**Use of reduction lists in large governmental investments**

## 1. - BACKGROUND AND INTRODUCTION

Several studies of major projects show that cost overruns are common and imply wastage of public resources that could otherwise have been used for productive purposes elsewhere. The causes of cost overrun in projects are varied, some are not only hard to predict but also difficult to manage. Delays and long implementation phases tend to increase the risk of substantial cost escalations. Major problems often occur as a result of poor design of projects. This risk of cost escalation is high for all project sizes and types. The risk of cost overrun could be reduced through investments in the early stages of the projects and that the remaining risks need to be understood and managed adequately.

In relative terms, cost increases may be even less significant if seen against life-cycle costs and revenues in a cost-effectiveness perspective. Thus, in most projects the choice of strategy and fundamental design is more essential than compliance with construction budgets. The potential rewards for improving quality at entry might be correspondingly higher.

In 1998 the Norwegian ministry of finance initiated an analysis of a number of major governmental investments. Effective from 2000, the Norwegian Ministry of Finance initiated mandatory quality assurance and uncertainty analysis of all governmental investments in Norway exceeding NOK 500 millions (60 Million Euro), the so-called Quality-at-entry Regime. The regime was introduced in response to a situation with large overruns.

As a consequence, the responsible ministries are required to undertake assessments prior to the parliament's appropriation of the projects, with a particular aim to review cost estimates and major risks that might affect the projects when implemented. Related to the project phases, the quality-at-entry analyses are made in the end of the front-end phase.

Quality assurance is performed by external consultants under a framework contract with the Ministry. It implies a through review of cost estimates before the budget is submitted to Parliament, but it also involves a comprehensive assessment of uncertainties and risks, a review of the proposed, contract regime and project organization. Hence, it tries to ensure that a realistic budget is established before the large projects are formally submitted to Parliament.

If key cost elements are not included or omitted by intention or mistake, quality assurance is designed to intervene. It is expected that the regime could have a disciplinary effect to establish a realistic budget both in the administrative and the political process. It is likely that the quality-at-entry regime could have a favourable impact on tactical budgeting, assuming that such practice actually ahs taken place.

Since this regime was introduced, the difference between the estimates made by the relevant government agencies and the external reviewers appear to have decreased,

when before this regime, initial overestimation from the external reviewers as underestimation by the responsible agency.

From 2005 onwards the scheme will be extended to include external quality assurance also at an earlier stage in the project cycle. As the result the scheme will include two separate analyses:

- Quality assurance of the choice of concept (QA1).
- Quality assurance of the basis for control and management, including cost estimates and uncertainty analysis for the chosen project alternative (QA2).

The purpose of QA1 is to assist the Ministry in making sure that the choice of concept has been subjected to a political process of fair and rational choice. The consultants' role is restricted to supporting the Ministry's need to control the professional quality of underlying documents constituting the basis for decision. QA1 will be performed by the end of the pre-study phase, before the Government's decision is made. Also includes performing a complete economic assessment of alternatives, according to guidelines from the Ministry of Finance. In the end, the consultants are required to rank the proposed alternatives and provide recommendations regarding decision strategy and implementation strategy for the project.

The purpose of QA2 is to provide the Ministry with an independent analysis of the project before the budget is appropriated by Parliament. Focus is on the control aspect. This is partly a final control to make sure that the basis for decision on appropriation of funds is acceptable in terms of scope and quality. Partly it is a forward looking exercise to identify the managerial challenges ahead. The main aim is to establish realistic cost, including necessary contingency to make sure the budget is realistic, and time frames for the projects and how the project should be managed to make sure the cost frame will hold. Four consulting groups were commissioned to undertake the assessments. The consultants shall made recommendations regarding organisation and management of the project to ensure cost efficient implementation.

The quality assurance scheme has been controversial because some have claimed that it instead of contributing to improvements has lead to enhanced costs and delays. It is a fact that itself has a cost, but much less than one per mille of the project estimate.

It is generally agreed that effective management will require a broad perspective on a project, taking into account not only the strategy, but also its impact and coherence with needs and priorities of users and affected parties.

Projects can be viewed in different perspectives. Success in an operational perspective is measured in terms of efficiency through cost, time and quality. In tactical perspective it is measured in terms of effectiveness. And the strategic perspective is explored in terms of the project's impact, relevance and sustainability. However, projects are unique undertakings performing under different conditions so this is not feasible. What seems to be a successful project in the operational perspective may be a disaster seen in a tactical or strategic perspective.

The ultimate choice of project alternative under the Norwegian quality assurance scheme is based on a ranking of alternatives on the basis of an early assessment of the anticipated project's efficiency, effectiveness, relevance and sustainability that are the key analytical elements in the project evaluation. In combination, the five evaluation criteria cover all three perspectives.

In order to improve quality at entry at an early stage the perspective will have to been widened. In that sense, the Norwegian quality assurance scheme is firmly rooted in a strong internationally approved evaluation tradition.

