Understanding and Handling Residual Risks

The marriage of science and psychology

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Abstract

Risk management and risk analysis techniques have been widely discussed and utilized in many energy firms. They are pro-active tools giving decision-makers forewarnings and scientific predictions. However, a less well known concept in the arena of risk management is worth elaborating. Residual risk, a terminology not common to most people in our industry, is rarely mentioned and discussed in the literature; it still remains a poorly understood notion. It often is confused with the Secondary Risk, and easily mistaken for missed risks in risk identification process. Depicted as "leftovers", residual risks are often neglected in risk management process as many regard such risks are well covered under ALARP (as low as reasonably possible). Moreover, residual risks are often deliberately eliminated from stochastic modelling process as many risk analysts reckon that extreme cases, beyond "normal" 80% confidence range, are not worth considering. In reality when unpleasant events occur the real culprit is more often than not either rare event driven risk or residual risk that caught people off guard.

The treatment of residual risks requires both diligent prudence and well thought-through risk taking. Failure Model Effect Analysis (FMEA) is often deployed to assess the severity of such risks, hence helping management better understand the devastation in case they occur. "Normally ranged" risks would often be handled by scientific manner and decisions are relatively easy, however, there isn't a clear path to handle residual risks, as it is not a pure mathematical exercise but demands strong incorporation of psychological judgement as well. The paper challenges decision makers to appreciate true implications of residual risks, and what they are about to bring to their businesses. The author, through the illustration of examples, proposes a residual risk handling process that combines qualitative risk assessment, psychology of risk taking and Monte Carlo simulation techniques. The process mainly applies to early phase project development and business case fruition process where large uncertainties may easily affect decision-makers, but it is also applicable to project execution phase.

Key words: Residual Risk, Risk-taking, Psychology

Pedigree of Risk Management in Energy Companies

Not surprisingly in today's global economy, risk management has risen to become a posh word in top management; a buzz word in middle management; and a hot-button in lower management. One positive trend is that more and more companies have embraced the concepts of risk management, and have endorsed it as one of their business processes. A lot of matured organizations start to see the fruition of having implemented risk management process in earlier times, resulting in less surprises, better predictability and smart budgeting. Many senior management staff members are no longer dubious about risk management, and their commitments to the process

further bolster the proliferation of risk practices in various industries. However a smart talk it may be, it is really difficult to thoroughly comprehend the width and depth of risk management, therefore it is not uncommon that risk management concepts are misinterpreted, misused, fragmented, disintegrated and twisted within a single company in micro scale and within society as a whole at macro level. Admitted or not, risk management is still a relatively young managerial discipline lacking sufficient academic research and adequate experiences and benchmarks. More over, risk management process is heavily shrouded by subjectivities relying on individual human judgement; therefore, in many cases risk management processes could therefore be "cooked" to satisfy special management taste.

Risk management does not have a very long history, a couple of hundred years perhaps according to Dr. Peter Bernstein's 1998 book *Against Gods,* but got well developed only in past 50 years or so. The recent well known uses of risk practices in USA can be traced back to the Manhattan Project in 1940s, Missile programs in 1950s, NASA programmes in 1960s, Nuclear Regulatory Commission's required probabilistic risk analysis in 1970s and FDA's hazard control methods in 1990s, and proliferated applications in energy companies in 21st century. The evolution of risk management has been influenced by expanding knowledge, use of new technology, globalization and increased competition for diminishing natural resources; subsequently many energy companies started to shift their paradigms from risk averting to risk taking, dragging themselves into a fascinating but less known world of residual risk management. It would be surprising today if a major oil company has not yet implemented a sort of risk management process, however, they do not necessarily have a uniform, consistent and aggregated Enterprise Risk Management (ERM) framework for business decision-makings; as a result, many companies still to this very date operate fragmented and silo risk management practices even though these practices do not stop them operate profitably but less efficiently.

From financial institutions to manufacturing companies, from large global conglomerates to local enterprises, there is little doubt that senior management is raising their risk appetite[1] hoping that an effective risk management process can boost his company's profitability. Increasing risk exposure and taking "calculated" risks are bold and brave gestures, however, it has increasingly become necessary, particularly it is the case with regard to the Residual Risks.

