

VALUE WORLD

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Managing Change and Uncertainty Using Value Engineering

Managing Change and Uncertainty Using Value Engineering

EDITORIAL

Today, business environment is becoming more and more complex. Rapid change and uncertainty that are occurred in business and organization should be dealt with and handled by conducting a structured way to plan, initiate, realize, and control. Analyzing the current situation after formulating the scenario and finally making a decision is a continuous process that needs to be prepared to anticipate the possible change and to manage the uncertainty. Business companies will continue to be challenged by this uncertainty in their industry, markets, and project, or product life cycles. Internal and external uncertainty (e.g. resources, information, knowledge, technology, policy and regulations, market, etc.) will increasingly affected competition and, therefore, it needs to be effectively responded.

In this role, the summer issue of Value World will discuss a theme of Managing Change and Uncertainty using Value Engineering as a strategy needs to be implemented in a dynamic environment that can be employed to achieve competitive advantages for the organization. Change and uncertainty may lead to various risks; therefore, the organization must plan for potential outcomes that may bring impact to the product or project objectives, such as function, cost, quality, and schedule.

Managing Change and Uncertainty Effectively

Based on the 50th annual SAVE International Conference and journal submission, the summer issue of Value World presents five selected papers to stimulate debate and to explore the application of value engineering in managing change and uncertainty for various project contexts.

The first paper, written by Dr. Pekka Leviäkangas and Anna-Maija Hietajärvi, presents a Value Study on how weather information is valued in transport management and how there is a shift in the valuation logic due to restructuring of the transport sector functions. The paper reflects on the chronological valuation logic of information: short-term information is cash valued; long-term

information is socio-economically valued. As a result, this paper, which is based on EVASERVE project in Finland, discusses opportunities of applying value engineering in transport service process design and re-engineering.

The second paper, written by Professor Chang-Taek Hyun, PE, AVS, Chang-Yeob Song, Myung-Jin Son, Seong-Min Jo, and Seung-Won Han, outlines the use of Value Engineering (VE) for program-level facilities where multi-projects are closely connected. This paper presents a proposed method of VE function analysis in the early stage of Mixed-Use Developments (MXD) in order to reduce uncertainty in the planning phase by showing some lessons learned from Korean urban development projects.

The third paper, written by Robert B. Stewart, CVS-Life, FSAVE, PMP and Greg Brink, PMI-RMP, CCE/A, AVS, provides an explanation on the exploration of relational dependencies of risks on project functionality allowing for uncertainty to be evaluated and managed in a more effective and proactive fashion. This paper employs a Function Driven Risk Management (FDRM) process to fully integrate function analysis into risk management practices as a mean to enhance the overall process. In addition, function analysis resulting from the development of the FAST diagram helps to bring focus to potential areas of uncertainty.

The fourth paper, written by Gary R. Myers, PE, CVS, describes how Minnesota Department of Transportation (Mn/DOT) projects can be offered with the highest opportunity via the value engineering process by assessing two key considerations: potential for beneficial change and likelihood of change. Indicators of a high potential for beneficial change through VE include high cost; a high degree of impact on human or on the natural environment; a broad scope; a high degree of complexity; and the presence of unusual features, unusually costly features, or unusual challenges.

The last paper in this edition, written by Dr Suyono Dikun and Herawti Zetha, discusses on the integration of Value Engineering And Risk Management in order to improve the efficiency and effectiveness of Indonesian infrastructure projects. The paper reviews various litera-

tures on both methods to maximize the chances of project success, in which VE method can be used to reduce risk and on the other hand, risk management can be utilized to provide opportunities to increase value.

I hope this edition of Value World conveys some new insights in the way we conduct our value methodology studies. I can be contacted at maberawi@eng.ui.ac.id and I will gladly accept and respond to any comment and enquiry you may have on the direction and content of Value World. Your valuable contribution and feedback are important to the success of our journal as it will guide its future development.

With warmest regards from editorial desk,



Dr. M.A. Berawi
Faculty of Engineering
University of Indonesia
16424 Jakarta
Indonesia



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Weather Information for Transport — The Value Shift

Pekka Leviäkangas and Anna-Maija Hietajärvi

Abstract

Weather information is valuable to the transport management value chain, starting from the planning, construction and operation of roads and yielding to value-added services to end-users. Prior studies in the field show multiple use cases for weather information and demonstrate a tangible value in many respects. Technological changes and new trends in public management will, however, change the valuation logic. In the future, recognition of the business value will become more relevant. Many applications such as variable message signs will be replaced by in-vehicle applications. Also, the unbundling of public sector functions will change the way different stakeholders look at weather information. Some systems, formerly regarded as public, will probably change into business tools for private/commercial operators. The 'public good' is changing increasingly to cash valued 'private good', while the total utility remains intact. This paper presents a Value Study on how weather information is valued in transport management and how there is a shift in the valuation logic due to restructuring of the transport sector functions. Finally, the paper discusses the many possibilities for applying value engineering in service process design and re-engineering.

1. Introduction

Weather information has value. This is a known fact, but what might not be known is exactly just how much it is worth in different situations and contexts. Without delving too deeply into the semantics of what is information and what is value, it can safely and without loss of content be said that information becomes valuable when it has impact. The impact may hit the decisions or decision-making processes, or it may hit at the heart of operations carried out in the field. Also in the latter case, decisions have to be made. In more general terms, information has value when it affects behaviour.

Information value studies have usually fallen under the science of information economics, where good references are to be found, such as Williamson (1982) and Lawrence (1999). On weather information there are also a number of studies. Leviäkangas (2009) studied how to value meteorological information in general, and in par-

ticular from the viewpoint of service provision. Leviäkangas and Hautala (2009) examined the usefulness of services provided by the Finnish Meteorological Institute (FMI), and found that the annual budget of FMI provided a service repertoire that generated benefits to the society worth at least five times the budget value every year. Some other benefit analysis studies on meteorological information and services have been published by e.g. Anaman *et al.* (1997) and Freebairn and Zillman (2002).

Value of information is not a one-lump concept. In fact, value can be decomposed into value attributes such as accessibility, accuracy and effectiveness. Herrala *et al.* (2009) list those attributes quite extensively, using traffic information as an example and combining several prior research sources. This approach was based on the principal question of value engineering: what constitutes the value? There are also multiple methods and techniques for valuing meteorological information, the most thorough presentation being that by Leviäkangas (2009). Another type of value-engineering-based approach, albeit a more general one, is that of Squires (2007). Both Herrala *et al.* and Squires list many similar information value attributes. Hence, also when considering the value of weather information for transport management, one should be aware that the valuation problem in itself requires different methods and techniques, depending on the nature and context of the valuation situation.

This paper was originally drafted for the 2010 Standing International Winter Road Conference (SIRWEC) held in Quebec on February 5-7, and is available on the conference website. This is the revised version of the paper.

2. Scope, Data and Methods

This paper reviews a number of studies and makes a synthesis on the value of weather information for transport management. Much of the emphasis is on road management in particular, but other transport modes are also considered briefly. In this article, the main source of information is the results of the FMI case study, which involved a wide-covering literature review and formed part of the EVASERVE meta-tool development project. The main conclusions of prior studies on the subject are reviewed and an attempt is made to formulate a synthesis of those conclusions. In this way the authors hope to

make available a condensed body of knowledge of what weather information can do for transport management in the light of reported research results, and how it can help the transport management community, meteorologists, road weather experts and infrastructure managers in general to justify the development of even more efficient forms of weather information utilisation in transport management and transport infrastructure management.

New Public Management represents the line of policy where business-mannered management is applied to public sector functions. Privatisations, corporatisations, commercialisations and public-private-partnerships (PPP) are manifestations and embodiments of this line of policy. Margaret Thatcher's administration in the UK is often considered as an initiator of the new public management policy line. In the 1980's, Thatcher launched her Private Finance Initiative (PFI) in order to introduce business-like thinking and private capital to public sector functions.

The empirical material is published literature, making this paper largely a literature review. The theoretical foundation comes from value engineering, information economics and transport engineering. If this paper were to be defined in Value Engineering terms, it would be regarded as a Value Study, following the definitions of Value Standard (SAVE International 2007). The aim is to improve the value of weather information services for transport by showing how the valuation logic is changing along with the transport sector as a whole, and how weather information is becoming more of a business asset for those transport management functions that are shifting from the authorities to commercial and/or private operators and service providers. Needless to say, this should likewise apply to any restructuring case — whether transportation, health care or education — where former public services are unbundled or outsourced to market-based providers.

The empirical material, i.e. studies with tangible results on the benefits and value of weather information for transport management, is reviewed with a brief introduction to a few relevant studies. However, the list is far from exhaustive and includes only those accepted as material for the EVASERVE project's FMI section.

Finally, a synthesis is drawn from the studies, grouping their results and making conclusions on how weather information is valued in the light of current knowledge, and how the valuation is changing along with the transport sector. Especially when the sector is unbundled and restructured, the value has a different meaning and different logic and metrics: the 'public good' is transformed

increasingly into cash value, while the total utility might remain intact. Usually public services are evaluated using cost-benefit analyses where even non-monetary elements are included or internalised as monetary benefits and costs. Private and/or commercial services are typically valued mostly in pure cash terms, seeking the maximum shareholder value. A couple of examples are elaborated further to illustrate the transformation from public good to cash value. The main focus is again on road transport, but other modes of transport are by and large analogous.

The EVASERVE project was carried out in 2006-2007 and aimed to develop a meta-tool to evaluate information services in general. The purpose was to develop a holistic evaluation approach—comprising multiple methods, tools and approaches, from which the evaluator could select the most appropriate ones, depending on each particular evaluation case, covering the whole life cycle of any information service process or system. Even an entire organisation, such as the Finnish Meteorological Institute, was considered as a “service system” representing one particular case in the EVASERVE project. The EVASERVE meta-tool prototype is publicly available in at www.evaserve.fi.

The EVASERVE project was funded by the Finnish Technology Agency, the Finnish Ministry of Transport and Communications, the Finnish Meteorological Institute, Destia Enterprise, and VTT.

3. Weather Information and Transport – Reviewing Some of the Studies

3.1 Winter Road Management

Boselly (2001) describes the use of road weather information system (RWIS) and de-icing technologies in the US. The study does not describe very well the empirical material, i.e. where and how the information is gathered, but it claims that the potential cost-benefit ratio of extensive use of RWIS may be as high as 5, although the case example calculation shows a B/C ratio of 1.1. The cost components consist of RWIS equipment, weather service, winter road maintenance, labour and material

costs. The benefits accrue from improved service level, cost savings (not identified in detail), reduction of environmental impacts and better safety.

Wass (1990) and Thornes (1990) estimated the costs savings in using de-icing substances in the UK due to improved weather service. During 1983-1988 the use of de-icing substances decreased by 15% and as a result the total costs of winter maintenance fell by 5%-30%.

Rural road ITS (intelligent transport systems) information systems were studied on US 395 in Spokane, Washington, by Meyer, Mohaddes Associates Inc. (2004). ITS was studied as an integrated concept using multiple applications, including RWIS and an enhanced traffic management centre (TMC) services. The impacts were mapped through a survey among road users and employees of Washington State Department of Transportation. The survey showed that there was a strong belief that ITS would in general have beneficial impacts, such as reduced use of de-icing materials, better decisions as to route and time journeys, and improved road safety.

Kempe (1990) estimated similar benefits in Sweden as the above studies regarding the use of salt for de-icing. His conclusions pointed to a reduction of about 50% in material use per winter.

Lähesmaa (1997) studied the benefits of weather-controlled winter road maintenance, looking at the benefit-cost calculus from a socio-economic perspective, including externalities. He found that pure maintenance cost savings did not amount to significant sums. Accident cost savings were substantial, but they were eaten up by increased time costs so that he ended up with a cost-benefit ratio of 0.5. The socio-economic profitability would change very quickly if a) the investment cost to related IT could be brought down, and b) there was a substantial traffic volume (threshold value of 20 000 vehicles per day in the case example).

Pilli-Sihvola *et al.* (1993) investigated the impacts of road weather service on driving costs, including the external costs of accidents. The article did not give details of how the study was devised and what was the data behind it. However, there were significant costs savings, the lion's share being from accident savings. The conclusion was that road weather service would pay itself back with a benefit-to-cost ratio of 5 to 1.

Rämä (2001) reported a decrease of vehicle speeds by 1.2 km/h on average when drivers were alerted via variable message signs (VMS) to slippery road conditions at one test site in Finland. At night the decreases in speed were more significant. This very careful research set-up included 139 situations, which were analysed in detail.

Schirokoff *et al.* (2005) carried out an analysis on the

wide-scale use of variable message signs, utilised especially in winter conditions in Finland, on a national network level. Once the weather-controlled VMSs was installed on a wider scale, hence reducing the relative fixed cost of investments, the system became profitable with a benefit-cost ratio of 1.4.

3.2 Weather Information and Other Road Management Aspects

Cooper and Sawyer (1993) studied the impacts of a fog warning system where dynamic message signs (DMS; essentially the same as VMS) were used to inform road users of fog ahead. Speeds were lowered on average by 3 km/h when the signs were activated. Hence it was concluded that the fog warning system would improve safety. The study was commissioned in 1990-1992 in London and included 4.8 million observations on vehicle speeds.

Kyte *et al.* (2001) study the impacts of an advanced weather information system on driver behaviour in Idaho, US. A field operational test was carried out in two stages between 1993 and 2000. The drivers were informed via VMS about changed weather conditions. VMS enhanced the driver behaviour impact, so that in poor weather conditions the lowering of speeds was more significant than without VMS.

Skarpness *et al.* (2003) described the FORETELL system in the US, the main idea of which was to gather real-time weather information in one place, or rather to be utilised via one single portal through the internet and dedicated website. The investigation was carried out during three winters during 2000-2002, but the actual investigation was for 1998-2002 including the design and reporting phases. The idea was to test the usefulness of such information that would be easily available and accessible. Interviews were the method of measuring usefulness. Most of the respondents (the number varied during the study) were happy with the information and found it useful and understandable, but only 20% would have been willing to pay for it.

3.3 Other Modes of Transport and General Aspects of Weather Information Value

No studies were found that looked explicitly into how weather information could improve the performance of railway transport and railway operations. Only two studies emerged, by Thornes and Davies (2002) and Smith (1990), that presented what impacts weather has on railways in the UK. Impacts such as measurable reduction in the reliability of timetables, increased maintenance costs and interruptions in traffic were among the typical ones.

Motte *et al.* (1994) looked into how weather informa-

tion affected the routing of sea vessels. The study was carried out using short-term (<72 h), medium-term (72 h < x > 240 h) and long-term (>240 h) forecast information. The study was commissioned in 1993 and surprisingly it concluded that the probability of errors in routing increase the shorter is the forecast horizon. In other words, routing “more in real time” did not improve performance!

Sonninen (2007) did an extensive analysis on weather information benefits to waterborne transport in Finland. She found that extensive benefits already with the existing level of weather information service improves safety in boating, helps proactive measures in oil combating and results in operational savings to shipping lines, especially when thinking of routing of vessels. As a method, Sonninen combined statistical data, interviews and prior studies (see e.g. Craft 1998) in the field. Empirical material as such was not really available.

In aviation, the use of weather information is self-evident and in fact there are few studies that directly address the question. Latorella and Chamberlain (2002) investigated the usefulness of graphical weather information to US airline pilots. Of the 12 pilots who were testing graphical information, all found it very useful and some even insisted on have something similar in the future.

Treinish and Praino (2004) studied a new fog forecasting system designed for airports. The idea was to improve forecasting of fog, fog having resulted in losses to the airline industry of about USD 4.2 billion in 2002. Of these costs about USD 1.3 billion were estimated to be preventable with better forecasting tools.

Allan *et al.* (2001) estimated the potential reduction of airline delays when utilising the Terminal Weather Information System at New York airports.

One should not forget the most relevant transport mode of all: light traffic. Hautala (2007) gathered information from several studies and concluded that in Finland in 2006, the potential cost savings in reduced accidents and more effective winter maintenance amounted to more than EUR 100 million. The potential for more savings was considerable. For those interested in Hautala's references, more information is available in the studies by e.g. Björnstig *et al.* (1997) and Vuoriainen *et al.* (2000). It is a pity that this mode of transport has received so little attention, but perhaps our understanding of its significance is about to increase due to climate change and better awareness of the multiple benefits of the most natural mode of transport.

A number of studies have been conducted on the generic value of weather information, e.g. by Murphy

(1994), Adams *et al.* (1995) and Thornes and Stephenson (2001) on long-range information, and by Beysson (1997), Rollins and Shaykewich (2003), and Gunasekara (2004). Most of them conclude, using various methods and valuation techniques, that weather information is most beneficial.

4. Summary of Reviewed Research

The aviation studies are not included in the summary table, but as mentioned above the case of aviation is so self-evident that further repetition on the need for weather information in aviation operations is rather meaningless.

For road traffic, what is obvious is that the use of VMS did have a real impact on driver behaviour in poor road weather conditions, whether that be slippery surface or reduced visibility. Reduced speeds mean improved safety and less severe accidents if such occur. This road side technology did gain a lot of attention but is already pretty much outdated as the technological applications with similar functionalities have taken their place inside the vehicles. However, it is yet known whether in-vehicle applications are as efficient in the long run as were the VMSs. Or they might be much more efficient. But nonetheless the road managers' role must obviously change from active information disseminator to something other, where this technological change is taken into account. Besides, reduced speeds mean also time losses, which tend to eat up safety benefits in socio-economic cost-benefit analysis. Hence, the controversy of this fact does not need to bother road managers too much, if the applications will be introduced by automotive industry as in-vehicle systems.

As to road maintenance operations, the pattern is definitely clear: less salt, less environmental burden on e.g. ground waters, more efficient and better targeted de-icing operations. Here the potential for better road weather information systems is still intact. The only thing that really is changing and must be considered is the fact that unbundling of road administrations will shift the responsibility of winter maintenance operations from formerly integrated road managers to various maintenance service providers. Road weather information systems are actually increasingly becoming business tools of service providers rather than tools for road managers, if the term ‘road management’ is understood to refer mainly to the authority role of road infrastructure management. And when RWIS becomes a business tool, its impact becomes measured increasingly in cash flow terms.

Considering other modes of transport, the business

and safety impacts of weather information for aviation are and always have been considerable. Functional airports and open runways have direct impacts on the profitability of airlines and airport operators. Also here, one could easily be inclined to emphasise the business impacts, which, incidentally, are not in the least bit de-

tached from matters of safety – quite the reverse.

Waterborne transport can easily be placed in the same category as aviation. Shipping lines and operators utilise weather information directly to reduce their costs. However, Sonninen's (2007) analysis clearly pointed out the great potential for private boating, which has

Table 1. Summary of reviewed research – how useful/valuable/beneficial is weather information?

Theme / aspect	References	Results / identified impacts	Notes
Winter road management, maintenance and operations	Boselly (2001)	Road weather information systems are profitable investments (B/C = 5)	Safety and service level impacts probably dominate among the benefits
	Wass (1990), Thornes (1989)	Improved weather information will reduce winter maintenance costs by 5%-30%	Note that external environmental costs (reduced pollution of ground waters due to less salting) are not included
	Kempe (1990)	50% less salt for de-icing with more advanced road weather information systems	Pilot project in Sweden
	Lähesmaa (1997)	Investments in weather-controlled winter road management systems not easily profitable (B/C = 0.5)	Time costs due to reduced speeds eat up accident savings; operational savings in maintenance not significant
	Pilli-Sihvola (1993)	Road weather service is beneficial (B/C = 5)	A system level assessment based mainly on expertise and inside observation on pilot projects in Finland
Other road management, maintenance and other operations	Skarpness <i>et al.</i> (2003)	Weather information portal found very useful by road management personnel and road users. However, low willingness to pay.	USA
Safety effects in winter conditions	Rämä (2001)	VMSs reduce speeds (1.2 km/h on average) and result in accident savings	Increased time not taken into account and no benefit-cost analysis performed
	Schirokoff <i>et al.</i> (2005)	A wide-scale adoption of VMSs would enhance safety impacts and aggregate system would have a B/C=1.4	Finnish main road network
Safety effects in general	Cooper and Sawyer (1993)	Fog warnings by VMSs reduce speeds and improve safety	4.8 million observations on vehicle speeds in London for 1990-1992
	Kyte <i>et al.</i> (2001)	VMSs warning drivers on poor road weather conditions had an additional marginal impact on driver behaviour reducing speeds	Sweden
Other transport modes	Thornes and Davies (2002); Smith (1990)	Weather impacts significant on rail operations (schedule, safety, reliability), but not quantified	UK
	Motte <i>et al.</i> (1994)	Weather information used for waterborne vessel routing did not significantly improve performance	USA
	Sonninen (2007)	When efficiently utilising weather information, significant impacts on boating safety, vessel operations and oil combating efficiency	Sonninen's analysis made extensive use of other prior studies and statistics
	Hautala (2007)	More efficient utilisation has great potential in improving pedestrian and light traffic safety especially in winter conditions	Hautala's study synthesised extensively different prior research results and statistics

launched tailored services for boaters – in Finland, e.g. the Finnish Meteorological Institute and the private met-service provider Foreca Ltd. both offer web-based and mobile weather services for boaters.

