



Reduction lists as tool for cost control in public building projects

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INTRODUCTION

Cost control is a key issue in major investment projects. One question related to cost control is if scope reductions can save investment projects from cost overruns? A large number of studies, including Hall (1982), Flyvbjerg et al. (2003), Shane et al. (2009) and Doloi (2011) point to cost escalation of major projects. In a comprehensive study of 258 projects in five continents and twenty nations, Flyvbjerg et al. (2003) concluded that 90% of projects had cost overruns of between 50 to 100%. They also claim that overrun had been constant for the last 70 years. Love et al. (2013) studied cost overruns from 276 construction and engineering projects and found a mean cost overrun of 12%. Berg, Kilde and Rolstadås (2003) discuss some lessons from five large Norwegian public infrastructure projects. They reported overruns between 10 and 222%, partly explained by unclear change processes and insufficient risk management. Cheng (2014) found that that clearly defined scope of project in the contract and cost control were major determinants for cost overrun of construction projects. Practitioners and academics in project management continuously strive to find means of avoiding and controlling the overruns. Several government agencies have implemented measures to control cost performance on public projects, including the UK, Norway, and Quebec.

This paper maps the use of potential scope reductions and contingencies. Reductions can be implemented in large Norwegian governmental investments if there is a risk of cost overrun. Such reductions are a part of a Quality assurance scheme required by Norwegian Ministry of Finance for large government investment initiatives over 750 million NOK (Concept 2015). The bulk of the investments that are subject to the scheme are investments in the sectors of public facilities, defense and transport. The scheme has two formal decision points, Quality assurance 1 (before the decision of the government) and Quality assurance 2 (before the decision of the parliament). As part of the Quality assurance 2, a quality assurer will propose budget contingencies and reductions that can be implemented if the cost is in danger to be exceeded. The reductions are summarized in so-called reduction list). The quality assurers are project management consultants. This type of pre-defined possible scope reductions have been applied to large governmental projects since 2000 in Norway. There have been raised questions about how these potential reductions were used during project execution. This paper analyzes the use of such scope reductions for major construction projects for special purpose buildings. In particular, we want to follow up projects that are completed to see to what extent the reduction are used.

The Norwegian reduction lists have been studied previously, but based on the Quality assurance 2 reports from the front end of the projects. These studies do not include analysis of actually implemented reductions. Olsson and Magnussen studied reduction lists in QA2-report in the first 47 projects. They found that reductions in quality and volume of the project delivery were the most common type of reduction. Cui and Olsson found that the size of the initial reduction lists in the Quality assurance 2 reports had a range from almost zero to 18% of project budgets. These ex ante studies describe expected potential reactions. Up to now, there has been a research gap regarding how these reductions have actually been applied for special purpose buildings.

In this paper, we study how the reductions have actually been implemented. The reductions lists can be seen as an example of value engineering, and this study adds to the literature that describes to what extent value engineering proposals are implemented (such as Palmer et al. 1996). A special feature of the Norwegian scope reduction lists is that they are unusual compared to most value engineering applications because they are pre-defined, before the projects know if there is need for them or not.

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3 The purpose of the study is thus to follow up the use of potential reductions for completed
4 building projects. The research questions in the study are:

- 5 • to what extent are the possible scope reductions implemented?
 - 6 • what are the characteristics of implemented scope reductions?
 - 7 • what is the relation between budget contingencies and scope reduction lists?
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10 The paper is structured as follows. Firstly, it gives a short introduction to the Norwegian
11 Quality assurance scheme for governmental investments, which requires reduction lists to be
12 prepared. Then follows a short overview of international experiences with scope reduction
13 lists and similar measures. There is literature that discusses approaches that have similarities
14 with the reduction lists, but few studies that explicitly address pre-defined potential scope
15 reductions. The research methodology in this study is then presented. We then present the
16 results and conclusions.
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18 **EXISTING PROJECT COST MANAGEMENT PROCESSES**

