THE RISK BREAKDOWN STRUCTURE (RBS) AS AN AID TO EFFECTIVE RISK MANAGEMENT

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Abstract

Risk identification often produces nothing more than a long list of risks, which can be hard to understand or manage. The list can be prioritised to determine which risks should be addressed first, but this does not provide any insight into the structure of risk on the project. Traditional qualitative assessment cannot indicate those areas of the project which require special attention, or expose recurring themes, concentrations of risk, or "hot-spots" of risk exposure.

The best way to deal with a large amount of data is to structure the information to aid comprehension. For risk management, this can be achieved with a Risk Breakdown Structure (RBS) – a hierarchical structuring of risks on the project.

The RBS can assist in understanding the distribution of risk on a project, aiding effective risk management. Just as the Work Breakdown Structure (WBS) has been the project manager's greatest tool because it scopes and defines the work, so the RBS can be an invaluable aid in understanding the risks to the project. The WBS forms the basis for many aspects of the project management process; similarly the RBS can be used to structure and guide the risk management process.

This paper presents the concept of the RBS, and gives a number of examples drawn from different project types and industries. The benefits of using the RBS are then outlined, including as an aid for risk identification or risk assessment, comparison of projects, providing a framework for cross-project risk reporting, and structuring lessons to be learned for future projects.

The Risk Breakdown Structure has the potential to become the single most valuable tool in assisting the project manager to understand and manage risks to his project. This paper shows how to use the RBS to gain these benefits.

Introducing the Risk Breakdown Structure (RBS)

The risk management process aims to identify and assess risks in order to enable them to be understood clearly and managed effectively. The key step linking identification/assessment of risks with their management is understanding. This is however the area where the project manager or risk practitioner gets least help from current guidelines or practice standards. There are many commonly-used techniques for risk identification (see for example the risk management chapter of the *Guide to the Project Management Body of* Knowledge, PMBoK®, Project Management Institute, 2000). These identification techniques however tend to produce an unstructured list of risks which often does not directly assist the project manager in knowing where to focus risk management attention. Qualitative assessment can help to prioritise identified risks by estimating probability and impacts, exposing the most significant risks, but this deals with risks one at a time and does not consider possible patterns of risk exposure, and so also does not provide an overall understanding of the risk faced by the project as a whole.

In order to understand which areas of the project might require special attention, and whether there are any recurring risk themes, or concentrations of risk on a project, it would be helpful if there was a simple way of describing the structure of project risk exposure.

In any situation where a lot of data is produced, structuring is an essential strategy to ensure that the necessary information is generated and understood. The most obvious demonstration of the value of

structuring within project management is the Work Breakdown Structure (WBS), which is recognised as a major tool for the project manager, because it provides a means to structure the work to be done to accomplish project objectives. The Project Management Institute defines a WBS as "A deliverable-oriented grouping of project elements that organises and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work." (Project Management Institute, 2000, 2001). The aim of the WBS is to present project work in hierarchical, manageable and definable packages to provide a basis for project planning, communication, reporting and accountability.

In the same way, risk data can be organised and structured, to provide a standard presentation of project risks which facilitates understanding, communication and management. Several attempts have been made previously to organise various aspects of project risk, mostly concentrating on the sources from which risk arises. However most of these are simple linear lists of potential sources of risk, providing a set of headings under which risks can be arranged (sometimes called a risk taxonomy). Examples include a generic risk taxonomy (Carter et al, 1994), and specific versions for construction projects (Akintoye & MacLeod, 1997), large projects (Jaafari, 2001), and international development projects (Kwak, 2001), as well as lists of risk categories or risk types in international standards and guidelines (for example Godfrey, 1996; AS/NZS 4360:1999; BS6079-1:2000; IEC62198:2001).

A simple list of risk sources does not provide the richness of the WBS since it only presents a single level of organisation. A better solution to the structuring problem for risk management would be to adopt the full hierarchical approach used in the WBS, with as many levels as are required to provide the necessary understanding of risk exposure to allow effective management. Such a hierarchical structure of risk sources should be known as a Risk Breakdown Structure (RBS). Following the pattern of the WBS definition above, the RBS is defined here as "A source-oriented grouping of project risks that organises and defines the total risk exposure of the project. Each descending level represents an increasingly detailed definition of sources of risk to the project." The RBS is therefore a hierarchical structure of potential risk sources. The value of the WBS lies in its ability to scope and define the work to be done on the project; similarly the RBS can be an invaluable aid in understanding the risks faced by the project. Just as the WBS forms the basis for many aspects of the project management process, so the RBS can be used to structure and guide the risk management process.