One of the great possibilities is light traffic, as shown by Hautala and Leviäkangas (2008). This could be a high-growth area for new met-information services, with a very important socio-economic aspect.

5. The Value Shift – From Public Good to Cash Flow

The discussion concluded in the previous section that there is evidently an ongoing shift from public weather information systems and services towards private or semi-private systems. This occurs for at least two reasons: first, there has been a considerable change in vehicle technology so that vehicles are in fact now monitoring the environment perhaps more efficiently and certainly more locally than any other monitoring system relevant for the driver; secondly, the unbundling (i.e. privatisation, commercialisation and restructuring) of former road authority functions have shifted the responsibility to private and/or commercial maintenance operators and service providers.

These changes are illustrated in Figure 1, which attempts to capture the shifts in the light of three simplified example systems:

- 1) RWIS, which is defined here as a system that comprises weather stations, the communication links and back-office systems which enable to monitor and forecast what the existing road conditions are now and in the near future.
- 2) Variable message signs, which in the authors' opinion represent already somewhat outdated technology and human-technology interface. Much of the same information will in the near or medium-term future be available through in-vehicle applications, either stand-alone or co-operative ones.
- 3) Weather-info services directly to end-users, meaning met-info services delivered mainly via wireless networks directly to personal devices; these systems

may supplement or in some cases even replace in-vehicle applications.

What makes the situation interesting is that the logic to evaluate the benefit-generating capability of the systems will also change as the system evolution proceeds. VMS have been replaced by more promising and efficient technical means. Hence they are becoming the automotive makers' value-added systems for consumers and their justification of existence will change from "safety devices" to "accessories" at least to a certain extent. When VMS were justified by road authorities using socio-economic cost-benefit analysis (CBA), the automotive makers would simply adopt cash flow analysis (CFA) based on market assumptions. There has actually been a radical "mutation" in the evolutionary process of transferring road condition information to road users on the spot.

New Public Management represents the line of policy where business-mannered management is applied to public sector functions. Privatisations, corporatisations, commercialisations and public-private-partnerships (PPP) are manifestations and embodiments of this line of policy. Margaret Thatcher's administration in the UK is often considered as an initiator of the new public management policy line. In the 1980's, Thatcher launched her Private Finance Initiative (PFI) in order to introduce business-like thinking and private capital to public sector functions.

Road weather information systems (RWIS) are still needed and have evolved from road authorities' informative tools to private or commercial road maintenance service providers' business tools which help them perform their operations more efficiently. The shift from public system towards jointly operated systems, which could in many cases be called some type of public-private partnerships (PPP), has already taken place. As and if the *new public management* trend continues, the

RWIS will turn into business tools of these operators and service providers. It should be remembered, however, that this also means that the systems are becoming increasingly closed, to be managed and hosted in-house only. The development of vehicle technology, vehicles being the monitoring infrastructure, could change this logic though. In PPP arrangements both parties, the public and the private/commercial, will use their own logic of valuation of the "goodness" of the system. The challenge is to combine the interests of both. It is not that easy, as reported in studies on other types of PPPs (see e.g. Leviäkangas 2007). Road weather systems are surely no exception.

Road weather info-services directly to end-users started initially as a public service but very quickly developed into privately supplied information services or

PPPs. Even if a significant amount of public finance is involved, the market pull will dictate how well and widely the information is utilised. And this being the case, the market push will also become more important, respectively. In any other case, there would only be a public service without too many users and this is simply not acceptable even from the viewpoint of the public sector.

In sum, the whole field (weather information for transport)

is under rapid evolution largely because new public management thinking is reshuffling the roles and responsibilities of transport authorities, maintenance contractors, met-service providers and other information service providers. This, combined with the aggressive development of vehicle and communication technologies, will make the future unpredictable. It is possible perhaps to see half a decade ahead but longer-term visions are truly visions in the word's truest meaning.

As to the value of weather information in transport management... well, this is easy to put briefly: if there is no business value — the cash value — in the foreseeable future of weather information, there will be less need for such a service, regardless of whether one thinks of experts, business people or public sector servants. All the trends point in this direction. The trend is neither good nor bad, though, just to be taken note of. The role of authorities is crucial, as they need to ensure that when the market is offering weather services to any part of the value chain (e.g. to maintenance contractors or to road users directly), the services must have a component of socio-economic good in them. The market itself will not do that on people's behalf.

Furthermore, there will most probably be a clearer distinction between day-to-day weather information, serving the operational purposes and provided mainly by commercial or private entities, and strategic, long-perspective weather information, which serves the public sector dealing with infrastructure placement (where to

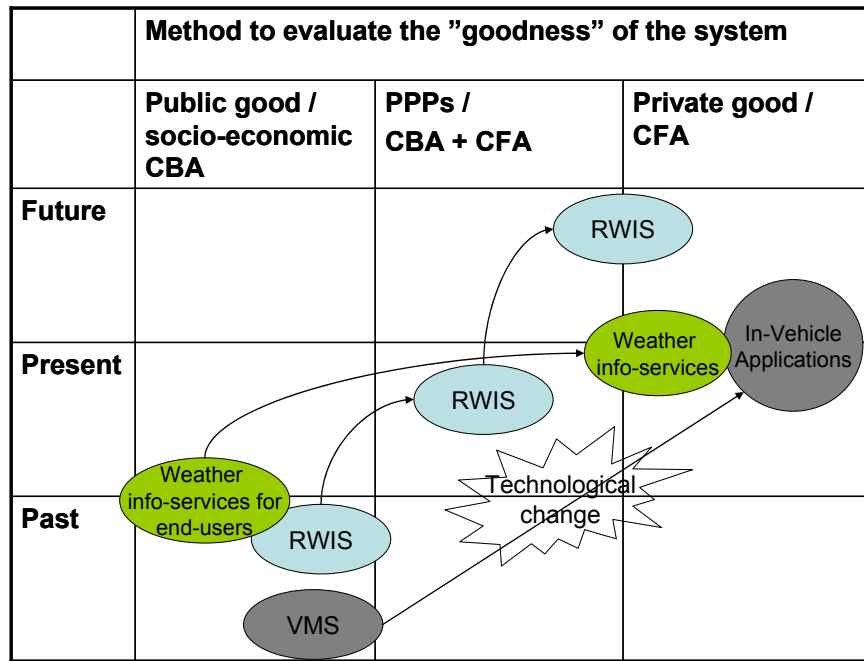


Figure 1. Three example system entities and their evolution

build) and climate impact mitigation (how to make infrastructure more resilient to weather). This could also reflect on the chronological valuation logic of information: short-term information is cash valued, long-term information is socio-economically valued.

The methodological challenge of the value shift was viewed in the light of the EVASERVE meta-tool for the evaluation of information services: how should the evaluation tool be

developed further when clearly evaluation of information services from socio-economic and cash-based origins differ from each other? The meta-tool already distinguished between the socio-economic and financial approaches, but the middle-ground, i.e. public-private-partnership type solutions, were not considered by of the modules of the tool. Also the process of shift, from public service to private or public-private, was not addressed by the tool. As the tool is still a prototype, this challenge has yet to be faced. It could well be that a new evaluation module should be developed to assess applicable public-private interfaces and the division of roles in the service supply.

6. CONCLUSION

This paper showed and discussed how major changes in transport sector governance and management affect the way weather information for transport is changing also in terms of valuation logic. This means that what was considered a useful and applicable evaluation method for "goodness" of some particular information service will not necessarily, or even likely, be that as the operating environment and roles of different functions change. Value analysis and value management must also be changed accordingly. If the standard definition for value is employed, i.e.

it is an obvious observation that functions might change as to what is their ultimate purpose, and resources can likewise be measured in different terms and met-

rics. Hence, the value changes... it shifts. This is one im-

$$Value = \frac{Function}{Resources}$$

portant realisation in the application of value engineering and the main conclusion of this paper.

When any service process is described, it comprises a series of subsequent functions that require resources. These resources are either public or private or both. Hence the standard definition of value can be used to model service processes and how one is able to resource different sections of the process (see Figure 2). The application field is wide from service companies' business planning to public sector planning and restructuring. The empirical examples of this paper show two cases: 1) restructuring of former public service (RWIS and weather info-services), and 2) process change due to technological change (variable message signs). It does not really matter whether the standard definition of function is understood as a technical functionality or as part of activity in the process, since each activity of the service process is meant to deliver various functionalities to the end-users of the service. This distinction is merely hierarchical in nature. Technical functionality, such as "real-time data", needs to be supported with an appropriate data-gathering activity and system, the latter being a sub-activity of any information service process. Value attributes of the service, such as reliability, depend on how well the technical functionalities are met and how well the designed process is able to meet this attribute.

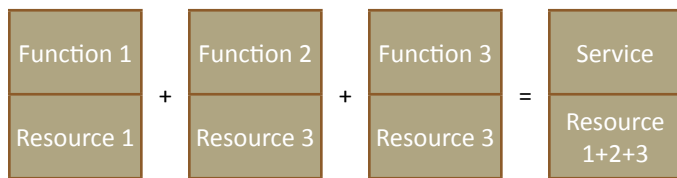


Figure 2. Service as a sum of functions and resources – standard definition of value can be used to model service processes

Finally, the authors would like to encourage the application of value engineering particularly in the complex context of service process engineering, where value definitions take on another meaning in different parts of the process and when the process is restructured. What is understood by 'service' will be a contingent question: in some cases it could mean delivering a motorway or in another it could mean delivering weather-information to users of the transportation system; it could also mean providing environmental information to a maintenance

organisation in-house or to the public sector on a contractual basis. The prospective cases are innumerable. Value analysis could actually prove to be a useful tool to analyse both *ex ante* and *ex post* the major sector restructuring cases. When taking a look back at many transport sector restructuring stories, one would even like to say that there has been too little of it.

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About the Authors

Pekka Leviäkangas is Chief Research Scientist and Anna-Maija Hietajärvi is a research scientist at VTT Transport and Logistics Systems in Finland. For more information, go to www.vtt.fi, or contact Leviäkangas at pekka.leviakangas@vtt.fi.

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Development of Improved VE Subject Selection and Functional Analysis at Planning Phase for Program Level

*Chang-Taek Hyun, Ph.D., PE, AVS, Chang-Yeob Song,
Myung-Jin Son, Seong-Min Jo, and Seung-Won Han*

Abstract

As some new issues such as urban redevelopment, urban balanced development, and urban competitiveness have become more important worldwide, the mixed-use developments of program level, which is, unlike the project-level, supposed to connect various individual projects, have been actively carried out. It is highly required that the program-level facilities with multiple projects and diverse stakeholders meet their original functions, create new values by maximizing the land efficiency and connecting different uses, and make OM&R (operation, maintenance, and replacement) more efficient. Therefore the research related to VE (value engineering) application for program-level facilities, which could support the value enhancement and the creative thinking, needs to be performed.

In Korea, as for the construction projects which cost over ten million dollars, it is mandated to perform VE more than once respectively at both design development phase and construction document phase for cost reduction, function improvement, and value maximization. In the meantime, VE needs to be applied at the early stage such as planning phase, in order to get maximum effect for large-scaled program-level facilities. However, to do this, some problems have been raised as follows: 1) VE job plan oriented to single project and design phase, 2) Difficulty on VE subject selection according to the variety of functions and spaces in program-level facilities, 3) Lack of connection between VE subject selection and function analysis, and 4) Lack of consistency between VE subject selection and idea creation.

Especially, VE subject selection has more important meaning on program-level facilities where multi-projects are closely connected. And the careful and efficient subject selection in program-level facilities could result in the great possibility of value improvement.

To apply VE efficiently at the planning phase of large-

scaled program-level facilities, this study tries to suggest the effective method for the subject selection. In addition, the connection process of the subject selection and the functional analysis, and the process to support the effective idea creation are to be proposed. Also the similarities and differences between 'a single project' and 'capital construction program with multiple projects' in terms of VE application, are presented.

Introduction

Background

Recently, mixed-use developments ("MXD" below) are actively being pursued with aims of urban redevelopment, urban balanced development and strengthening urban competitiveness. These projects are being conducted with the purpose of creating new value through maximization of land efficiency and a variety of comprehensive uses, and characteristics include many stakeholders, combination of equipment system and connected functions according to facilities and space characteristics. The project, related to various facilities and stakeholders, need to fulfill the unique functions and connect functional requirements throughout the different facilities.

Many studies are emerging in order to reflect the feature of MXD in value engineering ("VE" below). Especially, VE application method in the planning phase of project where VE improvement effects are great is continuously being studied. However, 1) single project and design oriented VE job plan, 2) difficulties of VE subject selection according to various functions and space characteristics of the construction business, 3) lack of connection between VE subject selection and function analysis, 4) lack of consistency between subject selection and idea creation are being presented as problems. VE subject selection is an important stage where the areas with good improvement effects are selected to distribute the

effort to VE workshops. So it is even more important to project that are closely connected with various projects.

Therefore, this study present improvement methods focusing on subject selection in the preworkshop stage and function analysis of VE job plan, in order to apply VE rationally and effectively in the planning phase of MXD. It especially present a space model, that can examine scale of facilities that are comprehensively included in MXD, to select effective VE subjects, and a VE function analysis method based on owner and user needs.

Method of study

This study focuses on the planning phase of mega-projects such as MXD, VE subject selection that aids selection of areas with high improvements, and the function analysis that analyzes major function of project.

The methods of study are as follows.

First, characteristics and subjects according to the phase of VE application are investigated to define the feature of planning phase VE. In addition, VE application related studies in the planning phase are analyzed to extract implications.

Second, the current situation of MXD is analyzed to extract the problems. VE subject selection and function analysis from design and construction are analyzed, and limitations of application in the planning phase are extracted. In order to solve these problems and limitations, VE improvement directions are selected in the planning phase of mega-projects, focusing on the VE subject selection and function analysis.

Third, in order to select VE subjects more rationally in MXD, a space model is developed and a method is presented to calculate appropriate scale of facilities in projects.

Fourth, reasonable function analysis method in planning phase of MXD is presented to derive the priority function that should be improved through selected subject.

Fifth, NFS model is developed to connect the owner and user needs, function analysis, and subject selection and make idea creation consistent.

Sixth, application of the methods presented in this study is examined through expert interview and application of examples.

Literature Review

Planning phase VE

The Korea Development Institute (2000) presented a method of VE application in the public sector project's pre-feasibility analysis stage by combining two methods, considering that the pre-feasibility analysis and VE meth-

ods are similar. This study proposed that VE application point is the 1/3 point of pre-feasibility analysis progress, and proposed 8 hour VE workshop process for a one day. The limitation of this study is that it is an early study for application of VE in the planning phase, and it does not study specific application methods according to each phase.

Gerner (1993) applied VE to department store interior in the planning phase. It was effective for understanding project goal and demands, and had advantages of making decisions for design beforehand. Green (1994) and Fong (2000) conducted a study on differences between planning phase VE and design phase VE. In addition, Green (1997) presented his opinion, "Whereas the perspective of design VE is objective, the perspective of planning phase VE is subjective." Unlike this opinion, Kelly (2002) studied differences of perspectives on value and said, "Planning phase VE focuses on clear analysis of overall goal the client hopes to reach through the project, and design VE is a subset of planning VE. It focuses on solving the project technically." Wandahl (2006) clearly defines VE according to phase of project execution, and the results are shown in Table 1.

Table 1. Purpose of VE according to phase

Category	VE Purpose and Effects
Pre-Brief	To use as a strategic method to set range and goal or project. Affects decision on whether or not to pursue project.
Brief	After decision is made to pursue project, used to clearly extract value and demands of client.
Concept Design	To review early plan before commencing design.
Detail Design	Last review to confirm client demands reflected in design.

MXD

Recently MXD are being conducted as large scale projects from 330,000 m² to 3,330,000 m² and MXD with diverse facilities structuring the business, such as residences, commercial spaces, business spaces and cultural spaces, are the mainstream. The reason why MXDs are increasing is because they can effectively use limited space, and there is a need and demand to create synergy and a landmark effect through connection of different facilities.

However, many problems are included in execution of projects, including large-scale budget expenditure

over a long period of time, conflict from having different stakeholders, uncertainty of business income estimation, changes in design, industry delays, and lack of performance data and know-how.

With the development industry becoming larger and comprehensive, successful pursuit is impossible with the role of either public or private sectors, thus a new form of development method that connects public and private is growing.

Subject selection of VE

As a result of examining cases conducted in Korea, VE subject selection was based on all facilities or type of construction. VE subjects were usually selected according to facility, space or work type in design VE, and work type or material in construction VE. The major methodologies used were the quality model which obtain the needs from survey of owner and user, and the cost model which is implemented with roughly estimated cost.

In addition, many methods are defined for VE subject selection, such as the high cost field selection method, cost to worth method, cost and performance evaluation method, and comprehensive evaluation after weight on certain areas method.

Recently, the high cost field selection method is used more than other methodologies. This is a method which compares the work type and cost with similar projects to check the areas where cost are over estimated and support VE analysis. However, problems such as establishment of database for similar projects, reliability of data, and difficulties in estimating cost according to space are still remained to solve.

Function analysis

Based on design outline and plan, which specify the information from early stage, function analysis is conducted with dividing information into space, work section, and required performance index. On the other hand, in construction phase, function analysis is conduct-

ed based on major construction method and characteristics of materials. This distinction occurs, because there is difference of information and demands according to the phase of project.

However, there is a lack of information that can be used in the planning phase, and above all, there are no clear definitions between planning and design. Therefore, methods applied in design and construction phases are not proper in the planning phase.

Development of subject selection and function analysis methodologies in the planning phase of MXD

Direction of subject selection and function analysis

Methods of improvement focusing on the subject selection and function analysis stages will be presented

for VE application in the planning phase of MXD. For VE subject selection, a method where space models structured according to business characteristics, business scale, large category facilities and the mid-category facilities will be presented, to solve the limitations of planning phase characteristics and VE sub-

ject selection as mentioned above. In addition, business goals, demands and information characteristics in the planning phase will be analyzed to present a method of function analysis that is “subject” based.

Development of a space model for subject selection

A space model comparatively analyzes information and scale of a similar project and target project, and aims to support VE subject selection focusing on over-planned field, space, and the facilities that are missing.

In order to present a space model in more visual way, a facility breakdown structure with different stages was developed. The facility breakdown structure has a horizontal correlation and vertical hierarchy. The top level is specified as project characteristics, project scale, and facility’s surface area.