19 **About the Quality assurance scheme**

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21 The Ministry of Finance in Norway launched a new project management model for
22 governmental projects in 2001. In a Quality assurance scheme, uncertainty analyses were
23 made mandatory for all large public projects exceeding NOK 500 million (\approx USD 64 million).
24 The threshold is later raised to NOK 750 million (\approx USD 95 million). The scheme was
25 introduced in response to situations with cost escalation of large public projects, including
26 public buildings. It is a set of requirements that governmental projects have to meet before
27 their approval and appropriation of funds by Parliament. The initiative for quality assurance
28 of project basis came in response to a situation with large overruns (Berg et al., 1999). This
29 requires the responsible ministries to undertake assessments during the front-end stage of
30 major projects, with a particular aim to review cost estimates and major risks that might affect
31 the projects when implemented.
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33 Pre-qualified external consultants are assigned to perform quality assurance of the decision
34 basis in public investment projects. From 2000 to 2004, four consultant groups commissioned
35 to undertake the assessments. From 2005, the group was expanded to include five consultant
36 groups. The process of such analysis is called Quality assurance 2 and its result is a report
37 delivered to the responsible ministry and the ministry of finance. Quality assurance 2 is
38 performed at the end of the pre-project phase, aiming to provide the responsible ministry with
39 an independent review of decision documents before Parliamentary appropriation of funds. In
40 addition to cost considerations, recommendations are made regarding organization and a
41 general comment on the maturity of project preparations.
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43 As a part of the Norwegian Quality assurance scheme, a forum was established consisting of
44 the involved consultants and ministries. One important topic in this forum has been to ensure
45 a uniform structure and terminology of the Quality assurance 2 reports.
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48 **Reduction lists**

49 The consultants shall assess the possibility for potential reductions that can be carried out if
50 other parts of the project turn out to be more costly than planned. Possible scope reductions
51 are identified, described, and summarized as reduction lists. The simplifications and
52 reductions are typically measures that are not desirable, but that can be implemented if
53 necessary. It is assumed, that the elements in the reduction list can be extracted from the
54 planned project activities without threatening the fundamental functionality of the delivery.
55 The reduction lists are an important part of Quality assurance 2 and they are carefully
56 discussed, studied and evaluated by consultants and project organisations. Prerequisites for
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3 the implementation of the measures must be described. It is common that the project
4 organization or the responsible agency propose potential reductions. If the agency does not
5 have a reduction list, Quality assurance 2 consultants can demand that the project to review
6 the possibility of reductions. It is not required, but many agencies and Quality assurance 2
7 consultants choose to set due dates for when the various reductions must be decided upon in
8 order to realize cost savings. The consultants are asked to take potential reductions into
9 consideration when they present recommended budgets for the projects.
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11 **Cost estimates**

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13 Total project costs have traditionally been estimated to an expected cost plus some 10-20% in
14 order to cover unexpected expenses. As a consequence of the Quality assurance scheme a
15 more sophisticated overview of the project cost is presented. Quality assurance 2 consultants
16 revise the cost estimates of the projects and present their stochastic cost estimates with
17 related probabilities. Estimation is typically done in a group work shop. To establish the
18 distribution, the group stipulates three characteristic values on the distribution curve for the
19 different parts of the project. Based on these values, it is possible to calculate the expected
20 value, and the probability distribution of the project cost. The allocated budget should
21 normally represent the cost that has 85% probability of being met (referred to as "P85"),
22 minus the identified potential for reductions. However, reductions list are not always applied
23 when recommending project budget. The total budget corresponds to a probability in per cent
24 that the project will be carried out on the defined budget. If a budget is based on 85%
25 subjective probability, this means that there is only a 15% probability that this sum will be
26 exceeded. Project budgets based on 50% subjective probability was typically used prior to the
27 introduction of the Quality assurance scheme. The reserves are not expected to be used, and
28 specific rules for the management of reserves have been established. The consultants
29 recommend what cost and probability level the project budget should be based on and how
30 the budget reserves should be managed, specifically who would have the authorization to use
31 the funds. The budget allocated to the projects is usually the most probable final cost (P50).
32 The reserves are not managed by the project manager, and usually not even by the executing
33 government agency. The responsible ministry must typically approve use of the reserves. It
34 should be noted that reserves are not intended for expanding project scope, but solely to cover
35 unexpected expenses. Olsson and Magnussen (2007) found that on average, the external
36 consultants recommended a 9% reserve (interpreted as a mark-up above the expected cost).
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41 **USE OF REDUCTION LISTS AND SIMILAR MEASURES**

