Driving Innovation in Crisis Management for ***E***uropean ***R***esilience

D23.31 - Costing Methods for Crisis Management Solutions

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List of Acronyms

Abbreviation / acronym	Description
CM	Crisis Management
KPI	Key Performance Indicators

Executive Summary

The Driver Costing methodology is developed in four iterations identified by the deliverable numbers D22.3n (where n is 1…4) and this deliverable is the first iteration of this deliverable series.

The purpose of this deliverable is to form the basis for developing a state-of-the-art methodology to assess the costs of crisis management innovations. Several methodological approaches to making cost assessments are presented and examined in order to produce a palette of methodological tools that can address different situational conditions. This enhances the flexibility of the costing methodology and allows for adjustments to address the different crisis management innovations. The final cost assessment will rely on data collected - amongst other sources – from the DRIVER technical partners via the use of an appropriate template that distinguishes the different cost elements.

Further in this deliverable series, the content presented and especially the methodological approach will be gradually evolving to higher levels of detail. Forthcoming (D23.3n) deliverables will be enriched with the results of the cost data collection exercise and the outcomes of the application of the costing methodology.

1 Introduction

1.1 Purpose

This deliverable describes the recommended contents and preliminary structure of the DRIVER Costing Methodology. The Costing methodology is developed in four iterations identified by the deliverable number D23.3n (where n is 1…4) and this deliverable concerns the first iteration, with initial and preliminary information on costing methodologies related to the DRIVER innovations.

The purpose of this deliverable and the subsequent deliverable iterations is to progressively produce a cost estimation methodology to address the costing of complex CM solutions as various stages of maturity as developed by DRIVER, as well as the development of guidelines regarding the estimation of required costs. The produced methodology will have to account for the:

- Potential mix of technological and human factors of the different solutions
- General lack of good baseline data

This deliverable focuses on existing costing methodologies and produces a preliminary proposal of the methodology that could be adopted for assessing costs for the DRIVER CM solutions.

1.2 Scope

The scope of the Costing methodology deliverable will evolve along with the more production of more concrete results from the technical SPs and with each successive round of experiments. This deliverable covers the potential methodological framework and sets the basis for consideration of the possible cost categories and elements that can be assessed.

1.3 Costing methodology objectives

The costing methodology objectives are specified in the DRIVER Description of Work (DOW). The top-level objective is to support the DRIVER evolving test-bed with validated, reliable and practical costing methods. That is, to support the planning and analysis of experiments for the exploration and demonstration of new crisis management solutions. Within this task, a cost assessment methodology will be developed and guidelines will be produced to facilitate the estimation of the cost of developing and implementing complex crisis-managements solutions at various stages of maturity.

1.4 Costing methodology development approach

The DRIVER costing methodology must be flexible enough to allow its application for the costing of significantly different CM solutions. The methodology will be enhanced and further detailed along the progress of DRIVER benefitting from a continuous interaction with SP3-SP6. The description of

the development approach will be in four iterations identified by deliverable number D23.3n. A more concrete conceptual design of the costing methodology will be presented in the second iteration of this deliverable, and will provide input for the second round of experiments.

1.5 Document overview

The remainder of this document contains the following chapters:

Chapter 2 provides a description of the methodological approach adopted to define the costing methodology.

Chapter 3 presents a literature overview of methodologies for cost behaviour assessment and costing methods, in this chapter we address the development of a cost estimation method.

In the forthcoming versions of this document, the following chapters are going to be added:

- A Chapter establishing an overview of the selected costing method that will apply to the portfolio of tools and to the experiments.
- A Chapter presenting guidance to the implementation of the costing methods.

Finally, the Chapter on the conclusions (currently Chapter 4) will develop to put forward the conclusions of the future deliverable versions.

2 Methodology

2.1 Overview

The costing methodology developed for CM solutions needs to be as detailed and specific as possible. However, given the wide variety of examined CM solutions, it has to be flexible enough to apply in the whole range of potential solutions as suggested in Chapter 1.

2.2 Main aspects of the Costing Methodology

The further development of the costing methodology requires the coordination with the technical SPs of DRIVER (3-6). Initially insight is required regarding the concepts developed in the SP3-5. This is necessary in order to be able to list the components of each CM solution and consequently derive the resources required for developing the solution. This is achieved by producing an analysis of the cost categories and elements that each of the CM solution components entails.