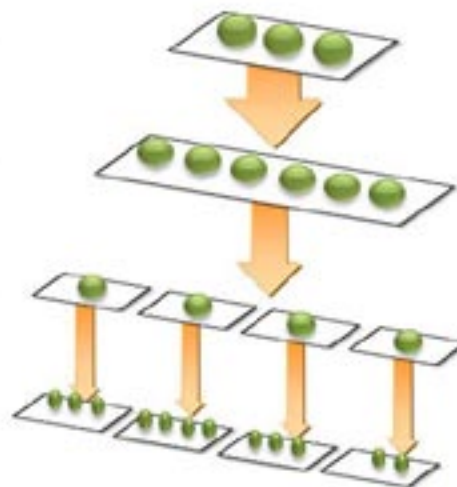
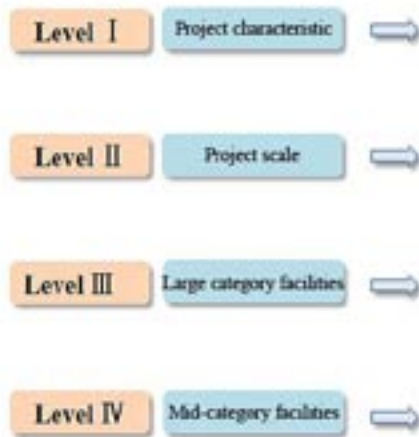


Figure 1. Structure of Space model

Table 2. Contents of each level

Level	Level I	Level II	Level III	Level IV
Category	Project Characteristics	Project Scale	Large Category	Mid-Category
Contents	<ul style="list-style-type: none"> • Business type • Region, district • Total project budget 	<ul style="list-style-type: none"> • Land surface area • Construction surface area • Total area • Landscape area • Building-to-land ratio • Floor space index • Above ground and underground stories 	<ul style="list-style-type: none"> • A-Block • B-Block • C-Block • D-Block • etc. 	<ul style="list-style-type: none"> • Joint residences • Accommodation facilities • Community life facilities • Other residential and commercial facilities • Offices and public facilities • Security and emergency facilities • Education facilities • Research and science facilities • Information and communication facilities • Business facilities • Sales facilities • Social welfare facilities • Other public construction facilities • Display facilities • Performance and gathering facilities • Rest and leisure facilities • Other cultural and gathering facilities • Medical facilities • Sports facilities • Religious facilities • Other welfare and religious facilities



Figure 2. Space model

Figure 1 (page 16) shows the facility breakdown structure of the space model.

The Space model, as shown in Figure 1, can be divided into four stages.

- 1) *Project characteristics.* Types and area of facilities shift according to project characteristics such as project goal, type and client, so factors that decide the characteristics of the project are selected as Level I, the top stage of the space model.
- 2) *Project scale.* In order to compare and review the scale of target project and similar project, Level II of the space model was selected focusing on the information in early stage of project, such as land area, construction area, total area, landscape area, building-to-land ratio, floor space index, above ground and underground stories.
- 3) *Large category facilities.* Level III of the space model was developed by adding ideas of a block unit so facilities of comprehensive uses due to diverse sub-facilities could be packaged or grouped. The structured facilities were generally divided into housing, commercial, business and public, cultural and recreational facilities which is included in MXD. Other facility group was added to reflect various facilities and minimize the omission of facilities.
- 4) *Mid, specific category facilities.* Since the mid and specific categories of facilities are different and diverse for every mega-project, this is not a good standard for reviewing scale of facilities. Therefore, Level IV of the space model is selected with major facilities that are acceptable from the top level.

The contents of the space model according to level proposed in this study are shown in Table 2 (page 17).

Based on the contents in Table 2 (page 17), the structure of the space model proposed in this study is shown in Figure 2 (page 17).

The characteristics of the space model proposed in this study are as follows.

- 1) *Provides standard for the subject to compare.* A mega-project is decided according to business scale and facilities area, and composition is decided according to goal of development, form of development, region, and client. Therefore, similar case is selected based on development purpose, demands, and information that can be used in planning phase, and provide the standard to compare with target project.
- 2) *Review of project scale and facilities scale.* The overall scale of the target project and similar project are reviewed, and then area and scale of the major and

specific facilities are compared to support the selection of subjects with high VE improvement effects. The facilities area and composition ratio are especially presented together to select better similar cases.

- 3) *Establish as hierarchical breakdown structure.* In order to structure a space model a facilities breakdown structure is presented to help comparatively analyze subjects in more visual and effective way. The facilities breakdown structure includes horizontal correlation and vertical hierarchy. It provides information according to business characteristics from the very top level of facilities. And from the bottom level, it can provide information related to project scale and specific area of each facility for target project and similar project.

Function definition and function organization

The purpose of function analysis in the planning phase is to functionally understand the project through information analysis of specific needs and project intentions of the owner. The results provide an opportunity to set the direction of the development plan and come up with ideas.

(1) Function definition.

Function definition is expressed in the “noun + verb” form. The noun is an expression that can be quantified through measurements, and it is recommended that the verb be a comprehensive, simple and active expression that can widen perspective. However, there are difficulties in using quantitative expressions for information on ideas in the planning phase of a construction project. In the early stage of the project, it is best to conduct a function definition with comprehensive expression of the overall project, not just with technical contents.

A function definition that reflects the goal of the overall project is especially demanded in the early stage. Unlike defining functions of product and physical object with hardware characteristic, conceptual information of early stage has a strong software characteristic. Therefore, questions to extract the background and purpose of the entire project are needed in the planning phase.

2) Function analysis

In the early stage of the project, it is important to review the overall process reflecting the intentions of the project from the owner and user perspective. Therefore, in the planning phase, it is effective to organize functions using the customer/task FAST diagram, which is useful for organizing overall functions and diverse demands of customers.

The customer/task FAST diagram method is consist-

Table 3. Examples of function definition questions

Category	Hardware (Product or Physical Subject)	Software (Overall Project)
Form of questions	<ul style="list-style-type: none"> • What is it? • How does it work? • How do you use it? • What is its purpose? • What is its goal? 	<ul style="list-style-type: none"> • What is the background of the project? • Why is this project necessary? • How does this project work? • What is the purpose of this project? • What is the goal of this project? • What are the demands of the owner? • What are the demands of the user? • What are the demands of those involved in the project?

Table 4. Specific contents of support functions of development with comprehensive use

Category	Specific Contents
Assure Dependability	<ul style="list-style-type: none"> • Function that stresses structural stability • Function that protects the user and keeps the user safe • Function that secures reliability of facilities operation • Function that lengthens life span and minimizes maintenance cost • Function that protects the environment • Function that stresses stability of project operation management
Assure Convenience	<ul style="list-style-type: none"> • Function that contributes to space arrangement and smooth route of movement • Function that makes maintenance and restoration easy • Function that offers user convenience • Function that stresses convenience of the public
Satisfy User	<ul style="list-style-type: none"> • Function that changes or adjusts basic functions (faster, smaller, lighter etc.) • Function that makes use easier • Function that makes user life more pleasant (e.g. minimization of noise) • Wants of owner (private, public)/investors/users/public
Attract User	<ul style="list-style-type: none"> • Function that stresses visual landscape and view • Functions preferred by owner (private, public)/investors/users/public

ed of task, basic function and support function through the results of the function definition. Task is defined by the demand of the client. In the planning phase, the task can be represented by a project intention or background of project. As basic function is an essential condition to conduct the task, it is classified from the task and organized through “how – why” logic.

Once the task and basic functions are roughly classified, the remaining functions are classified into categories of support functions. Support functions are not essential but effective in customers accepting results, and are very important functions when selling a product or service. These support functions are divided into four categories. (1) “Assure dependability” mainly deals with stability, (2) “Assure convenience” deals with contents that help the user. (3) “Satisfy user” deals with the part of improving materialization of basic functions, and (4) “Attract user” deals with design and parts users highly prefer.

Connection of Subject with functions and functional group establishment

1) Arranging relationship between function and subject

The relationship between each function and the subject in the planning phase should be arranged and the proposals made through idea creation after function analysis stage should be made to satisfy the relationship between “function and subject”

The functions are extracted from “needs (demands of owner, purpose of project, intention, background etc.)” The extracted functions are realized in the final proposal form with related subjects. The relationships can be shown as in Figure 3 (next page).

This method reviews which functions have a high relation with the subject, and make effective idea creation possible. In addition, it can strengthen the connection between function through systematic idea creation and final result.

2) Establish groups according to function

Since the planning phase is the phase where general plan of the facilities is drawn, it is best to come up with the ideas on overall functions extracted. At this point functions that are connected or need complementary review should be put in groups, and basic functions should be grouped with support functions. Support functions are not divided by basic function, but they deal with performance and what customers prefer, so coming up with ideas is effective. This method establishes groups with connected functions and aims for comprehensively reviewed idea extraction. Figure 4 (above) is a plan of this idea.

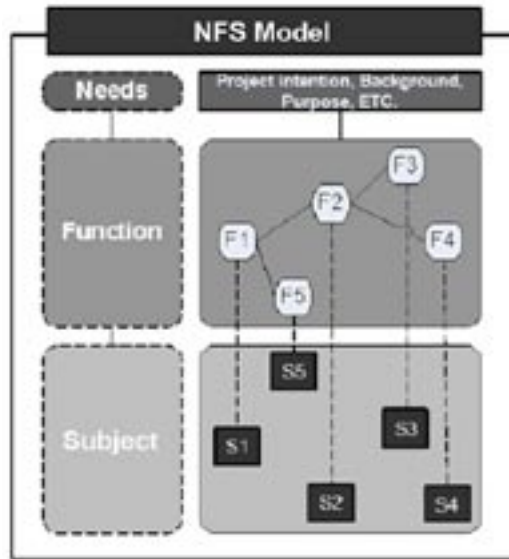


Figure 3. NFS model structure

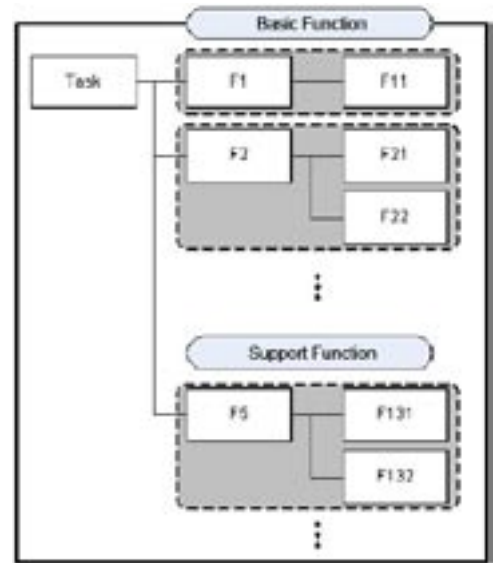


Figure 4. Groups according to function

Review of connection to creation stage

1) Ideas using visual information on similar cases

There is a lack of information in the planning phase, so there is a limit to extracting ideas based on function definition results along. There is a need to use material that can support effective idea extraction. Visual material stimulates ideas (Wandhal 2006), and especially visual information on functional spaces including function and function group through function analysis, and on similar facilities are effective for creating ideas. Using such visual information will help extract more specific ideas.

2) Idea creation process

Each function group comes up with ideas, and the subject in the planning phase that is connected to each function is also considered to create the ideas appropriate to the subject. Spaces that include function groups and functions and visual information on similar facilities are especially effective for ideas. The idea creating process is shown in Figure 5 below.

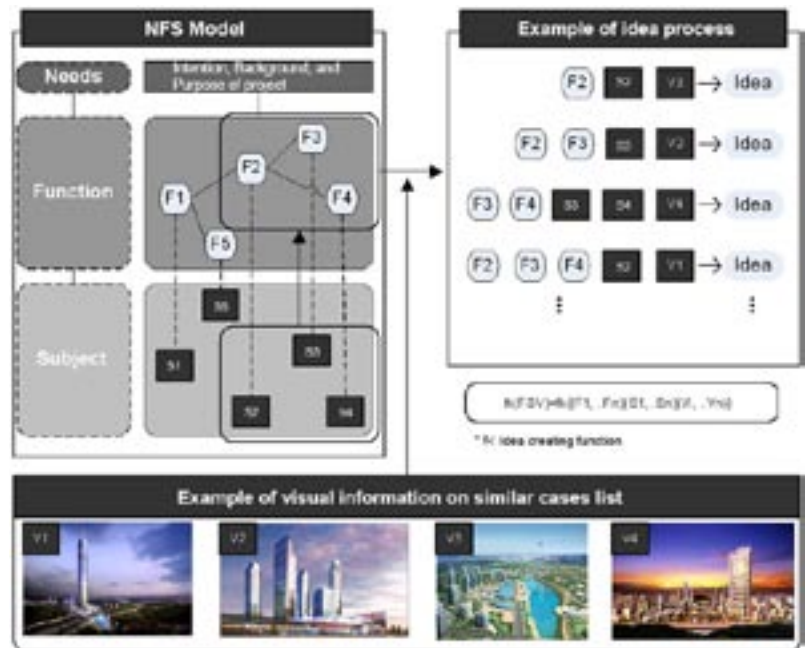


Figure 5. Idea extraction connections through NFS model (above)



Figure 6. **** residential land development area comprehensive complex development PF project

Validate through Case Project

The case project is a comprehensive complex development project in the scale of a mega-project, and public and private collaborating PF project, which are recently on the rise. Such public and private PF projects combine public land development know-how and private funds and construction technology to create a synergy effect, and solve the problem in lack of connection between land and construction.

Table 5. Project characteristics — Level 1

Category	Case Project	Similar Project
Project Method	Comprehensive complex development private and public collaborating PF project	Comprehensive complex development private and public collaborating PF project
Area, District	Residential land development project area / General commercial district, district unit plan area (special area plan)	Residential land development project area / General commercial district, district unit plan area (special plan area)
Total Project Cost	1.2565 trillion won	1.5216 trillion won

1) Space model

By selecting the most similar mega-project in project characteristics to the case project and comparing scale, the space model utility was verified. In order to select similar project, Level I (Table 5) contents of the space model, which are project method, region and district, and total project cost, are reviewed. The following table is a comparison of Level I contents of the case project and similar project.

As a result of conducting project scale (Level II, Table 6 below) review afterwards, it was confirmed that the landscape area of the case project was planned larger than the similar project.

Not only area was reviewed for absolute comparison of the two projects in the large category facilities item (Level III, Table 7) and mid-category facilities item (Level IV), but also ratio proportion was reviewed for comparative analysis. As a result, in the large category facilities item, the case project was 5.42% higher structured than the similar projects in terms of residential and commercial facilities scale, and reached 88.06%. Meanwhile, the public facilities were 5.19% lower than the similar project a weak 2.96%. Therefore, the structural proportion of facilities according to use of the case project are selected as a VE subject and require scale review for appropriate structuring.

Table 6. Project scale — Level II

Category	Case Project	Similar Project
Land Area	68,321m ²	73.919m ²
Construction Area	36,925m ²	43.333m ²
Total Area	525,372m ²	672.913m ²
Landscape Area	29,281m ²	12.377m ²
Building-to-Land Ratio	59.05%	61.33%
Floor Space Index	524%	564.59%
Stories	Above Ground	63
	Under Ground	5

Table 7. Project scale — Level III

Category	Case Project		Similar Project	
	Area	Ratio	Area	Ratio
Residential & Commercial	460,915m ²	88.06%	556,090m ²	82.64%
Public	15,488m ²	2.96%	54,820m ²	8.15%
Cultural & Gathering	29,226m ²	5.56%	32,607m ²	4.85%
Welfare & Religious	17,744m ²	3.39%	29,396m ²	4.37%
Total	52,373m ²	100%	672,913m ²	100%

In the mid-category facilities comparison (Table 8 below), the case project was 21.26% higher than the similar project for sales facilities, at 37.47%. It can be said that the structural ratio of sales facilities is higher than residential and commercial facilities, and why the residential and commercial facilities scale of the case project, which is smaller in scale, is bigger than the similar project. Therefore, the sales facilities of the case project could have been overly planned, so the scale needs to be reviewed. Also, education facilities were 4.65% lower than the similar project at 2.96%, and there were no social welfare facilities. When facilities to secure public characteristics have a low proportion or are missing like this, they are selected as VE subjects together with facilities that have been over-planned, for scale review.

As a result of applying the case project to the space model, the space model facilities were confirmed to include all facilities of the similar project. In addition, scale of case project and of each facility could be reviewed and verified to use for business profitability review which is the purpose of the planning phase.

2) Function analysis

First, functions were defined to understand project intention, goals, and owner demands and find out why the project is necessary. Basic functions such as “To gather the moving population”, “To spread metropolis function” and support functions such as “To minimize mobility” and “To improve aesthetics” were defined.

Second, a customer/task FAST diagram was used to

organize the functions defined. “To active the region” which corresponds best to the demands of the case project was arranged as the task, and the first basic functions to conduct the tasks were “To gather the moving population” and “To make people settle.” Other functions that were not categorized as basic functions were categorized as four support functions.

Third, relation to subject was reviewed according to function, and subjects selected through the space model were connected to functions, to create ideas on subjects that need to be improved in the creation stage.

Fourth, groups were established focusing on functions related to ideas, and the connected functions were a basis for widening perspective of ideas. In the planning phase, with a lack of information, in order to supplement the limit of creating ideas based solely on function definition results, visual material on existing facilities were studied. Ideas were created based on the function groups, subjects related to realizing each function and information on existing cases collected for reference.

As a result of setting the planning phase of the case project as above and applying the function analysis method, the study confirmed that logic of the function analysis stage could be maintained and characteristics of the planning phase could be reflected. In addition, there was easy connection to the creation stage after function analysis.

Table 8. Mid-category Facilities — Level IV

Category	Case Project		Similar Project	
	Area	Ratio	Area	Ratio
Apartment	209,962m ²	40.12%	313,869m ²	46.64%
Accommodation	-	-	21,747m ²	3.23%
Business	38,082m ²	7.28%	85,429m ²	12.70%
Sales	196,151m ²	37.47%	109,073m ²	16.21%
Community Life	16,720m ²	3.19%	25,972m ²	3.86%
Education	15,488m ²	2.96%	51,202m ²	7.61%
Social Welfare	-	-	3,618m ²	0.54%
Display	9.71m ²	1.85%	11,570m ²	1.72%
Performance & Gathering	10,480m ²	2.00%	18,392m ²	2.73%
Rest & Leisure	5,638m ²	1.07%	2,645m ²	0.39%
Cultural & Gathering	3.392m ²	0.64%		-
Medical	9,830m ²	1.88%	3,306m ²	0.49%
Sports	7,914m ²	1.51%	26,090m ²	3.88%
Total	523,373m ²	100%	672,913m ²	100%

Conclusion

MXD has project characteristics of being pursued by many different stakeholders for a long period of time in a large scale. Therefore, problems are being posed such as uncertainty and calculation of project use, scale and surface area in the planning phase, overlapping functions of facilities within the project, loss of space functions and value, and lack of reflection of owner and user needs. In order to solve these problems, there is a need to apply a VE that reflects the purpose and demands of the project in its early stage and supports function-focused ways of thinking. However, VE application is not frequent due to lack of VE application methodology, lack of useful information and uncertainty in the planning phase and program-level.

Therefore, this study developed a method to select VE subjects based on a space model that can compare and review the scale of facilities that are closely connected, in the planning phase of an MXD. In addition, it proposed a VE function analysis method that can fulfill demanded facility functions and simultaneously reflect owner and user needs.

The results of the study can be summarized as follows.

First, characteristics and analysis subjects of VE application term were analyzed and early stage VE characteristics were defined. In addition, in the existing planning phase, VE application related studies were analyzed and a VE application method in comprehensive use development projects was extracted.

Second, the current situation of MXDs conducted was analyzed and problems were extracted. In the design and construction phase of MXDs the VE subject selection and function analysis situations were analyzed, and limitations of adaption to the planning phase were extracted. In order to solve these problems and limitations, VE improvement directions were set in the planning phase, focusing on VE subject selection and function analysis.

Third, a space model structured according to a facilities breakdown structure divided by MXD project characteristics, project scale, large category facilities and mid-category facilities were developed. The developed space models were used to review facility scale according to project scale and use of the comprehensive use development project, and a method was presented to extract VE subject selection.

Fourth, a method was proposed for VE function analysis method in the early stage of MXD. In order to reflect the characteristics of the planning phase and owner and user needs, a customer/task FAST diagram and NFS were

developed for more effective function analysis.

Fifth, a method of idea creation was presented in the creation stage in connection to function analysis, and through expert interview research and adaption to a case, the application of the method proposed in this study was validated.