Examples of RBS structures

Some authors and practitioners have gone further in structuring risk than simply listing types of risk faced by a project. These have produced hierarchical structures under various names to describe sources of risk, or risk categories or types, though these are usually focussed on a particular project type or application area. Examples include the "risk taxonomy" for software development projects from the Software Engineering Institute (Dorofee et al., 1996), a "risk identification list" for an extra high voltage transmission line construction project (Tummala & Burchett, 1999), a "risk identification breakdown structure" for construction projects (Chapman, 2001), and a "risk-based taxonomy" for large engineering projects (Miller & Lessard, 2001). Each of these structures contains three or four hierarchical levels to describe the types of risk faced by the project in question. Figures 1 and 2 present two of these examples.

A more general approach was taken in the Universal Risk Project undertaken jointly by the Risk Management Specific Interest Group of the Project Management Institute (PMI Risk SIG) and the Risk Management Working Group of the International Council On Systems Engineering (INCOSE RMWG), who produced a structured list of "universal risk areas" which might apply to any type of project in any sector of industrial, government or commercial activity (Hall & Hulett, 2002). This structure is summarised in Figure 3.

This author has also produced specific RBS structures for consultancy clients in various industries with different project types, including defence software development, energy supply, pharmaceutical vaccine development, construction management, general engineering, and telecommunications. Examples are presented in Figures 4 to 6.

Each of these RBS structures is different, reflecting the range of possible sources of risk exposure for projects in various sectors and industries. It is therefore necessary for any organisation wishing to use

the RBS as an aid to its risk management to develop its own tailored RBS. The more generic versions mentioned above might be used as a starting point, but these are unlikely to include the full scope of possible risks to every project, so they must be modified accordingly. An organisation may wish to produce a single generic RBS covering all its projects, or there may be several different RBS structures applying to particular project types. Large projects may require their own specific RBS.

How to use the RBS

Once an organisation or project has defined its RBS, it can be used in a variety of ways. Some of these facilitate the risk management process on a particular project, while others are relevant across projects. The main uses and benefits of the RBS are outlined in the following paragraphs.

Risk identification aid. The upper levels of the RBS can be used as a prompt list to ensure complete coverage during the risk identification phase. This is accomplished by using the RBS to structure whichever risk identification method is being used. For example, a risk identification workshop or brainstorm might work through the various elements of the RBS, perhaps at the first or second levels, encouraging participants to identify risks under each of the RBS areas. Similarly, the RBS major areas can be used to structure risk identification interviews, providing an agenda for discussion between the facilitator and interviewees.

A risk identification checklist can also be developed based on the RBS, by taking each of the lowest RBS levels and identifying a number of generic risks in each area based on previous experience. Future projects can then determine whether each generic risk applies, answering “Yes”, “No”, “Don’t know” or “Not applicable”.

In addition, the RBS can be used to structure lists of risks identified by other methods, by mapping identified risks into the lowest levels of the RBS. This reveals possible gaps or blind spots in risk identification, and exposes any double-counting or duplication. It can determine whether the risk identification method has considered all potential sources of risk, and indicate whether additional risk identification activity is required.

Using the RBS to structure the risk identification task provides assurance that all common sources of risk to the project objectives have been explored, assuming that the RBS is complete. The danger that this assumption is incorrect can easily be overcome by including a short additional risk identification effort for “Other risks” not covered by the RBS.

Risk assessment. Identified risks can be categorised by their source by allocating them to the various elements of the RBS. This then allows areas of concentration of risk within the RBS to be identified, indicating which are the most significant sources of risk to the project. This can be determined by simply counting how many risks are in each RBS area. However a simple total number of risks can be misleading, since it fails to take account of the relative severity of risks. Thus one RBS area might contain many risks which are of minor severity, whereas another might include fewer major risks. A better measure of risk concentration within the RBS is therefore a “risk score” of some sort, based on the scale or size of each individual risk. A common method is the P-I Score, where numerical scores are associated with rankings of probability (P) or impact (I), then multiplied to give a combined value reflecting both factors. The risk management chapter of the PMBoK describes one such scoring scheme based on probability and impact (Project Management Institute, 2000). Concentration of risks within the RBS areas can then be assessed by comparing the total “risk score” for those risks within each area. This is likely to give a more meaningful perspective than a simple total count of risks, indicating which RBS areas are giving rise to more risk to the project.