Then, a categorisation of the identified cost components and an assessment of the parameters that contribute to their costing will be needed. Further, based on the performance of CM solutions in SP3-5 experiments, available data regarding the costing of the different cost components of each solution will need to be collected. .

Depending on the outcome of the latter the costing methodology will be further tuned, potentially creating some methodological variations for assessing the costs of specific components relevant to the development and implementation of the crisis-managements solutions. Finally, instruction on how to apply the costing methodology will need to be set in a form of applicable guidelines. The validation of these guidelines from practitioners should then produce added value.

2.3 Purpose and function of Costing Methods

One of the cornerstones in DRIVER is the selection of new solutions to CM. With the intention of determining the performance of each tool, a number of indicators that quantify the successfulness of the solution have to be established (see D23.21 – Performance and Benefit Metrics for further information). Among these key performance indicators (KPI), costing plays a fundamental role since it is a killing criterion that can discard a technically viable solution. In other words, if the costs necessary to develop, validate and/or implement a new concept is too high, it cannot be accepted as a feasible solution.

The economic cost plays two fundamental roles in the DRIVER framework. Firstly, from the point of view of the development, the cost has to be addressed in the conceptual phase in order to guarantee that the solution development is achievable. Secondly, the cost accounting must also address the validation stage at this point. In addition, the cost to implement a tool cannot be neglected in any of

its different dimensions, i.e. resources needs, staff training, licensing, maintenance, translation, etc. The sum of these factors determines the actual cost of the solution.

The cost-benefit analysis (CBA) is systematically used to assess alternative solutions. However, the application of this technique would provide only a partial meaning if applied to the DRIVER portfolio of tools. The reason is that DRIVER, being intended to cover the needs of a wide variety of stakeholders, must take into account that not all of them may have enough resources to afford the technically optimal solution. For instance, a solution requiring expensive maintenance may not be affordable for some end-users despite its potentially higher return of benefits.

The DRIVER project team not only intended to establish a portfolio of preferable solutions; Our ambition is to establish a catalogue of tools explaining their pros and cons as well as the costs involved, so that each can easily choose the one that is best suited to his or her situation.

Cost and revenue estimates can be further classified according to their detail, accuracy and their intended use as follows:

- Preliminary ”order of magnitude“ estimates: used in the planning and initial evaluation stage of a project.
- Final “semi-detailed” or budget estimates: used in the preliminary or conceptual design stage of a project.

Neither a preliminary estimate nor a final estimate is expected to be exact. The intention of the DRIVER team is to simplify the task of choosing one or few tools from a large number of similar offerings, and not to produce an online shop or a financial controlling instrument.

2.4 Implementation and testing issues

Developing a costing methodology for CM solutions is challenging. On the one hand, the methodology has to be generic enough to abide for the whole range of possible CM solutions; while on the other hand, the methodology needs to be practical enough to yield concrete and tangible results in its different applications.

Producing an assessment of the costs for developing a complex CM solution can be a very resource-intensive exercise depending on the level of detail of applying a costing methodology. This is the reason why the level of detail in the application of the costing methodology is an aspect that needs to be thoroughly addressed. The main point in this being is that it might be possible to deliver a more detailed estimation of costs by means of a more elaborate analysis and in-depth implementation of the costing methodology. Doing so is sensible if and only if, the additional effort pays back in matters of producing considerably more reliable cost estimation.

Another reason is that a very detailed and in-depth costing analysis does not necessarily result in significantly more reliable cost estimation.

Cost assessments regard costs which are a multi-parameter variable. Although it may be possible to assess the order of magnitude of many of the costs, it is nearly impossible however to produce an

exact estimation of every single cost element. At the end of the day, the overall accuracy will always be limited by those factors that are least accurately known[1].

Therefore, it is crucial to consider the levels of uncertainty in each assessment prior to apply any costing methodology. Only then, some methodological aspects can be fine-tuned for each application of the costing methodology and the exact level of application detail are chosen considering the available resources for this task as well as the detail gains for each level of committed resources.

In subsequent version of this document, we shall develop a guideline for applying the costing methodology. This guideline document needs to be validated by experts on operational aspects of CM solutions development to assess its ease of use.