Paradigm Shift to Embrace Residual Risks

It is fairly confident to say that most professionals working in major energy companies today understand the concept of risk management, and its applications of both qualitative assessment and quantitative analyses, as a tool to aid decision-makings. Unfortunately these people do not necessarily have full exposure to the entire risk management process even including many risk practitioners, such as risk managers and coordinators, who just stop short at risk "mitigation" actions. In fact, many text books and literatures are to blame for because the loop holes of the totality of risk management processes are never filled by those academic researchers, leaving an important segment of risk management void. One may argue that the "segment" in question is not so important, and not even an agenda item on the table worth discussing

[1] Risk appetite, at the organisational level, is the amount of risk exposure, or potential adverse impact from an event, that the organisation is willing to accept/retain. Continuity-Central.

with senior management. For the sake of debating, I would concur with this view point if it were fifteen years ago when risk management in oil & gas companies were treated like toddlers or even infant babies. With the help of academia and gradually increased maturity and ingenuity of the industrial practitioners, especially after we all have experienced the most recent economic crushes, this segment of risk management deserves that its status be raised, topic discussed, proposition understood and agenda added; otherwise the totality and completeness of risk management cycle would forever be deteriorated and truncated. This segment is called residual risk handling. Although risk is no longer a strange jargon and the terminology has been widely used, residual risk is indeed an exotic term that has not yet been commonly known to even some savvy risk practitioners in energy firms at least.

When residual risk is used in financial institutions, it is defined[2] as "the risk that is left over when other risks are taken into account, and is also termed unsystematic risk". In Residual risk has also been defined by the others as 1) "a portion of the risk that is left after a risk assessment has been conducted" (Wiki); 2) "any element of risk that remains once the risk assessment as been made and responses implemented" (PMBOK); 3) "remaining risk which cannot be defined in more detail after elimination or inclusion of all conceivable quantified risks in a risk consideration" (ENS[3]). From above, it does not appear easy that we can reach a common understanding and an acceptable definition for residual risk any time soon, but it is agreeable that residual risk is a leftover.

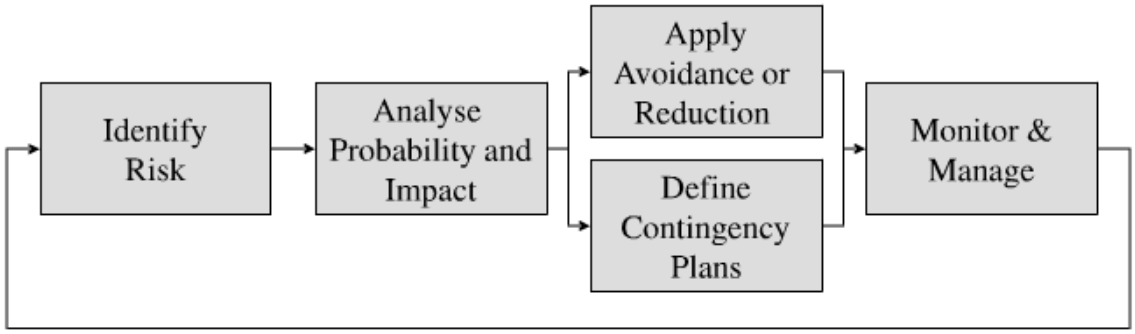


Figure 1-1: general risk management process

Most risk practitioners have been taught at universities and training centres that the Figure 1-1 depicts the entire risk management process, and this pictorial diagram is engraved deeply into their minds. However, what is missing from this picture goes to defining risk tolerance criteria and an organization's risk tolerability threshold, and the questions of what happens after a risk is properly treated, or what if the risk even exceeds such tolerance level. In real industrial practices, many "treated" risks or risks beyond 80% confidence ranges are often left over / out without further being effectively followed up to assess the effects and effectiveness of planned risk response actions by re-ranking residual risk levels. Being omitted from the Diagram 1-1 is the segment of entire residual risk identification, ranking and handling process, and it requires shifts of one's paradigm or mindsets.

Prerequisites for Identifying Residual Risks

Identifying risks undoubtedly is the first step; leaving these risks unattended is as bad as not identifying them. Whether risks should be attended to proper treatments depends

[2] The term is defined in wisegeek website.
[3] European Nuclear Society (ENS)

on their severity levels in comparison to the established risk tolerance criteria. The 2nd step in Figure 1-2, ranking probability and consequence, will be the first screening process to scrutinize out trivial risks (acceptable) using established risk matrix. It is important to devise the risk matrix that "trivial risks" still receive proper treatment even if the probability of their occurrences are extremely low but their consequences could be catastrophic. By definition, Residual Risks are leftover risks after proper treatment, so it is imperative to discuss the risk treatment techniques, or more academically, risk response action planning strategy using TEAM approach.

