RICS PRACTICE INFORMATION

Value management and value engineering

UK

1st edition, January 2017

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Document definitions

Document type	Definition
RICS professional standards	**Set requirements or expectations for RICS members and regulated firms about how they provide services or the outcomes of their actions.** RICS professional standards are principles-based and focused on outcomes and good practice. Any requirements included set a baseline expectation for competent delivery or ethical behaviour. They include practices and behaviours intended to protect clients and other stakeholders, as well as ensuring their reasonable expectations of ethics, integrity, technical competence and diligence are met. Members must comply with an RICS professional standard. They may include: • mandatory requirements, which use the word 'must' and must be complied with, and/or • recommended best practice, which uses the word 'should'. It is recognised that there may be acceptable alternatives to best practice that achieve the same or a better outcome. In regulatory or disciplinary proceedings, RICS will take into account relevant professional standards when deciding whether an RICS member or regulated firm acted appropriately and with reasonable competence. It is also likely that during any legal proceedings a judge, adjudicator or equivalent will take RICS professional standards into account.
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Introduction

This practice information – which comes into effect on 1 May 2017 – introduces the concepts of value management and value engineering in relation to construction projects, and in relation to the role of the chartered surveyor.

Value in this context is the ratio between benefit (outputs) and the cost or effort (inputs) required to achieve it. Value management and value engineering are both concerned with increasing this ratio, but are often separated in terms of their timing and their scale. Where concepts and ideas are applicable to both value management and value engineering, this will be explained in the text, as will areas where the two diverge.

Value is also a relative concept – different project stakeholders will have their own perspectives on it. In particular, the benefits and costs mentioned above will often occur at different points in the supply chain or vary according to the requirements of different project team members. One of the roles of project management, supply chain procurement and overall procurement is to manage these imbalances in an holistic and transparent manner so that the project as a whole provides value to the client.

Chartered surveyors have a key role to play in helping the whole team manage value across the project and in indicating the financial resources required to achieve project outputs. The importance of this role is partly a result of the quantity surveyor being the central professional concerned with project costs, but also of the surveyor's position outside traditional design disciplines and the construction team.

There are a number of guides and publications that explain the concepts of value management and value engineering in much more detail than can be covered in this note, as well as European Standards that support the implementation of value management. Details of both kinds of resource are given in the Bibliography.

Earned value management

Readers should note that earned value management (EVM) is different from value management or value engineering. EVM is a technique used in project management, for instance by contractors, to measure the progress of a project in a defined and objective manner, and assess whether resources are being used efficiently. It does this by comparing three different measures to determine whether the project is ahead of or behind its budgets for time and/or cost. The measures used in EVM are:

- the planned value of work over time (the agreed programme and cost plan)
- the earned value of work completed
- the actual cost of work completed.

Because chartered surveyors – especially quantity surveyors – have a key role to play in EVM, it is important they know this is different from value management and value engineering.

General principles (Level 1: Knowing)

1.1 Definitions and introduction to the concepts

Value can be thought of as a very simple idea – the ratio between the benefit derived from a course of action and the cost or effort required to achieve it. This idea is universal, but it can be seen very clearly in terms of design and construction decisions both large and small.

Value can be a very broad concept to apply to a project, but the following specific examples help illustrate the idea:

- demolition and rebuilding of a city centre office building represents value to the developer if the increased rents to be gained from the new building outweigh the costs of design and construction and the loss of existing rent during redevelopment
- selection of a more expensive yet more energy-efficient building services system, for example for heating or lighting, represents value to the client if the net present value of the operational saving outweighs the additional upfront cost
- overall value may be reduced if a structural design minimises the size of – and hence the raw materials used in – each beam and column, but requires much more complicated connections and site management that increase installation costs
- value may be reduced if a specified item of plant is substituted by a cheaper equivalent that has a shorter life expectancy.

The last two examples in the above list illustrate how value to the overall project may be different from the value perceived by individual members of the project team. The structural designer may see materials costs reduced by a more structurally efficient design, for instance, but the contractor or fabricator will see the additional cost of the complicated connections these entail. Likewise, a contractor may see the cost saving from purchasing a cheaper piece of equipment, but the building owner will see higher operational costs resulting from more frequent replacement.

One of the fundamental challenges in value management and value engineering is to understand the range of impacts that any particular decision may have, including their financial implications.

Value engineering (VE), originally known as value analysis, developed in the USA in the 1940s and 1950s when manufacturing materials were in short supply in the aftermath of the Second World War. This prompted the consideration of alternative materials and designs to achieve the same outcome, many of which were then found to perform better at lower cost. The phrase used at the time was: ‘If we can’t get the material then we must get the function.' This encouraged project teams to arrive at technical solutions while focusing on the underlying needs.

In the UK, value management (VM) developed in the 1980s and 1990s as a broader process to explore how value could be provided for a project at a strategic level by helping to develop the right project brief. Used effectively, it can reduce design and construction time by giving the team a clearer focus on the client's priority requirements.

In everyday use, the terms value management and value engineering tend to be synonymous, but in this practice information the distinction between strategic value management and tactical value engineering will be maintained where appropriate. Despite this, both VM and VE encourage the project team to reconsider the assumptions that are made during design and construction in search of more cost-effective ways of achieving the desired outcomes.

There are opportunities to apply VM and VE throughout the design and construction process. The benefit to be derived from carrying out VM and VE studies, however, decreases as the project progresses. Figure 1 illustrates the general pattern of increasing cost and decreasing impact from introducing change as a project progresses.