42 The idea of a mandatory Quality assurance scheme is not fundamentally new. Oil companies
43 have had a practice in which new projects were screened by senior personnel not involved in
44 the project. Standard projects models such as Ericsson's PROPS and its derivatives include a
45 sequence of decision gates which a project has to pass to obtain final approval (Eskerod and
46 Riis, 2009; Eskerod and Östergren 2000). The activities in the decision gates include an
47 uncertainty evaluation, which is usually carried out internally. However, it is not common to
48 include explicit use of reduction lists in most stage gate models.
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50 Most of the project management literature on scope management is focused on management
51 (and typically avoidance) of scope expansions (for example PMI 2004). Scope changes are a
52 well-documented cause of cost increases in projects (Eikeland 2001; Love, Irani and Edwards,
53 2004). Scope changes are known to contribute to cost increases especially if they come late in
54 the project. Andersen et al. (2011) took a somewhat different approach, and studied scope
55 changes that occurred during the first year after a project was delivered, and found that this
56 type of changes were not frequent in the studied projects. The literature on scope changes as a
57 means of cost control is more limited, but there are several examples.
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3 Gilbert et al. (1985) describe the use of reduction lists similar to those used in Quality
4 assurance 2 projects. They describe the use of this type of reduction opportunities in projects
5 within the chemical process industry. Reduction lists in Quality assurance 2 projects can be
6 seen as a part of the uncertainty management, as they are possible measures for handling
7 uncertainty. PMI (2004) and Chevroulet et al. (2012) recommend adopting risk management
8 and mitigation strategies in infrastructure projects. Chapman and Ward (1997) discuss the
9 need for contingency plans. Reduction lists can be seen as an example of such
10 plans. Chapman and Ward argued that the development of detailed contingency plans should
11 be minimized to avoid unnecessary planning costs.

12 Both value engineering and design to cost are approaches with similarities to the logic behind
13 the reduction lists. Value engineering includes to critically review deliveries and
14 specifications of a project to determine the most resource-efficient approaches to achieve the
15 core functionality of the delivery (Green, 1991; Younker 2003, Jay and Bowen
16 2015). According to Save (2007), the ideas of value engineering were introduced by General
17 Electric during World War II. A result of a value engineering review can be that functionality
18 that is not required to achieve. Since 1959, value engineering has been a part of procurement
19 regulations for the armed services (Younker, 2003). A result of a value engineering review
20 can be that functionality that is not required to achieve the core functionality can be taken out
21 of the project. In this sense, value engineering generates reduction lists and reduction lists are
22 largely value engineering in practice. Unlike the Norwegian reduction lists, value engineering
23 typically include a review of projects when a need has occurred. The following provides some
24 examples.

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27 Jay and Bowen (2015) describe that the USA General Service Administration demanded
28 independent value engineering studies in construction projects, and the US construction
29 industry developed different approaches for value engineering reviews. Based on a survey,
30 Palmer et al (1996) found that it was common to conduct a value engineering analysis at the
31 35 per cent design stage, typically using an external team of reviewers. The 35 per cent design
32 stage is a point in the process where cost data are readily available and savings can be
33 identified. Another approach mentioned by Jay and Bowen (2015) was to do the study earlier
34 in the project life cycle.

