cause-and-effect based logic where actors have to define those events that have either positive or negative effects on the project's objectives; utilizes the commonly used *"traffic light assessment matrix"* where risks are assessed using the probability times consequence logic; requires risk reducing actions to be undertaken and then compared to that assessment; and for them to be monitored, controlled, and reported on throughout the lifetime of the programme. It further enforces the use of a very complex IT-based management control system so to calculate risk values and allow for a decentralized use by project managers while still maintaining a centralized control by a few actors. It builds on the logic of setting a risk appetite and then comparing the calculated risk value against this so to make sure that, at worst, this value stays below the 30 percent contingency reserve included in the budget. It has been argued by several key actors, however, that the purpose is more to show reducing values than to actually compare this against the contingency reserve as risk value estimates rarely compare with budgeted and actual cost.

The practice (the programme) has been described as very successful by the Ministry of Finance and also those involved find it very useful. The case, however, reveals that several problems exist with this practice. One of these is that even though you include risks into the control system and agree that this poses a threat against the objectives of the programme, sometimes you cannot do anything about it. This was evident when one of the very large Danish entrepreneur companies went bankrupt. This event sent ripples throughout the sector as many smaller contractors employed by this company, Pihl and Son, were brought down with them. In the Signalling Programme this had been taken into consideration but to actually reduce this risk to zero, this would have required that contracts had been prepared with other large entrepreneurs, who then would have had to sign them so to avoid delays incurring. If this had been done it would have cost millions, and since no one expected this to happen, it seemed like an extreme measure to take at that time. It did help to create awareness of the possibility, and slack had been included in the schedule to deal with such events, but it did not decrease the costs that were subsequently incurred when a new contractor had to be found. As it turned out, everything worked out as the programme did have adequate time scales to deal with such unexpected uncertainties, but it has resulted in compressed deadlines so that further uncertainties incurring could topple the house of cards and thus points the problem: did the use of risk management, and the investment in risk management tools and practices, actually reduce any costs in this case?

Another unexpected consequence refers to the fact that only those uncertainties that can be described using the before mentioned cause-and-effect oriented logic can be included as a risk – but that require a high degree of existing, validated knowledge, which rarely exists on unique projects running over long period of time. On multiple occasions this had led to frustration from the project managers as they have not always been able to produce justified explanations. As the project runs for approximately 12 years and thus could be prone to many unexpected events, removing any ability to accommodate the gut-feelings, hunches, and intuition of actors with years of experience seems in itself risky. In one example, a project manager was very sceptical

of a newly signed contract with a supplier because he knew from experience that this supplier always makes mistakes. However, this was excluded as it could not be accounted for within the risk management system. Two years later, that same supplier made a significant design mistake that made the signalling hardware too heavy, several trains were grounded and new timetables with reduced train operations almost had to be made which would have caused a major media scandal.

This relates to another situation; namely that once the initial project description has been made and the budget approved, the practice of risk management focuses on this now fixed capital budget – and not the effects of their work on the later operations budget. This means that the practice only accepts those risks into the system that can be referred back to the initial capital budget. The quality or long term suitability of the budget, the effects its design has on later maintenance and operation – and not least the effects on other entities such as train operators - are excluded as risks within the programme. As an example, at one risk management meeting, a safety manager was discussing with a head subproject manager about raising the impact assessment of a certain risk because new events, as he argued, had caused them to face even more uncertainty than before. The head subproject manager found this to be straight up ridiculous as such a high assessment just seemed unrealistic. The two participants continued to discuss this but the situations seemed deadlocked as no one was willing to agree with the other party. At that time the safety manager had not mentioned that the impact would be on later operations. As the head manager during the debate suddenly became aware that the reason for the proposed higher assessment related to this, the deadlock was broken, because now he could explain to the safety manager that because the practice focused on the objectives of the programme and not later operations this higher assessment was irrelevant for the programme. The safety manager looked surprised but as the head subproject manager's words were backed by a risk consultant participating, who explained him that that was the rules of the practice, the discussion was cut short. In short, this situation illustrates that when risks have effects on anything else but the capital budget (or the chances to meet this), such as later operations, they are excluded from the practice as risks, and ignored.