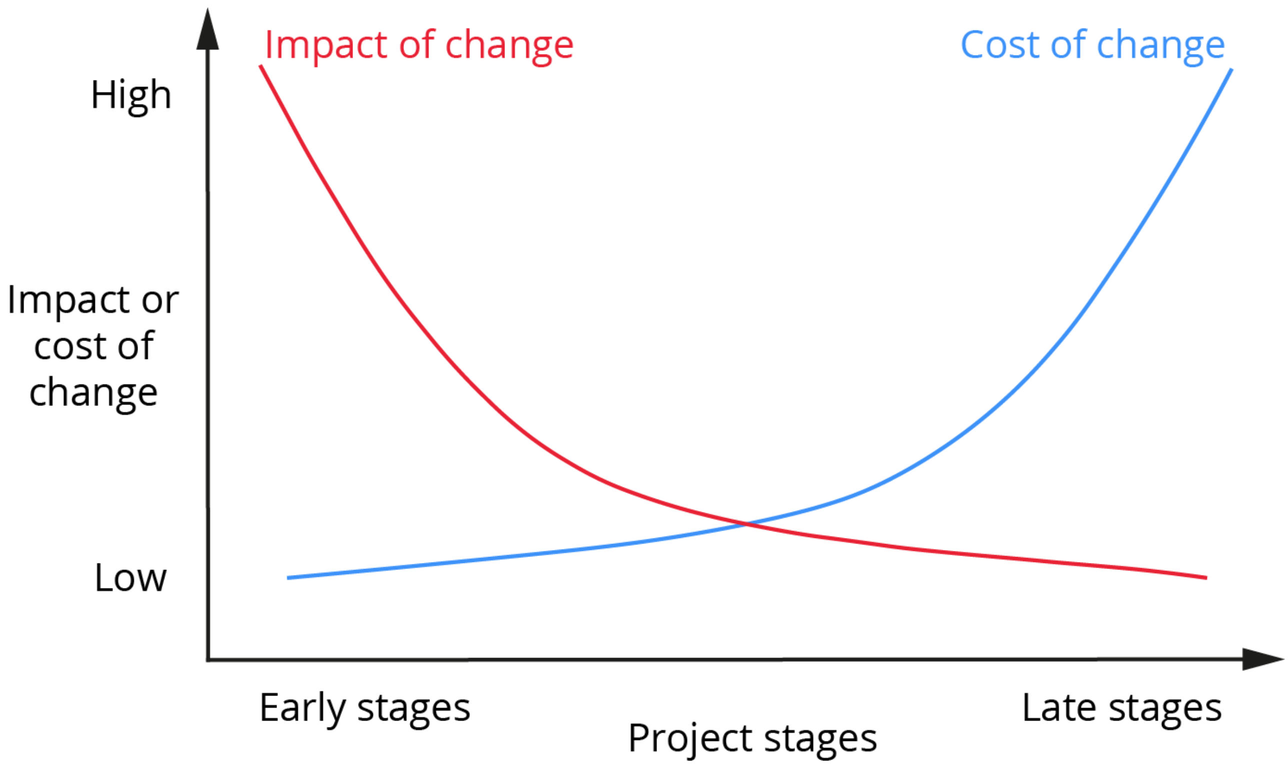

Figure 1: Cost of change increases as impact of change decreases

In the UK, it is generally accepted that VM takes place during the earlier stages of a project and that, once designs and specifications have been developed, the same process becomes VE. In practice, the terms tend to get used interchangeably and the surveyor should be prepared for this. It is important to understand what they have in common – a focus on eliminating **unnecessary** cost from the project or asset, or from systems, components or processes associated with it, to improve the ratio between benefits and costs. It can be argued that this should already be part of the surveyor's everyday work. The exercise is not about removing **necessary** cost from a project by reducing its scope, omitting work items or downgrading the specification below the level of performance required by the client.

VM and VE should be used to guide and direct project design and construction – that is, at the beginning of a project – as much as, if not more than, they are used to review design decisions after the event. VM and VE should also consider the impact of design and construction decisions on operating costs and on the client's business processes.

VM and VE aim to maximise project value given the time, cost and quality constraints. However, it should be recognised that improving whole-life project value sometimes requires extra initial capital expenditure. The key differences between VM or VE and scope or cost reduction are that the former are:

- positive, focusing on value rather than cost, seeking to achieve an optimum balance between quality, whole-life cost and time
- structured, auditable and accountable
- multidisciplinary, seeking to maximise the creative potential of all project participants, including the client, working together as an integrated project team.

1.2 The benefits of VM and VE to clients and delivery teams

There are two key benefits for a project client, and ultimately to an asset owner, from VM and VE that mean they have a role to play on projects of all sizes. VM and VE should be on the agenda at regular project meetings so there are opportunities to discuss improvements to both design and construction, even if the scale of VM or VE exercise described in this practice information cannot be justified. In this sense, providing value should already be one of the key objectives of all design and construction professionals.

One benefit is to reduce project cost by focusing specifically on the functional requirements of the project and then considering what alternative approaches can be adopted. This targets unnecessary costs that may have been built into the project specification as a result of unchallenged assumptions.

For example, an early design for an office building for 150 staff may be £500,000 over budget. One reason for this might be that it has been designed on the basis of one desk per staff member because that is what past and current work practices have involved. However, analysis of the organisation may indicate that use of better IT and more flexible staff management could support greater use of remote working, meaning that the building would still function with only 100 traditional desks and 20 hot-desks. A redesign on this basis, with a smaller gross floor area and reduced fit-out costs, may bring the project back on budget. Traditional approaches to cost reduction might instead have focused on lowering the general quality of the decor, removing the building management system and reducing the number of meeting rooms, without considering the underlying functions required. Although those changes could bring the project back on budget, the resulting building would not meet the needs of the occupiers.

The second key benefit is that earlier consideration of design, buildability and maintainability can encourage the different project team members to discuss ideas in a structured way and seek more efficient or effective ways of achieving the required project outcomes, improving the subsequent asset management.

For example, replacing hydraulic lifts in a low- to medium-rise building with faster traction lifts may enable the number of lifts to be reduced and also simplify construction by eliminating the need for an underground hydraulic cylinder. Specification of LED lamps in stairwells and high-ceilinged rooms may also reduce the frequency and therefore the cost of lamp replacements, among other things.

While the ultimate beneficiaries of VM and VE are the project's client and stakeholders, the interim beneficiaries are the members of the project delivery team as they can explore and identify better ways to achieve the desired outcomes.

VM and VE might themselves add cost to a project, albeit on the understanding that, if they are carried out at an early enough stage, they result in significantly greater savings in design, specification or construction. Under the right circumstances, returns on investment ranging from 10:1 up to 100:1 have been realised as a result of VM.

Clearly, there is little merit in spending large sums of money on a VM study that results in relatively small overall savings, and there is none at all in spending money on a study that generates no net savings or does not even cover its own costs.

But as with other speculative project studies, there is no guarantee at the outset of a VM study as to how far value can be improved. Experience is usually the only evidence that the exercise is going to be worthwhile.

1.3 A comparison of the features of VM and VE studies

VM and VE studies have many similarities, but also some key differences.

Similarities

There are five well-established steps in a VM or VE study, as follows:

1. information gathering
2. creative thinking
3. analysis, evaluation and shortlisting
4. development
5. presentation.

These steps are explained in more detail in section 2.1, but they follow a similar pattern to the processes for other types of project analysis as well as for general creative problem-solving.

Both types of study will generate a report summarising the process steps and recommending one or more preferred solutions. The output from a VM study is a report outlining different approaches to the relationship between project objectives and business needs, or to strategic, project-related problems such as which site to select for a new development or which procurement route to use. The output from a VE study on the other hand is a summary of different approaches to achieving the required functionality for a particular material, component or system, the comparative costs of each of the approaches assessed, and a recommended approach that provides the best value for the project.

It is also important to remember that VM and VE are all about optimising overall value, within the constraints of their respective scopes, rather than reducing the project specification or omitting work without considering the wider consequences.

VM and VE are also similar in that the recommendations made may be overtaken by future events, such as advances in technology or product innovation. However, this should not deter project teams from using VM and VE to maximise value to the best of their ability at the time.

Differences

In VM, a multidisciplinary approach is needed for the strategic and often highly complex problems being considered. For example, what is the best mix of different sizes and types of housing units in a residential development? This will depend on issues such as local demand, relative construction costs and planning constraints. Another problem could be: which is the best route for a new link road, which will depend on traffic models, land prices and local community pressure? These types of problem almost always require a workshop-based approach, and often need the services of an independent facilitator.

In VE, engineering solutions to the problems being considered have already been developed to some extent. The problem-solving exercise takes place at a more detailed level and it is more likely that VE can be carried out by a single-discipline team or even by one individual. However, it is usually helpful for there to be some external review of VE conclusions, not least to help ensure that unintended consequences have not been overlooked.