This study is significant in that it is an early study to apply VE to program-level MXD. A method to expand and apply VE that was used in the design and construction phase in the past, in the early stage of a project was especially provided, and this is expected to contribute to improving completion level of early plans of a project. Meanwhile, since this study reviewed applicability through application to part of MXD case, it is limited in terms of pan-application that can fulfill a variety of facilities. Therefore, there is a need to expand the space model through continuous collection of material on complex use development projects and accumulation of performance data. In addition, in connection to the VE job plan currently conducted, future studies should examine VE job plan at the level of programs and in the early stage of a project and present specific application methodologies.

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About the Authors

Chang-Taek Hyun, Ph.D., PE, AVS, is a professor at the University of Seoul, where he is currently engaged in the program of construction engineering and management (CE&M), focusing particularly on VE and contract. He has more than 20 years of academic experience and has worked for more than seven years as a professional engineer, both in the private and public sectors. He is also a leading light in the field of VE in Korea, having conducted many VE workshops for government offices and private construction firms throughout the country, and having written several VE manuals and academic papers related to VE and CM (construction management). He is currently the president of KCVE (Korea Construction VE Research Institute) and is delivering lectures on CM-related subjects, including VE, Project Delivery System, and Cost Management. He has currently participated in a couple of R&D by Ministry of Land, Transport and Maritime Affairs (MLTM) and is a principal investigator of R&D project titled by "The Development of Construction Management System for Mega Project". Especially his name has been recorded in global top 3 biographical dictionary (Marquis Who's Who in the World 2010, IBC 2000 Outstanding Intellectuals of the 21st Century 2009/2010, ABI Great Minds of the 21st Century).

Chang-Yeob Song is currently master candidate at the University of Seoul, and major in Construction Engineering and Management. He has a construction career in multi-house project and training facility project as a construction engineer for two years. And he has implemented two VE projects for post office in 2009. He has interest in green building, so he is trying to figure out how to apply green techniques efficiently to the design and construction phase. He has currently participated in a R&D by Ministry of Land, Transport and Maritime Affairs (MLTM) and is performing a role of researcher for part of R&D project titled by "The Development of Construction Management System for Mega Project". Now he is in the middle of the third semester and looking forward to learn more about CM and VE.

Myung-Jin Son is currently Ph. D. candidate at the University of Seoul, and major in Construction Engineering and Management. He is a member of KCVE (Korea Construction VE Research Institute) and has implemented many VE projects for office buildings, elementary schools, and academic buildings with professor Hyun since 2006. And he wrote a master's thesis about 'The Development of a Practicability Evaluation Model on VE Proposals using the Scenarios Planning and the Fuzzy Analytic Hierarchy Process'. He has interest in developing VE supporting tool. He has currently participated in a R&D by Ministry of Land, Transport and Maritime Affairs (MLTM) and is performing a role of project manager for part of R&D project titled by "The Development of Construction Management System for Mega Project".

Seong-Min Jo earned a Master's degree in MBA at 2008 and he is currently in master candidate at the University of Seoul, and major in Construction Engineering and Management. He has implemented three VE projects for post office in 2009. And he has currently participated in a R&D by Ministry of Land, Transport and Maritime Affairs (MLTM) and is performing a role of researcher for part of R&D project titled by "The Development of Construction Management System for Mega Project". And he has interest in decision making methodology for construction manager to conduct efficient multiple projects. Now he is in the middle of the third semester and looking forward to learn more about construction management and VE.

Seung-Won Han is currently master candidate at the University of Seoul, and major in Construction Engineering and Management. He has one year construction career as a taskmaster in military base construction projects and did his military service as a military engineer. Issues of construction sites have always been his interest. For implementation of three VE projects for post offices and a Museum in 2009, he learned and experienced more about VE. He currently participated in a R&D by Ministry of Land, Transport and Maritime Affairs (MLTM) and is performing a role of researcher for part of R&D project titled by "The Development of Construction Management System for Mega Project". Now he is studying about various fields of construction engineering in the third semester and looking forward to learn more about construction management and VE.

Function Driven Risk Management

Robert B. Stewart, CVS-Life, FSAVE, PMP and Greg Brink, PMI-RMP, CCE/A, AVS

Abstract

The effect of uncertainty on value can play a major role in decision making. Threats can just as surely erode project value, as can missed opportunities. The improvement and utilization of quantitative risk analysis and management techniques in recent years has brought greater attention to the role of risk in effectively evaluating and delivering projects of all scope and scale. Risk studies are becoming commonplace; however, there exist gaps in thinking that directly link to a lack of understanding of project functions. The exploration of relational dependencies of risk on project functionality can allow for uncertainty to be evaluated and managed in a more effective and proactive fashion. In addition, a developed understanding of project functionalities that drive risk affords proper management of the impacts of uncertainties involving threats and potential opportunities throughout the project lifecycle. This paper suggests a Function Driven Risk Management (FDRM) process to fully integrate function analysis into risk management practices that will bring focus to identifying project risks, aid in prioritizing them, and focus critical thinking on the development of appropriate risk response strategies.

Introduction

The discipline of risk management has traditionally focused on the identification and quantification of risk. This focus on problems, while it has indeed proven to be effective in improving decisions that involve uncertainty, often misses the mark with respect to identifying appropriate responses in an innovative way that maximize project value. Value improvement relative to the management of risk requires that attention be given to project functions. The integration of function analysis, specifically the technique of the Function Analysis System Technique (FAST), into risk management provides a powerful means to do this.

The application of function analysis first focuses the attention of the project stakeholders toward developing a deeper understanding the project and, consequently, improves their ability to identify and discover potential risks. Just as in cost management, Pareto's Law tends to be quite applicable with respect to risk management.

Most commonly 80% of the risk can be found in 20% of the project's functions. Exploring functions develops insight into which areas of a project may possess the greatest risk. As a result, stakeholders and workshop participants who are given the task of identifying risk can make better use of limited resources to focus on critical functions in order to target risks that are most in need of management in order to minimize threats and capitalize on opportunities as early as possible.

Prioritization of the critical risks is not as straight forward as simply calculating the expected impacts. This is due to the potential cascading of impacts resulting from risks that may not be fully understood when the analysis is performed. In addition, when project data and information is limited, a more qualitative risk assessment and management plan may be deployed in order to address concerns before the impacts are fully understood. As a result, sometimes risk management efforts can be misdirected toward managing non-critical project risks. By applying function analysis the prioritization of risks is made easier. The highest priority risks most commonly fall in the most complex and critical functions of the project, making it a natural way to prioritize risks based on the importance of project function.

By digging deeper into the functions of a project and evaluating risk from this perspective, the possibility of developing more targeted and focused risk response strategies emerges. Traditional risk workshops tend to place greater emphasis on the identification of risk. While it is important to identify risks as early as possible, one of the most important aspects of risk management is having the proper response plan in place. While this still requires the identification of risk, it shifts emphasis away from the traditional method of producing studies and reports that miss the main point of how to most effectively manage a project in the face of uncertainty. By introducing the concept of function into the analysis, the most important element, or risk response strategy, can be developed in a targeted and focused manner that is centered on the management of the execution and delivery of a project from beginning to end. This is increasingly important when considering the continued globalization of markets, national and international politics, and a number of other factors such as market volatility, all of which create a much more complex environment than is

often anticipated.

Function Driven Risk Management

The Function Driven Risk Management (FDRM) process is similar to the traditional risk management workflow; however, function analysis is applied at various points during the process. There are four major phases involved in performing FDRM with the related Value Methodology (VM) activities identified within each phase as outlined below.

- 1) Risk Identification
 - FAST Diagramming
 - Risk Brainstorming
- 2) Risk Analysis
 - FAST Dimensioning
- 3) Risk Response Planning
 - Risk Response Function Analysis
 - Risk Response Brainstorming
 - Risk Response Evaluation
 - Risk Response Development
- 4) Risk Monitoring and Control

Similar to most risk management workshops, FDRM utilizes a multi-discipline team composed of subject matter experts (SMEs) representing various areas of knowledge relevant to the project. In addition, FDRM requires a facilitator whom is also fluent with function analysis as well as other VM techniques. This may be the same person as the risk manager or a co-facilitator who will work in conjunction with the risk manager. It is important to note that a skilled facilitator with the necessary qualifications is important, as they will ultimately be able to best drive the process and achieve the desired outcome.

Figure 1 (next page) outlines a process flowchart for FDRM. The process essentially begins with the identification of the project's basic function(s) and ends with the implementation of specific risk response strategies. A detailed discussion is provided for each phase.

Risk Identification

The Risk Identification phase of a FDRM workshop provides workshop participants with a general understanding of the project's baseline assumptions and potential issues. Critical constraints, details, and target milestones should be reviewed to ensure that all workshop participants fully understand the project's scope, schedule, and budget. The following activities comprise the Risk Identification phase:

- a. Identification of Stakeholder Issues and Concerns –

Key stakeholder issues and concerns, as well as project constraints, are presented by the project team. Issues affecting decisions and concerns of the design teams or any other stakeholders should also be presented.

- b. Base Cost and Schedule Validation – The baseline cost and schedule assumptions should be verified by the team. This includes verifying key milestone dates and costs for the project or system by all stages of delivery.
- c. Function Analysis / FAST – A FAST diagram should be developed for the project's current design concept. A more detailed discussion of this step is provided in the section that follows.
- d. Preliminary Risk Identification – Initial Risk Identification should commence with the brainstorming of potential risk events. The critical functions identified during the development of the FAST Diagram should be focused on for team brainstorming. Risk events pertaining to the critical functions should be elicited first, followed by potential risk events relating to less critical project or system functions. The preliminary risks identified should be reviewed and validated by the workshop participants once it has been determined that the majority of potential risks have been identified.

Function Analysis / FAST

The analysis of functions allows for a clearer understanding of the reasons for why the various elements within a project exist. It requires the articulation of functions using a two-word abridgment. This convention forces conciseness in thinking and ensures a dissociation from specifics which is essential in developing a deeper appreciation for why specific elements in a project exist. For example, the basic function of a hammer would be described as "transmit force." This is a very concise description of what a hammer is designed to do without associating this definition to a specific means to do so. We are free to visualize any variety of objects and/or methods to "transmit force," a hammer being just one way.

In FAST, functions represent the basic building blocks that are then arranged into a logic structure that relies on "How-Why" logic. A function located to the right of another function answers the question "How?" while a function located to the left another answers the question "Why?" Building upon the example of a hammer (Figure 2), if one asked the question "Why transmit force?" the answer might be "To drive nails." Moving in the opposite

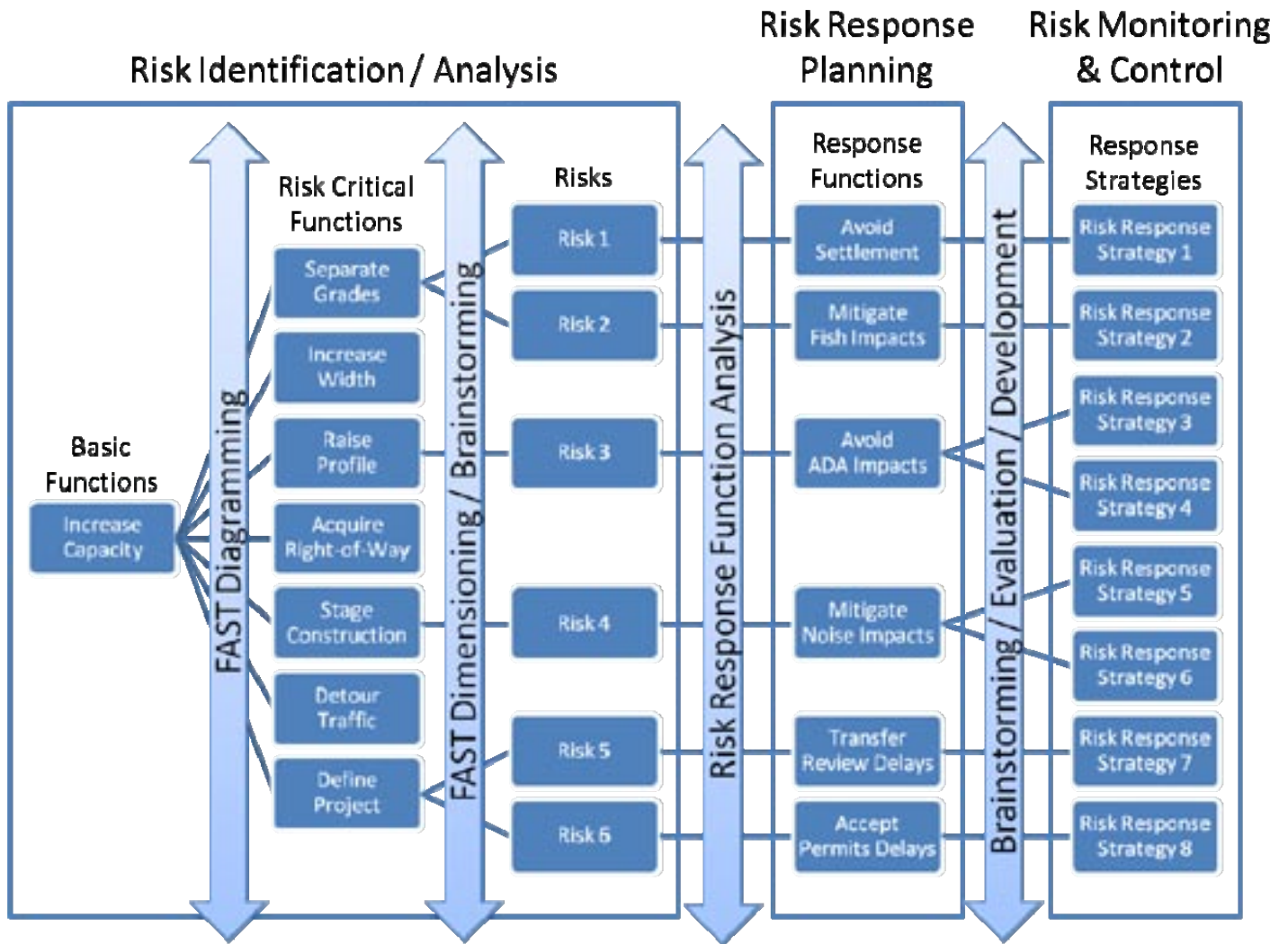


Figure 1. Function Driven Risk Management, Process Flowchart

direction, if one asked “How does it transmit force?”

A FAST diagram is essentially an elaboration of the simple linear diagram shown in Figure 1, and includes additional elements and logic paths. It is assumed that the reader has a basic understanding of function analysis and FAST diagramming, so details on the basic principles and techniques are not covered in this paper. It is recommended that those unfamiliar with these techniques refer to the bibliography at the end of this paper for further information.

So why use FAST? Perhaps the strongest reason to use it comes directly from Charles Bytheway, the originator of FAST:

“Most conflicts exist during an analysis because of poor communication between the parties involved when several people are working together on a given project. The main benefit of using Why-How Logic is the thinking and communication that take place as the

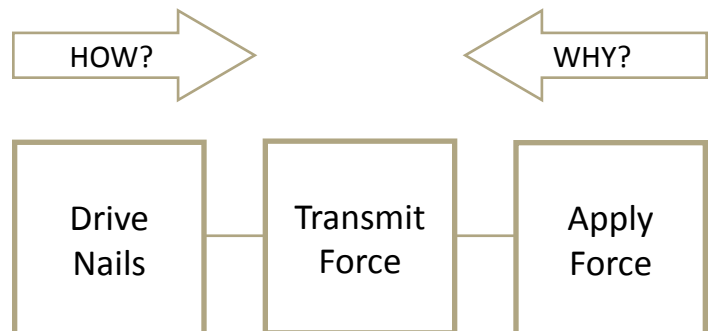


Figure 2. How-Why Logic

participants try to reason out the logic and arrive at meaningful answers.”ⁱ

Other important reasons are that it shows cause and effect relationships in an unambiguous way, reveals missing functions, and stimulates creativity. Lastly, it allows us to link information pertaining to project cost, time and performance value directly to the functions. This process is referred to as “dimensioning” a FAST diagram.

Provided in Figure 3 (next page) is an example of a FAST diagram developed for a railroad grade separation project that describes an over-crossing that is planned to be constructed over an existing rail line. The FAST diagram shows the relationship of all of the functions. Reading this diagram, one can see that the need for the project, referred to as the “higher-order function(s),” is to “Relieve Congestion” and “Improve Safety.” The purpose, referred to as the “basic function(s),” is to “Increase Capacity” and “Reduce Accidents.” The remaining functions located to right of the basic functions are referred to as “secondary functions,” and only exist due to the manner in which the basic functions are being delivered as part of the current design concept. If another way to “Increase Capacity” can be found, than it is possible that some or all of the secondary functions to the right could be changed or even eliminated.

Having completed the FAST diagram, the risk management team is now ready to begin brainstorming risks related to each function. Just like any good brainstorming session, the focus is on the quantity of risks rather than their quality – the risks themselves will be evaluated further during the next phase, Risk Analysis.

FAST Dimensioning

Depending upon the complexity of the project and the time available to perform FDRM, the risk management team may want to take the additional step of dimensioning the FAST diagram. Dimensioning refers to the process of linking project information, specifically cost, schedule and performance data, to the functions on a FAST diagram. If possible, it is recommended that all three types of data are included in the dimensioning process using the direct method.ⁱⁱ

Cost data should be evaluated by element or system based on estimates. The costs should then be distributed in a relative manner between functions as deemed appropriate by the team. For example, in the railroad grade separation project, assume that the cost for the roadway structural section is \$3 million for the project. Assume that the existing roadway is 4 lanes, which must be replaced, and the project is going to construct an ad-

ditional 2 lanes for a total of 6 lanes. This means that the costs could be approximately distributed between the following functions: \$1 million for “Increase Width,” and \$2 million for “Replace Roadway.” A cost-function matrix can be utilized to assist in this process if specific cost elements are distributed between many functions. A similar approach can be used for schedule information.

Information pertaining to project performance (i.e., scope) can also be considered. If specific project performance attributes have been identified, these can be assigned directly to the functions based on their relative influence on project performance. Methods for doing this are identified by previous work written by Robert Stewart.ⁱⁱⁱ For example, in the railroad grade separation project, the function “Increase Width” is being precipitated by the basic function “Increase Capacity.” Both of these functions are related to the dominant performance attribute, “Traffic Operations,” which is a measure of the overall level of service provided by the project. Therefore, these functions would be annotated with this information directly on the FAST diagram.

Once all of the pertinent information has been added to the FAST diagram, the risk management team can now consider how sensitive the functions are to risk. The risks for each function can be discussed and notes taken relevant to risk. Probabilities and impacts should be considered. In essence, using this approach is a form of qualitative risk analysis. The FAST diagram can then be dimensioned with this information. In Figure 4 (page 29), a dimensioned FAST diagram is shown for the project. The graphic information includes a mini-bar chart for cost information; the name of the key performance attribute; and a colored flag representing the overall risk level for each function.

This approach allows the risk management team to better assess the level of risk for each function relative to its influence on performance, cost and schedule. In projects containing many functions, this can help the team focus their efforts on functions that are both high value and/or possess a high level of uncertainty in identifying risks.

