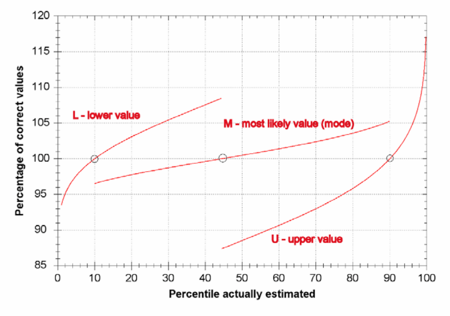
Uncertainty analysis – Selected sources of errors

Sensitivity of input variables in triple estimates in stochastic analysis

Methods using triple estimates as input to analysis of uncertainty and risk are widespread. This is also used up-front in cost estimation. What are the effects of entering faulty values in such analyses? We have looked into what the error would be if one of the values in a triple estimate is wrong.

Base distribution

We have found from anaylisis of empirical data from cost estimates that average probability distribution has a skewness of 0,42 and a 20% relative standard deviation. For more extreme distributions the effect will be larger than what is indicated in the graphs below.



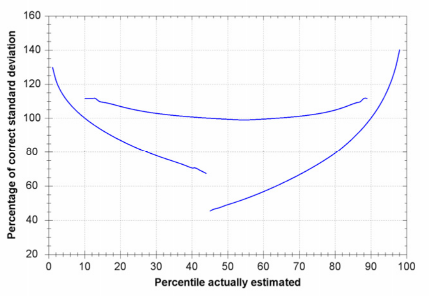
Effects on the expected value

The graphs to the left show what the effects are on the expected value of a single cost item if we were to estimate erroneously one of the values in a triple estimate.

It is assumed that we are trying to estimate the values of the 10-percentile, the most likely value and the 90 percentile.

Effects on the standard deviation

The graphs to the right shows the effects on the standard deviation of a single cost item if we were to estimate erroneously one of the values in a triple estimate.



Compound effects

The graphs only show what the effect will be for a single cost item expressed by a gamma distribution. If we systematically in an analysis over– or underestimate a value the effects will compound to potentially very large values (in the case of multiplying two items).

Conclusions

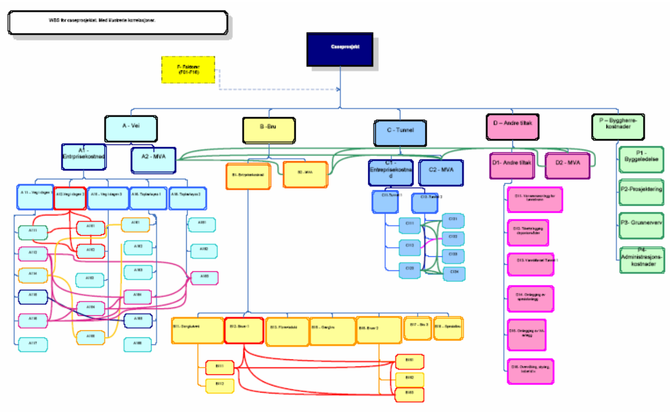
The graphs suggest the effect of faulty estimates of the upper and lower values are much higher than faulty inputs for the most likely value M. What this suggests in practical terms is that the upper and lower values should be estimated before the most likely value M in order to improve the output of stochastic estimation processes. This is confirmed experimentally in cognitive psychology.

Effects of correlation

If the basic premise for calculation of the distribution of the estimate is that every element in the estimate is statistically independent, and this assumption is wrong, we will underestimate the uncertainty of the estimate.

If the assumption of independency is wrong, and we in fact have high correlation, the error will increase with increasing number of elements. In a calculation containing 20 similar elements of which the half are 70 % correlated, the error of calculated standard deviation will be around 100 %.

The risk from a high level of detailing together with calculations assuming that the new elements still are independent, is that the calculated uncertainty is heavily decreasing. The detailing in it self does not influence on the real uncertainty, and the relative error may be huge.



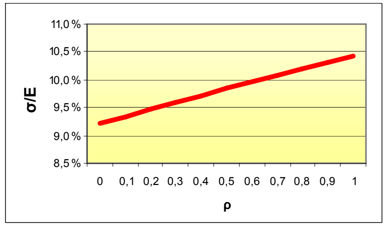
Looking at a real life case

We have studied how much this may amount to in practice by looking at a real life road construction project estimate . We did several tests simulating different thought up practical situations regarding correlation. The estimate was divided into group (correlation families), and with each group we introduced a correlation factor between the items. . The cost of each group is at first assumed to be independent of the other groups (correlation setup 1), and later on related groups are correlated (correlation setup 2).

Step 1

The relative standard deviation increases from 9,2% with no correlation to 10,4% with full correlation between the elements innside each family.

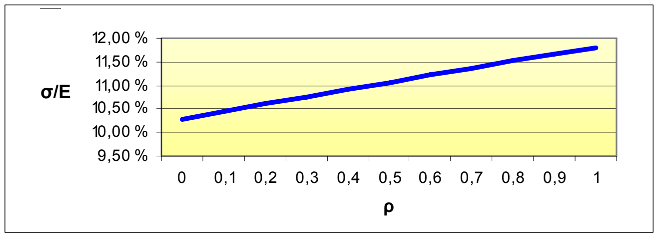
Correlation families:			
Round-abouts	Walk- and cycle ways	Tunnels	Portals overall
4-lane high-way	Ordinary bridges	Tunnel 1 portals	VAT for different ele-
2-lane roads	Un-common bridges	Tunnel 2 portals	



Step 2

The standard correlation increases in addition to 11,8% with full correlation between related

Correlation families:	Content of the family:
Roads and highways.	Roundabouts, 4-lane highway, 2-lane roads, Walk- and cycle ways, VAT.
Bridges.	Ordinary bridges, Uncommon bridges, VAT.
Tunnels	Tunnels, Tunnel portals, VAT.



families. In total an increase of the standard deviation from 9,2% to 11,8% represents slightly less than 30% in overall project uncertainty.

Conlusions about correlation

The results from the case shows us that the error might make ignoring correlation in a project estimate is 30% of the calculated standard deviation. This is assuming that the inputs are adequate for the situation, and that estimate hasn't been subdivided in an uncritical manner. If you do subdivide uncritically the error may be increased almost infinitely

Frode Drevland
M.Sc., Researcher

Department of Civil and Transport Engineering
7491 Trondheim
Norway

Email: frode.drevland@ntnu.no
Telephone: +47 73564640
Direct line: +47 73594642

Kjell Austeng
M.Sc., Associate Professor

Department of Civil and Transport Engineering
7491 Trondheim
Norway

Email: kjell.austeng@ntnu.no
Telephone: +47 73564640
Direct line: +47 73594753

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