The quality assurance scheme is an initiative to enforce a qualitative change in government practice and improve quality at entry of major investments. The most fundamental aspect of the quality assurance scheme is probably the new requirement that at least three alternatives should be consider and it should be done at an early stage when options are still open. The alternatives should have the same degree of specification; no alternative is better defined or planned than another. This would help making fair assessments of alternatives.

Reduction lists is a part of the consultants' assignment to assess the possibility for potential reductions that can be carried out if other parts of the project turn out to be more costly than planned. These possible reductions are summarized as reduction lists that are the most explicit use of project flexibility in the Quality-at-entry regime. These reduction lists cover parts of the project scope that are planned to be part of the projects, but if necessary, these parts of the scope can be taken out of the projects without threatening the fundamental functionality of the delivery.

The scope reductions shall be described, the cost reduction shall be estimated, a priority list shall be presented, and prerequisites and consequences shall also be described.

The need for fast decisions regarding possible reductions is very common. According to one consultant, reduction is system architecture and quality standards have to be made early in the projects. Reductions in volume are possible to make at later stages, depending on the contract structure. Another common comment is that the potential volume of the reductions is so small that it is not justified to set up a system to manage reductions.

The purpose of the reduction lists is to have possibilities to reduce the scope in response to cost overruns. A major challenge is that the due dates for the reductions typically comes before one can expect that project management have updated cost estimates that may indicate potential overruns.

Another part of the consultants' assignment to recommend a budget for the project is reserves. The projects are typically assigned a budget which consists of the expected cost including expected extras. In addiction, reserves were allocated to the investments in order to avoid the need for additional funding. The intention with the allocated reserves was to mitigate projects risks that could not be fully predicted.

The front-end of a project is defined as the period from an idea is conceived to the final decision to finance the project is made, and it is followed by the detailed planning phase. The purpose of front-end management is to produce thorough and

credible project concepts for evaluation before a final decision to finance the project or not is made.

Project results often are caused by insufficient or inadequate use of resources in the front-end phase, and this arise a need for improved project management in public investment projects.

A general view is that uncertainty affecting a project decreases during implementation. The uncertainty is at its highest and the cost of amendments at its lowest in the front-end phase.

The challenge in front-end management of projects is to analyse the project's purpose and goal. The decisions made in the concept definition phase of the project are the ones with largest impact on the final project results.

The majority debates on front-end management of projects have focused on the choice of methods together with the scope and quality of information needed as the basis for decisions. A front-end assessment usually starts with a search for relevant information; then methods are selected and applied and thus, a basis for decisions is established. The assessment carries on with communication of the results and a final decision of whether or not to finance the project.

Well performed front-end assessments involve a consistent focus on the original decisions made in the concept definition phase of the project. This will provide the project's stakeholders with a common framework when the project subsequently is planned and implemented.

A through front-end assessment of a project will tend to motivate management to focus on front-end issues and thus be of considerable benefit. The robustness of the front-end assessment will depend on the quality of the information available in the project organisation. Discussions about what method is best suited for front-end assessments regularly conclude that it is quality of the input to the method that counts, so the choice of methods is nevertheless essential in front-end assessment.

# 2. - RELEVANT THEORY

As a previous step to development the project report about reduction lists and quality assurance of projects, it is necessary to consult and analyse available information about these topics.

The most important theory applied in this report is based in articles about these questions: project planning under uncertainty using the successive principle, flexibility in engineering projects and changes in projects.

*Project planning under uncertainty using the successive principle:*

The successive principle is an instrument for general managers, project managers, decision-makers, planners and estimators whose work in the actual climate needs to be more up-front and proactive than hitherto and to include all relevant factors, whether fuzzy or well-documented.

They therefore need a realistic, unbiased early overview of the context, the consequences of their plans, and, in particular, the opportunities for improvement, as well as the risk involved.

To get a reliable forecast requires the joint effort of a balanced and competent analysis group of key individuals, identify all elements of possible importance, evaluate all relevant figures in a neutral and correct manner and to follow a top-down procedure for reasons of overview and prompt performance.

The Successive Principle is a set of procedures that follows these main phases:

- The qualitative phase:
  - *Establishing an analysis group*: must cover the primary areas of the subject matter. The analysis must always be guided by an individual with sufficient competence, knowledge of an expertise in the use of the Successive Principle.
  - *General sources of uncertainty*: should include technical and financial as well as social and organisational matters. The General Issues are bracketed into 8 to 15 independent groups so-called Overall Influences, and a Base Case is chose for each group.

- The quantitative and final phase of the process:

The steps of this phase are these:

  - *A relevant estimate structure is defined*: a set of specific main items is chosen and described according to the so-called work breakdown structure (WBS) rules. It includes both physical aspects of the task as well as a set of overall corrections.

We start quantification at the top level estimate sheet and then we sub-divide a crucial item into a new lower level estimate sheet.

This process continues until we consider it to be sufficiently close to the optimum accuracy.

- *Perform the group triple estimate procedure:* a triple estimate means evaluating the extreme minimum limit and the respective maximum limit as well as most likely value for each uncertain figure.

- *Factor mean value*: m = (min + 3·most likely + max) / 5. Negative and positive signs can be freely used in this expression. This formula cannot be used when major uncertainties are of the so-called "either/or" type, in which the outcome can only be one of two specific values.