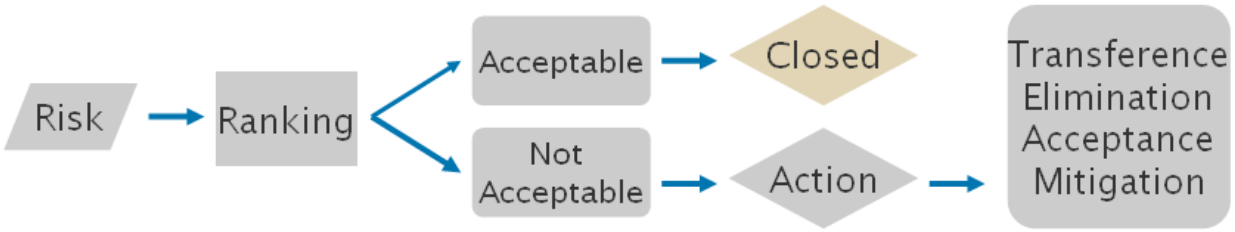


Figure 1-2: Initial Risk Treatment Process (TEAM)

- TRANSFERENCE (allocation)

Risks need to be better managed by the most capable parties who have knowledge, experiences, resources and required competence skills. In contractual relations, identified risks may be passed on to the other party in contract with or without risk premiums; hence one party successfully transfers risks to the others. Residual risks should be cleansed and wiped out by carefully designed contractual terms and skillfully crafted negotiations. The same strategy applies when a task-specific insurance coverage is purchased with a premium, however it may not be a clean cut. Insurance may compensate for financial losses however residual risks could be something intangible. Business interruption of a refinery operation due to fire breakout is covered by BI coverage, but residual risks could be related to corporate reputation, change in stock prices, shareholders relations, etc. which are unquantifiable.

- ELIMINATION (avoidance)

Some risks, if not all, can be avoided. This is particularly true when flexibility is observed and alternatives can be chosen. For business development opportunities, and in early phase project development, this strategy is an effective way to eliminate deadly risk events resulting in zero residual risks in most cases. The conditions for adopting this strategy, however, are the existence of available optional choices, being project execution methods or different ways to drill an exploration well. If water injection (WI) is planned for enhanced oil recovery but it requires major upgrade to water treatment system, this "plan" may be scrapped and gas lift is used instead. The risk response action (decision) to scrap the WI design virtually eliminates both initial and residual risks related to expensive upgrades.

ACCEPTANCE (contingency plan)

Voluntary risk taking, often dubbed as taking calculated risks, is one's own decision of choice. "Risk acceptance is used in risk management to describe an informed decision to accept the consequences and likelihood of a particular risk"[4]. If risk taking was a

[4] Argos Press Pty Ltd 2003 – 2004 Risk Management Glossary

common act many decades ago, it now has become a cautious undertaking. Before an initial risk can be accepted, its key characteristics must be thoroughly understood; its treatment plan carefully examined; its Failure Model Effects Analysis shall be prudently undertaken. Once the decision to accept such a risk is made, appropriate contingency plan, emergency preparedness, must be put in place and periodically reviewed. Residual risks equate to the accepted initial risks in this case! Risks in this category generally have unbalanced cost benefit equilibrium.