Risk Analysis

The Risk Analysis phase is the stage at which the risks that were identified are subsequently elaborated upon and analyzed. In addition, the nature and range of the risk impacts are further defined in order to gauge estimates of cost, performance and schedule impacts facing the project. The following activities comprise the Risk Analysis phase:

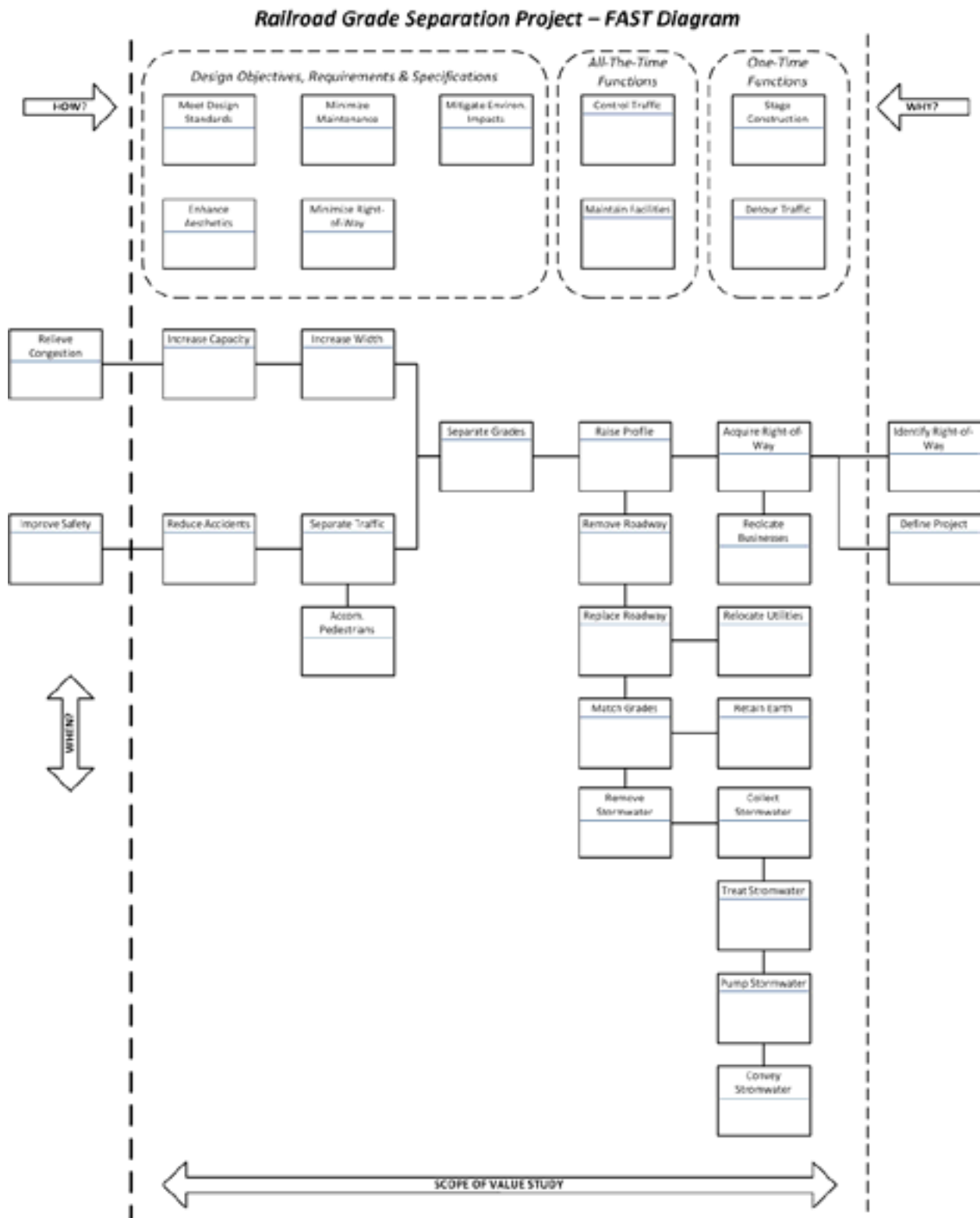


Figure 3. FAST Diagram of a Railroad Grade Separation Project

Railroad Grade Separation Project – FAST Diagram

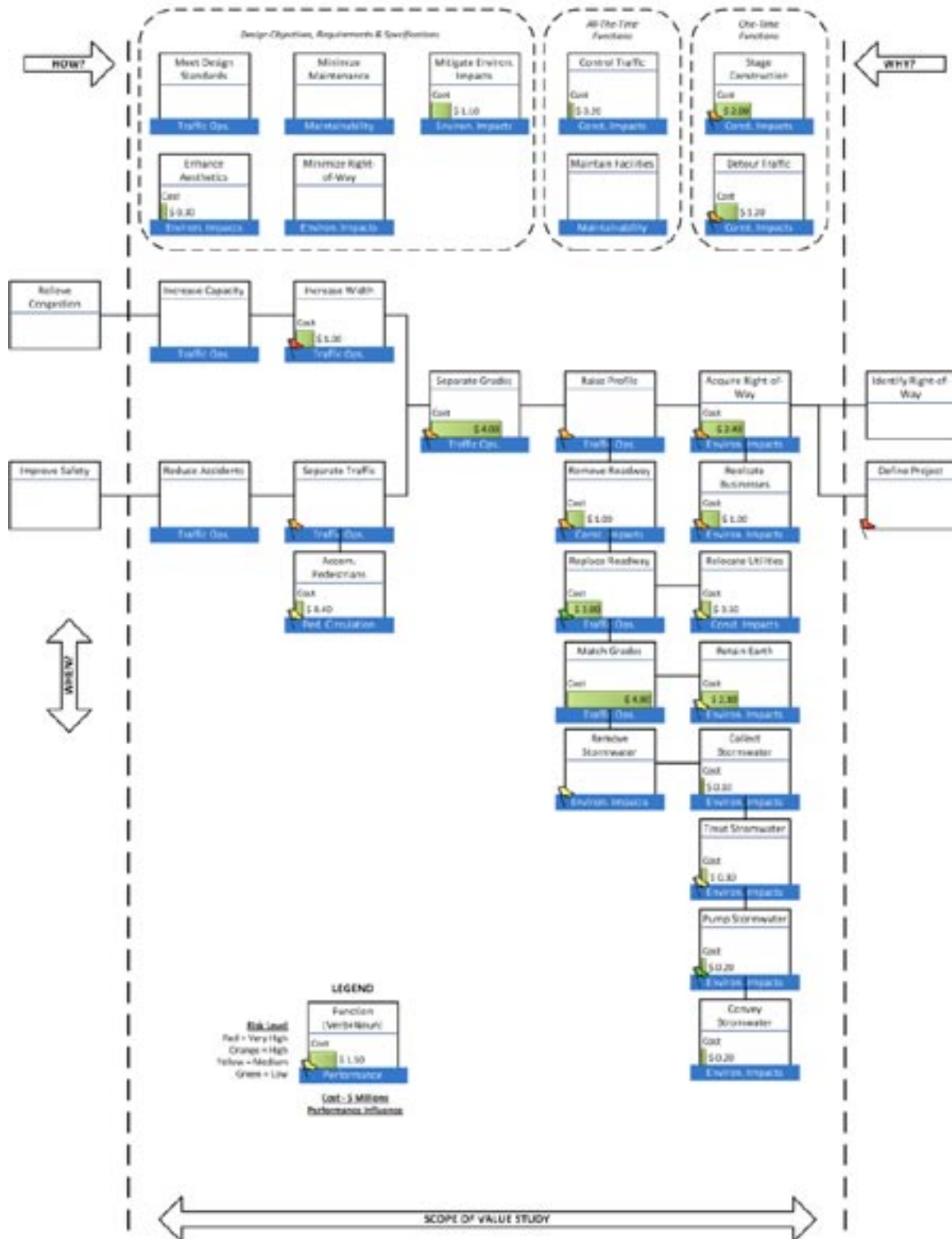


Figure 4. Dimensional FAST Diagram of a Railroad Grade Separation Project

- a. Additional Risk Identification – Further exploration of risks facing the project should be conducted. It is impossible to capture every risk, but the most relevant and highest impacting risks should be flushed out. This includes identification of new risks and expansion upon previously identified risks by the workshop team.
- b. Risk Register Refinement – The risk register should be qualitatively evaluated to determine what risks facing the project need review, modeling, response planning, and tracking. Again, priority to risks relating to critical project functions should be given. A way to qualitatively refine the risk register is to highlight the individual risk numbers in the risk register using a red, yellow, green color scheme to evaluate the risks. The following system of qualitatively coding risk priority can be used:
 - i. Red – Risks elevated to the highest priority and in need of risk management.
 - ii. Yellow – Risks elevated to a moderate level of priority and in need of risk management.
 - iii. Green – Risks determined to be at a low level of priority and not requiring direct risk management, but still requiring monitoring and tracking.
- c. Establishment of Probabilities and Impacts through Team Consensus – The probabilities and impacts for each individual risk should be developed. The team determines the range of cost and schedule impacts resulting from specific risks by establishing the low end of the range, high end of the range, and the most likely outcome. In addition, the likelihood of incurring the impact should be developed by the risk assessment workshop team. References for specific data elicited in the workshop setting needs to be documented in order to provide details surrounding the origin and basis of data being utilized. Commonly, most data elicited in a workshop setting is drawn from previous experience, so it is important to know the nature of the data to be able to gauge its relative reliability when conducting a quantitative risk assessment.
- d. Modeling of Pre-Response Risk – A pre-response risk model in which the risks are assumed to be in an unmanaged state is run in this step. Often the physical modeling is not conducted during the workshop time in which participants are meeting due to the complexity required in programming the mathematical risk model, as well as the time involved. Each of the risks and potential outcomes should be simulated 10,000 times using a Monte Carlo method. The result-

ing statistics should then be compiled and evaluated to determine the range of project cost, duration, and total risk under the specified conditions of uncertainty. *Note: The use of a more qualitative model is possible when data is scarce or unreliable, at which point the modeling effort will be far less complex and may allow for results to be more quickly generated.*

- e. Establish Secondary Risk Priority by Expected Value Impact Severity – The primary risk priority is dictated by the most critical project functions. The secondary risk priority is driven by the relative level of potential impacts that may be incurred. The expected value impacts of each of the individual risks are calculated and can be plotted on another tool known as a Tornado Diagram in order to visually demonstrate the risk impact severities. The Tornado Diagram has the highest level risks plotted at the top of the tornado and the lowest level risks at the bottom of the tornado. This diagram helps to provide a visual presentation of the risk priority ranking based on the expected value impacts. The larger the risk impacts, the higher the priority and vice versa. The Tornado Diagram can serve as a guide of where to focus the efforts of the Risk Response and Planning phase in combination with the consideration of project function. An example of a Tornado Diagram is provided in Figure 5 (next page).

Risk Response Planning

The Risk Response Planning phase is the most crucial phase of the entire workshop. This is the step where unique risk response strategies are developed for each of the risks, and each of the individual risk impact ranges and probabilities are updated to reflect the risk falling into a managed state. This stage focuses on laying the foundation for a solid management plan and includes full development of risk response strategies, complete with action plans. The following steps comprise the Risk Response Planning phase:

- a. Risk Object Identification – The affected area of impact is best described by the Risk Object. The Risk Object is the area affected by the risk in relation to the activity or project function being impacted. It is effectively also the elemental nature of the risk that can be managed. The object of risk for each individual risk is identified and utilized as the management target for idea development for risk response strategies. The Risk Object is typically the noun from the impacted project or system function, which is comprised of a two word abridgement of a verb-noun

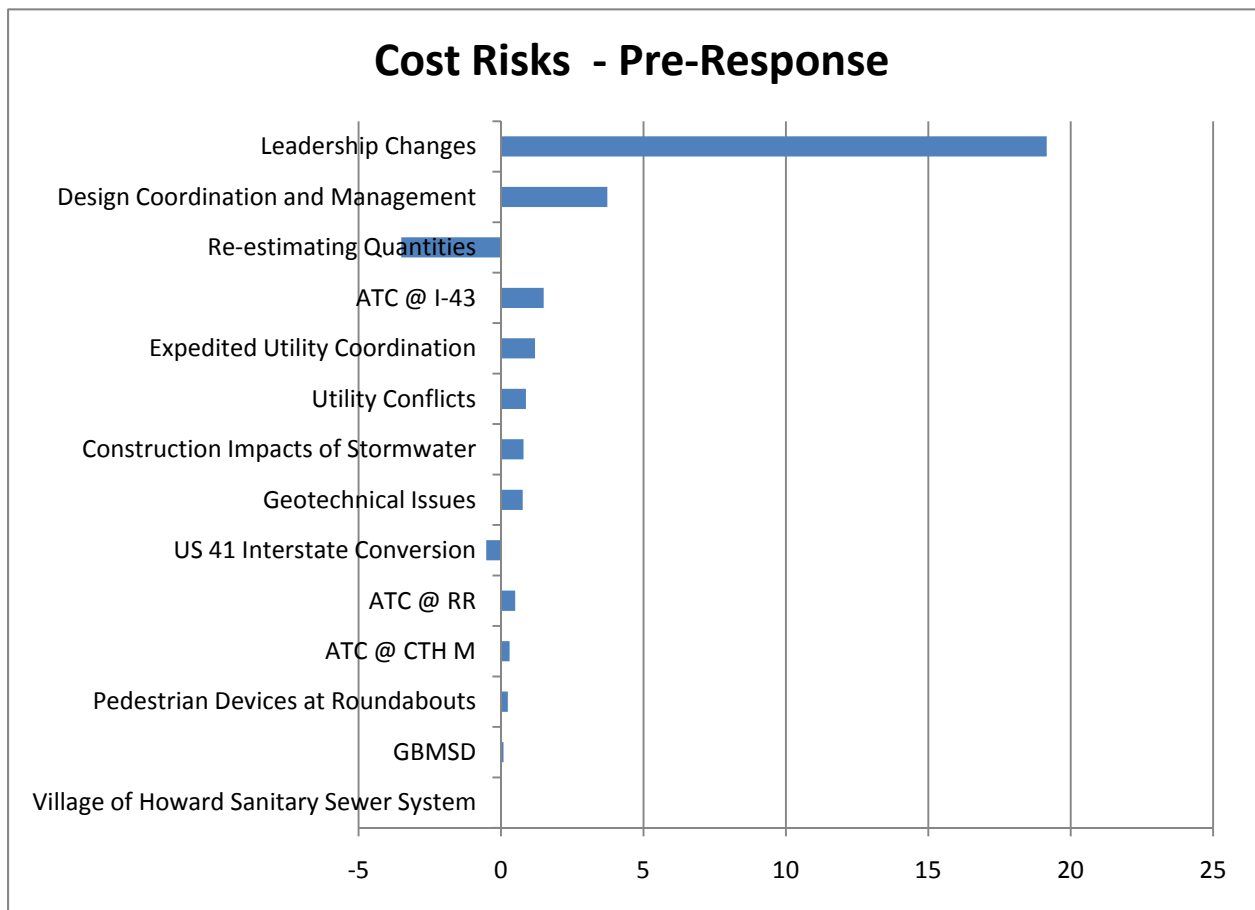


Figure 5. Pre-Response Risk Tornado Diagram

combination.

- b. Brainstorming of Risk Response Strategies by Function – The Brainstorming of Risk Response Strategies by Function is a three-step process. The first step is to establish the Risk Object, which becomes the target element that can effectively be managed, and it is also the element to which a risk response will provide the most direct buffering of risk impacts. Second, brainstorming of risk response strategies are developed by identifying the Risk Response Function. The Risk Response Function is a verb/noun combination that describes the risk response strategy to be employed. Third, a brief description of each idea is provided for each response strategy. Throughout the process of brainstorming, each high and moderate priority risk should receive attention. Also, the brainstorming process includes identification of specific strategies in the form of the function/verb that are possible to use, depending on whether the risk is a “Threat” or an “Opportunity.” For Threats the following function verbs are possible:
- i. Accept – Accepting a risk involves accepting a

risk as it currently exists.

- ii. Avoid – Avoiding a risk involves avoid impacts of the risk, often by spending additional capital up front to reduce later potential impacts.
- iii. Mitigate – Mitigating a risk involves reducing the range of impact of the threat, reducing the likelihood of occurrence, or a combination of reducing both impact range and likelihood.
- iv. Transfer – Transferring a risk involves the passage of potential impacts to another party or stakeholder. This often comes in the form of a premium to base costs, but it can often be less than the total impact of the risk by allowing a third party to manage and buffer risk impacts.

For Opportunities the following Function verbs are possible:

- i. Enhance – Enhancing a risk involves maximizing the potential opportunity in an attempt to realize the full impact. Often the outcome is anticipated to be better than originally planned.
- i. Exploit – Exploiting a risk involves taking advan-

Risk Response Strategies											
Team Brainstorming											
Risk ID	Risk Name	Type	Description	Object of Risk	Probability	EV Cost	EV Schedule	Function		Rating	
								Verb	Noun		Ideas
23.1	TransCanada at Main Ave/CTHG	Threat	A critical TransCanada pipeline crosses Main Ave/CTHG just west of the southbound ramp terminal, then follows the west side of the SB off-ramp and crosses US 41. This pipeline may be in conflict with the proposed storm sewer system, pond excavation, and street lights. TransCanada typically requests a 25-foot wide clear zone between their pipelines and any structures, such as manholes, inlets, and light poles. Whereas this line is primarily within the right-of-way, it's relocation will be minimally compensable and TransCanada is slow and expensive to move.	Pipeline Conflicts	75%	\$1.31	1.25	Mitigate	Pipeline Conflicts	Aggressively and clearly define all conflicts with the TransCanada pipeline	🟢
								Mitigate	Pipeline Conflicts	Early coordination with TransCanada to identify pipe location	🟢
								Mitigate	Pipeline Conflicts	Investigate legal coordination issues early on with TransCanada to establish who was there first and what the compensation levels were	🟢
								Avoid	Pipeline Conflicts	Redesign intersection to eliminate any conflicts with the pipeline	🔴
								Avoid	Pipeline Conflicts	Move to a tight diamond configuration to shift profile (assuming both Ashland Ave. structures are being replaced)	🟡
								Avoid	Utility Liability	Follow TRANS 220 process	🟡
								Accept	Utility Liability	Violate TRANS 220 process for the trade-off of getting projects built earlier and allocate necessary funds to budget	🟢
23.2	Expedited Utility Coordination	Threat	The risks associated with violating TRANS 220 timelines or the need to fairly compensate utilities may be outweighed by the need to minimize construction delays. Thus DOT would take on liability for construction delays due to unresolved utility conflicts.	Utility Liability	95%	\$1.20	2.53	Mitigate	Utility Liability	Engage in extra coordination with utilities	🟢
								Mitigate	Utility Liability	NCG monthly meetings with Beecher Hoppe for coordination	🟢
								Transfer	Utility Liability	Shift responsibility to contractor and have him price risk in bid	🟡
								Exploit	Cost Savings	Get consultant under contract to provide updated estimate to validate cost savings	🟢
24	Re-estimating Quantities	Opportunity	There is the opportunity to realize cost savings resulting from re-estimation of quantities	Cost Savings	75%	\$6.88	0.00	Exploit	Cost Savings	Review upcoming bids to "learn" what unit prices are looking to be and what the contractor-bidding environment is possibly looking to be	🟢

Figure 6. Risk Response Brainstorming and Evaluation

tage of an opportunity and putting strategies and actions in place to realize the impact. This often involves recognition of opportunities that were not previously identified.

- ii. Share – Sharing a risk involves recognition of an opportunity that can be dispersed across several activities, project segments, or future planned projects.
- c. Evaluation of Risk Response Strategies – The evaluation of risk response strategies are brainstormed and evaluated to determine which responses provide the most relative value to either minimizing threats or maximizing opportunities. Each response strategy should be qualitatively evaluated in relation to this criterion. For example, each response strategy can be given a green check mark, a yellow exclamation mark, or a red “X”. The response strategies that have green checks become the risk response strategies that are developed in further detail. The yellow check marks become fall-back strategies that could be put into place as efforts to manage the risk if the preliminary strategies are not working as effectively as anticipated. The yellow check marks also have

the possibility of being developed as additional risk response strategies. The red Xs are deemed to be invalid or ineffective risk response strategies to utilize in the context of the project. Keeping the evaluation simple is best in this case so that the time in the workshop can be most effectively utilized. Figure 6 provides an example worksheet of this process.