Although the reports from VM and VE will have the same broad structure, there are likely to be differences in the way they are presented. This is partly linked to their different technical scopes, but may also be influenced by the differences in readership. A VM report may be a strategic document aimed at a broad collection of stakeholders, whereas a VE report is more likely to be a technical analysis written for an engineering or project-focused reader.

1.4 Relationship to other project management activities

VM and VE should not be seen as isolated or stand-alone processes. They need to be considered as part of the periodic project review, where the question of value can be assessed alongside other aspects of project development and progress. This section cannot give an exhaustive description of every associated activity, but instead explains some of the overlaps and similarities with five other areas of project management.

Risk management

Risk management is the process through which the project team, including the client, identifies and assesses the risks that the project poses. This enables them to be acknowledged, prioritised and then managed in a structured way to reduce their effect on the project as a whole. However, some do not consider risk management an entirely mature process, because the links between risk and value are not always fully established, and in some cases only technical risks are considered.

Risks are associated with a lack of information, and where VM or VE studies introduce and ultimately recommend innovative solutions then a thorough risk assessment will need to be part of the exercise. This is in addition to any general risk management being carried out.

Techniques for risk assessment and management are well developed and documented in documents for construction as a whole, as well as for specialist project types or construction activities; see in particular the current edition of RICS' Management of risk.

Life cycle costing

Life cycle costing is a technique for assessing the long-term financial impacts of alternative technical designs in order that the best overall solution can be chosen. However, like VM and VE, it is not as widely used as it could be to benefit project clients.

Life cycle costing can be used on its own or as part of a VM or VE exercise. In particular, it can play a significant role in understanding the economic value of different design proposals in terms of their construction or installation costs and ongoing operational and maintenance costs. There is usually a significant role for the chartered surveyor to play in calculating life cycle costs or providing data for others to use. More detail is given in the current edition of RICS' Life cycle costing.

Configuration management

Configuration management is the process of compartmentalising a design so that there is maximum opportunity to select alternative suppliers of particular equipment, provided of course that the performance specification is met. This supports the ethos of VM and VE, where the focus is on understanding and meeting performance requirements in the most cost-effective way.

Configuration management is often seen in relation to manufacturing, where the technical design of the product only goes as far as setting out the performance requirements and defining the spatial allocation for the component or subsystem. For example, in car manufacturing, the brake discs, pads and actuators are defined in terms of the space available in the wheel assembly as well as by their technical performance so that supplies can be sourced from multiple or alternative providers. This is a form of VE in that it provides the manufacturer with the flexibility to seek the most cost-effective alternative in the event that the preferred supplier is unable to meet demand.

Lean construction

Lean construction is a technique for identifying and removing unnecessary steps from a construction activity to reduce cost and improve quality. This has many similarities to VM and VE – although VM and VE focus on both processes and products – and lean construction will also use many of the same tools and techniques to achieve this.

Lean principles can be applied to any kind of process, including design, installation, maintenance and the management of projects. The last is possibly rather wider than the focus of VM, and would certainly be outside the scope of VE.

For example, lean principles could be applied to a large, complex process such as the management of a motorway-widening project, or to a small, simple process such as the approval of a supplier invoice or the installation of a suspended ceiling system.

Building information modelling

Building information modelling (BIM) is a managed approach to the use of shared and structured data and information in the design, construction and operation of built assets. This involves much more than just the creation of three-dimensional computer models of buildings and structures.

BIM is now defined, through a series of published standards and online tools, as a requirement for centrally procured government projects in the UK. These standards and tools define BIM Level 2, and many other public agencies and private-sector clients are also embracing this standard for their projects. One of the key features of BIM Level 2 is a clear definition, from the client, of the project information that designers and contractors are required to provide. This includes 3D models, data schedules and documentation.

BIM has many overlaps with VM and VE in that both are concerned with preventing waste by avoiding overprovision – whether that is overprovision of information in the case of BIM, or of functionality in the case of VM or VE. Both these forms of waste increase costs for project clients and/or asset owners. BIM and VM or VE alike also incorporate a life cycle view of the completion and operation of built assets. Allowing more rapid analysis of alternative design proposals is one particular way in which BIM may support VM and VE.

Practical application (Level 2: Doing)

2.1 How and when to carry out VM and VE

VM and VE are ways of understanding how the required functionality of a construction project, or part of a project, can be achieved through a technical design or construction process that avoids unnecessary cost. Either approach needs to be owned and managed by the project team. This requirement may be spelt out in specific scopes of service, and may also be communicated through a responsibility assignment or RACI matrix ('responsible, accountable, consulted and informed'), identifying who is responsible for implementation, who is accountable for the costs and outcomes, who needs to be consulted during VM and VE studies, and who needs to be kept informed.

Both VM and VE techniques follow similar steps, which can be characterised as follows.

a Understand the problem

It is very important that all those involved in either VM or VE properly understand the scenario being studied and the value criteria. In both VM and VE, this needs input from the key stakeholders. The output of this step is a description of what constitutes success for the project.

Workshops are a good way to collect information about the problem. But for VE studies, it may also be possible to document the value criteria through a desk study if the problem is sufficiently constrained that a small number of people can tackle it on their own, in which case a surveyor may not be involved at this step.

b Identify different solutions

Identifying different solutions to provide the necessary functionality or meet the objectives requires creativity and open thinking. This is the step that engineering professionals often find the most challenging. However, there are many well-understood techniques that have been used for creative problem-solving, one of the most common of which is brainstorming. Whichever technique is used, the emphasis is on generating as many ideas and potential solutions as possible without critiquing or reviewing them at this point.
This step normally requires a workshop approach, so surveyors are likely to be involved as part of the professional team.

c Evaluate the different solutions

This step takes each of the technical ideas generated – see 2.1.b, above – and assesses them against the value criteria – see 2.1.a – to draw up a shortlist. In some cases, eliminating unsuitable solutions on grounds of cost or feasibility may be very straightforward; other solutions may require more investigation before they can be properly assessed. The output from this step is a shortlist of potential solutions along with documented evidence for their inclusion or exclusion from the shortlist.
Surveyors will have a significant role to play in this step, to identify estimated costs for the solutions being considered.

d Develop the shortlisted solutions in more detail

At the fourth step, the shortlisted solutions are examined in more detail. This usually requires additional analysis to understand the costs and benefits of each, among other factors. It would not be an efficient use of resource to analyse all the solutions from 2.1.b in this much detail, and it may be that several iterations of shortlisting and more detailed analysis are required.
Where additional cost analysis is needed – as is very likely to be the case – then surveyors have a role to play at this step. Depending on the amount of detail that is needed, this may have to be done outside the workshop environment.

e Identify the best solution and make recommendations

The identified solutions are gradually whittled down to a clear favourite, or perhaps a very small number of equally good solutions, through one or more rounds of shortlisting. The outcome of this step and of the study as a whole is the description of the preferred solution or solutions. This will usually be in the form of a report that also documents the whole VM or VE process.