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36 Palmer et al (1996) followed up implementation of the value engineering proposals, to find
37 the actual level of savings achieved. They found that proposals were often implemented
38 partially or in modified form. This made it difficult to evaluate actual savings. They found
39 that proposed savings made by value engineering studies were approximately 30% of project
40 cost and that the implementation of these proposals was around 30%. This means that cost
41 reductions equivalent to an average of approximately 10% of total budgets were implemented.
42 FTA (1996) describe how The Fort Worth Transportation Authority used value engineering to
43 bring the costs back into line with available funding for a project. They report that there were
44 87 value engineering proposals offered for consideration, of which 38 were accepted, saving
45 an estimated USD 11 million. Chan (2010) describes how the Mass Transit Railway
46 Corporation in Hong Kong used target cost contracts to move away from the fixed price
47 approach to a target cost approach. This was based on joint determination and agreement
48 between the client and the contractor on the allocation of shared risks, in order to manage the
49 project costs for mutual benefit. University of Colorado (2014) describes that buildings, this
50 can involve reducing the number of rooms or space reduction in the building. Reductions
51 were identified during the preparation for the Olympic Games in London in 2012. The
52 number of units in the Olympic village decreased from 4200 to 3300 (House of Commons,
53 2008).

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56 Reduction list can be seen as an application of real options. Real options are described by,
57 among others, Trigeorgis (1996), Hull (2006) and Kulatilaka and Trigeorgis (2001). An
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option is the right, but not the obligation to take an action in the future (Yeo & Qiu 2002). In 1973, Black and Scholes (1973) came up with a model for pricing financial options that has been used ever since. The real options approach is the extension of financial option theory to options related to real assets (Yeo and Qiu 2002). The ability to wait to commit to an investment until more information is available can serve as an option and have a corresponding value (Brach, 2003). Different types of real options may be to defer, expand, abandon, replace, or reduce liability of a project. Scope reductions are basically an option to reduce the projects. Brekke (2004) discusses real options associated with large investments. He emphasizes that value of the option depends on new information being fully utilized and shows that several analyzes suggest that this was not necessarily the case for large public investments.

The basic idea behind the reduction lists is to have identified measures that can be executed should the projects run the danger of cost overrun. This type of ideas is common in project management, including uncertainty and risk management, agile methods, value engineering, real options and target cost contracts. However, most of these methods have a fairly general approach. It is mainly a matter of installing general processes for identifying potential problems, and finding solutions. The processes are typically not aimed at predefined problem areas, but to install routines and methods that can be applied when needed. A common way of thinking is like “we do not know exactly what problems we will encounter, or what solutions we can apply, but we install systems to detect problems and identify solutions”. The Norwegian reduction lists are based on an unusually high degree of specification of potential actions. International best practice is more concerned with general approaches, and less on early identification of specific cost control measures. Knowing this, it can be questioned to what extent it is realistic to identify specific potential reductions early in a project phase.

PREVIOUS STUDIES OF REDUCTION LISTS

Olsson and Magnussen (2007) have studied reduction lists in the first 47 Quality assurance 2 reports. They found that reductions in quality and functionality of the project delivery was the most common type of reduction, representing 42% of all items on the reduction lists and 36% of the total value of potential reductions. Volume reductions were the second most common type of reduction (28% of all items on the reduction lists) but representing the largest value (39% of the total value of potential reductions). Other types of reductions include to reduce aesthetical appearance and to not prepare for alternative uses.

The deadlines of the decision to implement the reductions are often early in the project. Previous studies have pointed to the challenge that the scale of the reductions lists is reduced fast early in the projects. It is a paradox that it is typically in later phases of the projects that management gets updated information indicating risk of exceeding budgets. At those times the remaining items on the reduction list are often small. Olsson and Magnussen (2007) found that at the time for final approval, the items on the reduction lists were on average of 6% of the total project budget, maximum 18% and minimum 0.2%. Based on the reduction lists and due dates Olsson and Magnussen (2007) illustrated how the due dates and reduction options expires on a time scale. The average size of the remaining reduction possibilities falls sharply during the first year of the project, from nearly six to less than two percent. When the projects were halfway on the planned duration, the volume on the reduction lists had dropped from six percent to less than one percent of the total project budget. After six years, none of the projects had any scope reduction options available.