- *The local conditional uncertainty*:
  - Factor range → r = max - min
  - Factor standard deviation → s = (max – min) / 5

- *Local mean value* → When the item is evaluated directly as a figure, apply this: M = m

- *The related uncertainties linked to the local item:*
  - Local range → $R_0 = r$
  - Local standard deviation → $S_0 = s$

They contribute only via $R^2$ or $S^2$ to the total sum of squares and it is called the Priority Figure (P).

We have established a structure which consists of fundamentally independent parameters and we have evaluated the conditional uncertainty of each local parameter.

- *The effect on the grand total*: $R = R_0$ and $S = S_0$

- *The Priority Figures*: $P = S \cdot S = S^2$ or $R \cdot R = R^2$.

The Priority Figures are used during the analysis process to lead the successive sub-division cycles. The Priority Figures indicates the relative impact of the individual item on the total uncertainty.

- *The uncertainty of the grand total*:
- $R_{global} = (\Sigma R \cdot R)^{1/2}$
- $S_{global} = (\Sigma S \cdot S)^{1/2}$

- *Successive detailing*: the items or factors with the largest Priority Figures are successively detailed into sub-items and related factors.

Every time we perform a sub-division we must be prepared to establish a local correction item to include any aspects which are common to two or more of the new sub-items.

Moreover, a new overall correction item has to be included to ensure independence among the new sub-items.

This procedure continue until arrive an unavoidable level of uncertainty.

We evaluate the potential direct and indirect conditional and additional effect on the grand total from each of the Overall Influences.

When the Priority Figures dominate the analysis we are approaching the minimum uncertainty of the grand total or the maximum accuracy.

- The latter numerical result is used to establish a set of suggested action plans in order to improving the task or project.

- In cases when this information will not be sufficient, we can use a *distribution function.* The statistical S curve or the cumulative distribution function of the total result is the probability that the analysed parameter will not exceed a certain given budget value (if the analysed parameter are future costs).

- We need to use *factors* in order to maintain a high standard of analysis. This applies particularly in three situations: when the overall corrections significantly increase the Base Case value, when we use volumes and the related unit cost to calculate a cost item and for profitability calculations.

- The use of factors eliminates the error that is introduced because all the overall corrections tend to be more or less too small.

    - Factor mean value: m
    - Factor range: r
    - Factor standard deviation: s
    - Relative range: r/m (%)
    - Relative standard deviation: s/m (%)
    - Related terms:
        - Local range (R0)
        - Local standard deviation (S0)
    - Range (R) and standard deviation (S) indicate the effect on the grand total value from a local range ($R_0$) and a local standard deviation (S0).
    - Transformation Factor (TF) converts a local effect into the similar final global effect.
    - TF = mean value of the grand total / Base Case total.

- It is very dangerous to underestimate the extreme limits because the Priority Figures will not alert us if that is the case and a major error may go right to the end of the whole process without being detected.

The Successive Principle is based on the subjective probability theory and subjective numerical evaluations are accepted and can be dealt with according to the rules set out in the frequentistic statistical theory.

An uncertain parameter is described by its probability distribution. With the *distribution curve* or *frequency function* expresses the likelihood that the actual future figure will materialises within a given interval of possible values.

The most likely value is indicated by the top of the distribution curve.

The *related cumulative distribution* function or the so-called statistical S curve indicates the likelihood that he actual figure will be equal to or lower than a given value.

The possible types adequate for this analysis are Gaussian distribution function (symmetrical), Beta distribution function (many types of skewness) or Erlang distribution (uncertainty is basically related to unplanned interruptions in the above regular rhythm).

The well-documented difficulties in evaluation theses extreme values have been overcome by using this group triple estimating technique. All these evaluations are conditional because the evaluations are made on the basis of all other parameters being in their mean state.

At this stage, the statistical S curve for the grand total value is used by the decision-maker who selects the budget or deadline according to the degree of safety which he/she judges to be appropriate in the particular circumstances.

Moreover it is possible to make a more targeted and accurate evaluation of profitability, and we will attempt to reduce the fuzziness and variability of profitability by being more specific and detailed.

A basic concept is to define the scope of interest of the project and the domain of systems theory.

An analysis is always comparative, and the comparison is typically measured against the so-called zero-alternative which means no investment.

With this comparison we may omit all effects which are the same in all alternatives, as they will cancel each other out when compared.

The basic concept is the discounting of values which emerge over different periods. This is necessary in order to achieve a fair comparison between present and future cost and income. It is called the time value of money and it is measured as the annual discount factor “r” in per cent / year.

Other important term is the discount factor “Dn” that represents the relationship between the discounted value and the full nominal value through this formula:

$$Dn = 1 / (1 + r/100)^n$$

The discounted cash flow illustrates and visualises directly the individual contributions to the net present value. Every single year is condensed by 1 / (1+r) according to the defined annual discount factor.

Successively the analysis group brings the cash flow and related net present value calculation even closer to a realistic total result.