- d. Development of Action Plans for Risk Response Strategies – The final development of the risk Action Plans involves a combination of several elements. This includes the assignment of the risk to key individuals or groups that are deemed to be best equipped to manage or deal with the risk by the Risk Assessment workshop team. Development of action plans also includes providing more detail around the risk response strategy selected in the form of developing specific actionable steps that can be followed in order to best manage the risk.
- e. Secondary Risk Analysis – This step involves reassessing the probabilities and ranges of potential impact for each individual risk. Included in the reassessment should be the consideration of the risk response strategies and action plans to be put into place and

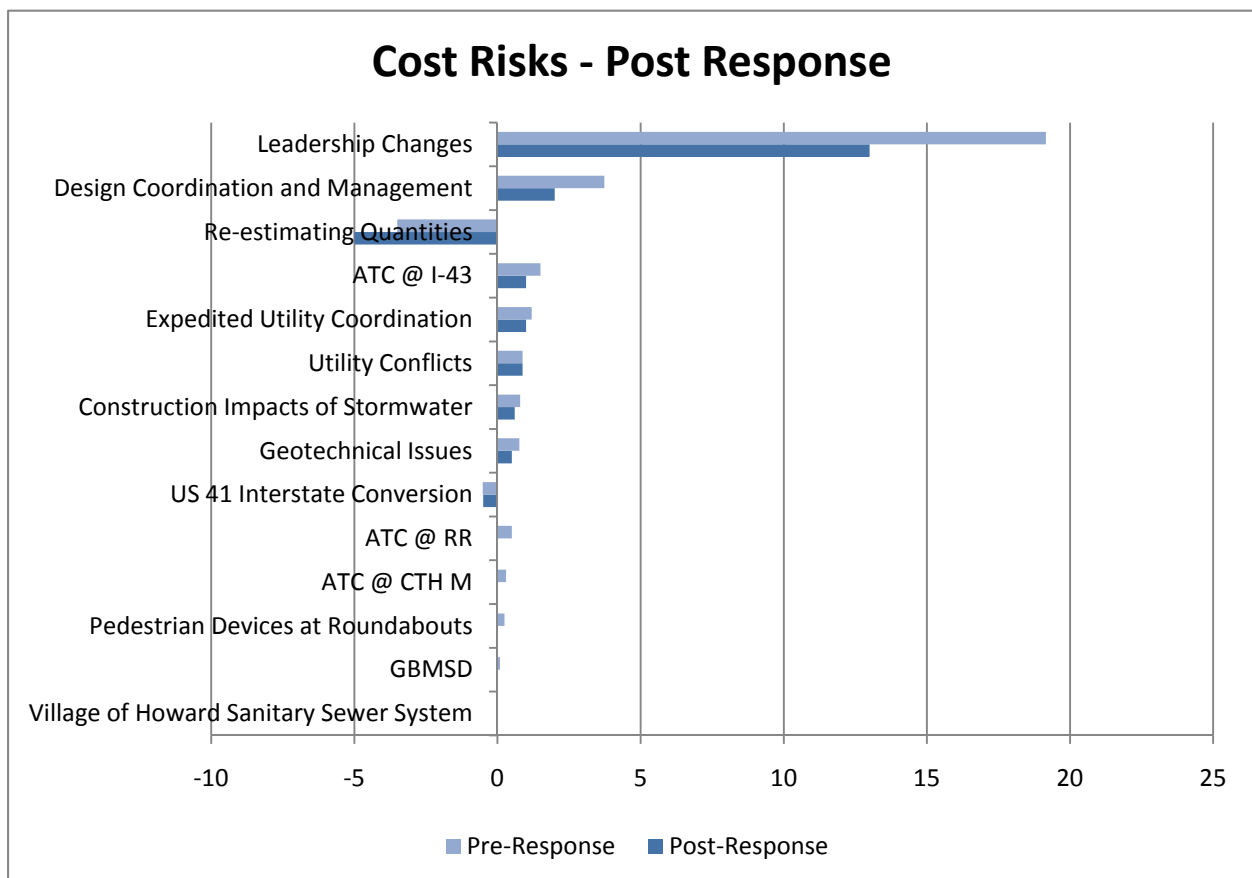


Figure 7. Post-Response Risk Tornado Diagram

how they would be anticipated to help in either minimizing or maximizing the risk impacts and potential likelihoods of occurrence. The following steps summarize the Secondary Risk Analysis phase:

- i. i. Establishment of Post-Response Probabilities and Impacts – The probabilities and impacts for each individual risk are developed again. This time the team determines what the range of cost and schedule impacts resulting from specific risks would be by establishing the low end of the range, high end of the range, and the most likely outcome by taking into consideration the risk response strategies and action plans. In addition, the updated likelihood of incurring the impact is developed by the risk assessment workshop team.
- ii. ii. Modeling of Post-Response Risk – A post-response risk model in which the risks are assumed to be in a managed state should be run. This is typically not conducted during the workshop due to the complexity required in programming the mathematical risk model, as well as time constraints. It is possible, however, when utilizing a more qualitative model to obtain results relatively sooner due to the reduced complexity of the model. In situations where a qualitative model is being used it may be possible to obtain the results during the workshop. When using a quantitative model, each of the risks and potential outcomes should be simulated 10,000 times using a Monte Carlo method. The resulting statistics should then be compiled and evaluated. The results of the post-response risk model can then be compared to the pre-response state in order to assess the difference that managing and responding to the risks makes.
- iii. iii. Reevaluate Expected Value Impact Severity – The expected value impacts of each of the individual risks are calculated again and plotted with the pre-response state on the original Tornado Diagram in order to provide a direct comparison of the post-response state. Again, the Tornado Diagram has the highest level risks plotted at the top of the tornado and the lowest level risks at the bottom of the tornado. This diagram helps to provide a visual presentation of the expected values resulting from proactive risk management. The Tornado Diagram with the pre-response and post-response results serves as a guide of the relative effectiveness of the proactive risk manage-

ment of the highest priority risks. Figure 7 (page 34) depicts a sample Tornado Diagram in which the pre-response and post-response results have been plotted.

Risk Monitoring and Control

The Risk Monitoring and Control Phase is the stage of the workshop that concludes the immediate assessment of risk and compiles and presents all of the data that was generated in the Risk Assessment workshop. This does not end the risk management process, but rather serves as a transition into the ongoing process of monitoring and controlling project risks. The following steps comprise this phase:

- a. a. Compile Results of Risk Analysis and Workshop – The compiling of the risk analysis and workshop data involves compiling of all versions of the risk register as it evolved throughout the workshop and prior steps of the risk management process, compiling the outcomes of risk response strategy brainstorming, evaluation, and development, and finally compiling of all of the resulting output data from the mathematical risk model. The data and results are compiled typically for inclusion into a final communication medium. In this process we will use the term “report”.
- b. b. Compile Risk Management Plan – Compilation of the risk management plan is effectively the editing and refinement of the Risk Action Plan development forms produced during the risk assessment workshop. The individual Risk Action Plan development forms combine to create the risk management plan as it presents the management strategies, action plans, milestone review dates, and risk owners for each individual risk.
- c. c. Produce Report – The production of the report involves compiling all of the data, results, and outcomes from the entire risk process. The report serves as the summary of the risk workshop, presentation of the risk analysis results, and the established and agreed upon risk management plan.
- d. d. Establish and Execute Risk Monitoring and Control Plan – The establishment and execution of a risk monitor and control plan is the final step in engaging in a detailed and comprehensive strategic risk management process. The risk monitor and control plan establishes the frequency of additional risk review, risk identification, and evaluation. It is an iterative process that engages the project team in continuous review and feedback of how risk is evolving through-

out the project. This step includes updating risks to be in an active, dormant, or retired state, as well as updating the progression of the risk throughout the project lifecycle by identifying any new risks and retiring risks that are no longer a threat or opportunity. For any newly identified risks the process of identifying adequate risk response strategies and developing the action plans should be repeated. In general, the risk monitoring and control phase is effectively the continuous follow-through step of the risk management process and ensures that risk response strategies and action plans are being followed, thus ensuring that the risks of the project remain in an actively managed state.

Conclusions

The integration of function analysis and FAST diagramming into the traditional risk management process is a means to enhance the overall process. Use of FAST diagrams helps to facilitate communication and enable workshop team members to focus on the project or system delivery goals. In addition, function analysis resulting from the development of the FAST diagram helps to bring focus to potential areas of uncertainty. The project critical functions can also be identified as a means to focus the elicitation of project risk. Furthermore, risk priority can be assigned based on function criticality in order to provide rank and order to the project or system risk profile. Finally, adequate risk response strategies can be brainstormed and developed with the focus of project function as the risk object. Each of these benefits carries an advantage that helps to enhance the overall risk management process in Function Driven Risk Management (FDRM).

The modification to the traditional risk management process comes in the form of three main changes. The first main change is to incorporate the use of function analysis and the development of a FAST diagram into the risk management process. Typically the risk management process focuses on the general project and what risk events may impact it. By looking more globally at project function, the process is enhanced by providing direct focus on the functions of critical importance. The second main change is the added step of dimensioning the FAST diagram in a manner that helps to establish function priority. The functions with the highest priority are of importance to the project or system in that if the specific functions were eliminated the project or system would be negatively altered. By using this as a means to brainstorm risk events on critical functions, the highest

priority risks of the project are naturally established. The third main change is the use of project function in the brainstorming and development of risk response strategies. The use of project function provides focus to the direct object of risk impact that requires solutions to optimize the impact of the risk event. The development of the risk response strategies and action plans is enhanced as a result of the focus on project function because of the direct linkage from top to bottom (i.e., the project function drives the risk identification, which in turn drives the risk priority establishment for risks to manage, which also establishes the object of focus for risk management strategies and action plans).

Overall, the use of function analysis as a means to augment risk management incorporates some of the tools of VM that best facilitate communication and understanding of the project or system. By enhancing the traditional process, the results generated provide for a better and more focused effort of risk management throughout a project or system's lifecycle. The process is directed toward holistic thinking while still providing for fully developed plans for dealing with risk. With better understanding and communication of function the effectiveness of the risk management strategy can be enhanced by allowing for focused decision making and efficient usage of resources in the execution of project or system delivery.

References

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About the Authors

Robert B. Stewart, CVS-Life, PMP, FSAVE is a vice president of Value Management Strategies, Inc. He is the youngest Certified Value Specialist to achieve "Life" status on his certification and was inducted into the SAVE College of Fellows in 2009.

Gregory W. Brink, CVS, is the Director of Risk Management for Value Management Strategies, Inc.

Seizing the Opportunity: Mn/DOT's Initiative to Go Beyond the Federal VE Mandate

Gary R. Myers, PE, CVS

Abstract

Recognizing the benefits of value engineering to its work program, the Minnesota Department of Transportation (Mn/DOT) decided to investigate expanding their VE program beyond the Federal mandate. The development of their expanded program entailed two phases: a pilot program to test the use of VE on projects not subject to the Federal mandate and the detailed development of the expanded VE program. The latter featured an inventory of six other state VE programs and consideration of nearly every conceivable facet of a state's VE program.

Selecting the projects to study using VE was a key issue. Simply lowering the dollar thresholds from the Federal requirements (i.e., \$25 million for road projects and \$20 million for bridge projects) would have been one way to expand the use of VE. The department recognized, however, that this would capture many projects that are not traditionally good candidates for VE, such as resurfacing projects. In addition, it would not be an effective way to prioritize the expenditure of limited VE funds.

Under the proposed program, projects will be selected for VE studies through a process that adopts familiar concepts already established in the field of risk (and opportunity) analysis. Two variables will be considered to evaluate the relative opportunity of each project in the state's work program for improvement via value engineering. The first, "potential for beneficial change," reflects project characteristics that have historically been associated with successful VE studies, including, but not limited to project size and complexity. The second variable, "likelihood of change," acknowledges that changes identified early in the project development lifecycle have greater chance of being implemented than those suggested later as construction letting approaches. Combined, the two variables will allow Mn/DOT to rank order the projects in its work program based on their relative potential for improvement through VE.

Other key features of the proposed program include separate tabulation of "value added" proposals; guidelines for team selection, composition, size, etc.; and several measures aimed at handling the administrative and

financial burdens of an expanded program.

As a pre-approved value engineering consultant with Mn/DOT, Jacobs Engineering Group Inc. was hired to assist the department with the development of its program. The author led Jacobs's activities in completing this assignment.

Introduction

In 2007, the Minnesota Department of Transportation (Mn/DOT) began an initiative to improve its value engineering program, including the possible expansion of the program to include selected projects for which the Federal VE mandate does not apply.

The initiative was conducted in two phases. Phase I tested the applicability of the value engineering process to projects with costs below Federal cost thresholds¹. In addition to confirming the benefits of value engineering for these "smaller" projects, Phase I also yielded valuable insights about the selection of projects most likely to benefit from value engineering.

Phase II developed recommendations for the proposed program. It began with an inventory of the established and well-respected value engineering programs of six state transportation agencies: Washington State DOT, California (Caltrans), Texas DOT, Missouri DOT, New York State DOT, and Florida DOT. These programs were compared and contrasted so that the features most appropriate to Mn/DOT could be identified. Following this review, Mn/DOT and its consultant melded selected practices with new ideas of their own in order to refine the program that is currently being implemented.

Phase I

Phase I consisted of two value engineering studies conducted in late 2007 and early 2008. The subjects of these studies were projects with total costs under the Federal cost thresholds. The projects studied, including a brief description of each, were as follows.

- Study 1: TH 8 from Shoquist Lane in Chisago County to East City Limits of Lindstrom.

- Reconstruction of a two-lane trunk highway in an urban setting: 2.7 miles in length; preliminary plans about 75% complete; estimated cost \$17.3 million.
- Study 2: 4 Projects (3 Preservation Projects; 1 State Aid Project).
 - Mill and overlay of a rural two-lane trunk highway plus safety improvements: 24 miles in length; plans about 20% complete; estimated cost \$6.4 million.
 - Bridge replacement with potential roadway realignment: current road embankment and bridge suffering from stream erosion and scour; preliminary plans about 50% complete; estimated cost \$5 million.
 - Mill and overlay of a rural two-lane trunk highway: widening (10' lanes widened to 12' lanes); geometric corrections at spot locations; 3 bridges; 22 miles in length; plans about 85% complete; estimated cost \$11.4 million.
 - Existing 2-lane rural design that has been encroached upon by businesses moving out towards the freeway: road will be converted to a four lane section with curb and gutter; signals; a trail; Categorical Exclusion and preliminary plans complete; final design has not started; estimated cost \$3.8 million.

The Phase I studies revealed valuable insights for the subsequent Phase II work. The more important of these insights were:

- The studies validated that value engineering can achieve benefits for projects with costs lower than the \$25 million Federal mandate.
- Some projects are better candidates than others for value engineering.
 - Projects must have adequate information available for the study.
 - Projects should be at a stage of development that allows time for modification without significantly delaying the project.
 - Some types of projects, such as those primarily involving pavement rehabilitation, may often offer few opportunities for improvement significant enough to justify the costs of a study.

Phase II

The scope of Phase II included the following key tasks:

1. Review the projects studied in Phase I of the Value Engineering Pilot Project (as described in the previous section).
2. Review the value engineering programs of five to six other states, selecting programs offering a diversity of features.
3. Inventory features of each reviewed program.
4. Develop a report and a Microsoft Excel spreadsheet detailing the features to be included in the proposed statewide value engineering program.
5. Develop a draft value engineering program report and recommendations for the State drawing on the best elements from the other state programs. This will include, but not be limited to, the following:
 - A screening tool that the State can use internally to determine which projects should have value engineering studies.
 - A measuring tool to evaluate how the value engineering process is working.

VE Program Inventory²

The review of the six state programs (WSDOT, Caltrans, TxDOT, MoDOT, NYSDOT, and FDOT) covered a wide variety of features in twelve categories. These categories are listed in Figure 1.

As might be expected, this inventory yielded a great deal of useful information. A very brief summary of a few selected topics is provided below, reflecting not only the results of the inventory but also the experience and input of Mn/DOT's Central Office VE staff and Jacob's cadre of VE facilitators.

Project Selection Criteria

Project cost remains the most often used criteria

- Project Selection Criteria
- Study Team
- Conflict of Interest
- Workshop Duration
- Individual Study Features
- Quality Assurance
- Implementation
- Dissemination of Innovative Ideas
- VE Program Administration
- VE Program Promotion
- VE in Design-Build Projects
- Value Engineering Change Proposals (VECP)

Figure 1. Inventory Categories

for the selection of projects to be studied, with several states having established a threshold below the Federal levels. Cost is often used as an indicator of broader scope, greater complexity, and lengthier project development time, although states often use the lower thresholds they've established as an initial screening tool and then apply additional criteria. These criteria can include:

- Projects that are likely to have far-ranging alternatives.
- New alignment or bypass projects.
- Complex designs.
- Designs that utilize expensive or hard-to-procure materials.
- Widening projects.
- Interchanges and freeways.
- Extensive cut, fill, or haul.
- Major traffic control challenges.
- Expedited design cycles.
- Extensive or unusual environmental challenges.
- Complex geotechnical challenges.
- Unusual safety issues.
- Large cost or schedule variances.
- Changes in the design team at critical junctures in project development.

Study Team Composition

Study team members are usually provided by the agency and/or by consultants. Local agency staff and other stakeholders are often included, but contractors are rarely used due to real or perceived conflict of interest questions. Engineering interns or trainees are often included on study teams to give them additional experience and exposure to senior engineers and other professionals in action.

Individuals who have been directly involved with the project in question continue to be excluded from most study teams out of concern that they may resist change and be overly protective of the current design. However, there seems to be some movement toward acceptance of a limited participation on the study team by such individuals. Those supporting their participation (in small number compared to the overall size of the team) believe that the benefit of their insight into project conditions and issues outweighs the negative impacts. In addition, the project team participants can convey the study team's viewpoints back to the project team at large, increasing the prospects for implementation of workshop recommendations.

In-house and consultant team members bring different resources to a value engineering workshop. Inhouse staff often have a better understanding of current department practices, more exposure to construction and

maintenance issues, and may have seen more instances where common problems were encountered and resolved. However, the experience of in-house team members may be limited to work within a single agency and a limited number of assignments within that agency. As a result, in-house staff may be more locked into a certain way of doing things and may have trouble "thinking outside the box."

On the other hand, consultant personnel have often had a more varied experience, not only in transportation but also in other fields of practice such as municipal projects, site work, buildings, water resources, airfields, etc. They also may have been exposed to different state agencies and experienced different approaches to solving similar problems. Both of these factors can result in a larger reservoir of different approaches that might lead to more innovative ideas.

Workshop Duration

Project size and complexity are the most common drivers in establishing the length of a workshop. However, while most states don't specifically address project type as a factor in determining study duration, in practice many recognize that certain types of projects warrant a lower level of resource expenditure. Rehabilitation projects are the prime example of such a project.

One state noted that the stage of project delivery was the most important determinant of workshop duration. Typically, a five-day study was recommended for a project still undergoing the environmental clearance process. In contrast, shorter workshops of three-day duration were recommended for projects late in final design.

Life Cycle Cost Analysis (LCCA)

The FHWA definition of value engineering requires that study teams "...provide the needed functions to accomplish the original purpose of the project...at the lowest life-cycle cost..." Most agencies include similar guidance in their value engineering policies and procedures.

In practice, there are several obstacles to conducting LCCA during value engineering studies.

- Many costs that need to be included are difficult to quantify. For example, there is often little quantitative information available for agency operations and maintenance costs.
- Agency staff and decision makers are often wary of net present value savings computed using LCCA methods. In spite of Federal guidance to the contrary, they may not be convinced that time value of money principles apply to agencies that don't have alternative investment opportunities available to pri-

vate enterprises.

- LCCA calculations do not reflect some considerations that are important to decisions involving deferred construction. In most cases, deferred construction, even when a second mobilization cost is included, offers net present value savings compared to construction in a single phase. However, in addition to difficulties in computing road user costs (and, in particular, those associated with the added future construction period), deferring construction may introduce the chance of future funding, approval, and environmental issues. Decision makers and agency staff often fear that LCCA encourages short-sighted decisions that will increase future challenges.

Dissemination of Innovative Ideas

Most agencies admit that they do not do a good enough job of disseminating innovative ideas generated during value engineering studies. Not only do most agencies fail to capture and disseminate good ideas from value engineering studies, they also fail to publicize like ideas that result from contractor change orders, design-build contract alternate technical proposals, value engineering change proposals, or other sources.