Cui and Olsson (2009) studied various aspects of reduction lists based on the first 82 Quality assurance 2-reports. The extent of reduction lists was studied in terms of project type, size, and how reduction lists have been used by various Quality assurance 2 consultants. Among the projects studied, 60 of 82 projects had reduction lists in the Quality assurance 2 report. For

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3 39 projects reduction lists were used in the determination of the recommended budget for the
4 project. 82% of transport projects had reduction lists in the Quality assurance 2-report, which
5 was the highest among all project types. Transport projects had the largest proportion of
6 projects in which reduction lists were used for the recommendation of budgets
7 (61%). Projects with a budget of 1000 - 2000 million NOK (\approx USD 125-250 million), together
8 with the smaller projects of less than 500 million NOK (\approx USD 64 million) had most frequent
9 lists (78%). Reduction lists were less often taken into account when defining the project
10 budget in smaller projects compared to larger ones. Cui and Olsson (2009) also studied the
11 evolution over time regarding the use of reduction lists. During the period as a whole there
12 had been an increase in the proportion of projects where reduction lists were used for
13 determining the budget of the project.

14
15 For those projects that had reduction lists in the Quality assurance 2 reports, Cui and Olsson
16 (2009) found that they were an average of 6% of the project budgets, with a range from
17 almost zero to 18%. There were differences between the consultants in how frequently they
18 include reduction lists in the reports, and how often they recommend using the reduction list
19 when determining the management framework. Some differences can be explained by
20 variation in the type of projects studied by the different consultants. However, interviews
21 confirmed that the consultant groups using reduction lists the most were also the most positive
22 towards reduction lists as a phenomenon, and those who used them the least had the most
23 objections. The referred previous studies of reduction lists have all been limited to the scope
24 reductions as they appear in the front-end of the projects. This study adds new knowledge by
25 following up how the potential reductions have been implemented.
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28 **METHODOLOGY**

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30 This study is based on a case study research approach. In the terminology of Yin the analysis
31 is a multi-case study. The study is based on two main data sources. The first is Quality
32 assurance 2 reports, which list the original reduction lists as well as budgets and
33 contingencies. The second data source, information about use of reduction lists is obtained by
34 contact with the project managers of the seven projects that had reduction lists established in
35 the front end phase. They were first contacted by e-mail, with a follow-up telephone
36 conversation about the use of reduction lists. The e-mail included a short introduction about
37 the research project, a copy of the reduction list from the Quality assurance 2 report and
38 questions about what reductions that were implemented, what cost reductions that were
39 obtained, and a question about their general experience with reduction lists. The same
40 questions were repeated in the following interviews with project managers. Questions related
41 to specific reductions were structured and specific, while the final question resulted in a semi-
42 structured discussion. Minutes were written immediately after the conversations.

43
44 The Concept programme has for a long time collected data of final cost of completed project
45 (Concept 2015). Final cost of completed projects is based on these data.

46
47 At the time of cut-off of the research, eleven building projects that were subject to the Quality
48 assurance scheme had been finished. This study covers the seven of these projects that had
49 reduction lists established in the front-end phase of the projects. No projects declined to
50 participate in the study.

51
52 Data for each individual project is collected in a research database, facilitating proper storage
53 and retrieval of data. The research data have a uniform and quality assured structure, thanks
54 so several measures aiming to make the Quality assurance 2 reports and their information
55 consistent across the studied projects. The database contains general information about the
56 projects, such as dates for key decisions, budgets and contingencies. The database also
57 include registrations of actual implementation of the potential reductions, including if the
58 scope reduction was implemented fully, partially or not at all, along with planned and actual
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3 use of reduction lists. There is no formal requirement for the projects to register
4 implementation of scope reductions with traceability to the reduction lists in the Quality
5 assurance 2 reports. This means that use of reductions and amounts saved are not easily
6 available in project documentation.