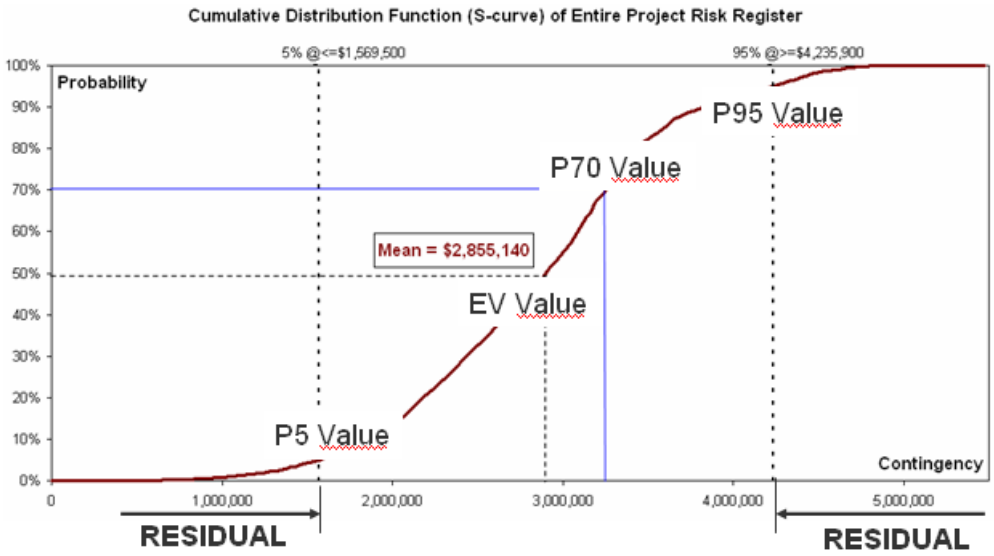


Figure 1-3: Residual Risk Values at 5% Chances

In quantitative risk modeling, we generously and unconditionally accept risks outside normal 80% confidence range. P10 and P90 values are invariably used in Monte Carlo simulations for reservoir volumetric estimation, cost and schedule risk analyses, economic modeling and even development of drilling programs, we conveniently truncate values of less than P10 and more than P90 chances assuming that values within 80% probability ranges should represent the totality. P. Bernstein[5] repeated the classical saying that "likeness to truth is not a truth", the residual values with even 5% chances may sometimes reverse the decisions that were made based on 80% confidence level because those furthest values on both ends of the mean can not simply ignored in totality. It is particularly the case when such values or outcome are significant for the decisions to be made.

- MITIGATION (actions)

Ambiguous risks sometimes will become clearer and their severity levels lessened over times when new information becomes available or known. Most of times however risks with unacceptable severity levels must be treated with appropriate mitigation plans and right competences and capacities. When risk response actions are initiated, such actions normally aim at one or all of the following results:

> reducing probabilities of risk from occurring;
> lessening the severity of negative risk consequences;
> removing or containing risk exposure;
> cost effectively implementing effective mitigating measures.

[5] "Against the Gods", 1998

It is assumed that we are all rational people when we come to make business decisions, and we will follow ALARP principle when we treat risks. We will do our utmost to mitigate risks but carefully considering the balances of costs and benefit / rewards. The reality is that we in many cases can not afford to continuously throw money and resources to reduce the severity levels of certain risks to desirable levels, or shield our project objectives from risk exposure; therefore we have to accept the fact that some risks are left in undesirable states, that we must be prepared to deal with such states.

Many of these leftover risks will not be accepted by management, so they are technically not classified as accepted risks with righteous contingency plans in place. Instead these leftover risks are left in risk registers with open actions for undue deadlines, because the implemented risk mitigation actions do not always seem effective enough.

Understanding Characteristics of Residual Risk

Too much ink has been wasted on how to identify risks and on explaining the precisions of risk probability and consequence ranking but leaving almost no ink for risk response action planning and their effectiveness tracking. This phenomenon has commonly happened in both academia and industry, because risk identification, being brainstorming workshop or Delphi interview process, and risk severity ranking, being qualitative (matrices) or quantitative (Monte Carlo), are highly abstractive and subjective relying on certain assumptions, knowledge levels, experiences and information reliability from participants, there is plenty of room for "imagination" hence this process is deemed a "challenging" task. On the other side, risk response planning and monitoring process requires much concrete steps with detailed activities and timely follow-up schedules with responsible individuals accountable to the risk owners, there is less breathing space for free manipulation therefore this process is not taken as "fun" tasks. More over, the results of this process may generate Residual Risks.

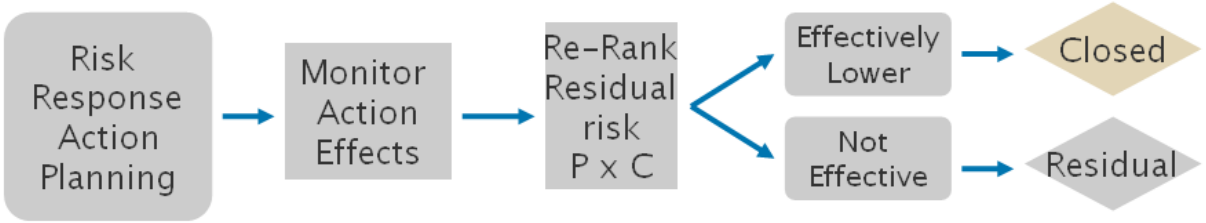


Figure 1-4: residual risk identification process

It is conveniently forgotten that subjectivity plays critical part in the processes of risk identification and ranking, and this equally applies to Residual Risks. Given the shortcomings of human nature and its short term memory[6], many risks would be missed out from the risk identification process, so some people mistakenly but handily categorize these "missed risks" as residual risks. Risk identification is a live, continual and dynamic process, and applies to anyone at any place and at any time without constraints. It is imperative to be comprehensive in identifying all critical risks that may affect defined objectives, though it is also almost impossible to be inclusive of all critical risk events; after all, risk identification is to predict future probabilities. It is therefore

[6] New Scientist Magazine, April 2011 (P43).

inevitable that some risks would be missed from qualitative risk register or quantitative risk analyses, and such missed risks shall not be mistaken for residual risks.