One agency publishes a brief list of recommendations from each year's program on the Internet, allowing designers to browse the list of recommendation titles for entries that are of interest. If a designer wants more information, he must then probe within the organization to locate someone who is able to provide greater detail.

The Ontario Ministry of Transportation (MOT) has one of the better programs for disseminating innovative ideas. The MOT requires each value engineering study facilitator to prepare a brief article on the results of the study. These articles are then considered for inclusion in publications available to the ministry's staff and consultants.

Recommendations

The following is a summary of the recommendations for the further refinement of the Mn/DOT value engineering program, as developed by the Central Office staff and its consultant.

- *Regardless of funding source*, determine the projects that offer the highest opportunity for being improved via the value engineering process by assessing two key considerations: *potential for beneficial change and likelihood of change*. This is a particularly unique and innovative feature of the proposed program that breaks with the Federal practice of selecting projects

predominantly based on total project cost. *Rank order projects* statewide based on these assessments and select projects to be studied based by considering the relative scores in the assessments. Repeat this assessment periodically.

Indicators of a high potential for beneficial change through VE include high cost; a high degree of impact on humans or on the natural environment; a broad scope; a high degree of complexity; and the presence of unusual features, unusually costly features, or unusual challenges. New alignments also offer a high potential for change since they are not constrained by the use of an existing alignment.

The likelihood that a change will actually be implemented is directly correlated to the stage of its progress in the project delivery process.

A project evaluation worksheet was developed as a tool to support project selection. The proposed worksheet is shown in Figure 2.

- Base the size of the study teams on the need to have a team with *sufficient experience and a broad enough background* to be able to understand the project and develop alternative layouts, features, materials, techniques, etc. that might be beneficial.
- Use teams with a *mixture of in-house and consultant team members*, but exclude contractors to avoid potential unfair advantages during the bidding process. Include *limited participation by those involved in the project's development*. Include other stakeholders as appropriate. *Let engineering interns participate*, but not as substitutions for more experienced staff.
- Adopt procedures that allow consultants to provide facilitators for value engineering studies without precluding them from consideration for more sizable engineering assignments on the same projects by *implementing firewall procedures*.
- Conduct studies of *four to five day duration* based upon the complexity of the project and the amount of relevant material, with an *additional one to two days* if *quantitative risk analyses* are to part of the workshops.
- Consider including *qualitative risk analyses* with all studies, but *quantitative risk assessments* only when warranted.
- Develop guidelines for *life-cycle cost analyses*.
- Develop *quality control* guidelines appropriate for the length of value engineering studies and the limited resources available to the team. Include a *dis-*

Potential for Beneficial Change	Maximum Score	>>>>Increasing Potential for Beneficial Change<<<<			Score	Comments
Total Project Cost	4	Under \$10M for roadway projects; under \$7.5M for bridge projects (1 point)	Over 10M for roadway projects; over \$7.5M for bridge projects (2 points)	Over \$20M for roadway projects; over \$15M for bridge projects (4 points)		
Degree of Human Impact	4	Human impact typical of routine projects (1 point)	Human impact in excess of routine projects, but no creating unusual hardship or similar impacts (2 points)	High degree of human impact, possibly creating unusual hardships (4 points)		
Degree of Environmental Impact	4	Projects requiring or likely to require a Categorical Exclusion (1 point)	Projects requiring or likely to require an Environmental Assessment (2 points)	Projects requiring or likely to require an Environmental Impact Statement (4 points)		
Scope & Complexity	4	Simple, routine projects (1 point)	Project of moderate complexity (2 points)	Highly complex projects, with complicated, interconnected features (4 points)		
Unusual or Unusually Costly Features	4	No unusually costly features (1 point)	Presence of unusual or unusually costly features, but with minor impact on total estimated cost (2 points)	Presence of highly unusual features or unusually costly features with significant impact on total estimated cost (4 points)		
Total	20				A= 0	

Likelihood of Change	Maximum Score	>>>>Increasing Likelihood of Change<<<<			Score
Project Stage	5	Over 75% Final Design (2 points)	After Preliminary Design But Before 75% Final Design (3 Points)	Preliminary Design (5 Points)	
Total					B= 0

Opportunity for Project Improvement

(A X B)=

Figure 2. Project Evaluation Worksheet

claimer in each report so that readers are aware of study limitations.

- Document decisions regarding the acceptance, rejection, or modification of each study recommendation with a standardize form. Monitor implementation.
- Provide feedback to study team members. Require facilitators to prepare an article summarizing each

study. Publish a summary of the recommendations of each study using a vehicle that makes the recommendations available to both in-house staff and consultants. Solicit and publish innovative ideas from other sources as well.

- Task the Central Office to assist project managers with the coordination and administration of individual studies. Establish a Central Office budget to pay the

Perspective	Qualitative Measures	Quantitative Measures
Stakeholder	Quality of recommendations (Districts)	Savings from implemented ideas* Value added by implemented savings Return on investment*
Process	Quality of supporting documentation (Districts) Quality of facilitation (Team members)	Percentage of recommendations that are implemented* Number of recommendations outstanding
Learning	Sufficiency of project information (Team members, facilitator)	
Resource	Quality of team (Facilitator) Sufficiency of workshop duration (Team members, facilitator)	

*Existing FHWA Requirement

Figure 3. Sample Program Evaluation Score Card

cost of facilitators for additional studies required under the Phase II program but not required by the Federal value engineering mandate. (Studies for projects required under the Federal mandate would continue to be paid for by the Districts.)

- Establish a *value engineering liaison in each District* as the point-of-contact for value engineering activities at the District level.
- Promote the program by *disseminating study information and other innovative ideas*, and through presentations at annual design conferences.
- Monitor activities of the Federal Highway Administration and the AASHTO Value Engineering Technical Committee as they pertain to *value engineering for design build projects*.
- Continue the use of *value engineering change proposals as covered by current policy*.
- Generate both *qualitative and quantitative measures* for each workshop. Solicit feedback at the conclusion of each study, gathering input from *Districts*, from *study team members*, and from facilitators.
- Utilize a *balanced score card* format based on workshop evaluations to summarize the performance of the overall Phase II Value Engineering Program. An example of such a score card is shown in Figure 3.

Status

As of the spring of 2010, a technical memorandum to implement the Phase II program recommendations is near completion, as is supporting material to be available on the Department's Internet site. Implementation is expected to take place in the summer or fall of 2010.

Conclusions

The Minnesota Department of Transportation is moving ahead to increase the benefits that its citizens receive from the practice of value engineering by maximizing the potential of its study teams, clarifying criteria for workshop features, formalizing the VE coordinator position at the District level, expanding Central Office support, and devising better ways of disseminating innovative ideas from workshops and other sources. Perhaps the most dramatic improvement comes in the means by which the Department selects projects to study that would not otherwise be required to have such studies by the VE Federal mandate. By utilizing a selection methodology that considers both the **potential for beneficial change** and the **likelihood that change will actually be realized**, the Department is taking a bold step to reinforce value engineering's proper role in the project development process as a unique and valuable opportunity for project improvement.

References

- ¹ US law mandates that a value engineering study must be completed prior to construction for all Federal aid projects on the National Highway System that have total costs of \$25 million, or \$20 million for bridge projects.
- ² Readers are referred to National Cooperative Highway Research Program Study 352, Value Engineering Applications in Transportation, for a more comprehensive survey of state transportation value engineering practices.

About the Author

Gary R. Myers, P.E., C.V.S. has managed the development of public works projects for nearly 30 years, with much of the last 10 years involved in the field of value engineering. He graduated with a Bachelor of Science in Civil Engineering from Purdue University and a Master of Business Administration from the University of Houston. Professional engineering licenses are held by Mr. Myers in the states of Texas, Florida, and Louisiana. He currently serves as a program manager and value engineer for Jacobs Engineering Group Inc. in Houston, Texas, where he manages the \$300 million expansion of the Port of Houston's Bayport Terminal and provides a number of state DOT clients with value engineering services.

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The Integration of Value Engineering and Risk Management in Strategic Alliance Public Private Partnership

Suyono Dikun and Herawati Z.Rahman

Abstract

Indonesia has just entered the second mid-term development planning 2010-2014. Economy is projected to grow from 5.5 percent in 2010 to 7.7 percent in 2014. A continued push for the development of infrastructure is therefore crucial to support the economic growth and to sustain it during the next five years and beyond. It is widely agreed that only efficient, effective, reliable, and stable infrastructure system and networks that can sustain Indonesia's rapid growth and increase its competitiveness in an increasingly global environment. Government spending on infrastructure has recently increased significantly. But efficiency and effectiveness of the expenditures are still low. To improve efficiency and effectiveness, government has been seeking private investors to build infrastructure through public-private partnership but so far has not been very successful. Since public spending for infrastructure tends to increase in the near future, it is necessary for Indonesia to find ways to improve the efficiency and effectiveness of its infrastructure project development and financing. Efficiency of both government expenditures and private investment are believed to be improved when risk assessment can be assessed simultaneously with the creation of value management.

This paper reviews studies and practical experiences about the integration of value engineering and risk management in Indonesia's infrastructure development and financing through public-private partnership. The main principles of the integration are then hypothetically applied to Selat Sunda Bridge project, a large scale forthcoming long-span bridge project connecting Jawa and Sumatera islands. It is also assumed that given the nature of the project, SSB would apply a strategic alliance type of PPP scheme which can simplify the integration process. The result of this research is intended to be contributing to the body of knowledge in both PPP and Value Man-

agement fields and in the best practice of modern project management where private involvement matters.

Keywords: Strategic alliance, public-private partnership, project financing, risk management, value creation

1. Introduction

Under the current administration, Indonesia is now stepping in the first year of its second mid-term development planning, 2010-2014. Economy was projected to grow steadily from 5.5 percent in 2010 to more than 7.0 percent in 2014. Total investment needed for making the growth possible is in the magnitude of around US\$ 1.1 trillion for the next five year. A continued push for the development of infrastructure is therefore crucial to support the economic growth and to sustain it during the next five years and beyond. It has also been predicted that Indonesia will need about US\$ 130-150 billion for infrastructure investment for both rehabilitating the existing inadequate infrastructure and building new facilities in the next five years to come. For Indonesia to reach a 6 to 8 percent medium-term economic growth target, additional infrastructure investments of 2-3 percent of its GDP per year are required from the current level of 3-4 percent of GDP. Government recognized the clear impediments to infrastructure growth and laid out a three-pronged approach designed to tackle these issues comprehensively:

- First, the Government is focused on sector reform to ensure a continually larger portion of infrastructure services are commercially viable and allow sustainable private sector participation in infrastructure investment and provision.
- Second, the Government will focus its own resources increasingly on sectors which are not commercially that can help the poor and remote communities.
- Third, over the medium-term, the Government will

enact programs to support greater private sector involvement in infrastructure investment and provision through creating and maintaining public-private partnerships (PPP) in infrastructure service and by removing all bureaucratic bottlenecks which currently inhibit private sector involvement.

2. PPP in Indonesia Infrastructure

2.1. The Background

The huge investment in infrastructure needed over the next five years and beyond represents an enormous challenge for Indonesia. Increasing PPP in infrastructure provision is therefore urgently necessary as state budget had been and would always be insufficient. On the other hand, private sectors have access to financial resources, new technology, and management skills that can lead to greater efficiency and effectiveness of infrastructure provision. Actually, PPP in infrastructure is not a new concept for Indonesia as it had been applied in several power and toll road projects in the early 1990s. The political circumstances evolved very recently have also indicated that it is not the issue of whether the public or private sector that should provide the infrastructure services but more to the issue of how the government with the participation of private sector could accelerate the provision of infrastructure services in an efficient and effective manner. The answers to this question involve economic and political choices that depend on the relative efficiency of public services in the country, on the potential availability of capital, on the social consensus about acceptable ways of delivering certain services, and last but not least on the willingness of the bureaucracy to change their attitudes. The public and social acceptability and strong political support of such partnerships is very often a key factor to the success of the undertakings.

2.2. Recent Development

On March 3, 2009, Bappenas issued Minister Regula-

tion Number 3/2009 on the procedure of PPP project planning and determination, categorized into potential projects, priority projects, and projects that are ready to be offered to private investors. The so-called Bappenas' PPP Book was first launched on March 15, 2009 containing 87 projects with an estimated total investment of US\$ 34.2 billion. The book was revised in early 2010, now with 100 projects and total investment of US\$ 47.3 billion. Table 1 summarized the projects listed in the 2010 PPP Book. Toll roads is by far the largest investment with US\$ 26.8 billion followed by railway with total investment of US\$ 9.5 billion and power plants with US\$ 4.05 billion. Listed also in the category of potential projects is the Sunda Strait Long Span Bridge with 29 km length and with an estimated cost of US\$ 11 billion. Indonesia is now working hard to finalize all the necessary policy and regulatory frameworks to smoothing out PPP for all aforementioned large-scale infrastructure projects. Preparation to embark on

the PPP undertakings includes the establishment of Land Acquisition, Guarantee, and Investment Funds under the auspices of Ministry of Finance in which around US\$ 500 million has been allocated from state budget to the funds as seed capital. Although the majority of the projects are potential in nature but the list has shown government strong will to go ahead with PPP projects.

Table 1. Indonesia PPP Projects by Sector (US\$ million)

Sector	Ready to Offer	Priority	Potential	Total
Land Transport	-	-	274	274
Ports	36	-	2,859	2,895
Airports	-	-	1,558	1,558
Railway	-	-	9,547	9,547
Toll Roads	-	7,592	19,261	26,853
Water Supply	-	522	1,328	1,850
Solid Waste and Sanitation	-	220	57	277
Power	-	-	4,045	4,045
Total	36	8,334	38,929	47,299

Source: PPP Book Bappenas, March 2010.

2.3. Basic Features of Indonesia's PPP

PPPs are contractual arrangements between the public sector and private entities company for the delivery of infrastructure services and are seen as a way of raising additional funds for infrastructure investment but more importantly as a means to extend or leverage better budget funding through efficiency gains (Delmon, 2009). PPPs are complex structures, involving different parties, long and demanding negotiations and relatively high transaction costs. PPPs invariably involve government at the planning, construction and operating stages. It is the responsibility of the government to ensure that the new facility will fit in with existing systems or networks.

But PPPs are much more complex than originally thought and requires a level of sophistication on the part of government that takes time to develop. The responsibility on the government to guide the process is even greater than when infrastructure provision was almost exclusively public. This is because adding a private component to any infrastructure network opens up a whole new range of complicated management, design and contractual issues.

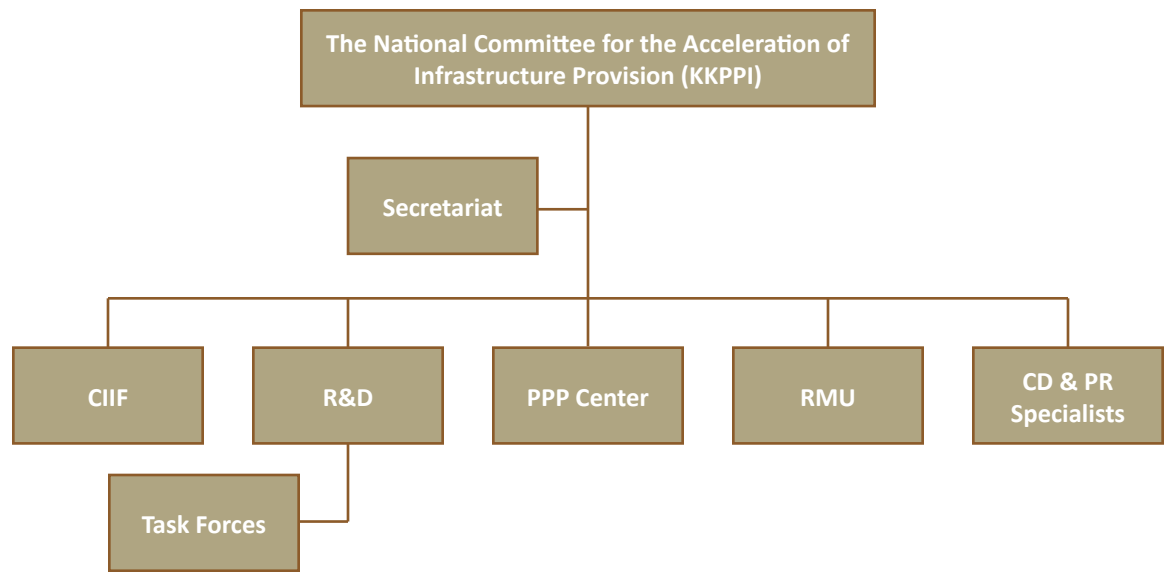


Figure 1. The Infrastructure Committee

Indonesia's PPP is administered by a national committee for the acceleration of infrastructure provision by means of private sector participation. Figure 1 shows the organization of the committee with its supporting units (public relation, R&D, forum, risk management unit, and PPP Center). This inter-ministerial coordinating committee is chaired by Coordinating Minister for Economic Affairs with related infrastructure ministers as the members and established by a presidential decree in 2001. In May 2005, the decree was renewed by a presidential regulation. The Committee was tasked with two main portfolios: (1) enhancing private sector investment (PPP) and (2) improving the policy and strategy of public service obligation (PSO). The Committee's main functions include coordination and decision making process of infrastructure policy, planning, and investment, including finding solution for various problems related with the acceleration of infrastructure development. Line ministries, however, will stay responsible for sector policy, project preparation, procurement, and transaction. Indonesia, however, has no PPP Law and the governing regulation is only a Presidential Regulation (PR No. 67/2005 and later revised by PR No. 13/2010). The PR regulates all the principles and procedures for public-private partnership for infrastructure projects from the preparation until the transaction.

2.4. Risk Management in Indonesia's PPP

Risks and uncertainties are a pervasive aspect of project management and public-private partnership scheme.

In general terms, risk can be defined as uncertainty in regard to cost, loss, or damage (Hoffman, 2001). In project management term, risk could also be looked at as an uncertain event or set of circumstances that could have an effect on the achievement on the project's objectives (Chapman and Ward, 2002,2003). In PPP terms, risk relates to uncertain outcomes which have a direct effect either on the provision of the services or the financial viability of the project. In either case, the result is a loss or cost which has to be borne by some parties (Yescombe, 2007). Risk management, therefore, can be defined as a systematic process of identifying, analyzing and responding to project risk, including maximizing the probability and consequences of positive events and minimizing the probability and consequences of negative events to the project objectives. The objectives of risk management is to ensure that risks are identified at project inception, their potential impacts allowed for and where possible the risks or their impacts minimized and to improve project performance via systematic identification, appraisal and management of project related risk (Ward, et.al., 1997). In other word, the aim of risk management is not to eliminate risk but to control it. Risk management ensures that risks are identified, reviewed, and mitigated accordingly and key stakeholders are made aware of the risks prior to any decision making process.

As a systematic process, there are many models used to manage the risks. The standard model is divided into four parts, namely risk identification, risk analysis, risk response, and risk monitoring and review. Meanwhile Baker et al (1999) developed a methodology encompasses 5 staged: identification, analysis, evaluation, response, and

monitoring. Successful risk management reduces the uncertainty in achieving a successful outcome to acceptable and manageable levels. A formal risk management process delivers the following benefits for the project team (Dallas, 2006):

- It enables management to embark on innovative, high reward projects in the knowledge that they can control the risks.
- It requires that the management infrastructure is in place to deliver successful outcomes. This includes setting clear, realistic and achievable project objectives from the outset.
- It established the risk profile of the project, enabling the appropriate allocation of risk, so that the party best placed to manage it has the responsibility for doing so. Risk allocation is a key component of contract documentation.
- It allows the team to manage risk effectively, concentrate resources on the things that really matter, resulting in risk reduction as the project proceeds.
- It also enables them to capitalize on opportunities revealed through use of the process. On infrastructure project, risk can have a positive impact upon project performance.