CONCLUSIONS

Three tentative conclusions spring to mind when examining these brief case descriptions. The first involves what gets lost through the enforcement of rational risk management processes. From the inability to include the ‘hunches’ of experienced engineers in the signalling case, to the threat of losing sight of the longer term value of the hospital projects as the rigidities of budget and risk control close off more ambitious future oriented thinking, relevance is lost and the hot cognitions and opportunities for foolishness are reduced. The second concerns the problem of a focus on identifying the responsibilities for specific risks, promoting a short sighted and self-interested approach to management, as seen with the dismissal of operational risks as unimportant for the delivery of the capital programme in the signalling case. Both of these conclusions suggest the partiality of existing risk management practices, and both represent in themselves potential longer term threats to the societal and economic value of the projects. Our third conclusion is that both cases involve the application of calculative practices to very uncertain contexts. We are not necessarily dismissing the utility of existing risk management practices, but it does need to be recognised that this is a practice of trying to rationally calculate under uncertain knowledge conditions, and that there might be other more inclusive ways of thinking about risk and uncertainty. We began this paper with Callon’s reminder of what

uncertainty is – something we do and cannot know. Embracing and responding to this in ways which complement more instrumental notions of risk management may have significant implications for risk management practice, but also produce significant benefits for the delivery and overall value of large infrastructure projects.

REFERENCES

Atkinson, R., Crawford, L. and Ward, S. (2006): Fundamental uncertainties in projects and the scope of project management. *"Int. Journal of Project Management"*, **24**, 687-698.

Beck, U. (1992) *"Risk society: Towards a new modernity"*, Thousand Oaks, Sage, CA .

Beck, U. (2009) *"World Risk Society"*, Polity Press, Cambridge.

Booz A. H. (2006) Signalanalysen. København, Danmark.

Callon, M.; Lascoumes, P.; and Barthe, Y. (2009) *"Acting in an Uncertain World: An Essay on Technical Democracy"*, The MIT Press, Cambrige, Massachusetts.

Callon, M. and Law, J. (2005) On qualculation, agency, and otherness. *"Environment and Planning D: Society and Space"*, **23**(5), 717–33.

Chapman, C. and Ward , S. (2011) *"How to Manage Project Opportunity and Risk"*. John Wiley & Sons, Chichester, West Sussex.

Christensen, S. and Kreiner, K. (1991/2005) Projektledelse i løst koblede systemer (12. edition.), Jurist-og Økonomforbundets Forlag, Copenhagen.

Corvellec, H. The practice of risk management: Silence is not absence. *"Risk Management"*, **11**(3–4), 285–304.

Coutu, D. (2003) Sense and reliability: A conversation with celebrated psychologist Karl E. Weick, Harvard Business Review, **81**(4), 84–90.

Engwall, M. (2002) The futile dream of the perfect goal, in K. Sahlin-Andersson and A. Söderholm (eds.) Beyond Project Management: New perspectives on the temporary-permanent dilemma, Liber and Copenhagen Business School Press, Malmö and Copenhagen, 261–277.

Finansministeriet (2010). Notat: Bilag 6: Erfaringer fra infrastrukturområdet. København, Danmark: Finansministeriet.

Flyvbjerg, B. (2006) From Nobel Prize to project management: getting the risks right. Project Management Journal, **37**(3), 5–15.

Jönsson, S. (2004) Product Development: Work for premium values, Liber and Copenhagen Business School Press, Malmö and Copenhagen.

Knight, F. H. (1921) Risk, Uncertainty and Profit, Houghton Mifflin, Boston.

KPMG and Grant Thorton (2008) Revisionsundersøgelse af DR's byggeprojekt i Ørestaden. Report to the Ministry of Culture, June 19th, Copenhagen.