Whilst risks are being treated, these "mitigating treatments" may also trigger new risks to the objectives. For example, if the risk of "fabricated process module with faulty functions may be shipped offshore for installation" is planned to be reduced by increased quality inspections at the fabrication yard, then a new risk of "frequent inspections may delay module delivery schedule" may surface if the project is time sensitive. The newly deduced risk from the action is called secondary risk, and it demands attention and response actions as well, but this freshly introduced risk is not residual risks, but simply a new threat to the objectives. The good news is, however, that not all risk response actions will trigger new risks, or secondary risks.

Fitted into the description of "leftover", residual risks are often left over in risk register and neglected because these risks have been previously treated already. Unfortunately the ignorance of those residual risks surprisingly and commonly became the real culprit that caught people off guard, sometimes with unpleasant consequences. Typically the residual risks have the following key characteristics:

Qualitatively;

- having very low probability / frequency of happening;
- having relatively huge consequences / negative impacts;
- being left over after "standard" risk response actions / treatment;
- influenced by human eagerness not to have residual risks;
- receiving less management attention after applying ALARP principle;
- residual risks are often taken off normal risk register / inventory;

Quantitatively;

- being extremely difficult to predict and to assign a contingency;
- being outside normally accepted 80% confidence range;
- conveniently left out of quantitative Monte Carlo simulation modelling;
- seldom considered in the applications of probabilistic decision trees;
- can be added in to quantitative risk analysis as probabilistic events;
- most suitable for quantified portfolio / aggregated risk management;
- many probabilistic residual risks in simulation models are not correlated;

Residual risks can only be recognized after identified risks have gone through entire risk management process, including the TEAM approach of risk response action planning and monitoring. The prerequisite for identifying residual risks has been discussed in previous chapter, but handling them is more challenging and demanding. Managing residual risks involves scientific modelling and psychological judgement using human's best wisdom, and techniques can be qualitative evaluation and quantitative analysis which is supported by a research article authored by B. Lehemann who concluded that "it is important to take account of the non-normality[7] when using quantitative simulation method".

Handling Residual Risks - Qualitatively

[7] Bruce N. Lehmann stressed the non-normality in his article of "residual risks revisited".

J. Robertson[8] described the meanings of A to Z in his work and stated that A is for "Acts of God" and Z is for "Zero Risk" which is not achievable in any human activity but acknowledging the magnitude of any risk at issue. It is prohibitive in energy industry to leave any type of risks in the hands of God simply because the stake is too significant; however, demanding a zero risk state is neither realistic nor expected. That discussion gives rise to the principle of ALARP which is that *the residual risk shall be As Low As Reasonably Practicable,* and it arises from the fact that infinite time, effort and money could be spent on the attempt to achieve "zero risk" state. The techniques of accepting residual risks and conducting cost and benefit analysis, or risk and reward comparison, are often employed to avoid spending "infinite resources" on risk mitigations.

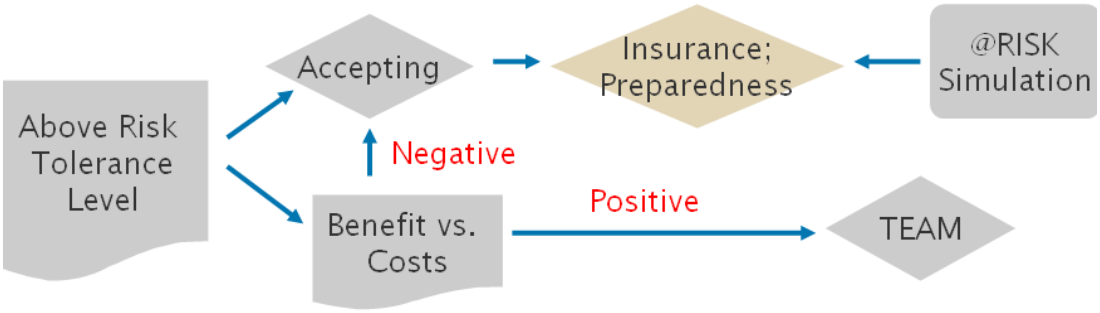


Figure 1-5: Techniques of Handling Residual Risks

Unless an organization or a project had unlimited resources to spare, nobody could afford to "treat" residual risks ad infinitum but to accept them at some points of time. Even when a residual risk is still above the established risk tolerance level, it could become more prudent and making more economic sense just by accepting it. Decision-makers taking that decision have to thoroughly understand the implications of what they accept, the magnitude of risk consequence and the probability of risk occurrence. The Business Dictionary defines "accepting risks" as when the cost of managing the risk is acceptable, however it may not be simply an economic decision, as the practical use of Utility Theory has also come into the play. This type of residual risks usually has characteristics of very low probability and the least frequency to happen, but with considerably huge consequences including mortalities should it happen. The recent examples included the nuclear reactor explosion earlier this year in Japan and deep water Horizon oil spill in GoM April 2010. In BP Horizon case, it is interesting to note the Oil Spill Commission's findings[9] that the BP's risk assessment stated that an accidental surface oil spill was "unlikely" and The US Interior Department accepted this "unlikely" risk by exempting BP from a detailed quantitative risk impact assessment; but BP had taken eight risky steps in its drilling operations worsening the acceptance criteria with a risk response plan of that "the response capabilities would be implemented".