7 Main focus of this study is on use of reduction lists, and not on cost overruns in general.
8 Ideally, an analysis of cost overruns should consider time and market conditions in relation to
9 the eleven projects, to investigate the effect of the prevailing economic climate and tender
10 market conditions for the different periods during which the case projects were conceived and
11 built. This paper studies use of reduction lists, and cost performance was assumed to be one of
12 the factors that could influence use of the reductions.

13 Table 1 shows a summary of the 11 studied projects. All projects are special purpose
14 governmental buildings. Ten of the buildings are built by Statsbygg. Statsbygg is a public
15 sector administration agency responsible to the Ministry of Government Administration,
16 Reform and Church Affairs. Statsbygg provides special purpose buildings to public sector
17 enterprises. One building is build by the Norwegian Defence Estates Agency. The buildings
18 are relatively large by Norwegian standard. Some buildings are high profile, most notably the
19 new opera house in Oslo. Six buildings house higher educations facilities. Two buildings
20 consist of offices for ministries. It is one prison and one customs control station.

24 **USE OF REDUCTION LISTS IN COMPLETED BUILDING PROJECTS**

25 We have studied use of reduction lists for completed building projects. Table 1 includes a
26 summary of reduction lists and contingencies for the studied projects.

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29 *Table 1 to be inserted about here*

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31 In the sample of finished building projects, reduction lists represented 1,7% of projects
32 budgets. For projects that had reductions list, these lists had a range from 1,4% up to 5%.
33 Contingencies were 9,5% on average, with a range from 5% to 13%. The reduction lists were
34 smaller than the contingencies, at about 20 to 30% of the contingencies. The reduction list was
35 larger, at 65% of contingencies, for one project. Two projects had two versions of reductions
36 list; one long list of possible reductions, and one short list with reductions that were actually
37 applied when establishing the size of contingencies. The larger versions of the reduction lists
38 were not applied when recommending size of contingencies for these projects.

39 Table 1 shows that seven of the 11 studied projects had reduction lists. Of these, only two
40 projects did implement some of the reductions. The only reductions that were implemented
41 were reductions of the quality of spaces, as shown in table 2. Both these projects had cost
42 overruns. However, three other projects also had reduction lists and cost overruns, but did not
43 implement any of the reductions on the lists. Another project also had cost over run, but this
44 project did not have a reduction list in the Quality assurance 2 report.

45 We note that most of the projects with cost overruns had values in the high end for the sum of
46 contingencies and reductions lists. This is both an indication that these projects were judged
47 to have large uncertainty, but also that the tools for managing this uncertainty, contingencies
48 and reduction lists, were not sufficient for managing this uncertainty.

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52 *Table 2 to be inserted about here*

55 **DISCUSSION OF USE OF REDUCTION LISTS IN BUILDING PROJECTS**

56 The study indicates that the reductions are only implemented to a limited extent. When used,
57 it was on projects with overruns. The applied reductions are of a general type. This indicates
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3 that it is challenging to identify specific reductions, and more realistic to implement general
4 reductions, which can be specified at later stages of the projects.

5 A general impression from discussions with project managers is that the reductions on the
6 reduction list are usually not a main issue in project implementation. One can ask why
7 reductions lists are used as little as they are for this type of projects. A major challenge with
8 specific reduction is that reductions must often be decided before the project knows if there is
9 a risk of overruns. Most consultants establish a matrix of feasible reductions in relation to
10 project phases, to define at what time decisions have to be made in order to generate a cost
11 saving. In essence, these matrices define due dates for each scope reduction option. The due
12 dates for the reductions typically occur before the project manager has updated cost estimates
13 that may indicate potential overruns. More general reductions, as reductions of quality levels,
14 are found in two of the projects. Discussions with projects representatives indicate that the
15 reduction lists contribute to cost-consciousness, but that they have limited use as an active
16 tool for cost control.