In Indonesia, risk analysis for private infrastructure projects is officially performed by Risk Management Unit (RMU), a unit under the Ministry of Finance (MOF), but works also under the Committee through the PPP Center. RMU is formed by MOF Decree in 2005. The Committee is to evaluate and determine whether specific infrastruc-

ture transactions qualify for public money support or any other non-financial supports. Together with the Committee, RMU works on different government support schemes and risk sharing to be provided. Government support and risk sharing arrangements will be finally decided by Minister of Finance based on the assessment and recommendation made by the Committee. In general, government will stay responsible for basic, non-financially viable infrastructure projects. For projects that are financially viable, private investors will be the main actors for financing with a possibility for government to provide a government support. Thus far, only three risks are covered by the decree: (i) political risk; (ii) project performance risk, and (iii) demand risk. Government has moved forward to enhance the Unit by establishing Indonesia Guarantee Fund (IGF) to take care risks arise from infrastructure projects with PPP and to formulate risk sharing arrangement which is appropriate according to the best practice of PPP contracts. Figure 2 depicts the government support scheme in which for any financially viable project, three funds would be made available: land fund in the preparation stage, guarantee fund in the bidding and construction stage, and investment fund in the operation stage. While Land Fund is tentatively managed by a special public service unit in an executing agency, Guarantee and Investment Funds have been established as a commercial legal entities under the supervision of Ministry of Finance.

2.5. Value Engineering in PPP

Value Engineering (VE) is the systematic review of a project, product, or process to improve performance, quality, and/or life-cycle cost by an independent multi-

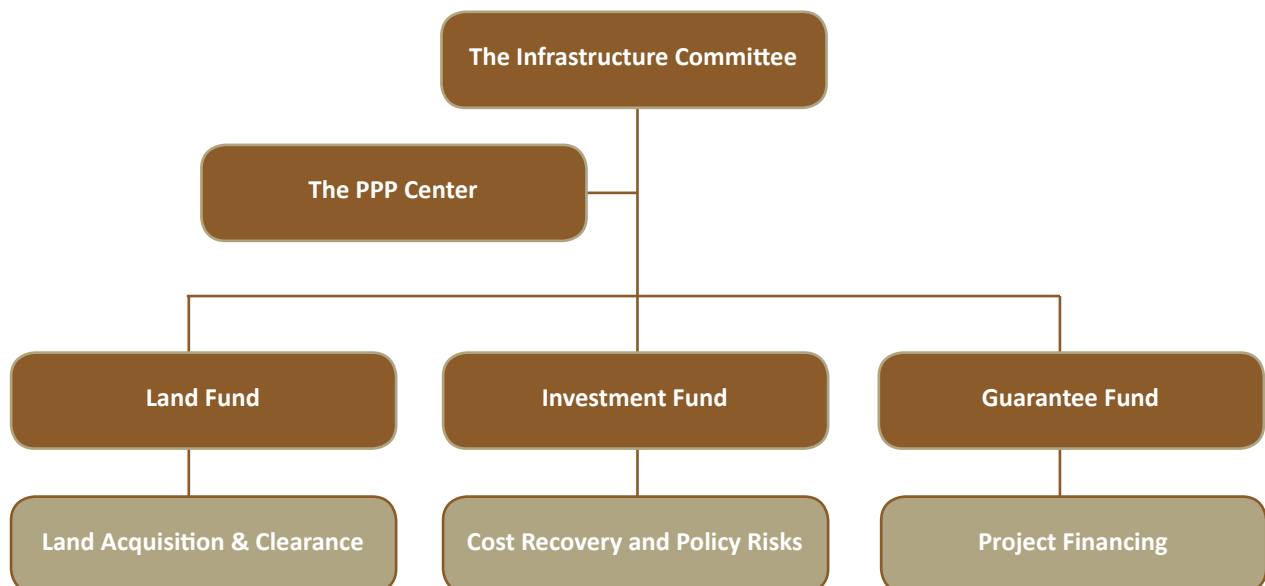


Figure 2. Government Support Scheme

disciplinary team of specialists. The VE process, referred to as the Job Plan, defines a sequence of activities that are undertaken during a VE study, before, during, and following a workshop. During the VE workshop, the VE team learns about the background issues, defines and classifies the project (or product or process) functions, identifies creative approaches to provide the functions, and then evaluates, develops, and presents the VE proposals to key decision makers. It is the focus on the functions that the project, product, or process must perform that sets VE apart from other quality-improvement or cost-reduction approaches. VE had been widely implemented in infrastructure projects, especially for large scale projects financed by public sector money (Bytheway and Charles, 1971; Palmer et al., 1996; Weatherhead and Griffin, 2006; Woodhead & Berawi, 2008).

Value engineering can be utilized as an appropriate strategy to enhance project implementation and to ensure the project satisfies its need and purpose in an effective and efficient manner (Hays, 2006; Berawi and Woodhead, 2005a; Berawi & Woodhead, 2005b). VE may occur during the project's design, bidding process, or execution phase. Each of the design, bid and execution phase of the project presents opportunities for the owner to benefit from VE activities. Generally VE is applied when there is a well defined scheme in order to optimize costs and benefits. VE has a rather long history to be improved, combined and used together with several other methods. Syverson (1992) and Berawi (2004) have combined VE with Quality Management to convert customer expectations into quantified technical design characteristics and development of the product plan. Noda and Tanaka (1997) have seen VE as an essential technique to Target Cost Management (TCM) while Al-Yousefi and Hayden (1995) have combined VE with TQM.

3. The Previous Integration Studies

There have been a number of studies looking at the integration between value management (VM), including value engineering, with risk management (RM) in project management discipline. In 1997, Dell'Isola, identified that the integration had probably began in 1993 when a city-port authority required a value engineering effort that would be augmented with an application of a risk assessment. Hilley and Paliokostas (2001) asserted the fact that VM and RM are two well-established disciplines and both are recognized as a part of best practice and that the links between them are strong. If risk is nicely managed it is possible to achieve a cost saving and an enhancement in value. Norton & McElligott (1995) sug-

gested that VE could enhance risk management process. This is because risk management is oftenly perceived as a negative process and its combination with value management approach would generate positive atmosphere to mitigate risks. Meanwhile, Paliokostas (2000) indicated that VM and RM appear to be so compatible and complementary that continuing to use them separately could mean waste of time and resources.

The VM and RM integration had been supported by some further studies. In 2003, the Office of Government Commerce (OGC) of UK asserted that VM and RM are interrelated concepts that should be carried out in parallel in preparing project management activity. According to OGC, the application of VM will help client to identify the best way of meeting business need while RM is used to manage the risks associated with the solution that offers the best whole-life value to the business and should not be seen as barrier to innovation. The OGC proposed that VM exercises are carried out first to determine what exactly constitutes value to the business from the delivery of a project. After that, the likely risks to occur to the preferred option are identified. This exercise will be repeated to all options in defining value and associated risks until they arrive at optimum balance of value and risk. The concept of integration, according to Weatherhead, (2006) and Griffin (2006), has been widely accepted as best practice tools for effective management of projects. Later, Abd Karim et.al., (2007) asserted that combining risk and value in project management is an observable fact driven by a desire to minimize the time taken to act and to produce results with optimum performance and quality.

The main idea for integrating VM and RM is to optimize the value of a project. Othman (2004) supported the idea of integration of VM and RM as two complimentary disciplines, saying that best value could not be achieved unless associated risks have been managed. The idea emerges from the facts that there will be rather meaningless to optimize the value of a project if significant risks prevail and impair its delivery, thereby destroying the value (Dallas 2006). Strong rationales behind the need for integration of VM and RM were provided by Connaughton and Green (1996), Paliokostas (2000), Smith et. al. (2006), and Thompson (2004). They have in principles agreed the following reasons for the integration: (1) avoidance of duplicating efforts by using the same resources and multi-disciplinary team; (2) involvement of stakeholders in the value management process; (3) providing a nice way of introducing VM and RM into an organization; (4) maintain and improve future appraisals and assessment of projects; (5) influences the VM

proceeds in this case-option appraisal, by allowing the users to consider specific options used in the past similar projects; (6) makes them aware of their weaknesses and strengths; (7) shortening the time taken to develop viable solutions based on the risks facing a project; (8) identifies specific risk allocation structures in association to contract strategies; and (9) provides in-depth assessment process.

4. The Integration Process

There are four advantages in integrating value and risk management practices (Weatherhead, et.al. (2005):

- Integration enables value and risk issues to be considered together. From the very beginning of the project a full picture is available to help decision-makers develop an understanding of opportunities and uncertainties.
- Integration is more efficient, not only from the depth and quality of the discussion process, but also because fewer workshops and meetings are required.
- The use of this integrated discourages the use of ambiguous and inconsistent language and so promote a common team understanding and coordinated effort to realize the client's objectives. This should reduce the levels of confusion in the industry and make it easier for facilitators and others to work within project team.
- Any value management, value analysis, value engineering or risk management tool or other relevant business management tool can be incorporated where, and whenever desired.

The fact that risk and VE are interrelated tasks that should be carried out in parallel and cannot be segregated from large infrastructure investment project was highlighted by Berends and Long (2007). The use of risk management and value management is instrumental to the successful delivery of construction project on time within the budget. Haghnegahdar and Ashgarizadeh (2008) pointed out the fact that more than 75 percent of many infrastructure projects are not accomplished in accordance with the apportioned expenses and schedules. One of the major reasons of this failure is risky eventualities and occurrences in projects. Like in many other parts of the world, Indonesian infrastructure projects are still struggling with inefficiency and ineffectiveness due to the lack of obedience, incomplete, and inaccurate analysis leading to inefficiency and ineffectiveness of budget spending in the infrastructure projects of public works

(Latief and Untoro, 2009). Long before that, Alwi et. al. (2002) had identified the problems of inefficiency and ineffectiveness of Indonesia's construction industry as caused by delayed schedule and cost overrun.

Indonesia is now embarking on a rather massive development of its economic infrastructure. Efforts to increase project performance and outcomes would certainly be demanded accordingly. As infrastructure plays an important role in economic growth, Indonesia would have to pursue new ways to significantly improve the performance of its infrastructure projects. Value management combined with risk management in PPP projects are perceived to be a legitimate option to this demand. There are two substantial conditions for the success of a project; first is contractor's capability to require expected value by project owner with initial agreed cost of the contract, and second is the effort of minimizing the impact of unavoidable risk and possible project loss (Ventakaraman and Pinto (2008). First condition can be fulfilled by value engineering (VE) which provides effective ways to maximization value in certain project according to owner expectation. Whereas the second condition is overcome by implementing risk management contributed to effective process in order to control the risk of a project.

The combination of value engineering and risk management within integration process is an excellent strategy, able to maximize the project value and reduce uncertainty. Should value engineering and risk management procedures be integrated during the project developments, compilation and recognition, one can gain mastery over the project's worth in a series of consecutive operations by means of several workshops to define, analyze, and control the pertinent values (Terry 2004). Griffin (2006) argues that the issue is no longer about whether they should be used but whether the processes should be integrated. The application of VE will help client to identify the best way of meeting business need while RM is used to manage the risks associated with the solution that offers the best whole-life value to the business and that way should not be seen as barrier to innovation (The OGC, UK 2003).

5. The Sunda Strait Bridge

5.1. Strategic Alliance Type of PPP

The concept of the integrated VM and RM is hypothetically applied to the forthcoming Sunda Strait Bridge (SSB) project. This long span bridge connecting Jawa and Sumatera islands in Indonesia (Figure 3), is listed in Bappenas' PPP 2010 Book with an estimated total cost of about US\$ 11 billion. With 29 km total length, in which

the longest span is 2.3 km, SSB would probably be the longest bridge in the world when it completely built 10-15 years from now. A presidential decree has been issued to officially commence the project by establishing a national coordination team headed by Coordinating Minister for Economic Affairs. The project had been initiated almost 25 years ago but still in preliminary study stage. It re-emerged recently by the pre-feasibility study conducted by two provincial governments at the end of the islands, supported by a private company as the sponsor. The history of the project generates a debate whether this project is solicited or unsolicited. Apart from the controversy, SSB would emerge as the largest PPP project ever built in Indonesia with the skeleton of its project financing illustrated in Figure 4. The sponsors would presumably be the government of Indonesia, the provincial governments of Banten of Jawa and Lampung of Sumatera, and other domestic entities. The sponsors would have to provide equity financing of 30 percent of the total cost. The sources of financing would be the state and provincial budgets, government bonds, international lending agencies, and investors. The lenders - which presumably are consortium of creditors-presumably bilateral and multi-lateral lending agencies, syndicate of international commercial banks, syndicate of China's bank, Middle East financial institutions, and others- would have to provide debt financing of 70 percent of total project cost.



Figure 3. Location of SSB Project

A strategic alliances type of PPP (SA-PPP) is hypothetically applied to SSB project, presumably for eliminating the controversy of solicited-unsolicited issue. In this strategic alliances of PPP, both government as the original sponsors and the investors, the initiator of the project, would need to form a strategic alliance as a consolidated, hybrid organization to conduct all the preparation works of the SSB project. In this scheme, unsolicited issue is no longer relevant as both government and project creators merge into the alliance. It is assumed that this type of PPP configuration would ease the implementation of VM-RM integrated approach during the course of the project preparation, construction, and operation. This is going to be a long range project management undertaking as a 10-15 years time span would be anticipated for the completion of the project. No empirical evidence has so far been emerged in this kind of project and its is realized that this idea still in the infant stage of implementation.

SSB project is a complicated undertaking, involving a large amount of parties, working together in an orchestrated work under the direction and supervision of the SA-PPP and executed by the SPV-SSB Newco. Complexity creates conflicts, uncertainties, and project risks all the way from financing down to construction risks. The room for risk management, as well as value management processes is large and mandatory. It is assumed that for this large-scale and complex infrastructure project, the process of VM-RM integration constitutes an important and coherent process, embedded within the course of project management from preparation until the operation.

management processes is large and mandatory. It is assumed that for this large-scale and complex infrastructure project, the process of VM-RM integration constitutes an important and coherent process, embedded within the course of project management from preparation until the operation.

5.2. The VM-RM Integration

The concept and process of VM-RM integration have not been widely used in PPP projects, at least not in Indonesia normal practice of PPP undertakings. While PPP is usually involving risk analysis in its preparation, it is, however, rarely involving value engineering (VE) as an integral part of the process. It is interesting, therefore, to see whether the application of value engineering and risk management could lead to a more efficient and effective project preparation and development for a large-scale infrastructure PPP project such as SSB.

Researchers have suggested the implementation of VM-RM integration, presumably for all stages of project development. In SSB project, this task would be carried

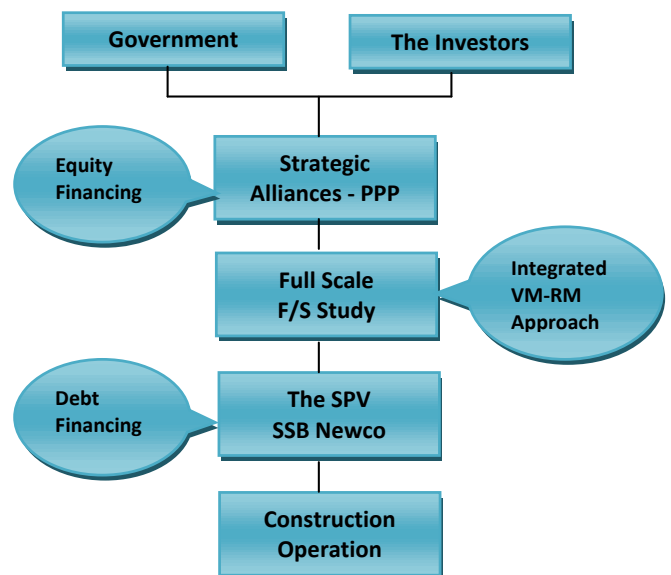


Figure 4. Strategic Alliances PPP Scheme

out by SA-PPP in the early stage of development and by SA-PPP and the SPV-SSB Newco in the later stage. It is noted that both equity and debt financing would have to demand a credible and legitimate risk analysis to take place. This risk analysis would have to be clearly stated and incorporated in the full-scale feasibility study of the project.

5.3. The Interfacing

SSB project is not a stand-alone project. It has to be closely linked with regional economic development in the two poles of the bridge as well as all supporting infrastructure projects and access facilities supporting the smooth economic movement between the two islands. Both risks and value creation could emerge from this circumstances. Figure 5 shows how the mechanic of the interfacing occurs. The SA-PPP of the SSB project will have to conduct preliminary studies for both RM and VM of the project, taking into account all possible risks and value creation that could emerge from the project by looking at the necessary aspects and spectrum of the SSB and regional development projects. The number and type of risks of SSB projects is predicted to be large and vary. Since the preparation works and construction of the project would probably need to take some 10-15 years and the investment costs are huge, it is very critical from early on to identify risks associated with uncertainties of regulation, security, and political umbrella of the project. These political risks are to be assessed and measures to mitigate risks are to be found and negotiated immediately. This process is expected to be finalized within the SA-PPP and later to be negotiated with the government. So far the process could provide all information necessary to the process of value management and the value creation in terms of positive functions that can generate value added to the project. Risks are expected to emerge as the construction begins all the way down to the operation. Risk management process continues with analysis and calculation of its associated exposures according to each of the value added. The in-

terfacing would end up with strategies for both risk mitigation and value creation and alternative function added to the characteristics and performance of the project.

6. CONCLUSION

This paper reviews the concept of integrating value and risk management that have been practiced in other countries, borrows, and hypothetically adopted it to forthcoming Sunda Strait Bridge project, a large-scale Indonesia PPP project. The integration between RM and VM, if planned and implemented nicely, is believed to be providing a positive impact on the performance of project management process. PPP always involving risk management from preparation to construction and operation stages. The larger the project the bigger the benefit to project performance. Although it seems practically possible to achieve much greater performance to project management undertaking, especially in big project, the integration, however, has never been implemented in Indonesia PPP project.

The application of the RM-VM integration concept to SSB project is still in academic thinking. But Indonesia has indicated the project will be undertaken with strategic alliance type of PPP. This will pave the way for the implementation of the concept easily since both government and private investors

will work very closely to investigate risks and value generated by the project. Combination of both within one integration process is a good strategy to maximize value of a project and in the same time could reduce risk exposure. This in turn would lead to a greater efficiency of project management. The SSB project is to start soon with all the preparation works, including the conduct of full-scale feasibility study. The idea laid out in this paper could inspire further research in the integration of risk and value management for Indonesia infrastructure projects. The SSB project provides big opportunity to conduct research based on real data and management process. It is the room for next research.

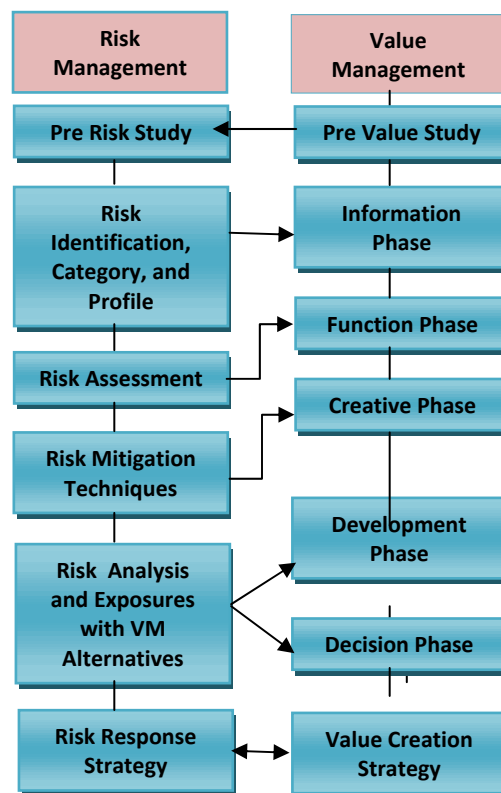


Figure 5. Risk and Value Management Interface.

Source: Adopted from Mootanah, 1998.

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About the Authors

Suyono Dikun is an associate professor of the department of civil engineering at the University of Indonesia in Depok, Indonesia. He may be contacted at sdikun@eng.ui.ac.id.

Herawati Z. Rahman is a doctoral student in the department of civil engineering at the University of Indonesia in Depok, Indonesia. He may be contacted at herazetha@gmail.com.

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