It is hard to stand at risk neutral position to make "reject" or "accept" decisions, though we assume decision makers are rational but optimism and pessimism biases always influence our human judgement. An optimistic decision-maker would be likely to accept this residual risk, and then the status of this risk is deemed closed with an apparatus in place ready-to-be-used should the risk happen, like the BP Horizon case except that the response capabilities were not in place. On the contrary, a pessimistic manager may likely reject the acceptance approach and continue with further studies, such as cost

[8] The author of the Book, "Decide the Nuclear Issues for Yourself", 2005.
[9] March 2011 by National Commission on Horizon, http://www.oilspillcommission.gov/final-report

and benefit analyses, FMEA (failure mode effects analyses), and Criticality Analyses. In the pessimistic case, the following rules should be observed when making major business decisions under influences of unfavourable risk conditions:

- The residual risk acceptance criteria must be defined first by ERM[10] policy;
- ERM Policy must be realistic reflecting companies' business objectives;
- Insurance policy or emergency preparedness plan must be always in place;
- Initial risk response actions including mitigations should be effective;
- Expected effects of residual risk impacts using FMEA must be quantified;
- Total costs of further risk response actions should be in general less than the incremental gains / benefits by further mitigating residual risks;
- When costs / resource expenses exceed the incremental benefits of further risk reduction, then the this residual risk should be accepted;

A lot of people are confused with and mistake the accepted initial risks as residual risks at least in semantics but they are quite different in fact. When a new risk is accepted as a part of TEAM strategy, the risk is virtually closed and covered by an effective risk management plan, insurance policy for example. When a residual risk is accepted as a part of business decision-making process, the risk still remains active indicating the initial risk response actions are not entirely effective as indicated in Figure 1-6.

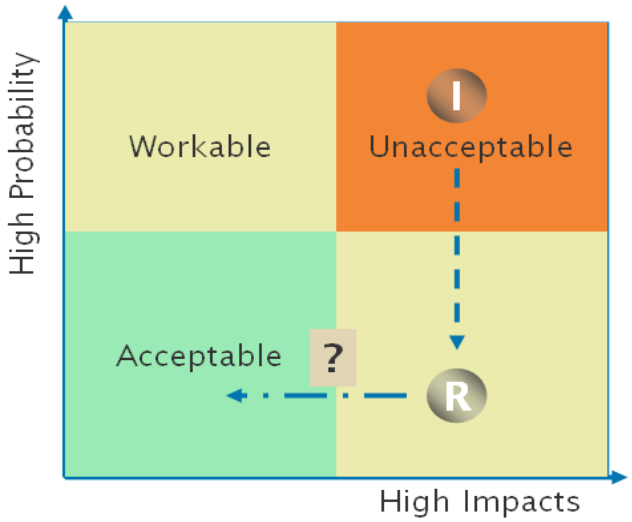


Figure 1-6: Movement of Risks upon Risk Response Actions

In today's economy, commercial aggressiveness seems to dominate the business world and decision-makers' mindsets have been exaggeratedly influenced by profitability. However the recently recommended legislative changes[11] requiring comprehensive risk assessment in oil industry will have significant impacts on this paradigm when a society or human lives are put at risk. Therefore, the risk-taking is not a simple financial decision but a string of considerations for its consequences. For example, should a safety devise (e.g. double HIPPS) may still fail with less than 2% probability in terms of Technical Safety Risk, the following need to be taken into account when deciding to accept or reject this risk as a residual risk:

- Marginal costs — little extra costs vs. cheap solutions
- Marginal benefits — extra expenditure vs. lowered risk level

[10] Enterprise Risk Management (ERM) or Corporate Chief Risk Officer as an equivalent
[11] National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, P306

- Disproportionality — extra money vs. gained extra safety / benefits
- Cost benefit analysis — cost benefit ratio vs. estimated risk level
- Risk-taking — calculated risk level vs. costs of contingency plan

Handling Residual Risks – Quantitatively

It does not seem convincing enough if risks are only qualified but not quantified. Numbers appear to be more powerful and quantification process is believed to be the "best" route for decision-making. It is only true when numbers become certain without much assumptions embedded in; when details form a clear logical decision path without blurring holistic decision objectives; when information is sufficiently provided to aid decision-making without overwhelming and distracting decision-makers. P. Bernstein reiterated in his *Against Gods* the dangers of under or over supplies of information, though more useful information may lead uncertainties to risks and to certainties. Following this hypothesis we may conclude that values of 80% confidence ranges would be sufficient to support decisions, and we could conveniently ignore truncated extremes of P10 or P90 values, i.e. the residual risks.