2.5 Planning and conceptualisation of deliverable series

2.5.1 Roles of partners / allocation of work

ECORYS will lead the task developing the costing methodology and will be responsible for designing the approach to be followed and developing the cost template. ATOS will be the lead technical partner and will be responsible for coordinating the technical input required from Driver partners for the various aspects of this methodology making use of the cost template and will support the guideline development and validation in which Ecorys will take the leading role.

The next versions of this document will focus on further refining the costing methodology and retrieving cost data from literature. Further, unit costs are going to be developed producing more reliable estimates. The first concrete cost estimations are expected to be presented in D23.33 (M27).

[1] We are talking about absolute values, not relative ones. The price of an element which is inexpensive and appears only once (e.g. “special buttons for commander’s uniform”) is practically irrelevant compared to the price of elements that are expensive or need to be purchased in large numbers (e.g. “protective clothing for all first responders in the country”).

3 Development of Costing Method

This chapter describes the development of costing methodologies to be applied in the context of DRIVER. First a general framework for assessing the characteristics and behaviour of the different cost elements is provided. Then, a variety of estimation techniques are presented to give a hint on the potential approaches that can be applied to estimate the different identified cost elements.

3.1 Literature research and information collection

As established in the E-OCVM ([1] and [3]), the concept life-cycle can be expressed in different stages: development, validation, verification and integration. Each of these stages is dominated by different processes.

. Following this perspective, cost accounting takes most importance during verification, once the concept is mature enough to prove that the components can be economically implemented. Additionally in a system-of-systems, the cost-benefit must be carefully analysed as the global performance is not the simple sum of all single aspects.

At this point we introduce a number of traditional terms in cost accounting that require explanation to avoid misunderstanding (see [5]).

- The costs may be classified according to its source in direct or indirect. *Direct costs* are expenses that can be clearly connected to a specific object, including items such as software, labour, raw materials or other pieces of equipment. On the other hand, *indirect costs* are expenses that are not easily traceable to a department, product or service. These typically benefit multiple cost objects.
- Another classification of costs can be done according to the variability: fixes or variable. *Fixed costs* are the expenses that do not depend on the level of service produced. In contrast *variable costs* are service-related and increase proportionally to the level of service.

Although costing is essential to prioritize development costs, it is not possible to obtain precise cost estimates for a long-term forecast. Thus costs estimates must be taken broadly, typically as orders of magnitude rather than literally, especially at early product maturity phases.

Initially, we will describe some methodologies that are used to analyse and measure cost behaviour. Afterwards, we will provide some more concrete costing methodologies that can be used.

3.1.1 Cost behavior methodologies

This process of costing assessment can start by classifying costs as either fixed or variable. The goal of this work is to estimate fixed and variable cost so that the total estimate can be calculated with the simple formula:

Total mixed cost = Total fixed cost + (Unit variable cost x Number of units)

Visually, this equation can be plotted as a straight line as in **¡Error! No se encuentra el origen de la referencia.**. Hence, fixed and variable costs can be identified with the slope and intersect that defines it.