KPMG (2008) Økonomisk styring af Større anlægsprojekter/sygehusbyggerier. Report to Danish Regions, October 2nd, Århus.

Kreiner, K. (1995) In search of relevance: Project management in drifting environments. Scandinavian Journal of Management, **11**(4), 335–346.

Kreiner, K. (2013) Restoring project success as phenomenon, in R.A. Lundin and M. Hällgren (eds.) Advancing Research on Projects and Temporary Organizations, Copenhagen Business School Press and Liber, Copenhagen and Stockholm, in print.

Langlois, R. N. and Cosgel, M. M. (1993) Frank Knight on Risk, Uncertainty, and the Firm: A New Interpretation. Economic Inquiry, **Vol. XXXI**, July, 456–465

Latour, B., (2002): Morality and Technology – the end of the means (translated by Couze Venn), Theory, Culture and Society, **19**(5/6), 247–260).

Lindkvist, L. (2011) Knowledge Integration in Product Development Projects, in P. Morris, J. Pinto and J. Söderlund (eds.) The Oxford Handbook of Project Management, Oxford University Press, Oxford, 463-482.

Lundin, R.A. and Söderholm, A. (1995) A theory of the temporary organization. Scandinavian Journal of Management, **11**(4), 437–455.

March, J.G. (1971) The technology of foolishness. Civiløkonomen, **18**(4), 4–12.

March, J.G. and Simon, H. (1958) Organizations, Wiley, New York.

Millo, Y. and MacKenzie, D. (2009) The usefulness of inaccurate models: Towards an understanding of the emergence of financial risk management, Accounting Organizations and Society, **31**, 638–653.

Ministeriet for Sundhed og Forebyggelse (2012) Kvartalsrapportering til Ministeriet for Sundhed og Forebyggelse om kvalitetsfondsbyggerierne, July 2nd, Copenhagen.

Morris, P.W.G (2010) Research and the future of project management, International Journal of Managing Projects in Business **3**(1), 139–146.

Power, M. (2004) The Risk Management of Everything, Demos, London.

Rigsrevisionen (2002). Beretning til statsrevisorerne om Banestyrelsen. (Rep. No. RB B303/02). Købehavn, Danmark.

Rigsrevisionen (2004). Beretning til statsrevisorerne om Trafikministeriets koncernstyring. (Rep. No. RB B301/04). København, Danmark.

Rigsrevisionen (2005). Beretning til statsrevisorerne om 7 sager forelagt for Folketingets Finansudvalg. (Rep. No. RB A604/05). København, Danmark.

Rigsrevisionen (2010) Notat til Statsrevisorerne om tilrettelæggelsen af en større undersøgelse af regionernes sygehusbyggeri, September 13, København, Danmark.

Rigsrevisionen (2011) Extract from the report to the Public Accounts Committee on hospital construction projects, December København, Danmark.

Rigsrevisionen (2013) Beretning til Statsrevisorerne om sygehusbyggerier II, October 2nd København, Danmark.

Simon, H., (1983) Reason in human affairs. Stanford University Press, Stanford, California.

Transportministeriet (2006). Ny Anlægsbudgettering. (Akt. 16 af 24. okt. 2006). København, Danmark: Transport- og Energiministeriet.

Turner, R., Huemann,N., Anbari, F. and Bredillet, C. (2010), Perspectives on Projects, Routledge, London.

Weick, K. and Sutcliffe, K. (2001) Managing the unexpected, Jossey-Bass, San Francisco.

Winch, G.M. (2002): Managing Construction Projects: An information processing approach, Blackwell Science, Oxford.

Winch, G.M. and Maytorena, E. (2009), Making good sense: assessing the quality of risky decision making, Organization Studies, **30**(2–3), 181–203.

Van Marrewijk, A. H (2007) Managing project culture: The case of Environ Megaproject. International Journal of Project Management, **25**, 290–299.