Technological advancement using computer science has conveniently provided a solution that residual risk values are not necessarily redundant but scientifically included and quantified in the decision making process using various methods, including

- "extreme value analysis of bimodal"[12]
- "double triangular distribution" [13]
- discrete distribution for portfolio management
- extreme value theory, Bayesian, InfoGap Theory, etc.

University of New South Wales has performed a study[14] in 2007 and concluded that "evaluations of extreme risks should be supported by quantitative analysis, even in data poor environment…". The Double-Triangular distribution method (Fig. 1-7) advocated by AACE Risk & Decision Group has merits to explore extreme potentials therefore residual risks are included in the simulation process, i.e. P1 or P99 instead of P10 and P90 values. This is however a challenging approach poking into human psyches, and removing the comfort zone of using trigen-distribution in Monte Carlo simulations.

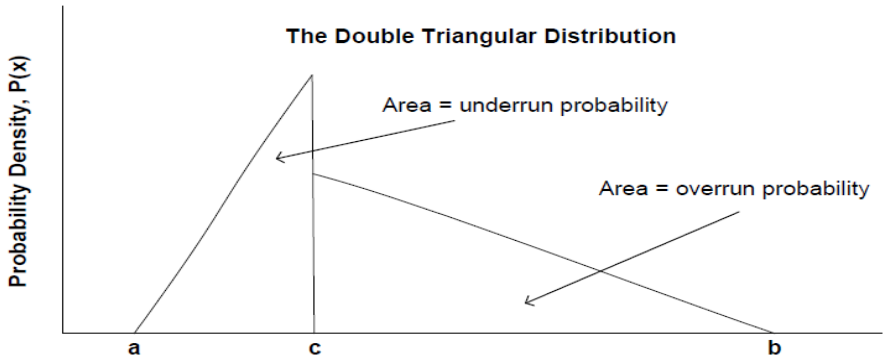
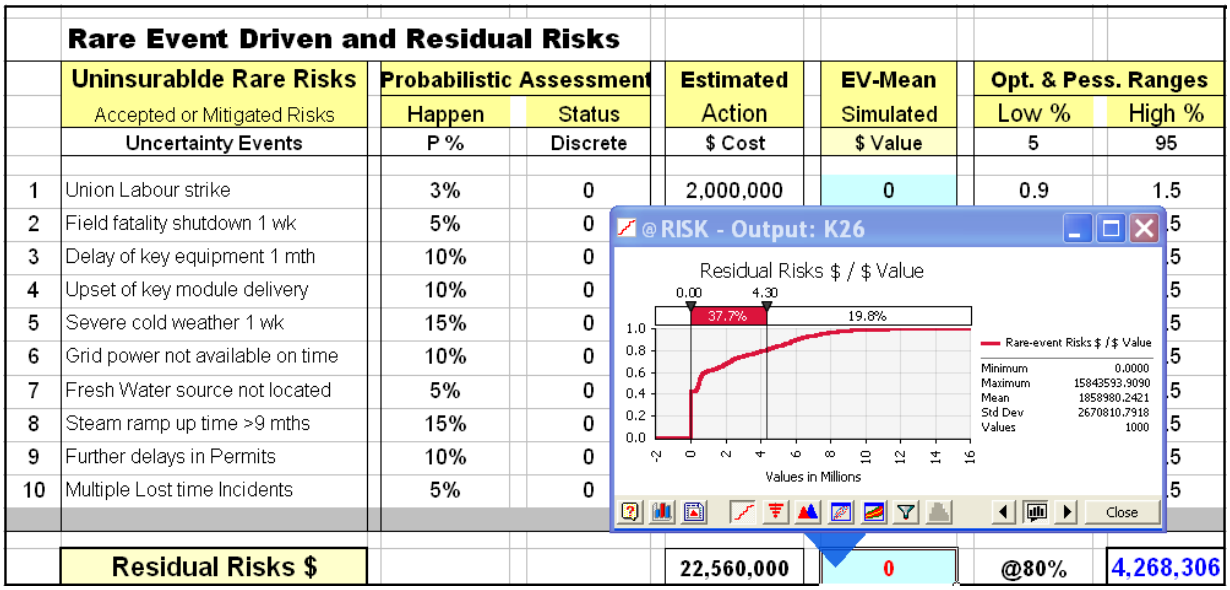


Figure 1-7: The Illustration of Double Triangular Method

[12] Y.M.Low, Nanyang Technological University, Singapore 2010.
[13] AACE International Recommended Practice No. 41R-08
[14] Assessment of Strategies for Evaluating Extreme Risks, authored by James Franklin, 2007.