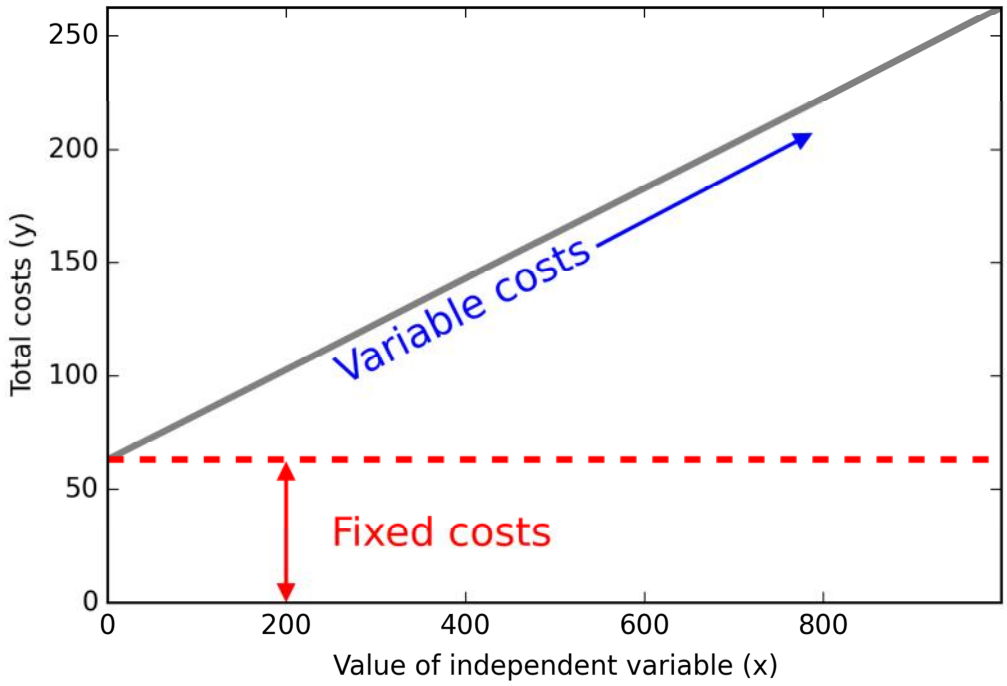

Figure 1: Meaning of fixed and variable costs.

There are four common approaches to estimating cost behaviours:

- *Account analysis*

  This simple technique is used to determine directly which of the costs are fixed or variable. Application of this methodological approach requires of an experienced group of experts with sound knowledge of the service and how it works. The total of all the costs identified as fixed, consist on the total fixed cost; and the remaining are the total variable costs that can be averaged into a per unit measure by simply dividing by the units produced.

- *High-low method*

  This is an alternative method for determining the fixed and variable costs. According to High-low method, the total fixed costs and the variable costs can be calculated by subtracting the costs occurring at the highest and lowest level of activity. The difference is the variable cost rate times the change in the numbers of units produced

- *Scattergraph method*

  This method is a graphical technique that extends the high-low one. In spite of considering only the highest and lowest levels of activity, all accounts during a period of time are equally used. The total (mixed) costs are plotted in the x-axis versus the activity levels (i.e. number of units, labour hours, etc.) in the y-axis creating a scatter plot. The plot is fitted by visual

inspection with a straight line. Then, total fixed cost and the variable cost per unit can be extracted from the line being, the y-intercept and the slope, respectively.

- *Regression analysis*

  The regression analysis relies on the statistical computation instead the visual fit used in the scattergraph method. In this method a least-squares formula is used to determine the exact line that best-fit to the accounts. Again, the total fixed cost and the variable cost per unit are extrapolated from the line obtained.