The VE Job Plan was described by Lawrence D. Miles, one of the originators of VE at the General Electric Company, in his book Techniques of Value Analysis and Engineering. Steps 2.1.a to 2.1.e are a generalisation of Miles' Job Plan. A more detailed breakdown of these steps is provided in BS EN 12973: 2000 Value management.

VM and VE should be part of the regular reviews carried out as the project proceeds through its various stages. In building projects, stages are defined by the RIBA Plan of Work 2013, and align with the Unified Plan of Work stages for use on many types of infrastructure project such as the standards and tools supporting BIM Level 2 in the UK. For some specialist types of project there are sector-specific plans of work, such as Governance for Railway Investment Projects (GRIP).

Table 1 shows how VM and VE could be used proactively at every project stage. This does not mean that a full VM or VE exercise is needed at each identified stage, but there should at least be a review of the value being added by the design and construction processes.

Stage	Unified Plan of Work	RIBA Plan of Work 2013	Potential VM/VE activities
0	Strategy	Strategic Definition	VM workshop (client-led)
1	Brief	Preparation and Brief	VM workshop (client + design team)
2	Concept	Concept Design	VM workshop (design-led)
3	Definition	Developed Design	VM workshop (design-led + contractor if appointed); and/or VE study (design team or discipline-led + contractor if appointed)
4	Design	Technical Design	
5	Build and Commission	Construction	VE study (contractor-led + design team or discipline)
6	Handover and Close-Out	Handover and Close-Out	
7	Operation	In Use	Post-occupancy or operation study (client-led + delivery team)

Table 1: Example of value management and engineering throughout the plan of work

The point made in section 1.1 about the focus on unnecessary cost being part of the surveyor's everyday work implies that VM or VE should already be part of the surveyor's mindset and not seen as a separate intervention.

If it is applied reactively, VM or VE is most likely to be used when costs are found to be too high, but this approach is far from ideal since it may already be too late to implement many of the ways to improve value. Value can be improved by VM or VE even when project costs are not under pressure.

2.2 Determining the value criteria for a project

The value objectives for a project will emerge from a range of different perspectives. Some of these will be the client's, and although these may be usually thought of as most important, other stakeholders will have objectives as well.

For example, Table 2 shows some stakeholder value criteria for a project to build a bypass round a town.

Highway authority	Increase local network capacity by 30,000 cars per day Reduce journey times between points X and Y by 12 minutes Project cost of less than £15m Average annual maintenance cost of less than £900,000
Residents	Limit project-related HGV movements through the town during construction to 25 per day Open the bypass within 30 months Minimise road noise from the bypass for local residents
Contractor	Enhance national and local reputation Minimise cut and fill volumes and off-site removal of spoil Support local employment prospects
Ecologist	Minimise use of greenfield land Minimise number of mature trees needing to be felled Provide safe passage or alternative habitats for protected species

Table 2: Examples of stakeholder value criteria

The value criteria for any particular project may not be neatly summarised in a single document. Even if there is such a summary, it would be good practice for the VM team to confirm these as part of understanding the problem – see 2.1.a. Finding out what the value criteria are could involve a series of one-to-one interviews or discussions, but a facilitated workshop is likely to be more effective.

It is important to remember that it is not the place of any stakeholder to overrule the value objectives of any other stakeholder. The issue of how much weight is to be allocated to each and determining their relative priorities is different from finding out what those objectives are.

It is almost certain that some value objectives will conflict with each other. This does not just mean objectives from different stakeholders, but can also apply to those from the same stakeholder. For instance, in the above example of the bypass, the project cost and maintenance cost objectives may be incompatible. In such cases, the relevant stakeholder has the final say over the balance to be struck. This means that stakeholders need to be involved as VM and VE studies progress.

Many conflicts associated with VM or VE arise because of the reward strategies that have been put in place for the project. For example, if a client has appointed a contractor solely on the basis of the lowest price, which has thus lowered or even removed that contractor's profit margin, then the client should not be surprised when the contractor seeks to maximise the payment for any variations. This could extend to the contractor agreeing to changes that they know will create further problems and variations later in the project. Conflicts occur between the public priorities set out by stakeholders and the private priorities of different organisations because of the way they have been engaged and appointed. Where surveyors are involved in the design of procurement strategies or drawing up contract documents, then they need to be aware of the likely consequences of these possibilities from a VM point of view.

VM studies often recommend changes that represent trade-offs between different members of the project team – more design work that simplifies construction or installation, or standardisation of a component type that reduces design effort and construction time. It is highly unlikely that all the changes proposed across a project will exactly even out the gains and losses for each organisation in the team, so there are almost always going to be winners and losers in terms of fees or contract sums. This means that for all organisations to participate in the spirit that is required, there has to be a project-wide mechanism for sharing the savings made as a result of VM and VE studies.

These mechanisms for distributing pain and gain have to be incorporated into the procurement approach and the contracts for designers and contractors. Surveyors also need to be able to advise project clients on such aspects of VM and VE. Partnering-style approaches to procurement and appointment are needed, but detailed discussion of these is outside the scope of this practice information.

It is important that a VM workshop facilitator or VE discussion leader manages the process so as to identify these potential areas of conflict to guide the group towards a consensus that benefits the project as a whole. This means ensuring the potential risks from an alternative design or material selection are considered, as well as the potential cost or time savings.

For example, reducing the specification of a flat roof covering may lower capital costs by 25% but may also decrease the life expectancy of the roof from 40 to 25 years, meaning that it has to be replaced more frequently than originally intended, and also increasing the potential for damage that has to be repaired during the covering's life. This could reduce overall value for a client who is a long-term owner-occupier, but may not be a significant consideration for a short-term occupier or a speculative developer.

2.3 Identifying what does and what does not add value

Understanding how value is provided for all stakeholders, especially the project funder, is a fundamental aspect of carrying out VM or VE. By extension, this enables understanding of why the various features of the proposed materials, equipment, systems or processes either add value or do not. Characteristics that do not add value are prime candidates for review.

Function analysis is an established technique for understanding the functionality that is required from the project. This can then be compared with the alternative costs of providing such functionality using any of the proposals under investigation. A function analysis breaks down the primary function(s) of the project or value problem into a hierarchy of more and more detailed function statements. Such a statement is a verb–noun combination describing an action and the object of that action. Function statements should be kept abstract rather than made specific so as not to pre-judge acceptable solutions. For example 'Improve transport links' is more appropriate than 'Provide a footbridge to the railway station'.

One way of depicting the result of a function analysis is a function tree. An example concerning the concept design for an office development is shown in Figure 2.