*Flexibility in engineering projects:*

Flexibility management is a systematic approach to prepare for the effects of uncertainty in planning. But flexibility may also be described as a way of making irreversible decision more reversible or postponing irreversible decisions until more information is available. In addiction, flexibility can also be seen as a response to environmental uncertainty.

In civil engineering, flexibility is the possibility for construction and technical changes with minimum cost and disturbance.

A measure of flexibility may be the number of remaining alternatives after a decision has been taken.

Three strategies to achieve flexibility in the decision process may be identified. Firstly, a late locking of project concepts, specifications and organisation can be used, as key success criteria for large engineering projects. The second strategy is related to a continuous step-by-step locking of the project by a successive commitment to projects. The third strategy is found in contingency planning, where a set of base plans is defined, but also a set of alternative plans that can be activated if needed. Contingency plans are alternative plans that can be used if the baseline plans cannot be executed.

This flexibility can be applied in the project's decision process or in the final product of the project. Flexibility in the decision process is based on an approach where decisions and commitments in the projects are made sequentially over episodes. Flexibility in the product is achieved when the final product of the project is prepared for alternative use. This approach is used in building construction. In these terms, flexibility is the possibility for construction and technical changes with minimum cost and disturbance. Finally, elasticity means the potential for adding or reducing the size of the building.

Flexibility can be related to the degree of modularity in the project or in other words, the possibility to divide the project into more or less independent sub-units.

Flexibility is discussed as a double edged sword, because it can be a risk or an opportunity to improve the project.

On one hand, flexibility is seen as undesirable in the execution phases of projects, because the high and unpredictable cost of change orders is the key argument against flexibility. Flexibility is often seen as a threat to delivering the project on time and within budget. This aspect of flexibility in projects are also emphasised by projects stakeholders that are responsible for the execution of projects, such as contractors.

On the other hand, flexibility allows improving the outcome of the project using risk avoiding strategy, based on minimal commitments at each stage where decisions are necessary. Flexibility is also seen as a help to achieve the project's purpose and increase the value of the project. One effect of this is that flexibility is more valued by the stakeholders that have a responsibility for the overall profitability or societal benefit of a project.

At this time is the moment to define the concepts of efficiency and effectiveness. *Efficiency* is the immediate outcome of a project. It is a question of doing things right and producing project outputs in terms of the agreed scope, quality, cost and time. And

*effectiveness* is the longer-term effects of the project. It is an external measure. How the results of a project contribute to value added for owners and users.

Flexibility is primarily useful to improve effectiveness of projects rather than efficiency, and in order to maximise efficiency, projects needs to be clearly defined in the front-end phase and executed according to the plans.

Because of this, the use of flexibility in the execution phase is likely to reduce efficiency.

It is important the stakeholders' opinion about flexibility, because they will decide all relevant decisions about the project.

On one hand, stakeholders such as project owners and users want flexibility because this can cause the increase effectiveness of the project. But in the cases where the project management was found in the same organisation as the owner, project management was more likely to be positive to flexibility.

On the other hand, stakeholders such as project management and contractors not want flexibility because they are responsible of the cost of the project, and flexibility allows scope changes that can cause overrun the project budget, because changes and extensions bring risk for cost overruns in the project.

*Changes in projects:*

The ability to adapt to changes along with short response time is heavily emphasised in disciplines such as strategic management and supply chain management. Study after study indicates that a clear project definition is a key success criterion for projects.

The scope change cost is low in the front-end phase of projects, and getting higher and higher as time goes by. The possibility to influence the final outcome is at its highest in the early phase of the project, while at the same time the knowledge of what lies ahead is at its lowest. However, scope changes may be avoided by the use of flexibility in the product.

Changes in both plans and goals of projects reduce both the efficiency and customer satisfaction of engineering projects and are a source of major disagreements between different actors in projects.

There is a close relation between changes in projects and flexibility, and between changes and efficiency – effectiveness, because flexibility may increase the probability of changes in a project, and with this changes we get improve the effectiveness but the efficiency is smaller. Once a project has been decided upon and the planning or execution has begun, changes are likely to reduce the efficiency of the project.

The different stakeholders have different opinions about changes in projects, due to the effect of these changes in their priorities, because the project owner is made the guardian of the project's effectiveness while the project management is made the guardian of efficiency.

Projects owners and users are likely to be more positive towards changes aimed at increased effectiveness.

On the contrary, project management and contractors are less likely to embrace changes, because their main responsibility lies on the cost side of the project. From a project management and contractor perspective scope changes are generally seen as undesirables.

A typical scope change is proposed because the users or project owner wants to increase the effectiveness of the project.

In that sense, two sources of conflicts related to scope changes can be identified, so conflicts may arise regarding the quantification of the increase in effectiveness and reduction in efficiency, and the responsibility for the reduction in efficiency.

Two factors must be present in the early phase of successful projects and changes in projects: top management must be interested in evaluating different alternatives and to open-mindedly address the risks and flexibility related to the alternatives, and the organisation must be able to generate this information.

In a world in which markets shift, technology advances and requirements evolve, projects must be able to accommodate all of these types of changes and to the impact of these changes in the project.