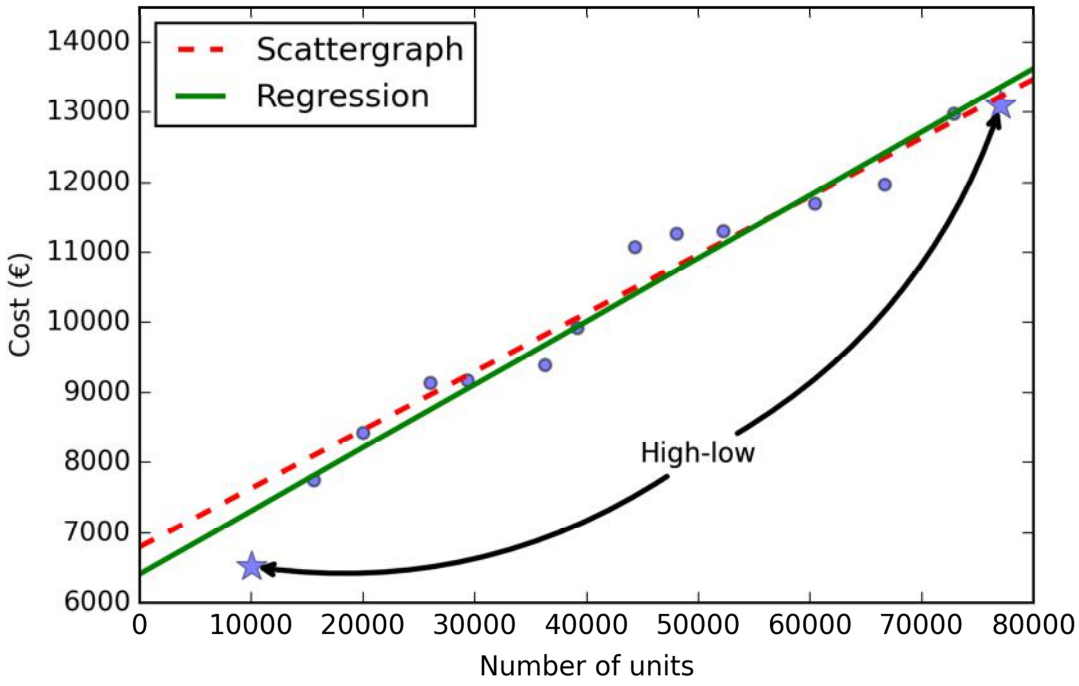

Figure 2: Example of high-low, scattergraph and regression methods. Blue dots represent the total cost versus the number of units produced. Blue stars represent the highest and lowest levels of activity, which are used for the high-low method. Red dashed line represents a *visual fit* obtained by the scattergraph method. Green line shows the mathematical best-fit calculated with regression analysis.

Figure 2 shows a graphical representation of the abovementioned methods high-low, scatter graph and regression for a mock-up data. On this figure, the total costs of production are represented versus the number of units produced each time. Notice that the increasing complexity of the methods also translates in a larger accuracy in the results. For instance, the high-low method only takes into account two points while disregarding rest. The scattergraph method considers the whole dataset, but the accuracy of the y-intercept estimate can be poor and the results aren't reproducible. Finally, the regression method takes into account all data returning and also returns the most accurate fixed and variable costs[2].

[2] However, the accuracy of the estimates may be easily overestimated. In reality, the fixed costs vary in time (external causes) and the unit costs are not constant either.

It is easily understood that the 3 latter approaches are heavily reliant on existing observations and measurements of cost in previous cases. As this might not be always the case for the Driver innovations, the previously described approaches could prove be of little value. In that regard they might be useful in order to assess the costs of some specific cost elements as identified by the costing methodologies that are described in the following section.

3.1.2 Costing methodologies

Several costing methodologies exist, but no one is universally accepted as their field of application can vary. Accordingly, the cost estimation of a particular solution can vary substantially depending of the purpose of cost data estimations for which it is generated. The most common techniques applied are [4]:

Top-down (often used when fine detail is not available): This approach requires listing the major tasks that need to be performed for the Project to be completed. Breaking the project into stages helps to identify these main tasks and the costs involved. Experience and judgement are used, to estimate the time and resources required for each task. This methodology is usually applied at an early stage in a Project when the overall outcome and approach is known, but the fine detail is unclear. As it is a high level process, the result cannot be very precise, and may be best expressed as a range of values.

Bottom-up (usually used when fine detail is available): In this approach each activity required to complete the Project needs to be identified. Further, the costs, resources and time required to complete the activity are also estimated. This methodology can lead to more precise cost estimations than the top-down approach. However, the bottom-up approach is quite time-consuming and its application requires the analyst to be an expert in operational aspects of the development and operation of the end product. This also means that the end product must be well defined as this approach allows little flexibility for unknown factors.

Analogy (used when a comparison with similar is possible)**:** The cost estimation is based on establishing a comparison between the costs elements of the current project and the relevant cost elements of previous completed Projects. This estimate is therefore based on actual experience rather than opinion. This methodology can be a good way to estimate costs, provided the information is available and the two projects are comparable.

Expert judgment (expert's estimation of project costs)**:**

This is technique takes a number of independent "expert opinions" as the input and combines them to provide a single best estimate. The technique does not determine how each of the experts is supposed to estimate the costs, but top-down estimates the expert judgement is most commonly used in conjunction with the top-down estimates.

Activity based costing (accurate but time consuming and data-demanding)**:** This costing methodology is used to measure costs in relation to activities and defined cost objects. The basic principle is that production of a specific level of output requires specific activities and resources to materialise. Connecting the resources needed for each activity to these activities and the activities in turn to output units eventually delivers a cost assessment per output unit.

A successful implementation of the latter costing approach requires a managerial cost accounting system to access several types of data that can be collected and classified in different manners. The centre of attention should be identified with specific customers, jobs or processes. The activity based costing methodology is influenced by the type of operation and the extent of cost accounting information needed. We comment briefly on four methodical variations of the activity based costing:

- Job order: costs are accumulated by jobs, orders or lots. The key is that each job is different as it is done with different specifications.
- Process: costs are accumulated by departments. Each division usually has its own procedures, so the work done within its department may be is standardized in a naturally way.
- Backflush: is a simplified method that relies on the idea of delaying the costing process until the production is completed. This removes the detailed tracking of costs through the process, which is a feature of traditional costing systems.
- Hybrid of mixed methods: applied when more than one costing situations are required.