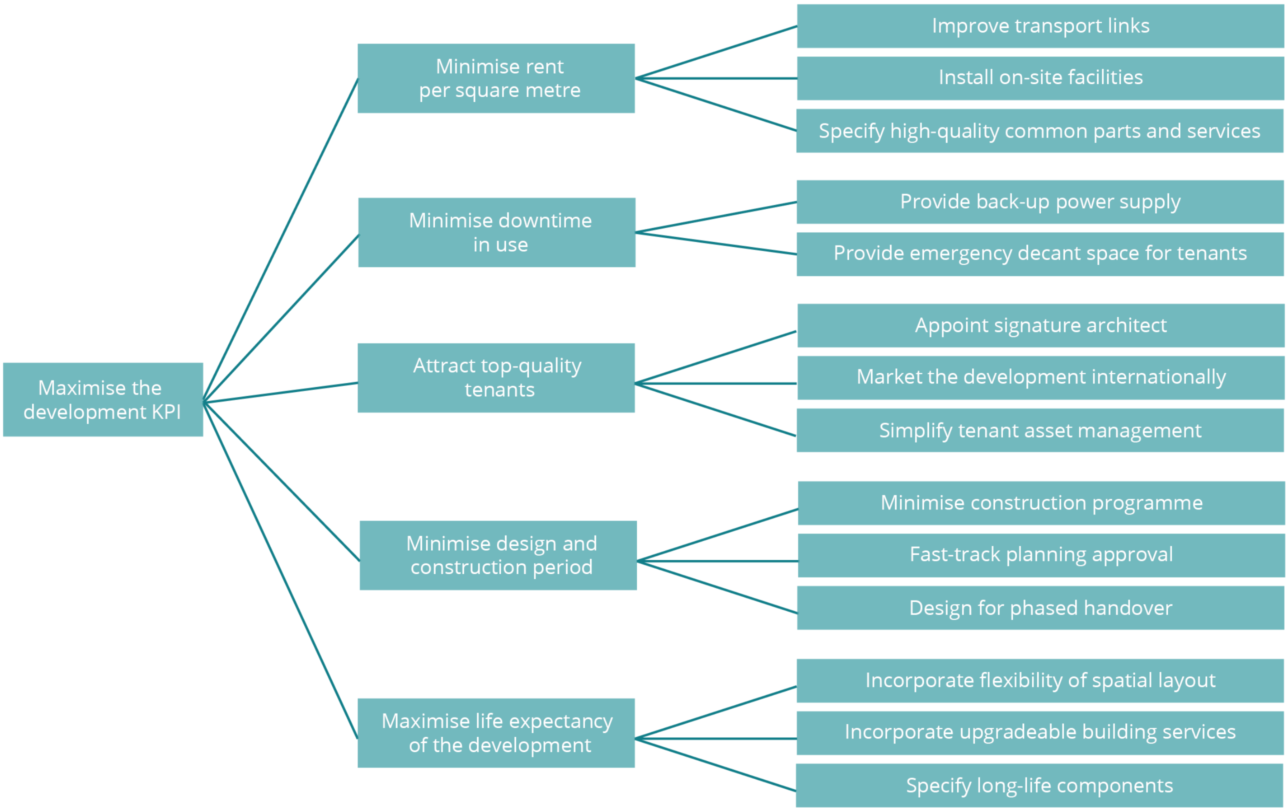

Figure 2: Function analysis of office development concept design

In Figure 2, each item answers the question 'How?' in relation to the item on its left and answers the question 'Why?' in relation to those on its right.

For example, the requirement to maximise rent per square metre is addressed by three more detailed function statements: improve transport links; install on-site facilities; and specify high-quality common parts and services. The reason for including any of these three features in the project is answered by the column to the left – to maximise rent per square metre.

The function analysis chart breaks down the functionality required from the project or design decision. The different costs of providing these functions for all the potential technical solutions can then be estimated. This analysis also offers the opportunity to indicate where a particular technical solution cannot provide part of the required functionality. Depending on the weighting or priority given to that functionality, this may rule certain solutions out from further consideration.

A solution assessment matrix is one way of summarising the costs and other measures associated with the various solutions. An example is shown in Table 3, relating to a function analysis for a lighting system. Although this includes values for costs and engineering properties, these are only given to illustrate how a cost–function matrix is used. Each solution is ranked 1–4 in brackets for comparison by the different value criteria.

Function (unit of measurement)	Solution 1	Solution 2	Solution 3	Solution 4
Minimise installation cost (£)	5,000 (2)	8,000 (4)	4,000 (1)	6,000 (3)
Minimise energy use per year (£)	500 (2)	400 (1)	650 (3)	800 (4)
Maximise life expectancy (years)	12 (2=)	12 (2=)	10 (4)	15 (1)
Maximise output of each lamp (lumen)	400 (4)	800 (1)	500 (3)	700 (2)
Maximise uniformity of lighting (%)	100 (1)	60 (3=)	60 (3=)	70 (2)
Minimise output degradation over time (%/year)	5 (2=)	5 (2=)	3 (1)	7 (4)
Simplify control of lighting (1–5 scale)	4 (2)	2 (3)	1 (4)	5 (1)
Ensure flexibility in control system (1–5 scale)	3 (2)	2 (3=)	2 (3=)	5 (1)
Ensure all components are accessible (1–5 scale)	1 (4)	4 (1=)	4 (1=)	4 (1=)
Reduce variety of fittings (number)	10 (3)	4 (1)	12 (4)	8 (2)
Improve reporting of unit failure (1–5 scale)	4 (2)	2 (4)	3 (3)	5 (1)
Number of 1st places	**1**	**4**	**3**	**5**

Table 3: Example of the cost–function matrix

Under this method, the preferred solution is number 4, as this has the highest number of 1st-place scores against the value criteria. This is a very simplistic assessment, however, and a more detailed approach may be needed, which would involve prioritising and weighting the functions and assessing the alternative solutions accordingly (see section 2.4).

2.4 Prioritising and weighting alternative technical solutions

The detailed breakdown of required functionality in the analysis described in 2.3 will almost certainly result in a set of functions that vary in importance among the stakeholder group and across the project as a whole. The different priorities of stakeholders need to be identified and any conflicts resolved before the various alternative solutions can be assessed.

If the scenario is straightforward, then this could be achieved by comparing each function against the original project brief, perhaps in a meeting with the client representative. Such a meeting may not be needed if the client has already given authority to implement any change that does not contravene the original brief, in order to streamline the decision-making process. This is more likely to be a suitable approach in VE exercises than in VM.

In more complex situations, for example complex projects or VM exercises involving a diverse group of stakeholders, then a more systematic process is called for, as described below.

There are different approaches that can be used to identify stakeholder views on functional priorities, including:

- open discussion
- open voting after a discussion
- secret voting after a discussion.

The first is probably the most straightforward approach, taking the form of a plenary discussion among all stakeholders, for instance. But depending on the personalities of the stakeholders involved this may not be the most suitable method, as it may be felt that it gives those with the loudest voices the greatest say. If this situation is likely to arise, then strong chairing of the discussion is needed to avoid it.

Open voting, in which each stakeholder has a number of votes to cast, is more democratic than open discussion, but there is still the possibility of stakeholders being influenced by or reacting to the earlier votes cast by others.

Secret voting is both democratic and less prone to influence, but may strike some stakeholders as being too elaborate.

Once an approach for gathering views has been decided, there are then different mechanisms that can be used to allocate priorities:

- complete ordering
- identifying outliers
- grouping.

Complete ordering asks the group or each stakeholder to prioritise the complete list of functions from 1 to n, where n is the number of functions. This can lead to agonising discussions about whether function X is more or less important than function Y, however, when in fact they have very similar priorities.