Categorising risks according to the RBS provides a number of additional insights into the assessment of risk exposure on the project, which would not be available from a simple list of risks, even if the list were prioritised. These include:

- Understanding the type of risk exposure on the project

- Exposing the most significant sources of risk to the project
- Revealing root causes of risk, via affinity analysis
- Indicating areas of dependency or correlation between risks
- Focusing risk response development on high-risk areas
- Allowing generic responses to be developed for root causes or dependent groups of risks

Comparison of projects or tenders. Risk exposure on different projects or competing tenders can be directly compared since the RBS presents a common framework. The RBS allows risks identified on each project or tender to be structured in the same way, permitting direct comparison. In the case of tender evaluation, risks can be identified for competing tenders and then structured using a common RBS. Instead of trying to compare unstructured lists of risks for each tender, the amount and types of risk associated with each option are presented in a consistent format, allowing the relative risk exposure to be considered when the preferred tender is being selected. Similarly the risk exposure of individual projects within a related programme or portfolio can be compared using a common RBS to allow them to be prioritised or ranked on the basis of their associated risk exposure, or to permit construction of a risk-balanced portfolio.

Risk reporting. The RBS can be used to roll-up risk information on an individual project to a higher level for reporting to senior management, as well as drilling down into the detail required to report on project team actions. Reports to senior management may include total numbers of risks or total risk score in each higher-level RBS area, perhaps with metrics or trend analysis presented graphically. Project teams can also be notified of risks within their part of the project, by selecting relevant RBS areas for each team member.

The RBS can also be used to provide cross-project or multi-project reports to senior management, since it provides a consistent language for risk reporting, removing or reducing the potential for misunderstanding or ambiguity between projects. Risks within the same RBS area can be directly compared across projects since it means the same for all projects. This can be further enhanced by using a RBS-based numbering scheme to identify risks.

Lessons learned for future projects. One of the most difficult tasks in the post-project review is to structure the information so that it can be referenced and used by future projects. Many organisations lose the benefits of such reviews since the information is not held in an accessible format. The RBS can provide a common format for analysing risk-related information from each post-project review. An RBS-based analysis will reveal risks which occur frequently, allowing generic risks to be identified and recorded for future reference, together with effective responses. If routine analysis of post-project reviews indicates that a particular risk is occurring repeatedly, then preventative responses can be developed and implemented. Risk identification checklists can also be updated and maintained to include common or generic risks exposed by an RBS-based analysis of post-project review data.

Conclusion and summary

Successful and effective risk management requires a clear understanding of the risks faced by the project and business. This involves more than simply listing identified risks and characterising them by their probability of occurrence and impact on objectives. The large amount of risk data produced during the risk process must be structured to aid its comprehension and interpretation, and to allow it to be used as a basis for action. A hierarchical Risk Breakdown Structure (RBS) framework similar to the WBS provides a number of benefits, by decomposing potential sources of risk into layers of increasing detail. The RBS is a powerful aid to risk identification, assessment and reporting, and the ability to roll-up or drill-down to the appropriate level provides new insights into overall risk exposure on the project. A common language and terminology facilitates cross-project reporting and lessons learned. The RBS has the potential to become the most valuable single tool in assisting the project

manager to understand and manage risks to his project. The approach outlined in this paper shows how to use the RBS to gain these benefits.

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LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Product engineering	Requirements	Stability
			Completeness
			Feasibility
			…etc…
		Design	Functionality
			Interfaces
			Testability
			…etc…
		Code & unit test	Feasibility
			Testing
			Coding/implementation
			…etc…
		Integration test	Environment
			Product
			System
			…etc…
		Engineering specialities	Maintainability
			Reliability
			Security
			…etc…
	Development environment	Development process	Formality
			Process control
			Product control
			…etc…
		Development system	Capacity
			Reliability
			System support
			…etc…
		Management process	Planning
			Project organisation
			Management experience
			…etc…
		Management methods	Monitoring
			Configuration management
			Quality assurance
			…etc…
		Work environment	Cooperation
			Communication
			Morale
			…etc…
	Program constraints	Resources	Staff
			Budget
			Facilities
			…etc…
		Contract	Type of contract
			Restrictions
			Dependencies
			…etc…
		Program interfaces	Customer
			Subcontractors
			Corporate management
			…etc…

Figure 1 – RBS for software development (after Dorofee et al., 1996)

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Environment	Statutory	Planning approval delay
			Legislation changes
			Ecological constraints
			…etc…
	Industry	Market	Increase in competition
			Change in demand
			Cost/availability of raw materials
			…etc…
	Client	Client team	Client representative fails to perform duties
			No single point of contact
			Client team responsibilities ill-defined
			…etc…
		PM team	Inadequate project management controls
			Incorrect balance of resources & expertise
			PM team responsibilities ill-defined
			…etc…
		Targets	Project objectives ill-defined
			Project objectives changed mid-design
			Conflict between primary & secondary objectives
			…etc…
		Funding	Late requirement for cost savings
			Inadequate project funding
			Funds availability does not meet cashflow forecasts
			…etc…
		Tactics	Brief changes not confirmed in writing
			Change control procedure not accepted
			Unable to comply with design sign-off dates
			…etc…
	Project	Team	Poor team communication
			Changes in core team
			Inadequate number of staff
			…etc…
		Tactics	Cost control …
			Time control …
			Quality control …
			Change control …
		Task	Site…
			Design…