In that sense, we can categorise the impact of changes in projects. The direct impact of any given change is likely to have multiple dimensions, but there are three dimensions that are helpful in achieving the translation of an impact into one measure. The first is an added of scope, for instance, another building, more meters of pipe … The next measure of impact are delays, that derive in extending period of performance on the project. And the third dimension is de design uncertainty, although not a direct cost source, one of the best early indicators of disruption impact is the degree of the design package affected by changes.

Hence, it is crucial that the management of change be a high-priority aspect of managing project. The key is not to avoid all changes but to anticipate the, be prepared for them, and react to them properly, with trained staff aided by clear guidelines and processes and systems.

# 3. - APPLIED METHODOLOGY

In determining what is the most appropriate approach to adopt, the main priority is to ensure that the research maximises the chance of realising its objectives.

*Research methodology* refers to the principles and procedures of logical thought process which are applied to a scientific investigation, while *method* concerns the techniques which are available and those which are actually employed in a research project. The questions involved in making decisions over the execution of a research project are the following:

- What? Concerns the selection of the topic with consideration of the level of detail, resources available and the appropriate scope of study.
- Why? Explain the reasons because the research is being undertaken.
- Where? Indicate the places where the research occurs, for example, the library, the university, visits to experts…
- When? The time available to carry out the project must be specified. It is useful to produce a timetable for the work by dividing the time available between the component activities.
- How? Is the main issue of methodology. Commonly a topic may be investigated in a variety of ways, so a choice must be made, influenced by the purpose of the research, the subject paradigm, the expertise and experience of the researcher and supervisor, as well as practical considerations of resource and data available.
- Whom? Four main groups of people who are involved in the execution of research: the researcher, the supervisor, the sample personnel, who provide the data and others who can help.
- How much? This issue concerns the resources which can be used.

It is important to determine the scope of the work at the outset, because the most common problem is for a researcher to greatly overestimate what is required of the work, what can be achieved and the amount of work that can be done. The programme and scope of the research intended is realistic.

The most difficult task for any researcher is to select a topic for study and then to refine that topic to produce a proposal which is viable. It is necessary to restrict the study in order that adequate depth and rigour of investigation of the topic can be undertaken.

It is important to evaluate the quantities of resources which can be devoted to the study, calculating the time available for the research, and of course, within this time is included the time to redact a project report.

To select a subject it is helpful to consider the process of subject selection as one of progressive narrowing and refinement, so can be useful to begin by constructing certain lists about topics of interest, personal strengths and weaknesses, topics of current interest in practice, access to data and research limitations.

Within overall subject domains, a number of topics will have emerged, and we have to choice the topic that satisfying by the best way the imposed purpose of carrying out the project.

The process of selection will continue for some time as investigations proceed and the topic emerges and undergoes progressive refinement. With this we want to achieve a state in which the topic is delineated sufficiently well for the aim and objectives of the research to be identified.

The final topic content and parameters determined by aim, objectives, hypotheses, definitions of terms and assumptions.

The outcome of the initial considerations and investigations will be a proposal for the research that should contain with these elements:

- Title

- Aim: a statement of what the research will attempt to do or, with another words, what the researcher would like to do if resource constraints and other constraints did not exist.

- Objectives: are statements within the strategic statement of aim and specify what it is hoped will be discovered by the research. Also the objectives may concern how the study will be undertaken and some details of what is to be studied.
  For most research projects, especially smaller ones, it is good discipline to restrict the project to a single aim and the objectives to about three.

- Hypothesis: are statements which are produced to be tested as objectively as possible. It is useful to have one main hypothesis derived from the aim of the research, and sub-hypotheses relating to the objectives. Too many hypotheses will tend to promote confusion.
  Hypotheses also focus the work on relevant aspects and help to identify boundaries of the study in researches.

- Methodology: the methods by which research ca be carried out. This section is very important because many good ideas remain uninvestigated or unfunded because the methodology has not been considered adequately. Therefore it is vital that the methodology is given careful consideration at the outset of the research so that the most suitable approaches and research methods are adopted.
  In determining the methodology attention should be given to:
  - Definitions of the main terms involved.
  - Assumptions which are made.
  - Theories relating to the subject matter of the research.
  - Analyses may be carried out.

- Programme: the production of a timetable or programme is fundamental to ensure the project's viability. It is essential for researcher to decide how the activities should fit together and the time to be devoted to each one.
  Due to the nature of research, it is important that the programme have sufficient flexibility to enable novel, potentially productive, lines of investigation to be noted or pursued in some way.

Preliminary research involves searching sources of theory and previous studies to discover what the appropriate bases for the subsequent, detailed work are likely to be alternatives will be found. At this stage, the design of the main research must be formulated.

Whatever method is adopted, it is essential that the research be conducted rigorously to ensure that it is an objective and valid study.

Thus, it is essential that every researcher embarking on a project endeavours to discover what relevant work has been executed, as well as what theory bases apply.

During the initial research phase, it will be useful to review the research model that will depict the main variables and the hypothesised relationship between them. Therefore, the model identify what lies within the boundaries of the research project, known as *endogenous variables*, and what lies outside the boundaries, called the *exogenous variables*. The permeability of the boundaries determines the degree of influence exogenous variables may have on the system under investigation.