Identifying outliers is a way for each stakeholder to pick out a few functions that are particularly important or particularly unimportant to them. If this gives a clear set of middle-ranking functions, then the exercise can be repeated on that set.

Grouping is a method that acknowledges the difficulty of placing functions in a specific order, and asks each stakeholder to grade every function as high, medium or low priority.

Where a method of individual voting has been used, the aggregate result for each function is reported once each stakeholder has made their choice. It may be that further discussion is then needed to resolve any discrepancies in the results before the weightings are applied to the solution assessment matrix.

Table 4 shows a set of weightings applied to the solution assessment matrix from Table 3. This has been done using the high, medium and low grouping method, and represents the most common priorities given by the hypothetical stakeholders for this problem. Where the priority for a function was split – for example, where equal numbers select high and medium priority for a function – a group discussion was held to decide the final outcome. By cross-referencing the priorities with 1st-place rankings, the matrix shows that the most favourable solution will be the one with the most top scores for high-priority functions.

Function (unit of measurement)	Priority	Solution 1	Solution 2	Solution 3	Solution 4
Minimise installation cost (£)	High	5,000 (2)	8,000 (4)	4,000 (1)	6,000 (3)
Minimise energy use per year (£)	High	500 (2)	400 (1)	650 (3)	800 (4)
Maximise life expectancy (years)	Medium	12 (2=)	12 (2=)	10 (4)	15 (1)
Maximise output of each lamp (lumen)	High	400 (4)	800 (1)	500 (3)	700 (2)
Maximise uniformity of lighting (%)	Medium	100 (1)	60 (3=)	60 (3=)	70 (2)
Minimise output degradation over time (%/ year)	Medium	5 (2=)	5 (2=)	3 (1)	7 (4)
Simplify control of lighting (1–5 scale)	Medium	4 (2)	2 (3)	1 (4)	5 (1)
Ensure flexibility in control system (1–5 scale)	Low	3 (2)	2 (3=)	2 (3=)	5 (1)
Ensure all components are accessible (1–5 scale)	Low	1 (4)	4 (1=)	4 (1=)	4 (1=)
Reduce variety of fittings (number)	High	10 (3)	4 (1)	12 (4)	8 (2)

Function (unit of measurement)	Priority	Solution 1	Solution 2	Solution 3	Solution 4
Improve reporting of unit failure (1–5 scale)	Low	4 (2)	2 (4)	3 (3)	5 (1)
Number of 1st places		**1 Medium**	**3 High** **1 Low**	**1 High** **1 Medium** **1 Low**	**2 Medium** **3 Low**

Table 4: Prioritised solution assessment matrix

Using the priorities for the functional requirements, this now indicates that solution 2 is the best lighting system to select, rather than solution 4 as Table 3 suggested. This illustrates that a more sophisticated assessment can result in a different conclusion.

The outcome for each proposal should be recorded in the VM or VE report, including those that have been rejected. This provides an audit trail to inform later discussions, as it helps avoid previous decisions being revisited unless there is a particular reason to do so. It also provides evidence that a thorough VM or VE exercise has been undertaken.

2.5 What resources are needed to carry out VM and VE?

VM and VE need a range of different resources so they can be implemented successfully. Four key resources are briefly described in this section – it is the responsibility of the person leading the VM or VE activity to ensure that these are made available.

Time

VM and VE studies take time to complete, which will need to be allowed in project programmes, but they can reduce the overall project duration. There is no hard and fast rule about how long a VM or VE study should take – it may be a few days or many weeks or months, depending on the complexity of the problem being considered. Studies that are constrained by project factors, such as a predetermined date to start on site, are less likely to lead to the best outcomes.

Organising a workshop involving a wide range of stakeholders can take several weeks, even though the workshop itself may only last a day or two. The lead time for the workshop will depend heavily on the availability of the stakeholders.

US value engineers developed the format of the five-day workshop as a way of making the approach to VE more systematic. Although this may still be appropriate for very large projects, however, it seems to be rarely used in the UK. Apart from the resource required, the US approach has usually been carried out by external experts, which has limited the buy-in from the project team and failed to encourage implementation of recommendations.

The timeliness of a study – that is, when during the design and construction process it is scheduled – is also important. As was discussed in section 2.1, VM studies can be most productive when they take place in the early project stages; say, during RIBA Stages 0, 1, 2 or 3. VE studies are more helpful when they take place in the later stages of design development and construction – for example, during RIBA Stages 3, 4 or 5.

The point in a project at which VE becomes possible depends on the issues being studied. For example, a study on lifts will be possible earlier in the project than one on signage.

Background details

VM and VE studies require two distinct types of background information to support effective group working:

1. information about the project or scenario being assessed for value
2. details of the different technical solutions being considered.

Project or scenario details about the required functionality come primarily from the stakeholders. But the delivery team, including designers, surveyors and contractors, can help clarify the functional requirements through discussion and by challenging any overt or hidden assumptions that emerge.

Solution details come primarily from the delivery team, first in terms of descriptions of the possible solutions that could provide the required functionality, and then in terms of the costs and other resources needed to implement those possible solutions so a comparative assessment can be carried out.

Chartered surveyors, with their professional expertise in project and system costs, life cycle costing and contractual matters, have a central role to play alongside their delivery team colleagues from design practices, main and specialist contractors, and equipment manufacturers.

Skills and knowledge

The technical skills and knowledge of those involved in VM and VE studies are taken as read. This subsection introduces the skills and knowledge needed to lead or facilitate VM and VE studies.

A facilitator is almost certain to be required for a VM exercise, in which a broad group of stakeholders and professional contributors are involved. A facilitator may or may not be needed for a VE exercise, depending on the complexity and scale of the problem under consideration.

The choice of whether or not to use an independent facilitator will also be guided by project size. On smaller projects, a member of the project team may have to take on this role, in which case it is important for them to have the necessary skills and experience.

The role of a facilitator is to guide and help a group achieve their desired outcome, in this case a thorough investigation of the project value across a range of alternative technical solutions to a project-related problem. It is not necessarily the role of the facilitator to contribute significant technical knowledge, although they may be able to make some contributions. Their primary focus is the process that is used to achieve the outcome – to take a lead in designing and running workshops, to enable everyone to contribute and to encourage questions to be asked.

Facilitation requires specific skills such as:

- familiarity with VM and VE
- being able to encourage teamwork quickly from dissimilar groups
- knowledge of problem-solving and group-work techniques, and of workshop dynamics
- excellent interpersonal and assertiveness skills, such as active listening, reflecting progress, managing discussions and dealing with difficult individuals.

There is no reason why someone with a surveying background cannot be an excellent facilitator. However, specific training, knowledge and experience are required for anyone to perform this role successfully. Facilitation training is widely available, and even those with lots of experience of chairing meetings and project discussions should get specific training before embarking on this role. VM and VE training should come from recognised organisations such as those approved by the Institute of Value Management's Certification Board.