17
18 With respect to project implementation, project managers state that realistic reductions should
19 be possible to isolate technically and contractually. The ability to make a late decision
20 regarding the implementation of a reduction assumes that there are technical means to isolate
21 the reduction. For example, the reduction can be individual building in a building complex. It
22 must also be contractually possible to make a late decision. This can be achieved by using
23 options in the contracts, or to postpone signing binding contracts for the parts of the project
24 that is on the reduction list.

25
26 One potential reduction in one of the projects was one particular part of a building complex
27 was of this type. One major lecturing room should be possible to not be built. The Quality
28 assurance 2 report describes in some detail how this reduction can be prepared for. As it turned
29 out, the project did not need to do this reduction, or any other. The project manager had not
30 prepared for this potential reduction as recommended in the Quality assurance 2-report.

31 To be realistic, the reductions should have some formalization in relation to the users. It is
32 common practice to have user participation, to involve future users and their organizations in
33 the design of this type of buildings. Even if users are aware of the existence of reduction lists,
34 they typically disagree on the use of them. It is therefore a controversial decision to
35 implement reductions. Formalization in relation to users includes a clarification of
36 expectations and an identification of the parts of the project that in an emergency can be
37 removed without seriously compromising the functionality of the main delivery. It must be
38 secured that it is possible for users to perform their operation even without the part of the
39 project listed on the reduction list. One must expect that this create negative reactions from
40 users. That reductions are developed in co-operation with users and stakeholders need not
41 imply that they accept or want the reduction, but that they have considered that if reductions
42 are necessary, these are the areas where they do least damage in relation to future use. At the
43 same time, working on potential reductions can help users to become aware of how the end
44 product will be used, and contribute to discipline in user participation.

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46 Reduction lists are among other things, used to set the size of the uncertainty reserve. The
47 amount on the reduction lists is often deducted from the P85 value when determining the cost
48 framework. This study indicates that specific reductions were not implemented. Specific
49 reductions do not appear to be realistic reductions. More general reductions seem more
50 possible to perform. Several project managers stated that they develop a second set of
51 reduction lists in co-operation with future user. This is done after the Quality assurance 2
52 review and parliamentary approval of the project. These list have not been subject of study in
53 this paper. Because the reductions in the Quality assurance 2 reports are rarely used, one
54 alternative could be to use a greater degree of differentiation when determining the
55 uncertainty reserve, so that it reflects the uncertainty of the project. We noted that scope
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3 reductions appear as a threat in a facilities management perspective, and that there was a
4 potential for conflicts between future facilities management and project management related
5 to the reduction lists. Several project managers mentioned this potential conflict. One
6 explanation to the limited use of reduction lists in practice is a desire to avoid such conflicts.
7 The projects pride themselves in delivering good facilities in accordance to established scope
8 descriptions. They hesitate to apply reductions and deliver an inferior product.
9

10 **CONCLUSION**

11 The purpose of this study was to follow up the use of potential reductions for completed
12 building projects. As a background, we gave a short introduction to the Norwegian Quality
13 assurance scheme for governmental investments, which requires potential scope reduction to
14 be identified. We studied international experiences with scope reduction lists and similar
15 measures. There is literature that has similarities with the reduction lists including value
16 engineering.
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18 A special feature of the Norwegian scope reduction lists is that they are unusual compared to
19 most value engineering applications because they are pre-defined, before the projects know if
20 there is need for them or not. This study adds to the literature that describes to what extent
21 value engineering proposals are implemented (such as Palmer et al. 1996). A special feature
22 of the study is that it illustrates the possibilities to predefine value engineering actions.
23