Research designs will need to take a more comprehensive view of context in order to locate units of study more precisely in relation to the factors that potentially impact on their organization.

An essential early stage of virtually all research is to search for and to examine potentially relevant theory and literature that are the results of previous research projects. Theory is the established principles and laws which have been found to hold, while literature concerns findings from research which have not attained the status of theory.

It is a good principle to identify assumptions and to define terms that will be used in the research, or at least those terms to which particular meaning must be attributed. Before progressing, it is good practice to review the proposal with the supervisor of the research to ensure that the assumptions and the important terms have been noted clearly and defined appropriately for the intended work. In addiction, it is important to establish a final deadline to close entries to the review.

For conducting a search it is important to establish a structure that leads the research. The references are useful in providing an introduction to the literature and it is helpful to have several approaches to discovering this information. Although the list of authors will grow and grow; therefore it is a good idea to limit the list of keyword's size to a small number, so a good definition of topic is essential.

Bodies of theory must be examined and evaluated to arrive at a theoretical basis or framework appropriate to the research proposed. The basis of such a choice may be personal preference caused by expertise with an approach, sympathy with the theoretical perspective or findings from leading research in the topic.

The collection data is a communication process which may involve a chain of statement, much of which may be invisible to the researcher. This step needs to be executed with attention and accuracy to ensure reliability of the data obtained.

The primary aim in collecting data is to maximise the amount and accuracy of transfer meaning from the provider to the researcher, so much of the likelihood of success of convergence is determined by methods selected for data collection and the expertise with which the methods are employed.

Methods of collecting data may be categorised as either one-way or two-way communications; One-way methods require either acceptance of the data provided or their rejection, clarification or checking are possible only rarely, whereas two-way methods permit feedback and gathering of further data via probing and include semi-structured interviews and participant observation. Hence, one-way communication methods may be regarded as linear data collection methods whilst two-way communication methods are non-linear.

In the case of surveys, the research involves asking and obtains answers to questions by using questionnaires, interviews and case studies; while using interviews the communication can vary in the nature, and the interview can be:

- Structured: the interviewer administers a questionnaire with little scope first and then he ask supplementary questions to obtain more details.
- Unstructured: the interviewer introduces the topic briefly and then records the replies of the respondent.
- Semi-structured: fill the spectrum between the two extremes.

Other techniques of communication are used when the case research is the respondent. In this case the result is the particular occurrence of the topic of research. In addiction, we can use two or more research methods to investigate the same thing, it is called triangulation.

Due to the increasing number of research projects, collecting data is becoming progressively more difficult. Since this reasons, the questions must be clear, precise and easy to answer.

Furthermore the request for date may be present neatly and politely ensuring that the respondent will get a return commensurate with the effort expended to provide data.

Other issues which concern data are reliability and validity; reliability concerns the consistency of a measure whereas validity concerns how well a measure does measure the concept it is supposed to measure.

After the research project has been structured, the theory and literature studied, the data collected and analysed, the next stages are to produce the desired results. It is important to be sure of the validity of the work, or in other words, the confidence which someone may have in the findings.

Almost inevitably, important issues will be identified during the course of the research; some will be incorporated into the study and should be subject to conclusions, whilst other will remain outside its scope and should be noted in the recommendations for further research.

The selection of appropriate tests to analyse data is very important, and the attention can focus on the analyses which produce results which agree with each other broadly, if not exactly, and any which produce conflicting results.

Naturally, for some purposes small errors in coding data may not be significant, but for any type of research, errors are likely to be essential. Apart from mistakes in allocations, ambiguity is the main source of errors.

Differences between samples desired and those obtained may affect the validity of the results in terms of confidence, at least in terms of confidence, due to size of data sets useable and considerations of bias.

About substantive results, the main sources of possible errors should be noted and yield an overall measure of experimental error, and can be categorised as follows:

- Contextual: identifying the form and nature of what exists.
- Diagnostic: examining the reasons for what exists.
- Evaluate: appraising the effectiveness of what exists.
- Strategic: identifying new theories or actions.

It is important to be appreciative about the differences between results and conclusions; results are produced from analyses of data, whilst the conclusions consider the results in the contexts of the topic and the whole of the study in order to determine what exists, why and how, and the considered consequences of issues examined in the research.

The meaning and implications of the results are determined through inferences, in order that conclusions may be drawn. In order to gain full understanding of the results and appreciation of their implications, it is helpful to present the results in a variety of ways.

Results must be interpreted in the context of each other, of the theory and of the results of previous research. Thus, a difficulty in investigating causal relationships between pairs of variables is the potential causal influence of other variables.

Therefore, it is important to be aware of both the principles and the sets of assumptions, in order to assist the researcher to move between the two sets of results with ease.

In interpreting results, we have to use two perspectives separated in time that prior to the execution of the empirical work and that following its execution and production of results. Through this comparison we can demonstrate how knowledge has change due the study.