Facilities

As well as participant and facilitator time, which all cost money, VM and VE exercises need facilities such as workshop venues, and access to experts in design, construction and cost. The success of a workshop partly relies on the quality of the venue, which should be away from the distractions of everyday work. The room should be as large as possible with furniture that can be rearranged or moved easily, to give the opportunity for group work and plenary work, or there should be separate rooms for the former. There should be plenty of wallspace where participants can work on flipcharts or other visual records that are kept in view. Natural light is always helpful, as is effective heating or cooling. Good catering arrangements are also required – their presence may not occasion comment, but their absence is quickly noticed.

If the client or project team only has access to traditional meeting rooms with boardroom-style tables, these are unlikely to be suitable for interactive workshops. Serious consideration should be given to hiring an external venue. The cost is obvious, but is often dwarfed by the cost of 10–12 expert participants' time, and usually much less than the cost of a sub-optimal workshop.

2.6 Reporting the outcomes of the study

A VM or VE report presents the information identified during the analysis phase of the study, technical recommendations, and an action plan for implementing the decisions. Clearly, the technical recommendations are of most immediate interest to the client and the project team, but the description of the process is also important to provide reassurance that a robust and detailed analysis has been undertaken. The report should be completed and circulated as swiftly as possible after the study has been concluded.

Depending on the length and complexity of the report, there may be an **executive summary**. This is a helpful way to present the key points from a report, particularly the recommendations. If included, the executive summary should be limited to between one and four pages. Care should also be taken over the language and terminology used: executive summaries may be circulated more widely than the whole report.

Thereafter, the report may be arranged into a number of technical sections as summarised below.

Introduction and context

The report needs to explain the project scenario or problem that has been subject to VM or VE. The introduction should also describe any constraints placed on the study, and explain any potential technical solutions that have already been excluded from consideration by the client or project team.

The introduction should describe the general nature of the team members engaged in the study as well, including any facilitator(s), and the timetable for any workshops or meetings held. Detailed supporting information would usually be placed in an appendix.

Required outcomes and value criteria

This section sets out the functionality or other performance outcomes that the client requires from the project or system under investigation. It should also include any function analysis assessments derived through consultation with stakeholders. If prioritisation or weighting has been applied to the functional requirements, then this must to be included here as well.

The aim of this section of the report is to set out a clear statement of the objectives of the VM or VE exercise.

Alternatives considered

This part of the report sets out the longlist of potential solutions, or the list after an initial screening has been applied, and summarises the results of the creative exploration of alternative solutions. Where potential solutions have been rejected at this early stage, the report should also explain the reasons, including where this decision has been taken by the client. This may be because they are clear outliers in terms of cost or performance, or because they fall outside any stated constraints.

The aim of this section is to show that a wide range of potential solutions were considered, before successive rounds of assessment narrowed the field of solutions down to a few alternatives.

Value assessments of alternatives

This section explains how the potential solutions were rated according to the functional requirements identified. Where more detailed definition of shortlisted solutions was necessary for in-depth assessment, this should be explained. All iterations of assessment, shortlisting and development of solutions that were run in order to arrive at the ultimate shortlist should be outlined, but for ease of reading much of the material describing these could be put into appendices.

For each potential solution that has been rejected during the assessment process, the key reasons for doing so should be summarised, including solutions rejected by the client.

Conclusions and recommendations

The last main section of the report should document the conclusions of the study and the final recommendations. This will typically be a description of the one, two or three preferred alternative solutions, along with the principal reasons for their recommendation.

It may also be the case that a VM or VE study has not been as conclusive as was originally hoped. In this case, the conclusion may be that further work is warranted, and if so then this should be outlined.

Appendices

Following the main body of the report, one or more appendices may be provided to include any supporting information, such as more detailed cost breakdowns of the alternatives considered or lists of individuals involved in workshops or discussions.

Practical considerations (Level 3: Doing/advising)

3.1 Potential problems when carrying out VM and VE studies

There are many problems that might arise in relation to a VM or VE study. This section cannot cover all of them, but does introduce the most common or most serious issues.

Not enough time

The time and resources required to carry out VM or VE activities can easily be underestimated. Where the individuals involved in VM or VE also have other deadlines to meet, then the pressures are compounded.

Surveyors advising clients on the structure and implementation of VM or VE studies should bear in mind that many weeks may be required for a detailed study on even a moderately sized project. Studies with a very wide-ranging scope or that require the mobilisation and co-ordination of large groups of stakeholders are likely to take longer still to complete.

On the plus side, VM and VE are sometimes carried out in parallel with other design review activities, such as life cycle costing or design risk assessments.

Lack of precision

VM and VE are not an exact science. The margin of error in any of the calculations or analyses that are used to select preferred solutions should be taken into account and this may mean that no single firm conclusion can be drawn. Some clients may be concerned when studies do not produce precise results, but it is important to remember that value studies are primarily comparative; in other words, they are intended to identify the best value-adding solution from among those being considered.

It is helpful to remember as well the typical levels of precision at different project stages, drawn from project management texts. These have been aligned with typical project stages:

- feasibility and briefing stage (RIBA Stage 1): ±30%
- concept stage (RIBA Stage 2): ±25%
- technical design (RIBA Stage 4): ±10%
- construction (RIBA Stage 5): ±5%.

The above figures are based on findings from the UK, in the *Gower Handbook of Project Management*, and from abroad, by the Canadian Construction Association.

This inherent lack of precision in calculations means that it may not be possible to rank alternative solutions in a clear order, and they may instead have to be grouped into bands.

Not starting the process early enough

The opportunity to influence the out-turn cost of a project reduces as it progresses. A rule of thumb for calculating the percentage of project cost spent by different parties and their level of influence over the total cost is given in Nigel Standing's book *Value management incentive programme* as in Table 5.

Party	Project cost spent	Cost influence
Client and specialist consultants	5%	65%
Design team	10%	25%
Contractors and suppliers	85%	10%

Table 5: Project cost compared with cost influence

The implication is that if VM is to have a significant impact, then it must be used from the very earliest stages of a project.

As surveyors are usually among the first members of a professional team to be appointed by a client, they are in a good position to recommend that VM is used during briefing and feasibility studies.

Where a surveyor is providing advice at an even earlier stage – perhaps when the client is still considering the strategic need for the project – then the opportunity to benefit from VM is even greater.

Not including the appropriate stakeholders

VM studies need to involve the right stakeholders, both to identify the most effective solutions for the project and to make sure that the recommendations are accepted. This is particularly important where there is a political dimension to the project, meaning that very many public-sector projects will need to achieve wide-ranging buy-in.

The list of stakeholders is project-specific, but typical stakeholder groups include:

- occupiers
- public users
- third-party funders
- regulators
- local authorities
- internal departmental representatives, such as facilities and asset management, operations, finance and legal, health, safety and environmental compliance, and public relations

- delivery team representatives, including external appointees, for example project managers, structural and civil engineers, designers, building services designers, architects, contractors and specialist subcontractors.

Revisiting previous decisions

It is inefficient to revisit and reconsider potential solutions that have previously been rejected, but it is a common situation, particularly likely when there is a change of participants in the VM and VE studies or where an inexperienced facilitator is involved. One solution is to circulate summaries of previous studies in advance to the stakeholders, and also allow time for these to be read before any new workshops are held.