24 One research question in the study was about to what extent are the possible scope reductions
25 implemented. The study indicates that for buildings, few of the projects applied the potential
26 reductions that were identified in an early phase of the projects. We have studied 11 such
27 investment projects. Seven of the studied projects had reduction lists established in the front-
28 end phase. The studied practice shows that two projects did implement some of the
29 reductions.
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31 Another research question related characteristics of implemented scope reductions. The
32 projects that did implement reductions applied general reductions of the quality of spaces. The
33 Norwegian reduction lists are based on a high degree of specification of potential actions for
34 cost control. However, observed practice indicate that it is mainly the general, not the
35 specific, types of reductions that were implemented.
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37 A last research question addressed the relation between budget contingencies and
38 implemented scope reductions. Reduction lists are intended to be tools for cost control. Both
39 of the projects that used reductions had cost overruns. However, other projects with cost
40 overruns did not use their potential reductions. In the studied building projects, reduction lists
41 were equivalent to 2,7% of projects budgets, with a range from 0 to 9%. We have also studied
42 contingencies, because reduction lists and contingencies are closely related. Contingencies for
43 these projects were 9,5% on average, with a range from 5% to 13%. The reduction lists were
44 typically smaller than the contingencies.
45

46 Practical implications from the study include that reduction lists contribute to cost-
47 consciousness. However, they have a minor role in controlling costs. One indication is that
48 budget contingencies appear as a more powerful and flexible tool for cost control compared to
49 predefined scope reductions. To function as intended, the possible reductions must have the
50 support of relevant stakeholders, and be technically and contractually possible to implement
51 in a late phase of the projects. The implemented reductions are of a general type, rather than
52 specific reductions. This is in accordance with the studied literature, which typically
53 emphasizes general approaches for cost control, and to a lesser extent aim at identifying
54 specific cost control measures.
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56 This paper has focused on implementation of scope reductions from a project cost control
57 perspective. Further research can address the utility consequences of project cost reduction
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3 decisions, to study what loss of function or quality occurs, and how is this perceived by
4 project end-users?
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	Budget (million NOK)	Contingency	Contingency (% of budget)	Reduction list (million NOK)	Reduction list (% of budget)	Reduction list as percentage of contingency	Contingency + reduction list as percentage of budget	Reduction list used to recommend budget	Had reduction list in QA2	At least one reduction implemented	Not used reductions	Cost overrun (related to approved cost)
New Opera house	3569	460	12,9 %	80	2,2 %	17,4 %	15,1 %	X	X	X		X
University college Remmen	574	48	8,4 %	0	0,0 %	0,0 %	8,4 %					
Akershus fortress, ISL building	510	40	7,8 %	26	5,1 %	65,0 %	12,9 %		X		X	X
Svalbard research center	402	32	8,0 %	0	0,0 %	0,0 %	8,0 %					
Border control station at Svinesund	290	15	5,2 %	4	1,4 %	26,7 %	6,6 %		X		X	
University college in Vestfold	565	80	14,2 %	0	0,0 %	0,0 %	14,2 %					X
University college in Oslo and Akerhus, Patologibygget	497	65	13,1 %	0	0,0 %	0,0 %	13,1 %					
Odontology building. Bergen	570	50	8,8 %	10	1,8 %	20,0 %	10,5 %	X	X		X	
Halden prison	1105	72	6,5 %	15	1,4 %	20,8 %	7,9 %	X	X		X	X
R6 –expansion of ministerial building	870	70	8,0 %	22	2,5 %	31,4 %	10,6 %	X	X	X		X
Domus medica University of Oslo	490	60	12,2 %	19,5	4,0 %	32,5 %	16,2 %		X		X	X
Average			9,5 %		1,7 %		11,2 %					
Sum	11							4	7	2	5	6

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Table 1. Size of reduction lists and contingencies for each of the projects, along with summary of implementation of reduction lists and actual reductions. Information about budgets and cost overruns are also included. N=11. 1 USD =7,7 NOK at the time of writing.

For Peer Review

Project	Possible reductions (on list)	Actual savings (on items on list)	Type of reduction
New Opera house	1,2 mill NOK	Not stated	Reduce quality in one area
R6 – new office for ministries	12 mill	Not stated	General quality reductions

Table 2. Actual savings from use of reduction lists.

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