The application of each of the described costing methodologies is dependent on the level of information available for the specific cost categories (and/or subcategories). While depending also on the available level of detail of cost data, a mix of the different methodologies can be applied to estimate the different cost elements.

Given the level of knowledge regarding cost data availability currently available in DRIVER, we consider that the most appropriate methodology for the cost task is to adopt a hybrid approach combining elements of a number of the above mentioned methodologies. Applying initially a bottom-up approach to define the basic cost categories and elements, our proposed approach would then move forward to apply alternative cost assessment methodologies (i.e. analogy, activity based and expert judgements) to complement the cost assessment where possible and increase the level of detail.

3.2 Development of Cost Template

The cost elements identified in the costing methodology need to be coherently presented in a standard template. The format of the final template departs from the assumption that initially a bottom-up costing approach is adopted to produce a basic break-down of cost categories. Further, the application of complementary costing methods is pursued for the assessment of more specific cost elements.

The following template aims to present the main cost categories of the various CM innovations and identify their dependency on product characteristics and service levels. A basic set of cost categories is identified and for each of their cost elements, costs are estimated based on a fixed costs and variable costs division:

- R&D costs: These are the costs of research and development of the service.
- Procurement costs: These are the costs of procuring the necessary material and immaterial goods for establishing the service.
- Implementation costs: This cost category comprises of the costs undertaken to establish and operationalise the service. This cost category may include costs for making a transition from the previous existing services to the new service, costs of training personnel as well as the cost of resources applied to establish the new service.
- Operation costs: These are the costs of operating the new service through time. This cost category may include resources committed for operating the service, costs of obtaining licenced software as well as regular and irregular maintenance costs, etc.
- Other costs: This cost category is included to indicate the possibility of including other cost categories depending on the level of desired detail. Such categories may be i.e. depreciation costs, end-of-life costs etc.

When possible and relevant to provide more detailed cost estimates, the cost categories can be split into subcategories. All cost categories are usually defined as one-off costs and are therefore estimated in lump sums. An exception to this rule is the operational cost category which is defined as annual operation cost of the service.

Table 1: Cost template

Cost categories	Fixed costs	Variable costs	Cost unit definition	Cost estimation technique
R&D costs				
Procurement costs				
Implementation costs				
- Transition costs				
- Resources				
- Staff training				
- Translations				
- etc.				
Operation costs				
- Resources				
- Licencing				
- Maintenance				

- etc.				
Other costs				

The future versions of this document will move further into collecting cost data from technical partners as well as from literature. Further, an analysis of the data gaps will be made to identify the information missing to produce cost estimations. Additionally, the cost estimation methods will be further developed to match the needs of this cost estimation task.

4 Conclusion

Estimating the cost of developing, implementing and operating CM innovations is of high importance to decision makers when choosing for the developed of crisis management innovations. Developing a flexible yet accurate costing methodology at this early stage of innovation developments is crucial, to be able to assess the cost elements of these innovations and to make the necessary decisions regarding possible trade-offs between system costs and performance. Therefore in this first version of this deliverable series, a flexible approach to the costing methodology is proposed and a series of methodological options that can be applied are presented, while a draft template is developed with the aim to use it for cost data collection.

The forthcoming versions of this deliverable series will focus on presenting the data collection results, the fine-tuned costing methodology and delivering the outcomes of the cost estimation task.

References

[1] DRIVER, (2015) D23.21 – Performance and Benefit Metrics

[2] EUROCONTROL, (2010), *E-OCVM Version 3.0, Volume .*

[3] EUROCONTROL, (2010), *E-OCVM Version 3.0, Volume II and Annexes.*

[4] ProjectTools.co.uk, Project Management – Estimating, http://projecttools.co.uk/Estimating.htm, accessed 02 February 2015

[5] Ruth, James Bennett, Overview of cost definitions and costing methods, World Bank, http://siteresources.worldbank.org/INTPRS1/Resources/383606-1201883571938/Cost_Definitions_and_Methods.pdf, accessed 19 February 2015