Sometimes there are good reasons for revisiting previous decisions, particularly where the increase in value has not been sufficient – for example, to overcome a budget shortfall. Even so, this is an exercise that needs to be carefully managed and facilitated to avoid time being wasted.

3.2 Appropriate facilitation skills and VM workshop techniques

Facilitating a successful workshop is a specific skill, summarised in the subsection ‘Skills and knowledge’ above. Some members of the project delivery team or representatives of other stakeholders may have this skill, and it may be appropriate to ask them to facilitate the VM workshop(s). But in doing so, they may lose their ability to contribute their technical views to the workshop because it is usually more straightforward to separate the facilitation role from such technical discussions.

However, it may be that no one from the stakeholder group has the appropriate facilitation skills or wishes to give up their ability to make technical contributions to the discussion. In these cases, it is important to identify and appoint an independent facilitator to lead the VM workshop. In the absence of any other leads, suggestions can be found on the website of the Institute of Value Management, or by searching online for VM facilitators.

Facilitation techniques

There are very many techniques to use as part of an overall problem-solving process. This subsection can only summarise some of the more common ones.

Generating ideas

During the generation of ideas for potential solutions to improve value, it is important that as many ideas are recorded as possible. Facilitating this process is about opening attendees’ minds and suspending judgement. Possible techniques include the following.

- Brainstorming: a rapid exercise to generate as many different ideas as possible, as quickly as possible. Allow 10–20 minutes for suggestions to be made; no criticism or assessment of the suggestions is permitted during this stage. Brainstorming may be carried out in plenary sessions, in subgroups or by individuals working separately. Record ideas on flipcharts, sticky notes or similar.

- Reversals: the description of the problem is broken down into its constituent parts and then each is considered in terms of its opposite and how it can be avoided. For example, the problem of how to shorten construction duration is rephrased as one about how **not** to **lengthen** construction duration.
- Rolestorming: this is a variation on brainstorming in which a group of stakeholders swap roles with one another and brainstorm from those new perspectives. This can help challenge things that are otherwise taken for granted.

Clarifying and grouping ideas

Ideas that are generated during a creative session are likely to contain some ambiguities and duplications, and it is helpful to sort these out before further analysis is attempted. Ambiguities arise because, during idea generation, there is not time to stop and clarify the shorthand that is often used, so there should be an opportunity for the group as a whole to ask questions and seek clarification of the ideas. This does not, at this stage, extend to criticism or assessment of those ideas.

When all the ideas are looked at together, some will probably seem to belong with one another or even express the same underlying principle in different ways. A process of de-duplication is helpful to reduce as far as is reasonable the total number of ideas needing to be assessed. Grouping can be done in an ad hoc way, for example by gathering together sticky notes with similar ideas, or in a more structured way, for example by placing the ideas on an Ishikawa ‘fishbone’ diagram. Strictly speaking, an Ishikawa diagram is used to organise the possible causes of a problem, but it can also be used for grouping potential solutions. The ultimate problem is written at the head end of the fishbone, primary spurs off the backbone are used for themes that group solutions together, and secondary spurs are used to describe the solutions themselves.

The process of structured grouping may itself identify gaps that can be filled with new ideas.

Screening and prioritising ideas

In addition to the guidance in section 2.4 on methods for applying priorities and weightings, there are some more structured methods available. Two are described below.

Progressive hurdles (the Battelle method)

This is an approach for reducing a large number of plausible ideas to a small number of ‘best’ ideas for further investigation or implementation. It operates through a series of screening questions where the effort needed to make each set of evaluations increases by an order of magnitude, and the number of ideas being considered at each stage should then be reduced by a similar proportion. The stages are as follows.

1 Cull: this stage uses one or more yes–no questions that can be answered very quickly and easily; for example: 'Does the technology exist to implement this idea?' Ideas for which the answer to this question is 'no' are eliminated.

2 Rate: this stage uses some more sophisticated questions, where moderate effort is needed to provide an answer; for example: 'Does this idea provide the highest-priority functionalities required?'

3 Score: the final stage uses the most sophisticated questions, where in-depth research is needed to provide answers. This could include estimates of life cycle cost, or the impact on end-user satisfaction.

Paired comparison

This is a useful method for prioritising a list of 10–15 ideas.

Draw up a half-matrix, with all the ideas except the first along one axis, and all except the last along the other. Each cell in the matrix represents the comparison of two different ideas, as in Table 6.

Idea	B	C	D	E	F
A	A or B	A or C	A or D	A or E	A or F
B		B or C	B or D	B or E	B or F
C			C or D	C or E	C or F
D				D or E	D or F
E					E or F

Table 6: Half-matrix for paired comparison

Each pair is considered in turn, and the group or each individual chooses their preference. The result is recorded. When all pairs have been compared, the number of comparisons in which each idea was preferred is totalled. This can also be extended to strength of preference in each comparison: high, medium or low.

3.3 Designing large-scale VM programmes

VM can be applied to projects of all sizes and complexity, including very large and complex programmes of work that would typically be managed as multiple, linked projects. While the same underlying VM principles would apply in all cases, using VM successfully on large programmes does entail some specific considerations.

The complexity of interconnected projects

The scope, scale and timing of a programme of linked projects means that VM has to be tackled on multiple levels, even in addition to the more detailed and specific analysis that is used in VE.

VM at programme level can be used during the earliest stages of strategic planning, briefing and concept design to help define the scope and the timing of the detailed projects, for example by identifying those that can run parallel to one another rather than sequentially.

When the separate projects start their own detailed VM studies, programme-wide co-ordination provides the opportunity to identify common problems where solutions can be shared. For example, an approach to off-site manufacture and assembly may be applicable across a number of projects. Where projects have separate delivery teams involving different design consultancies and contractors, these common lessons can be difficult to implement. Programme-level VM provides a mechanism for these different teams to communicate and learn from each other.

VM for serial clients

The difference between a client procuring a complex programme of work and a serial client procuring many projects over a long period of time may only be one of timescale. The complexities of working with multiple delivery teams and wide-ranging scopes of work still exist. In this case, the serial client is the bridge between successive projects and the means by which lessons learned in the past are retained and can be implemented in the future. In this case, the serial client has a key role to play in overseeing and providing connections between VM activities from project to project.

Where a serial client has a framework agreement with a group of consultants to provide masterplanning and cost consultancy and that client does not have the capacity or capability of implementing long-term VM, then this can be delegated to those consultants.

Dedicated VM resource

The complexity of multi-project programmes, or of carrying out multiple projects for a serial client, lends itself to a more formalised support structure from which to oversee and co-ordinate VM activities. This could include a permanent facilitation resource available to support multiple project teams, which would have the inherent advantage of separating oversight of the VM process from the technical identification and assessment of different solutions.

Programme-wide VM facilitation can also be combined with other methods for collecting learning and feedback from multiple projects, for example soft-landing activities, inter-project design reviews and knowledge management.

The costs of providing programme-wide support will be more obvious than if VM is dealt with only at project level, because of the greater visibility given to programme budgets in the sponsoring organisation(s). However, there should be a corresponding saving in terms of project costs, and greater value could potentially be secured for the programme as a whole because of the communication links and feedback loops that would be built into the process.

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