Figure 2 – RBS for construction design (after Chapman, 2001)

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Management	Corporate	History/experience/culture
			Organisational stability
			Financial
			…etc…
		Customer & stakeholder	History/experience/culture
			Contractual
			Requirements definition & stability
			…etc…
	External	Natural environment	Physical environment
			Facilities/site
			Local services
			…etc…
		Cultural	Political
			Legal/regulatory
			Interest groups
			…etc…
		Economic	Labour market
			Labour conditions
			Financial market
			…etc…
	Technology	Requirements	Scope uncertainty
			Conditions of use
			Complexity
			…etc…
		Performance	Technology maturity
			Technology limits
			…etc…
		Application	Organisational experience
			Personnel skill sets & experience
			Physical resources
			…etc…

Figure 3 – RBS for generic projects (after Hall & Hulett, 2002)

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Technical	Requirement specification	Specification may be inadequately defined
			Change control procedures may be unclear
			…etc…
		Technology	Technology may become obsolete
			Capability may not be available
			…etc…
		Complexity & interfaces	Complex design may unduly affect future maintenance
			Interface complexity of project may be unacceptable
			…etc…
		Performance	Criteria for acceptable performance may not be defined
			Equipment may not be fit for purpose
			…etc…
		Reliability	May be unable to meet reliability requirements
			Unsuitable modifications may affect reliability
			…etc…
		Quality	Available materials may be of insufficient quality
			QA procedures & standards may be inadequate
			…etc…
		Safety	Safety may not be considered in design
			Employees without correct knowledge to work safely
			…etc…
		Security	Fire may cause delay or additional cost
			Equipment may be stolen or vandalised
			…etc…
	Management	Strategy	Company strategy could change
			Project strategy may be ill-defined
			…etc…
		Organisation	Projects objectives may conflict within organisation
			Organisation may change project objectives
			…etc…
		Project management	Project planning may be inadequate
			Inaccurate estimates may cause overspends
			…etc…
		Resources	Unplanned loss of manpower (sickness or resignation)
			May be unable to obtain competent staff
			…etc…
		Communication	Unclear communication may cause work omissions
			Inadequate communication channels may be available
			…etc…
		Information	Sub-contractors may lack the required knowledge
			Irrelevant information may cause information overload
			…etc…
		Health, Safety & Environment	May not communicate HS&E Regulations to employees
			May be unable to meet environmental regulations
			…etc…
	Commercial	Contractual	Contract specifications may be poor
			Contract T&Cs may be inappropriate
			…etc…
		Financial	Interest rate fluctuations may occur
			Cashflow may not be acceptable
			…etc…
		Regulatory	Possible change of requirements by Regulator
			May not comply with existing regulations
			…etc…
		Consents	Delay may occur in receiving consent
			Consent achieved may be heavily qualified/conditioned
			…etc…
		Reputation	Unplanned outages may occur affecting reputation
			May damage reputation causing share value to fall
			…etc…

Figure 4 – RBS for energy supplier

LEVEL 0	LEVEL 1	LEVEL 2
Project risk	Regulatory	Approvals
		Filing
	Process	Expression
		Fermentation
		Downstream
		Formulation
		Analytics
		Stability
		Scaling up
	Pre-clinical	Immune response
		Immunoassays
		Animal models
	Clinical	Clinical study development plan
		Read-outs
		Target population
		Reactogenicity
		Medical
	Marketing	Costs
		Competition
		Commercial
		Market assessment
	Management	Team
		Core technologies
		Collaboration
		Strategic fit
		Intellectual Property
		Organisation
		Milestones

Figure 5 – RBS for pharmaceutical projects (vaccine development)

LEVEL 0	LEVEL 1	LEVEL 2
Project risk	Technical	Scope definition
		Requirements definition
		Technical processes
		Technical interfaces
		Technology
		Performance
		Reliability
		Safety & security
		Test & acceptance
	Management	Project management
		Organisation
		Resourcing
		Communication
		Information
		Health, Safety & Environment
		Reputation
	Commercial	Contractual T&C's
		Financing
		Liabilities & warranties
		Payment terms
		Suspension & termination
		Internal procurement
		Subcontracts
		Applicable law
		Partnering
	External	Legislation
		Regulatory
		Exchange rates
		Site/facilities
		Competition
		Weather
		Political
		Country
		Pressure groups
		Force majeure

Figure 6 – RBS for engineering (contracting organisation)