Adjustment and anchoring are important because a very common aspect of forecasting is to select some starting point and the adjust hat value to produce the result or prediction. But commonly, adjustments are not adequate and results are biased toward the starting value. Hence, selection of the starting value takes on much more importance.

Conclusions are the output of the research and present what has been found out about the topic under study through the execution of the research. With conclusions the task of the research has completed from what it was desired to find out to what has been

found out. The conclusions of any research project must truly emerge from the research actually done.

To write the conclusions is important to remind some essential aspects as:

- Establish the relationship between each conclusion and the foundation in the research which has been executed.
- It should be possible to reference each statement in each conclusion to a section of the research.
- The conclusions must truly emerge from the research actually done; no new material should be introduced in the conclusions.

Due to any study can be comprehensive and hope to meet the majority if not all of the objectives, it is important to examining the conclusions and comparing them with the aim and objectives will suggest as recommendations for implementation, limitations of the study and recommendations for further research.

The limitations, especially those occurring during the research and outside the control of the researchers, are important to note with their consequences. Recommendations for further research should suggest topics for study, appropriate methodologies, given the knowledge gained from the research just executed, and the reasons why such further studies would be useful.

## 4. – RESULTS

In this part it is analyze the project "*Dobbeltspor Skøyen-Asker, Fase 1: Sandvika-Aske*". This project consists in a double track of railway to connect Sandvika with Jong and Jong with Aske.

The planned finish for this project was December 31st of 2005 and with a recommended cost of 4065 million NOK.

The most important due dates in reduction list, for the project, are in Table 1.

Some important comments or pre-requisites suppose not must built some elements of the project as Jong turn station or a branch tunnel to preparation for the Ringerike line, in spite of this reduction will increase the cost in the Ringerike line if this line is built. Moreover, the requirement that the whole line from Sandvika to Asker is built all-in-one derive from this item of reduction list. Other pre-requisites derive in some changes in the project as adjustments of the rail tracks after frost heave.

The total planned reduction list might save an amount of 115 million NOK and the main consequences of these items of reduction list are cost, quality and image. This amount of reductions list is the sum of 90 million NOK plus 25 million NOK which the project itself may come up with.

The total planned reduction list provides a percentage of money save of 2.80% respect of the total budget of the project.

In the next stage of this project, the information in first table will update and the actual project documentation of reduction list is shown in Table 2.

The main changes between first and second table are the increase or decrease of sum in each item of reduction list derived of changes in the description of the items.

On one hand, both not preparation for a turn-around train station at Jong and not preparation for the Ringerike line achieve save an amount of 60 million NOK (in table 2 this amount is divide in 30 million NOK in first item and 30 million NOK in fifth item). These two items raise the amount of reduction list from 10 million NOK to 30 million NOK in item one, and from 25 million NOK to 30 million NOK in item five.

On the other hand, the remains items decrease the total amount of money in reduction list. The second item will save only 0.5 million NOK and not 6 million NOK as show on planning reduction list (Table 1).

By reducing esthetical work, for instance green areas, the reduction is 0.9 million NOK whilst on planned reduction list (table 1) was 6 million NOK.

The sixth item that relate the reduced user friendliness at station was planning a reduction of 24 million NOK, but in fact, with the actual reduction list the money save in this item is only 10.6 million NOK; this amount is the sum of 9 million NOK for no heating in platforms at Asker plus 1.6 million NOK for one less elevator in Asker station track 6.

The total actual reduction list provide an amount of 72 million NOK, that mean a percentage of money save of 1.77% respect of the total budget of the project and a 62% of the planned reduction list.

To go on with the next stage of the project, it is important to analyse the final reduction list, which include the real reductions performance in the project. Thus, there are four main items that will be described and evaluated, as shown in Table 3.

The reductions in the place between Sandvika and Jong, during the project phase of planning means a total amount of 23 million NOK. These reductions are news, and they are not included in planned reduction list of Table 1.

In the same segment of the project during the project phase of execution, the reduction list saves 29 million NOK, though 1.5 million NOK was included on planned reduction list. Hence, the real reduction list of this item during execution phase is 29.7 million NOK.

The next item considers the fragment between Jong and Asker, with a reduction of 39 million NOK. In this reduction is included the reduction on both planning and execution phases. However, the real reduction list is 25.8 million NOK because 13.2 million NOK is not real reduction due to this amount is paid by somebody outside of the project.

The last item included in the final reduction list considers Asker station during planning and execution phase. The first figure in this reduction achieve an amount of 57 million NOK, but in this amount is included 10.6 million NOK that is counted on planning reduction list and 26 million NOK which is paid by somebody outside of the project, therefore the real reduction list of this item is 20.4 million NOK.

It is achieve a total not on planned reduction list of 96.7 million NOK, which imply a percentage of 2,38% of the total of budget.

The comparison between different reduction lists during the project is show in Table 4.

The total reduction list provides an amount of money save of 168,7 million NOK, which mean a percentage of 146,70% of the planned reduction list (115 million NOK) and a 4,15% of the total budget of the project.

# 5. - DISCUSSION AND CONCLUSIONS

In this section the results are discussed between them and in relation to the theoretical overview of project reduction list.