In a project scenario, there always are lists of rare-event driven and residual risks from different disciplinary groups that the project normally carries from concept development phase to execution and operation phases. A portfolio method, working like an insurance mechanism, is a preferred way to accumulate all important risks in a quantified manner (guess-mates at its best). Considering low probabilities of risks' occurrences, discrete distribution would generate a "pooled" monetary fund to deal with the circumstances when one or very few of such residual risks indeed occur. The Risk-Binomial function in @RISK is used to generate a risk management fund with at least 80% confidence level in addition to normal project contingency with an optimistic view that a fund of $4.27Million would be adequate in lieu of $22.6Million (Figure 1-8) to cover the multiple rare event risks.



Rare Event Driven and Residual Risks

	Uninsurablde Rare Risks	Probabilistic Assessment		Estimated	EV-Mean	Opt. & Pess. Ranges	
	Accepted or Mitigated Risks	Happen	Status	Action	Simulated	Low %	High %
	Uncertainty Events	P %	Discrete	$ Cost	$ Value	5	95
1	Union Labour strike	3%	0	2,000,000	0	0.9	1.5
2	Field fatality shutdown 1 wk	5%	0				.5
3	Delay of key equipment 1 mth	10%	0				.5
4	Upset of key module delivery	10%	0				.5
5	Severe cold weather 1 wk	15%	0				.5
6	Grid power not available on time	10%	0				.5
7	Fresh Water source not located	5%	0				.5
8	Steam ramp up time >9 mths	15%	0				.5
9	Further delays in Permits	10%	0				.5
10	Multiple Lost time Incidents	5%	0				.5
	Residual Risks $			22,560,000	0	@80%	4,268,306

Figure 1-8: The Analogue Insurance Mechanism for Management Fund

It must be noted that having a dynamic and live project risk register is the prerequisite to make the above method work, and continual reviews of risk status to update the residual risk lists are critical. Subsequently the residual risk management fund needs to be revisited periodically to reflect the change of project risk profiles. It is imperative to remember that the inputs to residual risk simulation are the information extracted from project risk register which is normally mandated in any investment projects with proactive risk response action plans. From the Fig. 1-8 we can conclude that 42.5% of time we don't need any additional fund[15]; there is 20% chance we need more than $4.2M but we are 80% confident the $4.2M residual risk management fund is adequate to cover identified rare-event and residual risks. For clarity, rare-event driven risks and residual risks can also be separated out for simulations.

Conclusions and Summary

Many practitioners have spent years working on risk management processes, and many academia researchers have devoted time and efforts theorizing best risk management approaches. Both qualitative and quantitative methods and techniques have been

[15] It is assumed that the normal project contingency fund has been included using appropriate quantitative risk analysis technique.

exhausted on risk and contingency management for capital investment project, I however dare to conclude that the current understanding and handling techniques of residual risks remain poor and are at an elementary level at the best. The topic has been mentioned in many places but I found that its true meaning has been skewed to denote something else. It seemed, though without substantiated statistical evidence, that many decision-makers, or senior management individuals, suffer severe myopia that they only focus on near term objectives, i.e. risk items that can be easily and quickly fixed for visibility. Residual risks have profound implications and also bear characteristics of having long lasting negative effects endangering project's objectives, therefore ignorance of them is not an option.

Upon understanding of residual risks, managing and handling residual risks should be the amalgamation of art and science, the marriage of psychological and scientific approaches and the combination of being prudent and courageous. Residual risks can be easily ignored in an optimistic environment but can also be overly stated in pessimistic surroundings; keeping fine balance and equilibrium are challenging but not impossible. When making decisions to accept or reject a residual risk, biases need to be removed and subjectivities be supplanted with objective evidences, benchmarking and historical statistics. However it is also recognized that naïve positivism[16] is not entirely possible therefore assigning a true value to a particular residual risk becomes difficult. It does not mean though that bravery should dominate so that to take in all residual risks without quantifying their consequences and estimating their probabilities of occurrence.

Scientific approach would aid psychological judgement; quantification would compliment risk qualification process. When different techniques are smoothly woven together taking each other's merits and advantages, decisions to handle residual risks will be made a lot easier saving time, resources and unnecessary debates.

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