In that sense, the initial flexibility of this project is lower than we could expect, because in Table 1 we can check that the decisions about items of reductions list must be decided before year 2001 or 2002, it is three years before the execution of the project. However, we can observe along both planning and execution phase occur several reductions cost, so in the project some changes are allow in the execution phase.

It is important to compare the figures achieve in results section. Firstly, the planning reduction list give an amount of 115 million NOK, but a later analysis of these items has a result of 72 million NOK as reduction list. This variation in the results is due to a detailed study of each planning reduction list item. It means that only the 62% of the planning reduction list will be performance. This figure represents 1.77% of total budget of the project.

In addiction, as shown Table 3, during planning and execution of the projects the reduction lists grow up and, due this, the amount of reduction increase in 96.7 million NOK, or in other words, in 2.38% of total budget of the project. Moreover, in some items of this table,

With these reduction lists the amount save on total is 168.7 million NOK, which mean a percentage of 4.15% of total budget of the project.

In this report it is discussed the necessity of carry out a planning reduction list and the outcomes of these reductions list in one example as the project of double track between Sanvika and Asker.

Through performance reduction list it is possible to avoid overrun cost in major projects and to deliver it without delay.

This study indicates the mean feature of project flexibility: flexibility is frequently used but rarely prepared for.

Current project management theory then proposes a stronger emphasis on the front-end phase in order to prepare the projects as well as possible. But if there is flexibility and changes are allowed, it is possible that the total cost will decrease, as occur in this case.

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# 7. - APPENDICIES

In this part will be shown the tables comment in this project report.

| *Ranking* | *Description* | *Sum (million NOK)* | *Must be decided before* | *Consequences* | *Comments/ pre-requisites* |
|---|---|---|---|---|---|
| *1* | Not do preparations for a turn-around-trains station at Jong | 10 | 2001 | Cost | Do not build Jong turn around station |
| *2* | Reduce freeze protection of the bottom of the tunnel | 6 | 2001 | Cost, Quality | Less isolation. May require adjustments of the rail tracks after frost heave |
| *3* | Esthetical work (green areas etc) | 6 | 2001 | Quality, image | |
| *4* | Bridge over E-16 road is build simpler | 4 | 2001 | Quality, image | The gravel layer of existing bridge is too thin, which causes extra maintenance costs |
| *5* | Not prepare for the Ringerike line | 25 | 2002 | Cost | No need for a branch tunnel, which also reduces concrete works and conduit width. Means increased cost if the Ringerike line shall be built |
| *6* | Reduced user friendliness at stations. Shorter platforms, no heating in platforms, no roof on platforms, other minor things | 24 | 2002 | Quality, image | |
| *7* | Not building 4 long tracks | 15 | 2002 | Cost | Requires that the whole line from Sandvika to Asker is built all-in-one |
| | In addition, the project has identified possible reductions of 25 million NOK which are not verified. | 25 | 2001 | | Technical verification during the 1st half of year 2001 will verify if these reductions are realistic |

Table 1: Planned reduction list

| *Ranking* | *Description* | *Sum (million NOK)* | *Must be decided before* | *Consequences* | *Actual project documentation (million NOK)* |
|---|---|---|---|---|---|
| *1* | Not do preparations for a turn-around-trains station at Jong | 10 | 2001 | Cost | 30 |
| *2* | Reduce freeze protection of the bottom of the tunnel | 6 | 2001 | Cost, Quality | 0,5 |
| *3* | Esthetical work (green areas etc) | 6 | 2001 | Quality, image | 0,9 |
| *4* | Bridge over E-16 road is build simpler | 4 | 2001 | Quality, image | |
| *5* | Not prepare for the Ringerike line | 25 | 2002 | Cost | 30 |
| *6* | Reduced user friendliness at stations. Shorter platforms, no heating in platforms, no roof on platforms, other minor things | 24 | 2002 | Quality, image | 10,6 |
| *7* | Not building 4 long tracks | 15 | 2002 | Cost | |
| | In addition, the project has identified possible reductions of 25 million NOK which are not verified. | 25 | 2001 | | |

Table 2: Actual reduction list

| *Ranking* | *Description* | *Total (million NOK)* | *On planned reduction list (million NOK)* | *No real reduction (million NOK)* | *Sum (million NOK)* |
|---|---|---|---|---|---|
| *1* | Between Sanvika and Jong, during planning | 23 | 0 | 0 | 23 |
| *2* | Between Sanvika and Jong, during execution | 29 | 1,5 | 0 | 27,5 |
| *3* | Between Jong and Asker | 39 | 0 | 13,2 | 25,8 |
| *4* | Asker station | 57 | 10,6 | 26 | 20,4 |

Table 3: Final reduction list

| | *Sum (million NOK)* | *% of total budget* |
|---|---|---|
| *Planned reduction list* | 115 | 2,83 |
| *Actual reduction list* | 72 | 1,77 |
| *Not on planned reduction list* | 96,7 | 2,38 |
| ***Total reduction list*** | **168,7** | **4,15** |

Table 4: Comparison between different reduction lists during the project